beAware: Self-tracking feelings and activities for self-awareness and flourishing

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Abstract

Health care technologies have been traditionally focused on treating illnesses. We took a more holistic view of well-being by considering human flourishing. We borrowed positive psychology principles to outline the activities and emotions important for human flourishing and incorporated those activities and emotions in a self-tracking app, called beAware. We conducted a 3-week study with 15 participants and our qualitative survey showed that the app helped people in four main ways: (i) increasing self-awareness, (ii) improving focus and daily planning, (iii) encouraging self-care, and (iv) helping develop a habit of self-reflection. Compared to conventional persuasive technologies that aim for specific behavior changes, our app simply enabled people to self-reflect on their lives in the light of positive psychology and the behavior change happened organically as a result of increased self-awareness, without the need for explicit persuasion. Our app also helped people develop a mental model for their habits and trained them to be more mindful of their feelings and activities, without having to rely on the app. Given the positive short-term results of our app, we plan to conduct more studies to quantify the influence of the app on long-term well-being.

Author Keywords

self-awareness, mindfulness, positive psychology, flourishing, self-tracking, well-being

ACM Classification Keywords

H.5.2 [Information interfaces and presentation (e.g., HCI)]: User Interfaces; Human-centered computing Empirical studies in ubiquitous and mobile computing

Introduction

Recently, there has been a lot of interest in more holistic approaches for mental well-being [1, 2] and self-care technologies [3], especially using mindfulness [4] and self-awareness [5]. Our research aims to inculcate self-awareness in people about their daily activities and feelings to not only make people more mindful about their lives, but also to help them lead more fulfilling lives. Instead of focusing on treating mental or physical illnesses, we seek a holistic view of health, i.e. health is not just the absence of mental and physical illnesses, but "a state of complete physical, mental and social well-being" [6]. We take inspiration from the field of positive psychology that studies human strengths to help people thrive, and our application, beAware, provides a framework for people to reflect on their activities and feelings in light of positive psychology theories, like flourishing [7, 8]. By self-tracking their activities and feelings, we aim to help people learn about their behavioral patterns, and use this knowledge to guide self-care and self-improvement.

Related work

Technology has been used to support health care in several different ways. Some examples include tracking people's behavior [37, 38] (both self-reporting and automatic tracking, e.g. footsteps tracking), influencing behavior change (e.g. f.lux [https://justgetflux.com/] that changes computer light to improve sleep cycle), and managing diseases and illnesses (e.g. Oiva[10] for behavior therapy). Our application falls mainly in the first category of self-monitoring and self-tracking.

There are several examples of self-tracking applications. Mobile Mood Diary [11] allowed users to track their mood (using mood charting), energy, and sleep, and the results showed high levels of adherence to therapy and improved self-awareness in users. Mood Map [12] used mood-related experience sampling and CBT-inspired psychological exercise to increase emotional self-awareness. PRISM [13] used experience sampling for mood states and illness triggers for people with bipolar disorder. Mobilyze! [14] gathered data in user's context and moods using experience sampling methods and phone sensors to help people with depression. myCompass [15] used self-tracking, reminders, and tips to help with stress, anxiety, and depression. MONARCHO [16] allowed self-tracking of sleep, mood, subjective activity, and medical adherence for people with bipolar disorder. BeWell [17] automatically tracked social interactions, sleep, and physical activity. ShutEye [18] allowed self-tracking of sleep hygiene. BALANCE [19] tracked calories intake and energy expenditures. AndWellness [20] used experience sampling and sensors for tracking user sleep, saliva, emotional state, and diary entries.

The aforementioned work showed promising results, but only used self-tracking for a limited set of activities and emotions, and/or were targeted towards specific illnesses, such as depression, or conditions, e.g. lack of sleep. As detailed in design considerations section below, our application allows people to track a relatively wider range of activities and feelings for a generally "thriving" lifestyle.

Design considerations

We wanted to give people a way to self-reflect on their activities and feelings that could improve mental, physical, and emotional well-being.

