

# Sleeping with Technology—Designing for Personal Health

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## Abstract

Wearable smart devices are coming more and more into our lives. The quantified self-movement is becoming mature and could lead to a new way of looking at personal health. We might be on the verge of a new form of preventive healthcare, based on in depth insights, facts and figures of our existing behavior and attitudes, and act on if necessary. This could completely change the way we look at our health.

This paper gives an overview of the different aspects of self-monitoring. We especially want to learn about the awareness these devices create to reach the goals that will be set by participants in this research.

Research method used:

N =10 will be wearing Body Media armbands and using the Body Media Activity manager to monitor their progress and goals for two periods of two months. One in the fall and one in the spring. The gap in between will allow to see if the participants spontaneously continue to track themselves. The two periods are in different season offering a different perspective as well.

N=10 control group with no armbands, but will be participating in the surveys and interviews during the same periods set up for the experimental group.

## Introduction

Worldwide we are increasingly confronted with health problems due to people's lifestyle: lack of physical activity wrong eating habits, lack of sleep, resulting in more health risks and chronic diseases. For example according to the World Health Organisation 60 % of the global population does not succeed in having a minimum of daily physical activity of 30-minutes This inactivity contributes to large medical costs (WHO - 2003).

Mobile monitoring technology could help us to a more active lifestyle by creating new insights and awareness

through 24/7 self-monitoring and quantifying ourselves. In recent years we've seen a lot of mobile apps and sensor wearable devices coming into the market, which measure physical activity, calorie burning, sleep and steps. These devices are available, but at this stage mostly used by early adopters. It is important to reflect on the features of these technologies that foster behavioral change in people, since it is not the technology itself that cause the behavioral change. In this paper we want to reflect on the relation between 24/7 self monitoring and the creation of awareness, and the persuasion of changing to a more balanced lifestyle. Will it for example 'generate a feeling of general wellbeing with self-monitored people?', 'Will the design of the devices and the accompanied applications trigger them to make small changes in their daily life?' To make this reflection we use data collected in a social experiment in which 20 people participate to evaluate the daily experience with a Body Media armband and software. To evaluate the behavioral changes inscribed in the features of the technology as well as mapping the changes in the participants, we use Fogg's behavior model (Fogg, 2003) as well as his behavior grid (Fogg 2009).

In this paper we explore recent research on Personal Informatics and wearable devices. In using Fogg's Behavior model we look at the Persuasive side of wearable devices and the different aspects on motivation. In our results we report the evaluation process of our social experiment from a participant perspective on behavior changes, attitudes and routines and technology perspective, design of device, ease of use, services around the device.

## Wearable devices as Personal Informatics

Personal informatics envisions the use of tools to help people to gain insight and awareness in their existing behavior, habits and thoughts. Trough self-reflection they have the possibility to act on it (Li 2012, p1).

The wearable devices and tools should enable the goal setting which is an important element in the cycle of possible behavior change. Goal setting theory teaches us that, *proximal, specific, difficult yet attainable goals result in higher task performance compared to 'no goals' or 'easy goals.'* (Locke, Latham, 2002, p.705-717).

To give an idea of the available technology today we highlight some of the current commercial wearable devices. These devices are not aiming the market of medical technology, but are positioned as preventive healthcare devices, to create a general wellbeing and easy integration into people's everyday life.

Basically there are two categories in this area, based on the way they synchronise the gathered data: synchronic and asynchronic. Synchronic, wearable devices synchronize in real-time with blue tooth or wireless technology. Asynchronic, wearable devices transfer the data with a USB connection to a website online. These are the 'older versions' of the system, and usually have a smartphone application available that shows your data on your smartphone. Though you cannot actively work with it, it is basically a presentation of the data the user gathers.

The optimal solution lies in real-time data synchronization and sending real-time information that can stimulate the motivation of the user while he or she is in a certain mode (mobile or web). We call this putting 'Hot Triggers' in motivated people's path (Fogg.com).

