A Spark Of Activity: Exploring Informative Art As Visualization For Physical Activity

Chloe Fan, Jodi Forlizzi, Anind K. Dey
Human–Computer Interaction Institute, Carnegie Mellon University
5000 Forbes Ave, Pittsburgh, PA 15213
{chloef, forlizzi, anind}@cs.cmu.edu

ABSTRACT

In this note, we describe Spark, an informative art display that visualizes physical activity using abstract art. We present results from five deployments, lasting two to three weeks, that suggest that while graph visualizations are useful for information seeking, abstract visualizations are preferred for display purposes. Our results show that informative art is an appropriate way to visualize physical activity, and can be used in addition to graphs to increase enjoyment and engagement with physical activity displays.

Author Keywords

Informative art, physical activity, data visualization.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design.

INTRODUCTION

Visualizations are important in personal informatics tools [3] because they help users reflect on and gain insights about their behavior, which encourages them to continue tracking [4]. Most consumer tools that track physical activity (*e.g.,* Fitbit, Dailyburn, Runkeeper) use charts (*e.g.*, bar, line, pie charts) to represent physical activity. Ubicomp research has explored visualizations based on living metaphors (*e.g.,* flowers [1], fish [5]) for physical activity and found that they are also successful in conveying information, but, unlike charts, they are more engaging, motivating, glanceable, and ambient. Living metaphors reward users when they are physically active by thriving or looking happy, but they can also discourage users. For example, with a fish-based display in [5], people did not want to look at the display when they were inactive because they knew the fish would be sad.

We want to explore other forms of ambient visualizations that might be appropriate for displaying physical activity

without the weaknesses of graphs and living metaphors, and without requiring users to remember to check the device's website or mobile application for their information, which poses additional barriers to reflection for users of personal informatics tools [3]. In particular, we are inspired by the abstract nature of informative art [8] and its potential to provide graphic feedback that is more neutral and potentially less discouraging than living metaphors.

In this note, we introduce Spark, an informative art display for reflecting on physical activity, and the results of five deployments lasting between two to three weeks. From this explorative work, we contribute the following to the Ubicomp community: 1) an informative art display for visualizing physical activity data gathered from a consumer personal informatics tool, and 2) four design guidelines for future systems that track and visualize physical activity.

The following sections will describe 1) related work in physical activity displays and informative art, 2) Spark's design decisions, 3) an evaluation in in-home deployments, 4) results from the deployments, and 5) design guidelines.

RELATED WORK

Our work lies in the intersection of physical activity displays and informative art. Most physical activity displays [*e.g.,* 1] use living metaphors, charts, and numbers on personal mobile displays to present physical activity information. Fish 'n' Steps [5] displayed a virtual fish tank on both public and private displays (*i.e.,* computer monitors). Ambient displays located in the user's environment [*e.g.*, 2, 9] have also been shown to change people's behaviors by providing live feedback.

Informative art is another way of displaying information that has been not been explored, to the best of our knowledge, in physical activity displays. Redström *et al.* [8] introduced Informative Art in 2000 to display information in everyday human environments in a way that is aesthetic, decorative, and dynamic. In addition to reflecting some aspect of users' behavior or environment, it also serves as a decorative visual art piece intended for reflection [*e.g.*, 7].

Spark is different from previous systems in the following ways: 1) It combines an informative art display with a consumer tool that tracks physical activity; 2) while previous systems are designed specifically to change behavior, Spark is more of a probe created to generate

design knowledge about visualizations used in personal informatics tools; 3) it provides users with several choices of abstract visualizations with varying levels of abstractness, including a bar chart, and 4) the ambient display is located in a prominent place in the home, rather than on a mobile display or in the office. We describe the implementation and design of Spark in the next section.

SPARK

Spark (Fig. 1) is a web application that pulls physical activity data from the Fitbit Tracker using the Fitbit API, and visualizes step count through abstract art, created using Raphaël, a JavaScript visualization library. Spark can run in a web browser on any tablet, but we used the 7" Archos 70 internet tablet running Firefox on Android 2.2.1 for our study due to its low cost, built-in stand, and low profile.