Tracking Activities

We consulted three resources to decide what activities could be important for flourishing: (i) Seligman's PERMAH model [7, 8], which states that there are 5 core elements of well-being, i.e. Positive Emotions, Engagement, Relationships, Meaning, and Accomplishment. (ii) Healthy Minds Platter [9], which states that humans need Focus Time, Connecting Time, Play Time, Physical Time, Time In, Down Time, and Sleep Time to maximize their well-being. (iii) Daily Rituals [21], which categorizes days of famous creative people in these categories: Primary Work, Other Work, Sleep, Exercise, Making Ends Meet, and Social and Meals. We also asked a group of 12 people to label the activities they did during their days. Based on people's responses and above resources, we decided to track the following 7 activities:

- Primary Work: Work can lead to Accomplishment (PERMA Model) and could also contribute to Focus Time (Healthy Minds Platter)

- Secondary Work: Our survey results showed that people spend a lot of time doing 'other work', like writing emails and having meetings, and wanted to label this as a separate category from their primary work

- Exercise: Exercise can be considered as Physical time (Healthy Minds Platter) and several research studies have shown the importance of exercise in well-being [22, 23]

- Sleep: This is similar to Sleep Time (Healthy Minds Platter), and sleep has been shown to be important for one's well-being [24]

- Personal time: This could fall under Down time (such as watching Netflix alone) or Time In (e.g. meditating) or Play Time (e.g. playing computer games alone) from the Healthy Minds Platter. Personal time includes leisure time which has been shown to be important for well-being [25, 26]

- Social time: This could be Connecting Time or Play Time (Healthy Minds Platter), and is also important to build Relationships (PERMAH Model)

- Errands/chores: This was included to cover any miscellaneous things that our model could be missing.

Tracking Feelings

We consulted three resources to decide what feelings could be important for flourishing: (i) Broaden and build theory of positive emotions [27, 28], which suggests that positive emotions help broaden the momentary perspective of a person, and in the long-run, help build physical, intellectual, and social resources to augment people's well-being. (ii) The Upside of Your Dark Side [29], which highlights the role of negative emotions in people's well-being. (iii) Wheel of Awareness [30] which has these categories: Interconnectedness, Mental activities, Inner body sensations, and Body's 5 senses, i.e. such as smell, sight, touch, hearing, and taste.

The mood charts used in traditional self-tracking applications usually use Likert scale to let users indicate how they are feeling, but even other emotion models such as Ekman's six basic emotions or Plutchik's wheel of emotions [31] do not seem to include common feelings like focused, productive, tired, etc. Therefore, we came up with our own list of feelings/emotional states. We listed positive and negative feelings that people may commonly experience, and then categorized those feelings into four categories, each with a set of 3 positive and negative emotions. The categories and their respective feelings are

as follows: Our categories were Heart, Mind, Body, and Spirit (i.e. how people feel towards other things/people), and each category has 3 sets of positive/negative emotions. Here's a list of all the feelings included in our application.

- Body: Energetic/Tired, Confident/Insecure, and Relaxed/Stressed

- Heart: Happy/Sad, Peaceful/Anxious, and Hopeful/Hopeless

- Mind: Focused/Chaotic, Inspired/Unchallenged, and Effective/Frustrated

- Spirit, i.e. how we feel towards other people and beings: Grateful/Disappointed, Extroverted/Withdrawn, and Empathetic/Carefree

These feeling categories could be related to the Wheel of Awareness - our Spirit category is similar to Interconnectedness in the Wheel of Awareness (WoA), our Mind is similar to Mental activities in WoA, Heart is similar to Inner Body Sensations, and Body to Body's five senses.

Manual Tracking
Instead of using automatic tracking using sensors and machine learning, we used manual tracking, which came at a cost of potentially fewer data points because users maybe too busy to log the information. We accept this potential drawback of self-reporting in the hopes that manual tracking would lead to higher levels of self-awareness because users were self-reflecting before they entered the information. Indeed, in the QuantifiedSelf community, people have reported more 'intimacy with data' when they were self-logging compared to automatic tracking [39]. Self-reporting also allows us to get information about a wider range of user activities and feelings compared to

automatic tracking, because feelings like hopelessness, etc are still relatively harder to classify using machine learning algorithms.

