TastyBeats:
Celebrating Heart Rate Data with a Drinkable Spectacle

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ABSTRACT

Visualizing heart rate on screen has become popular to measure physical activity performance and progress towards set health goals. However, we believe that this prevalent method of visualizing data often reduces the interaction to only reading of information. In response, we propose a new way of visualizing heart rate data through a public interactive water fountain installation we call, TastyBeats. TastyBeats engages participants in a fluidic spectacle by creating a personalized sports drink representing their heart rate data while serving the additional purpose of replenishing lost energy during physical activity. We present findings and three design strategies from the three exhibitions of this work to inform designers interested in using drinkable fluids to support the physical activity experience. Ultimately, with our work we aim to expand our understanding of the potential of interactive technology to support the energy-cycle when being physically active.

Author Keywords

Physical activity; biofeedback; fluidic interfaces.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Heart rate monitors are gaining popularity to monitor and support physical activity experiences [2]. By visualizing heart rate, individuals can gain better insights into their physical activity levels and make this gained knowledge actionable in terms of their health and performance related aims [19]. Currently, the most common way of representing heart rate data is on a smartphone screen or wristwatch in a numerical or graphical form. However, this predominant method of visualization often reduces the interaction to reading of information in order to make personally relevant inferences.

This work expands the view of visualizing physical activity beyond the screen by providing a fluidic representation that can also be consumed later; thereby, serving an additional

purpose of replenishing lost energy during physical activity. We designed *TastyBeats* to induce an active engagement of the user with a fluidic representation of personal heart rate data in the form of a sports drink created by mixing different flavors together. Furthermore, rather than simply adding different flavors together based upon one's efforts, we explore an opportunity to create a fluidic spectacle that celebrates the experience of being physically active. Such a public rendering of heart rate data can not only be widely seen and interacted with, but can also be tasted; thus offering vivid ways of engaging with the data. We showcased our system at three international academic events where over 400 participants interacted with the system and shared their experience with us through follow-up discussions. This paper describes our system along with our findings from the public demonstrations. Later, we present three design strategies to inspire and guide designers to utilize fluidic forms of interactions to support the experience of being physically active.

RELATED WORK

Our work is concerned with the fluidic representations of heart rate data of physical activity. Therefore, we present the related work in two categories. First, we discuss the existing works concerning the representations of heart rate data. Secondly, we discuss fluidic interfaces as a representation medium.

Related work on representing heart rate data

Previously, heart rate has been used for several purposes. For instance, Nacke et al. [13] captured player's emotions through heart rate to adjust game interactions, while Nenonen et al. [14] used heart rate as a game input. Furthermore, Walmink et al. [23] and Curmi et al. [3] facilitated social experience through public display of heart rate data on cycle helmets and social networks respectively. Lately, Khot et al. [10] studied individual's relationship with physical activity through 3D printed physical artifacts created from their heart rate data. These works inspired us to explore public representations of heart rate data through other physical mediums such as fluids.

Related work on fluidic interfaces

The most popular example of a fluidic interface as a public spectacle is a choreographed musical water fountain, the Fountains of Bellagio [8]. Similarly, Currency fountain [4] shows relative currency rates using water fountain display.

In HCI, fluidic interfaces have been proposed to support tangible interactions with water: Wantabe [24] and Mine et

al. [12] used fluidic interface for browsing and mixing of multimedia files respectively. In other works, Richter et al. [18] designed water jets for tactile feedback on virtual touchscreen elements, while Sylvester et al. [22] created a Soap Bubble Interface to control sounds and room light. Fluidic interfaces can also offer interactive play experiences through manipulation of water flow within a receptacle [9]. Additionally, Steve Mann designed various fluidic musical instruments such as Water Hammer piano [11] for interactive entertainment. Student Innovation Contest at UIST 2013 [6] also featured various fluidic interaction possibilities developed using PumpSpark water fountain kit.

These works illustrate the potential of fluidic interfaces in representing information and creating engaging experiences. However, there has not been much exploration on drinkable fluid interfaces except a system by Daisuke [5] that creates a drink from the backend web processing data. We believe that such fluid interfaces have the potential to facilitate the recovery of body fluids lost during the physical activity. Addressing this, we present a drinkable fluid interface, *TastyBeats,* as a representation of one's physical activity data.