To design Spark, we followed the eight strategies for designing behavior change technologies [1] as a guideline. We highlight the three most relevant guidelines that describe how Spark differs from previous systems.

Abstract & Reflective

Spark uses data abstraction to display raw, step count data into abstract forms. Using circles of different colors and sizes animated in different ways, we represent the passage of 24 hours and steps taken every five minutes. To create mappings for the colors and sizes, we studied common statements about physical activity to identify the desired state, *e.g.*, generally, more physical activity is considered to be better. We used blue and green for less intense activity such as casual walking, red and yellow for brisk walking, and pink and purple for running. A larger circle indicates a higher step count.

When a user touches a circle, they see the time stamp and step count for that five-minute period. The abstract visualizations we created are named Spiral, Rings, Bucket, and Pollock, each more abstract than the last to evaluate the appeal and usefulness of varying levels of abstractness. We also created a bar graph similar to the one Fitbit provides on their website to compare users' experiences with abstract and chart visualizations.

Spiral

The Spiral visualization (inspired by TODAY [6]) creates a circle representing step count every five minutes in the middle of the screen, and pushes circles outward in a spiral such that most recent steps are in the center, and the earliest steps are on the outer edge of the spiral.

Rings

Inspired by tree rings, Rings depicts one circle as it grows over the course of the day, with concentric rings to represent five-minute periods of steps throughout the day. Inner rings represent earlier steps. Unlike Spiral, Rings only displays moments of activity.

Bucket

Inspired by the metaphor of *filling* one's quota of 10,000 steps in a day, in Bucket, circles fall from the top of the
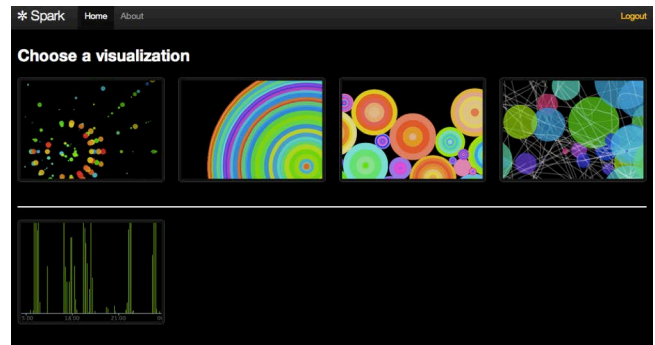

Figure 1. Spark's main screen, which allows users to choose from among five visualizations (4 abstract and 1 bar graph). The visualizations are, starting from the top row, from left to right, Spiral, Rings, Bucket, Pollock, and Column.

screen and stack on top of each other to fill up the screen as more steps are taken. As the circles fall, they bounce off other surfaces, shifting previously fallen circles and slightly disrupting the chronological order of activity.

Pollock

Inspired by artist Jackson Pollock's abstract art, we created a visualization with a continuous white line drawing randomly across the screen. For every five-minute step count, a circle appears where the line is currently drawing, creating a splash of color similar to a large paint blob. This visualization was meant to be the most abstract.

Public

The tablet visualization is intended to be easily glanceable, so it resides in a common space in the home, such as the living room or the kitchen. The abstract nature of the display masks any personal information that users may not want to share in a public space.

Positive

The abstract art only uses visual rewards as positive reinforcement (*e.g.,* presence of colorful circles, warmer colors indicating higher intensity of activity) for any amount of physical activity. When the user is inactive within a five-minute period, no circles are created on the screen. This lets users see when they are sedentary, without negative reinforcement for being so.

EVALUATION STUDY

In order to evaluate Spark, we conducted deployments in five households (six participants) for two to three weeks. As mentioned earlier, we were mainly interested in people's experiences with the display, not its ability to change behavior and increase physical activity.

Our participants included four females and two males. The three participants recruited from Craigslist were female graduate students between the ages of 23 and 28 (P1 to P3), chosen for their regular structured physical activity, and the other three recruited from a lifelong learning center were a couple aged 58 and 71 (P4 and P5), and a male 58 years old (P6), chosen to represent older adults with varying physical activity levels. P4 and P5 have been using Fitbits since its

Figure 2. A subset of locations where users placed Spark in their homes. Top: In front of iMac computers in the office. Middle: On the kitchen counter facing the living room. Bottom: On the bookshelf facing the living room. Other locations included a coffee table and in front of the television.

release in 2008. The others have never owned a Fitbit and we provided one to them.