Application Design

Software Development
We developed a Progressive Web Application (PWA), called beAware, with Google's Polymer Project and Firebase database, and deployed the app using Heroku: https://be-aware.herokuapp.com/. As a PWA, the app could be added to user's home screen on mobile phones and could act like a native mobile phone app. Thus, instead of developing a native app for iPhone and Android along with a web app, we decided to develop a PWA, which worked equally well on iPhones, Android phones, computers and any other devices with web browsers. Even though there are a number of wearable health and fitness devices, we decided to not develop a smartwatch app in the short-term because according to a PricewaterhouseCoopers survey, only 21% of US population uses some type of wearable and only 10% use the wearable daily [41]. So, we decided to reach our users mostly through cellphones and computers. Wearable devices also allow limited micro-interactions and we wanted our users to have the space to log information about their activities and emotions.

User Interface
Activities input
Users can click on a 24 hour clock to select a time period in one-hour increments to indicate which activity they had done during the selected time period. Users have the option to change the date for their activities, and thus, can enter not only today's data, but also past information or future plans. Figure 1 shows the interface for tracking activities.
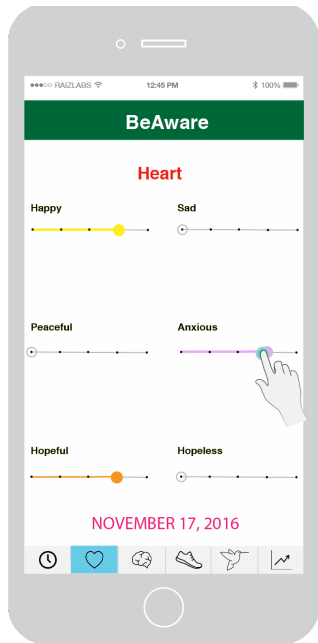

Figure 1: UI for tracking activities

Figure 2: UI for tracking feelings related to heart

Feelings input
Each feeling category, i.e. Heart , Mind, Body, and Spirit, has a separate page, and each feeling has a four point scale so that users may indicate the intensity of that feeling. Figure 2 shows the Heart feelings page. Users can also select any day to enter their feelings and thus, can enter historic information if they had forgotten to record data for previous days.

Aggregate data visualization
We used D3 area graphs to show one cumulative graph for all activities and one for all feelings. The charts for activities and feelings are vertically aligned in terms of dates so that people can see their activities and feelings for each day side by side. Figure 3 shows the charts for user activities and feelings.

Experiment Design
We launched a 3-week Self-Awareness and Self-Improvement (Self-AI) challenge at the MIT Media Lab for people to learn about themselves using our app.

Participants
We had a total of 15 study participants (Gender demographics: 12 females and 3 males; Age demographics: 7 under the age of 20, 7 in the 20-40 age group, and 1 above the age of 40). We had a mix of occupations from artists to engineers, undergrad students to post-doctorates, and staff members to research scientists. The study participants received a $50 compensation for completing all the surveys in the experiment and the compensation was not at all tied to app usage. We also had a control group of 12 people, who did not use the app but filled out the quantitative survey that we gave to our study participants. The control group received no compensation.

Time Frame
We told the participants that in our 3 week study, the first week was for orientation so that they could familiarize themselves with the app. The second week was for self-awareness so they could record their activities and feelings in the app, and the third week was for self-improvement based on people's findings about themselves in the second week. At the end of week one and week three, we gave our study group as well as the control group a quantitative survey. At the end of week two, we gave our study group, not the control group, a qualitative survey to evaluate the effectiveness of the app in improving self-awareness. We also had 30-minute non-mandatory group meetings with our study participants every week to answer any questions they had about the app. The second week of our study happened to be elections week in the US, but the study was not intentionally planned to coincide with the elections.

Qualitative Survey
After the end of the self-awareness week (week 2), we asked the users how their week was, if they had self-reflected, if the app had helped them, and if there were anything the app could do better. This questions allowed free-form responses, and this survey served as the main criteria for evaluating the app because it asked specific questions about user's short experience with the app.