TASTYBEATS

TastyBeats is an exploration into drinkable fluidic representation of physical activity. TastyBeats creates a personalized sports drink using the measured heart rate data of individuals during their physical activity session. With *TastyBeats* we also focus on creating a spectacle by using a familiar water fountain-based interaction to celebrate the experience of being physically active. Additionally, since heart rate vary over time and are different for different individuals [2], flavor of the created drink will be distinctly personalized and will vary with different activities.

In our system, we have divided heart rate data into four zones with the following ranges: 60-95 beats per minute (bpm), 96-130 bpm, 131-165 bpm, and 166-190 bpm, where each zone denotes the intensity levels of physical activity. Heart rate values below 60 bpm and higher than 190 bpm are discarded as they occur rarely. Earlier research suggests that color plays a crucial role in users' perception of fluids [15]. We, therefore, chose four flavors with distinct colors to highlight different zones. Figure 1 illustrates the mapping between heart rate zones and corresponding flavored sports drinks.

As an initial exploration, we have focused on short physical activity sessions, lesser than 90 minutes. Since such sessions do not require electrolyte or other supplements [20], our current system utilizes only flavored water with zero calorie content. In the future, we envision the use of specific supplements for intense physical activity sessions.

TastyBeats setup includes four containers containing flavored water along with a food-graded water pump [7] and a central glass as shown in Figure 1. These pumps

shoot water into the central glass where the different flavors get mixed and are controlled by Arduino [1].
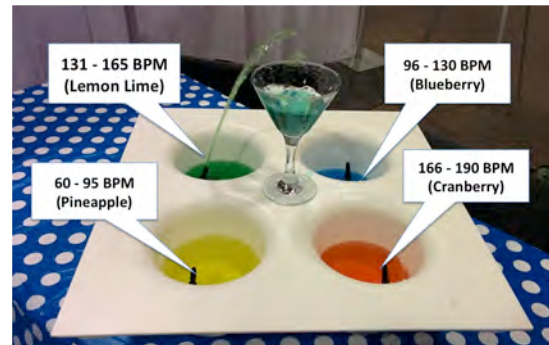

Figure 1: TastyBeats utilizes heart rate data to create a personalized drink.

We have used Pulse sensor amped [15], an Arduino compatible heart rate sensor, to record the heart rate data of an individual. The user holds this sensor between her fingers, while performing a physical activity and her heart rate data is sent to the system. Based upon the recorded value, the system identifies its corresponding heart rate zone and initiates the water pumps accordingly. Water from the corresponding container is pumped into the central glass for about 3 seconds. As long as the heart rate value stays in the same zone, pumping from that container happens only once. And when the zone shifts, water from the corresponding zone container gets pumped into the central glass (Figure 1). Thus, rapid transitions will add more flavors to the drink. This interaction continues until the central glass is filled. The user can then enjoy the drink representing their physical activity.

LEARNINGS FROM PUBLIC DEMONSTRATIONS

TastyBeats was exhibited in three different international academic exhibition events that cater to large audiences. In total, more than 400 participants directly interacted with our system, while the others around cheered up the participants. Figure 2 shows an example of *TastyBeats* being exhibited.

Figure 2: Participants were thrilled to see how their heart rate data obtained a fluidic form in the early version of *TastyBeats*.

Participants were from a diverse background of academics and professionals from engineering and HCI backgrounds. Their age varied from 18-60 years. Participants shared their

experience through verbal conversations, while interacting with our system. We also had a brief discussion with about 70 participants afterwards to understand the potential of how our system could integrate into their day-to-day activity. We describe below the insights gained from observations and conversations with participants.

The overall response from the participants was positive and encouraging. Participants appreciated the novelty and playful nature of the interaction with *TastyBeats* in comparison to the routine way of checking heart rate data on a screen. Participants particularly enjoyed the fact that the interaction was not just a visualization of their heart rate data, but there was also a drinkable reward associated with it. They were able to correlate the created drink with their heart rate: "*It's really cool to see how what I just did is now somehow in the glass!*" Unfortunately, one caveat of the exhibition was that participants were not allowed to taste the created drink due to the exhibitions' policies on food regulation. Participants showed interest in knowing the ingredients, and wanted to know if they can choose their favorite flavors if they were to use the system at home.