We visited participants' homes to set up the Fitbit and the tablet (Fig. 2), and asked about their existing physical activity levels. P1-P3 had structured exercise at the gym at least four days a week. P4 exercises at least one hour a day, and P5 works out at least 30 minutes a day. On nice days, they would go for walks together for about four miles with their dog. P6 would walk whenever he could, but does not do any structured physical exercise.

After three weeks, we interviewed the participants about their experiences having Spark displayed in their homes. Detailed field notes were taken of the audio recordings and coded and analyzed for common themes.

RESULTS

We found several results that supported findings from previous research, such as the questions people asked while viewing the display [4], and the increase in awareness participants gained by using a physical activity display [1, 5]. We will describe our findings specific to using informative art as a display for physical activity.

Different uses for abstract and graph visualizations

Participants preferred the graph when they were looking for specific information or historical patterns. For example, P2 looked for specific information about when her runs were the most intense, P6 thought charts would be useful to look for daily trends, and P3 wanted to see her physical activity over time. *"For informative purposes, I guess, I like the graphs better...I really like seeing progression over time, like sedentary over active, it's like a really easy and fast way [to see it]. [Bucket] was fun to play with, but I didn't feel like it really told me anything."* – P3

However, all participants agreed that the abstract visualizations were more appealing and aesthetic than the graph when they wanted to *glance* at the display, rather than analyze it for detailed information. P1 mentioned wanting the display to be available as her Android phone's live wallpaper. P3, P4, and P5 all independently and without prompting mentioned that Spark would be "cool" as a screensaver. P3 and P6 also expressed interest in having Spark displayed on a larger screen mounted on a wall like a piece of artwork. P6 especially favored the abstract art over the graph, because *"it's [just] a chart, and by the time you're my age, I bet I've seen a billion charts. It would measure where I had been, whereas [the abstract art] gives me kind of, 'here's where you can go.'"*

Participants chose one of the four abstract visualizations for their display that mirrored the type of information they wanted to see. P1, who just wanted to know how many steps she took, preferred Rings over the bar graph because it was simple, more aesthetic, and *"clear what the beginning and [end] of the day was."* – P1

P2 found Bucket to be the most aesthetic, while still providing useful time information about her steps (circles on the bottom were steps taken earlier in the day). P3 preferred Spiral because it gave her more semblance of activity over time, and was more aesthetic than Rings. The other three participants chose the abstract visualization that was most fun and motivating for them.

Engaging elements of abstract art

Three elements motivated participants to engage more with the display: color, movement, and filling the screen. These visual rewards increased with more physical activity, which encouraged some participants to be more active than usual.

Color

P4, whose favorite visualization was Bucket, enjoyed seeing large circles with warmer colors representing more intense physical activity on her screen. She would refer to the smaller, blue circles as "nothing." According to P5, *"she likes to gloat over me...that hers was fuller than mine, prettier than mine, so I switched mine to a different mode [Pollock]."* P6 would walk in the hallway in his home at a fast pace for five thousand steps to try to get pink and purple circles (his favorite color is purple). He describes the motivator as: *"You're taking a black surface and bringing color to it. It's like painting with your feet in a way, with your movements. You're making something. With a chart, you're creating something, yes, but it's boring."* – P6.

Movement

The circles' animation throughout the day was also a motivator for some participants. P6 described it as *"a moving picture, it would evolve and show you how your day was going."* Both P2 and P6 mentioned liking getting different patterns every day because it kept things interesting. Similarly, P3 and P4 liked having a variety of visualizations to choose from.

Filling the screen

P4 favored Bucket because she made a personal goal of filling the screen with the circles. Similarly, P6 says, *"I was trying to fill up the screen. I'd walk faster, whatever. I wasn't interested in linear progression, I was interested in filling the screen up."* He selected Pollock because it provided the busiest display.