Quantitative Survey
We compiled a quantitative measure of people's well-being, life satisfaction, happiness, and awareness using a combination of five positive psychology surveys: Mindful Attention awareness scale [4]; PERMAH-Profiler survey [32]; Ryff's psychological well-being scales [33]; Subjective Happiness Scale [34]; Satisfaction with life scale [35]. Our study group and control group took this survey after
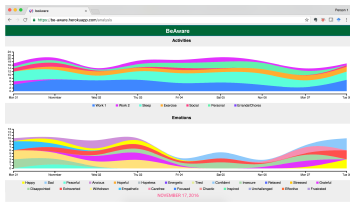
orientation (week 1) and at the end of the experiment (week 3). We compared the changes in our study group's well-being with the changes in our control group's well-being over the same two weeks. Given our small study size and short experiment duration, this quantitative survey was a secondary measure for us because it was evaluating long-term well-being measures, which we did not expect to radically change during our short study. Changes in these long-term well-being measures would be more suitable measure for our future longer longitudinal studies mentioned in future work.

More data
We also had access to data that users entered over time so we could see for which days users entered their information, and how people's entered activities and feelings changed in the app. However, we kept our focus on the self-awareness experience rather than specific behavior change because our small study group and short experiment duration meant that our chances of seeing statistically significant changes in people's feelings and activities were limited.

Results

Qualitative Results
Based on user responses, we think the app helped people in the following areas:

Increased self-awareness
Almost all of our participants discovered behaviors and feelings that they had not been aware of before, e.g. they needed more sleep or that they had been really anxious. One participant mentioned, "Using the app the week of the election and in general made me more aware of feelings and aspects of my life that I hadn't really thought about previously...Using the app made me pay attention to these emotions for the first time. Usually I never feel or think of

Figure 3: UI for showing feeling and activity charts

hopelessness, but after the election I felt exactly that" In addition to recognizing their feelings and activities, people started to develop an understanding of the relationships between their activities and feelings, e.g. "I'm happier when I sleep more"

Our app also helped people constructively deal with their feelings, especially the negative ones. One of the participants mentioned: "Given that the results of the elections were not what I had wished for, and how hard it hit me, I had to look inside to help my mind interpret what was going on in the exterior...This self-reflection has allowed me to develop more patience, continue to be compassionate and caring, and be optimistic in my core". Another participant mentioned that self-reflection "...led to more productive ways of dealing with negative happenings rather than just reacting and doing nothing about it."

Encouraged self-care
There were several examples of participants taking better care of themselves even before our self-improvement week, and without us having to nudge them: "I started to take more walks as active meditations"; "I feel as if last week's tracking of emotions allowed me to realize that social situations were stressing me out (I am being very social, as it is the first couple months of college). This weekend, I bailed on all of my social commitments and spent a lot of time to myself"; "I really took stock of my way of being and I felt I needed to be more happy. So I actually shifted (!!!) what I did in my day to do less work (!!!) and more personal (!!!), which is something I would normally have NOT EVER DONE...I took a lot more time for myself to do nothing, but I bounce back with more happiness when I get back to work." Moreover, the app encouraged people to reflect on 'Meaning' (one of the pillars of PERMA flourishing model). One participants shared that he asked himself "'What does

a successful day for me look like?' It led me to design a day in terms of activities for that day, in hopes of establishing good habits like reading an hour a day...I would wonder if having a successful day is truly important if I am still unhappy after a successful week. e.g. having read a book an hour a day for a week, why do I still feel unaccomplished or unhappy?..."

Improved focus and daily planning
Our participants noted that the app helped them become more organized, e.g. "When I successfully get to record my day with the app, I tend to make todo list for the next day as well, which is pretty helpful to start the next day more intentionally" According to another participant, "It has made me focus on one task at a time...the need to record what I do later, sometimes makes me focus on one task at a time...I appreciate the app help me focus more". Being more focused is valuable because attention determines what is admitted in our consciousness, which in turn controls the quality of daily experiences [36]. It is possible that focus and voluntary control of attention would eventually allow our participants to experience not only self-awareness, but also flow [36], i.e. the mental state of being focused and fully engaged in activities.