There are quite some monitor devices in the market, the smartphones for one, has a lot of apps available that allow you to track your food, your physical activity, steps or even tiny habits you can measure. In addition you have smart clothing that is well on its way to measure all kinds of activity. However here we focus in specific on the wrist or armbands because these devices allow multi-tracking. The wristbands that are in the market today are Jawbone Up, Lark Life, Nike Fuel and Body Media armband, smart watches and so forth. Within these 4 examples, Body Media is the only one who has the sensors on the skin and has the longest sensor research, while with the other examples the wristband is hanging around your wrist.

These wrist/armbands measure physical activity, steps, calorie burning, sleep efficiency and have the possibility to put in your food as well, either by a dashboard functionality or by taking pictures of food. The device comes with either an application on your smartphone or online website, where you synchronize the data that is gathered by these devices, the dashboard gives detailed information on your daily activity and sleep. The more you synchronize data the more the system gets to know your patterns and will provide feedback on it, this feedback is given within the applications or through email, depending on the different devices you use.

In the next section we categorize the several steps in the follow up system used by these devices and their software by making use of the taxonomy for Self-monitoring procedures we adapted from the taxonomy of wearable technology by Ananthanarayan, Siek, 2012

## **Taxonomy of Self-monitoring**

In this taxonomy we categorize the self monitoring process in three aspects: first goal settings by the user, second data interpretation or reflection on the synchronized data, third feedback loop and coaching provided by the software. In the case of the Body Media system, the user can set goals towards, more physical activity, lose weight or stay the same. While providing your profile in the system, the software will calculate the time necessary to reach your goals. The dashboard presents the data and will help you to reflect on the data, and is one of the key motivators of the system together with feedback and coaching you get by using the system over a longer period. To have more impact on the user one might consider a fourth element in the taxonomy, in the form of personal coaching adding a human touch (Fogg, 2007, p75) either through chat application or physical encounters on a regular basis. This is not an integral aspect of the Body Media system, but was part of our social experiment (infra method section).

## **Persuasive Methods**

The devices we mentioned have all different ways of persuasion. The dashboard is one of the methods that one can use, others will have an external factor as well, like Lark Life, will start glowing in a certain color given feedback when you are not moving a lot, or when you have reach a goal, Jawbone Up will start vibrating after being still for a certain time, and when it is time to move, this immediate feedback might stimulate but could also becoming irritating (Ananthanarayan, Siek 2012).

Besides the awareness the technology creates, there are other contextual factors that come in play when changing behavior or having the ability to change a certain behavior. The theory of Fogg's behavior model, says that three elements need to occur at the same time or moment to make a behavior change possible: motivation, ability to act and a trigger. In addition to these three elements that need to come together at the same time, there are subcomponents that make a behavior change more accessible than others. Components to consider when evaluating the ability to act and trigger in a wearable device as an enabler of self-monitoring for behavioral change are: Simplicity (depending on the audience and context there might be trade offs),

money, time, physical effort, cognitive effort, social deviance (out of comfort zone, not the usual), none routine.

Also motivation can be described in a more complex whole of sub dimensions. Fogg describes three core dimensions of motivation: Sensation (Pleasure and pain), social cohesion (Social acceptance and Social rejection) and Anticipation (Hope and Fear)

If we look further at motivational factors and personal informatics we should also pay attention to the difference between intrinsic and extrinsic motivation. In the latter we can distinguish three different aspects: identification, integration and introjection, (Ryan & Deci, 2000)

First, identification, because the user of wearable devices is identifying with the personal importance of a behavior. Accepting regulation in the form of feedback and reporting he or she gets from the dashboard data to change a certain behavior based on one's own goals set in the dashboard.

Second, integration, integration lies closely to intrinsic motivation, but differs because of integrated regulation is separate from the behavior and its instrumental value, even though there is a will and valued by the self. *'Integration occurs when identified regulations have been fully assimilated to the self. This occurs through self-examination and bringing new regulations into congruence with one's values and needs'* (Ryan & Deci, 2000, p62).

Third, introjection, is based on peer to peer pressure, or social pressure, to maintain a certain image, to have higher self-esteem, avoid guilt and anxiousness.