Furthermore, dynamics of the fluid interaction provided a momentary pleasure of being physically active, while the visual and sound effects of fluids such as color and flow sounds intrigued people and motivated the use of the system. Participants were mostly excited about how many different colored drinks they can get in a glass and what activities can increase their heart rate in a short period of time. As a consequence, they were enthusiastically engaged in the interaction to beat each other's heart rate and talked over the outcomes. Participants tried different physical activities such as push-ups, jumping and running to raise their heart rate, whereas some utilized 'tricks' such as controlled breathing to achieve the same outcome. Sometimes the heart rate was also raised with emotions such as thrill and surprise related to experiencing the system socially. The audience also got involved by tickling their friends who were interacting with the system and by loudly cheering them up. As a result, the interaction became a public spectacle of someone's fitness and every attempt was encouraged and applauded by the audience.

Sometimes, due to accidental movements or low levels of fluids inside the containers, the fluid was spilled on the nearby surface of the setup. To our surprise, spilling made the interaction more dramatic. Participants considered it as a part of their performance to get the desired outcome of shooting the fluid correctly into the central glass. For example, one participant felt that she did not deserve the drink because of an average performance and that was why the drink spilled over the table surface.

Unlike a traditional method of viewing heart rate on a screen, where data is accurately communicated to user, we explored a vibrant yet abstract form of representation with *TastyBeats*. For example, although users could identify the heart rate zone in which their heart rate was falling in, they could not see the exact heart rate value. Furthermore, there was a little delay between the measured heart rate and the fluidic outcome because of the lag in reading the sensor data and initiating the water pumps. As a result, participants did not know what would happen and when: "*from where does the water come out and how much will spill?*". On one hand, the delay was sometimes frustrating as participants felt that there was something wrong with either their body or the system. On the other hand, the delay also invoked fun conversations as participants teased each other, "*You are a zombie!*", "*You don't have a heart (beat)*". But it also encouraged more efforts from the participants as they tried to increase their heart rate through different activities.

Some participants raised concerns on safety of the created drink. The interaction also challenged their notion of whether it is good to play with food (drinkable fluids). In follow up discussions, few participants also hinted towards a clean and tidy setup, where the fluid interaction could be akin to a coffee machine setup and fluid will flow downward rather than shooting upwards.

In summary, public rendering of heart rate data in a fluidic form made participants laugh, cheer, expressive and playful with their personal heart rate data and encouraged different physical activities. This suggests that there is a potential to use fluidic interaction to support the experience of being physically active. However, there are also a few concerns regarding the design and food safety when exploring the fluidic interaction with the data.

DESIGN STRATEGIES

Based on the reflections on our design process, we put forward the following three strategies to support designing drinkable representations of heart rate data.

1) Encourage playing around with drinkable fluids through spilling: In *TastyBeats,* spilling was accidental and caused mess on nearby surface. On one hand, participants welcomed it as a dramatic outcome of the playful interaction; while on other hand, it also challenged their notion of playing with drinkable fluids as for some of them food is mostly a forbidden object to play with. We believe that encouraging the users to play around with drinkable fluids provides an opportunity to facilitate immersive engagement that can further entice the user to fulfil a daily need of having appropriate fluid intake [20].

2) Harness physical creativity through public fluidic spectacle and drinkable rewards: Sheridan [21] defines physical creativity as the ability to innovate through exertion to acquire skills and agility; it involves the use of body movements for self-expression, improvisation and imaginative play. In our system, participants liked how a drink became a celebration of their physical activity along with an opportunity to express themselves in front of a large cheering crowd. As such, the fluidic spectacle of heart rate becomes a public display of self, allowing the participants to be imaginative and creative with their movements.

Designers, therefore, can utilize such interaction and public display to nurture physical creativity.

3) Support abstract visualization of heart rate data through fluids: The public fluidic display of heart rate facilitated creative and exertive self-expression among participants even when the system did not reveal the exact values of heart rate or the information about how it attains a fluidic form. For participants the dynamics of fluidic interaction were more engaging as compared to the actual information. We recommend the designers to consider abstract visualization of data using fluids by being 'secretive' (on how data gets transformed into a new representation) and 'expressive' (to support exertive self-expression and spectator engagement [17]).

CONCLUSION

TastyBeats creates a personalized sports drink where the making of and ingredients of the drink are decided upon the heart rate data sensed as part of the physical activity. By utilizing a familiar water fountain based interaction in a public space, the interaction can become a public spectacle and a celebration of personal fitness that can further incentivize physical creativity among users. We would also like to encourage design thinking towards cross model aspects of the drink such as color, flavor, and texture to support the experience of being physically active.

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