Helped develop a habit of self-reflection
Our participants pointed out that they have been more in tune with themselves without having to rely on the app: "...I realized that, despite forgetting to enter the information on the app to track it, I've been keeping track of my emotions... Since we've started this exercise, I noticed I am more attuned to my own thoughts and feelings, allowing myself more time to understand them. When less-positive emotions like anxiety and bad mood kick in, I'm able to identify them a bit more quickly, and I am able to take deep breaths before making decisions. I think this new understanding of what happens within me has helped me address my ongoing sleep issues. Now, before going to bed and letting negative thoughts invade my mind, I take time to breathe deeply, calm my mind, and welcome happier, calmer thoughts." This is a particularly big success for our app because a survey done in 2012 [40] shows that 60% of health-apps were discontinued by users after 6 months. Therefore, for long-term benefit, we wanted to create an app that is not just an activities and feelings logger, but could also train the users to be mindful and aware without always relying on the app. Based on user feedback, we seemed to have achieved this goal at least in the short-term because our participants reflected on their mindfulness: "I learned I am NOT mindful at all by default. I forget a lot of things. I multi-task"), and were able to become more mindful of their activities and feelings. The users developed a habit of self-reflection and mindfulness, and could go back to the app if they started losing the habit, but it was primarily important for us to instill a useful framework of self-reflection in people. Moreover, one of our participants mentioned that she used to self-reflect too much and was harsh on herself, but with the app, she was able to objectively and categorically reflect on her feelings and activities. Having a simple framework to self-reflect and self-analyze made self-reflection less stressful and more productive for her.

Quantitative Results
We did not see significant changes for both our study group and our control group in our quantitative surveys before and after the experiment. For our study group of 15 participants, the survey questions had an average t-value of 0.037 with standard deviation of 0.064, and an average p-value of 0.971 and standard deviation of 0.050. Based on the t- and p-values, the results from the quantitative survey are not statistically relevant, but this was not unexpected because those surveys deal with longer term well-being measures

and habits, which were less likely to significantly change in short-term, and our study group was also relatively small.

Future Work
Our preliminary experiment showed promising results in the area of self-awareness, and we plan to conduct longer longitudinal studies in the future to evaluate the influence of the app on long-term well-being. For our future studies, we are planning to add some extra features to the app, e.g. giving user the option to enable notifications that remind them to reflect on their day, allow users to set personal goals, and giving people personalized recommendations based on user's individual patterns. We are also planning to add a comments section for each feeling because knowing why the user is feeling a certain way may not only allow the user to self-reflect better, but may also allow us to consider factors other than our 7 activities that may influence user feelings. We may consider adding physiological data, like EEG, heart rate and GSR, to better understand the physiological responses for feelings like focused, hopeless, etc.

Conclusion
In this research, we applied positive psychology theories to compile a comprehensive list of activities and feelings considered to be important for flourishing. We incorporated those activities and feelings in an app so that people could track and reflect on the relationship between their daily activities and feelings, and become more self-aware. During our 3-week study to evaluate the effectiveness of our app, our participants expressed that the app was not only successful in making them more self-aware, but also helped them focus more and plan their days better. As our participants became more self-aware, they started practicing more self-care, without the app trying to explicitly enforce behavior change. This unenforced self-care may be an important insight for persuasive technologies, which traditionally focus on achieving a specific behavior change. Our app helped the users reflect on and understand their own behavior patterns and the behavior change happened organically as a result of increased self-awareness and self-reflection, without the need for explicit persuasion. This reflective rather than corrective approach also gives users the freedom to choose personalized self-care habits such as reading a book or taking a meditative walk, rather than a generic activity, such as taking 5000 footsteps. Our participants also pointed out that the app allowed them to develop a habit and mental model of self-tracking and self-reflection so that after using the app for a couple of days, they were able to be more mindful of their activities and feelings. Our app is an example of technology that train the users in the realm of well-being so that people do not have to rely on using the technology constantly to sustain their well-being. beAware is a mobile journal/diary for the busy, who may not have time to write down everything, but still want to be mindful of the activities and feelings that are important for human flourishing from a positive psychology standpoint.

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