If intrinsic motivation plus these three elements in extrinsic motivation can be triggered by the wearable devices we've talked about in previous sections, one can almost be certain that a change of behavior might occur, because of a self identification with the devices. We will clarify this assumption later on. (Ryan @ Deci, 2000)

## Field Test methodology

To gather data to reflect and evaluate a real live experience with the Body Media device, we designed a social experiment in the form of a field test with 10 people in the experimental group and 7 people in a control group. Both groups are more or less matching profiles. So in both groups there is a variety of participants in gender, age, education, tech savvy or not, available time, city and rural area living.

## Sampling: choices and selected participants

A variation on the previous mentioned characteristics was purposefully selected. Therefore we recruited volunteers for the experimental group of the broad social network of

contacts of one of the authors. All participants enjoyed higher education, avoiding digital divide issues that are overarching every use of digital technology and are not specific for the issues in relation to personal informatics.

We purposefully tried to select people who are not early adopters of self-monitoring devices. All but three has therefore no tracking experience or even knew about this movement. This gave more insight in the adaptation process, the trust in the technology, and the potential behavior change. The exceptions are two male participants one who is using heart rate monitoring while doing sports and one for professional reasons, one female who was in the previous research we did in the same area.

The total group age range is between 30-60, 5 male and 5 female, living in the US-California (4) and Europe-Belgium (13). In the experiment are 3 participants with medical conditions that moved and pushed them to get more active.

Next we used the same method of recruiting people volunteering to take in the control group, matching them on the selected personal characteristics without them knowing of the other group.

## Measuring behavior and behavioral change

Due to the selection of the Body Media system, the behavior we focus on in this experiment are physical activity, food and sleep.

To be able to measure the behavioral change, as we learned from literature setting a goal is essential. The Body Media system affords changing the level of your physical activity, food intake and sleep quality. Each participant had to set personal goals. In the experimental group, participants need to choose a certain goal in the application. In the control group these goals were also communicated to choose a certain goal during the period. So most of the participants did.

To map the behavioral change we used the Behavior Grid of Fogg (2009). At the start of the experiment we looked at the profile of each participant to see where on the grid each one started. This could than be used as a tool during the experiment to measure the change.

Fogg's Behavior Grid outlines 15 ways of behavior change (see also [behaviorwizzard.org](http://behaviorwizzard.org)) In our experiment we looked at the Gray Span behavior and Purple Span behavior. Both of these types are either decreasing a certain behavior – like eating less bread - or increasing a certain behavior – like more physical activity. These Span behavior types could evolve to Path behaviors, this means that once the behavior change happened participants might go over into forming a routine and creating then Gray or Purple

Path Behavior. When the social experiment started, some participants had a regular physical activity or were trying to have a regular activity, most of them were just having a physical activity when there was time, it was not planned at all or routine in their life.

### **Data collection**

To evaluate the experiences we collected data with our participants making use of short survey (weekly), an in depth interview and for the experimental group two exports of their Body Media Dashboard.

During 5 weeks, we sent a short survey to the experimental participants. The experiences with the Body Media system are questioned by asking about the feelings, the changes, the compliance in wearing the bracelet, their general mood, eating habits, physical activity, events during the week they wanted to share, how much time they spent in analyzing their data, how frequently they synchronized the data, if they felt positive or negative influence by wearing the armband.

After one month of monitoring we interviewed each participant. The in depth interviews gave more insight in the experiences, especially in the way they felt about the armband. In addition there was a Google doc platform created where the experimental group could exchange information on their experiences with the armband, problems that could occur, discussions on specific items, like using the software for activities that could not be tracked like swimming and other details they discussed, In the beginning the platform was used more often, depending on the topics that were posted, the topics were mainly introduced by the researcher. The platform was created for them to mainly get more involved in the experiment. The control group had the same treatment, here the surveys were the same except the questions that were armband related were left out. Each participant also had an in depth interview after 6 weeks. Some of the participants set goals other didn't.