Awareness of sedentary behavior

Whereas previous work mentioned that having a display increased awareness of how active users were, the abstract visualizations also increased awareness of sedentary behavior through the use of negative space. For example, when her visualization only took up a small portion of the screen, P1 found it more stimulating than discouraging because it made her aware of *when* she was lazy, which stimulated her to plan an active day the next day. Both P2 and P3 reacted the same way when their screen displayed more empty space than visualizations.

Technical issues

We encountered technical issues with the setup that offered insights into the design of this type of system. The largest issue was navigating around the site on the tablet due to limitations of the OS. This caused many participants to suggest larger screens to display Spark as a work of art on the wall (P3, P6), on their fridge (P2), or on a mobile display that is better integrated into daily routines (P1).

The small 7" display also affected the scale of the visualizations, which P1 and P6 called "disappointing," even when they took up the whole screen. P6 said that after walking nine thousand steps, his visualization would still feel like *"not much. All that work and all I get was this?" – P6.* He was still motivated to try different things to change the display and see more on the screen, but the visual reward was smaller than he hoped. Also, P4, P5, and P6 were not able to run, which limited the range of colors they could obtain. Although P1 did not have any physical limitations, she voiced that the user's abilities and walking range should be calibrated into the system.

DESIGN GUIDELINES

From our lessons learned, we derive four design guidelines for future systems that track and visualize physical activity.

1. Tools can provide both charts and abstract art to increase engagement with the system over time. Use graphs for establishing initial awareness and allowing users to search for specific information, and abstract art as an ambient display in the user's environment.

2. Provide choices of different visualizations to allow people to customize their experience and choose the level of information they want to see, increase variety, and tailor to their individual aesthetic tastes.

3. Integrate visualizations into daily routines, such as cell phones, tablets, and standalone displays in the users' environment.

4. Instead of prescribing one number or range (*e.g.,* 10,000 steps) as the ideal goal for all users, the system should adapt the goal to the user's physical abilities.

CONCLUSION

In this note, we introduced Spark, an informative art display for physical activity. We described the implementation, design, and deployment, and presented four design recommendations for the design of future physical activity tracking and visualization systems. In the future, we would like to conduct a longer-term study to evaluate effects on behavior change. As personal informatics tools become more pervasive and allow users to collect more personal information, creating compelling and engaging visualizations will be crucial in facilitating insight discovery and helping users change their behavior.

ACKNOWLEDGMENTS

REFERENCES

1. Consolvo, S., McDonald, D. W., & Landay, J. A. (2009). Theory-driven design strategies for technologies that support behavior change in everyday life. *Proc of CHI* '09.

2. Jafarinaimi, N., Forlizzi, J., Hurst, A., & Zimmerman, J. (2005). Breakaway: an ambient display designed to change human behavior. *CHI '05 extended abstracts*.

3. Li, I., Dey, A., & Forlizzi, J. (2010). A stage-based model of personal informatics systems. *Proc of CHI* '10.

4. Li, I., Dey, A. K., & Forlizzi, J. (2011). Understanding my data, myself: supporting self-reflection with ubicomp technologies. *Proc of UbiComp* '11 (405-414).

5. Lin, J., Mamykina, L., Lindtner, S., *et al*. (2006). Fish 'n' Steps: Encouraging physical activity with an interactive computer game. *Proc of UbiComp* '06 (261-278).

6. Oliveira, S., Hawkey, J., Ferreira, H. (2008). TODAY. Accessed on March 19, 2012, at http://www.visualcomplexity.com/vc/project_details.cfm?id=598&index=598&domain=

7. Pousman, Z., Romero, M., Smith, A., *et al*. (2008). Living with tableau machine: a longitudinal investigation of a curious domestic intelligence. *Proc of UbiComp* '08. 370-379.

8. Redstöm, J., Skog, T., & Hallnäs, L. (2000). Informative art: using amplified artworks as information displays. *Proc of DARE* '00, 103-114.

9. Rogers, Y., Hazlewood, W.R., Marshall, et al. (2010). Ambient influence: can twinkly lights lure and abstract representations trigger behavioral change?. *Proc of Ubicomp* '10. 261-270.