### **Results of the social experiment**

In the results of our social experiment we will discuss the ease of use and adaptation process of the Body Media armband, how participants identified with the armband, followed by the small changes they made during the evaluation process. In addition we looked at the contextual factors that made these changes possible, difficult or not possible. And as a last item we also looked at the services around the device.

### **Ease of use and adaptation process of the Body Media armband**

Getting adjusted to wearing the armband went very well, after week 2 surveys showed that the participants didn't notice anymore they wore the armband. It became a part of their body. The only thing most of them reported was a slight irritation when wearing it for more than 20 hours in a row, the sensors sticking on their arm. Another aspect in wearing the armband was the reaction of the outside world. Some of the participants didn't like the design because it was not discrete enough. The perception it creates in the outside world is diverse, but some reactions were in the trend of 'do you wear a jail armband device', 'do you have a medical condition'. Depending the environment people reacted positive or negative when participants explained why they did this. None digital people acted very suspicious and found this really weird to do, while people working in a digital space found it really interesting and wanted to try it themselves. This also came up in the control group, most people in the control group were not interested or were hesitant to wear some kind of tracking device in general, basically because of the unknown.

Using the activity manager was perceived as user friendly. However the interviews showed us that the participants don't use all the functionalities in the activity manager to get in detail on their analysis. We have indications that people who are more tech savy are more explorative than the participants that were labeled as non tech savy. In the beginning the participants were eager to put their food intake into the application, but after week 2 this decreased as it is basically a very time consuming task and a few participants found that the tracking system failed because of that. One main issue is that for EU countries the American Food that is used in the system as the standard reference is not usable, because of very different eating habits and products. Therefore the participants needed to put in manually the food intake, which is a big task and will never be accurate. The participants noted their food on separate paper to keep track. In general food intake is a problem at the moment in the different apps and devices, to handle this in an easy and accurate way. People try to simplify the paths they take. They try to simplify their lives, preferring short routes to longer ones. (Norman, 2010, p 126-127) The other point that came up, was not being able to share your food input with others, if you use the device with more than one in the family you have to put the food in for each person.

A lot of participants said, in future use they would not wear the armband all the time, but more when they are going to exercise, or when they have a problem, than they would be more triggered to wear the armband

The participants spent an average of 37 minutes, a minimum of 20 minutes and a maximum of 60 minutes a week to analyze the data and evaluate their behavior.

The participants found that this was a confrontation and created a lot of awareness around their behavior.

Most participants see this as a good tool for a healthier life. Most admitted that they need the extra awareness it creates, even though they know how they behave, the facts and figures are confrontations in a positive and negative way.

Depending on the location and their occupation, they were also surprised sometimes about their lack of physical activity, or the other way around that they had quite a lot of physical activity. This awareness is the trigger and stimulates motivation as mentioned in the process of Fogg's behavior model. We will see later in the ability process that it is not always obvious to change behavior and act on this awareness and consciousness.

As mentioned before not all the participants are tech savvy or early adopters, so the mobile aspect is not something they are waiting for or is so important for them. Although they could see the advantage, those who have a smartphone would like it to be accessible and have immediate feedback when they wanted it.

### **Identification with the device**

We asked about the experience of the armband as an extension of oneself, following the idea of McLuhan (1964) that technology becomes an extension of our senses. The feelings the armband elicits depends on how the participants were dealing with the device. Not that they were emotionally involved with it, but saw this more as their external conscious to see the details on their physical activity, food and sleep patterns and act on it where necessary. Others saw it as a tool to reach their goals, get more insight on their health and lifestyle as a whole and using the data to discover patterns and learn from it.

Most of the participants see a positive change in their attitudes and behave more consciously because of the device, they need that extra push to act and most of them also in a way liked the controlling factor that device has on them.

### **Making small changes**

In line with the expectations of the behavioral change model of Fogg, small changes in behavior and attitudes were reported by most participants: trying to have more activity in terms of taking stairs more, park a bit further away, drink more water, drink less coffee. So mostly focused on the goals the BodyMedia system supports in the first place: physical activity and food intake. A few were

focusing on their sleep patterns and were surprised of their good sleep, others were surprised they had a lot of interruption in their sleep and were surprised they did not sleep so well.

As mentioned before three of the participants had medical conditions, it is clear that they are much more motivated in changing lifestyles. All three of them were bicycling and running 3 or more times a week, two of them changed their eating and alcohol drinking habits very drastically and succeeding in continuing these newly created habits before they started tracking. Two of them were in the control group, and one of them was acting on little changes as well, the survey questions helped them to think about their daily activity apart from the routines they already created. Once people are confronted with a medical condition they are much more serious and conscious about the fragility of life. We can clearly see primary and secondary needs in self-tracking our behavior. In relation to this research and research we did before in the same area, is that participants who are a bit older close to 40 and up, are much more conscious and aware about their lifestyle, and are willing to change little things, but have a hard time in doing it. Work, time and family related factors are playing a big role in this.

The other participants in both groups who set goals (Locke, Latham, 2002) for themselves, succeeded in their goals, and hope to continue them in the next phases of this research. Most of the participants in the control group admitted that having the weekly surveys were helping them in pursuing their goals and needed that extra attention or pressure to succeed in their goals and stay aware. They were also less involved in the whole process of the social experiment.

### **Contextual factors**

Clearly there are a lot of contextual factors that play a role in changing behavior (Fogg, 2009). In Belgium the main obstacles were the weather – is big influencer for not being triggered to go outside, especially in the winter period. In addition living in the city or more a rural area, will make the latter more attractive to exercise, since the area is very inviting to run or to bicycle.

The participants who live in California more specifically in San Francisco find it very enjoyable to be active there, and the hills are challenging for walks and biking. They find it an attractive environment to have a healthy live.

Family has a positive and negative impact. Negative because it is time consuming and not everybody is on the same page. Then again if they are and they can integrate their changes in the whole family it works great.

The participants have a full time job, some of them work a bit less, and then obviously have more time to exercise.

Work seems to be the biggest obstacle to balance out their lives. There is not much time left to do other things, so somehow the physical activity needs to be integrated in the work environment, one could think about lunch walks or meet and walk but here also location plays a role, the weather, is it socially accepted.

The eating part is with most of them not a big problem, they are all very conscious about food, and try to eat fresh and home made food as much as possible. We see a difference in the American Food, mainly in quality of food. As the Body Media system uses a American product database, the US participants who input food, got 'too much sodium' as feedback on a regular basis, EU participants didn't get that message because they use different products which they don't find in the database.

### Services around the device

The way we collected data about the participants by weekly survey, created another insight related to the general services needed around these kind of tools. All of the participants liked the personal mediation in having a weekly form to fill in, that follow up and checking in they find stimulating and put also some pressure in achieving their goals. Personal coaching might be something to consider with all these application either via chat applications, or even physical meet-ups. If this would be a professional setup, and within an acceptable price range, most of our participants are willing to use this service.

### Conclusion

This is the first phase of mid-long term research, but the first phase shows that using self-tracking devices makes the participants more aware about their behavior, and most of them also acted on it. The participants also had a better self-esteem because they achieved in their goals they set in the beginning. The application that comes with the armband is user friendly and stimulates the participants to check it on a regular basis, and spent time on it every week, most of them like to do that at ease and take their time for it. Being part of a study influenced them, and stimulated them also, so it will be interesting to see how they will do in the three month quiet period. We see that in the control group the participants who set goals they also succeeded in achieving them on a regular basis, but after two weeks of not receiving a check in form, some of them let it go a bit, although they wanted to continue. The idea to have some sort of external control that checks in on you on a regular basis is a stimulation to continue good behavior or attitudes, unless participants have medical conditions then the whole thing changes and behavior changes are

taking much more seriously. In our next tracking phase in the spring, weather condition will be changed, the environment will be different, it will be spring and we expect people to be more active because of that. We will also discover whether they tracked themselves spontaneously during the three month of silence, without personal mediation.

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