The Scientific Reasons Why People Should Break Up With Their Standard Bathroom Scales

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ABSTRACT

To fight obesity and diabetes, we came up with a scale with no display. Sound odd?
This is what happens when you let a social scientist design a solution for better weight management.

Given the current obesity epidemic in the United States, there is an obvious need to come up with effective interventions that help people lose weight and sustain weight loss over time. The project discussed here proposes that a scale without a display, combined with feedback-aggregation on a separate app can address the key problems around the psychology of weight management and weight loss. In particular, we propose that the following psychological building blocks **need** to be addressed for any weight loss system to be effective: 1) a scale can and should provide both present and constant reminders of health goals, 2) reporting feedback at lower resolution can help avoid what we call "gain aversion," 3) reporting feedback at lower resolution can make the relationship between health actions and outcomes clearer, and 4) reporting feedback at lower resolution can help avoid demotivation when good behaviors are not immediately followed by weight loss.

Outcome of a 12-week randomized controlled trial

We tested a system that included the aforementioned psychological building blocks and found an average weight *loss* of 0.61% of body weight per month compared to a *gain* of 0.91% of body weight per month for those who used a traditional digital bathroom scale.

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THE PROBLEM

The prevalence of obesity in the U.S. has increased dramatically in the past few decades, with the current rate as high as 36.5% among adults.[1] Obesity-related conditions include heart disease, stroke, type 2 diabetes and various types of cancer, making obesity one of the leading causes of preventable death.

The standard proposed remedy to such large-scale problems is usually to provide information. The basic logic for the information hypothesis is twofold: First, that if people are not acting in their long-term best interest, it must be that they just don't know what is the right thing to do. Second, that if they only knew what is the right thing to do, they would change their behaviors instantly. The problem, however, is that the information hypothesis has failed over and over in domains that range from financial literacy[2], to calorie-labeling[3], to smoking[4], and so on. In fact, one of the primary conclusions one can draw from many informational campaigns is that providing information rarely works to change behavior.

Let's take food as an example. The information about what we should and shouldn't eat is all around us. We get it from TV, the Web, newspapers, public health campaigns, our physicians, etc. And yet we eat processed food, fast food, fried food, and lots of it. Similarly, at this point we basically know how many teaspoons of sugar there are in a can of soda, yet we drink soda anyway. Most of us could be considered amateur nutrition experts, yet we go out for an unhealthy lunch and have the large order of French fries with that. In short, information doesn't work. We need to look elsewhere for solutions.

Why doesn't information work, and what explains the gap between what we know about nutrition and what we do day in and day out? In short: temptation. Temptation shows up when our own long-term health interests conflict with the short-term pleasure of unhealthy food. And the temptation of unhealthy food is everywhere, eyeing us from supermarket displays, restaurant menus, convenience store shelves, and our kitchen pantries. The point is that while we know what is healthy and not healthy for us, applying this knowledge to our decisions multiple times a day is just not realistic.

Given the low efficacy of information-based interventions and the prevalence of temptation, how can we help people with good intentions to engage in healthier behaviors? This is where our scale sans display (Shapa) comes into the picture.

1 https://www.cdc.gov/obesity/data/adult.html

2 Fernandes, D., Lynch, J. G., & Netemeyer, R. G. (2014). Financial literacy, financial education, and downstream financial behaviors. *Management Science, 60*(8), 1861-1883. doi:10.1287/mnsc.2013.1849

3 Kiszko, K. M., Martinez, O. D., Abrams, C., & Elbel, B. (2014). The influence of calorie labeling on food orders and consumption: A review of the literature. *Journal of Community Health, 39*(6), 1248-1269. doi:10.1007/s10900-014-9876-0

4 LaVoie, N. R., Quick, B. L., Riles, J. M., & Lambert, N. J. (2017). Are graphic cigarette warning labels an effective message strategy? A test of psychological reactance theory and source appraisal. *Communication Research, 44*(3), 416-436. doi:10.1177/0093650215609669

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SOCIAL SCIENCE PRINCIPLES

When we began thinking about the question of how we could tackle the problem of weight loss, we took a step back and considered the basic psychological principles at play. Then we reimagined how we might want to restructure and recombine them to build a more robust weight-loss system. Here are the basic social science principles we started with:

1) People need reminders

Sadly, losing weight is not a one-time behavior. It's the culmination of many, many small behaviors over time and every day: eating oatmeal for breakfast, packing a salad for lunch, walking to work, choosing an afternoon coffee instead of soda, not adding sugar to it, etc. Because weight loss is an outcome of many behaviors, people need constant reminders to take these many small steps. The presence of a scale on the bathroom floor can act as such a reminder. In accordance with this idea, it has been found that daily weighing is positively correlated with weight loss.[5] Moreover, stepping on a scale and weighing ourselves in the morning can act as a non-binding commitment device (or ritual) to remind us of what we are trying to achieve. This morning ritual can drive behavior change for the next few hours (in other words, when we weigh ourselves in the morning, we're more likely to choose a peach, not a donut, as our morning snack).

1) People need reminders

Because weight loss is an outcome of many behaviors throughout the day, we need constant reminders. The presence of a scale on the bathroom floor serves as such a reminder. Even more salient is the act of stepping on a scale daily.

2) Gain aversion (loss aversion applied to weight)

Weight fluctuates substantially from day to day. The theory of loss aversion means that weight gains make us more miserable than equivalent losses make us happy. These fluctuations, even for those who maintain their weight, translate into negative experiences, which make people stop weighing themselves.

3) Confusion and demotivation

Sometimes weight increases after a day of "good" behavior and sometimes weight decreases after a day of "bad" behavior. Unfortunately, people expect that the response from their body will be quick and direct.[6] Given that the body is a noisy (stochastic) system, people get confused about the relationship between their actions and their weight. This confusion leads to demotivation.

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5 Levitsky, D. A., & Pacanowski, C. R. (2015). Frequent self-weighing and visual feedback for weight loss in overweight adults. *Journal of Obesity*, 1-9. doi:10.1155/2015/763680

6 O'Brien, J., Fernandez, J., Zenko, Z., Kahn, R., Ariely, D. (2017) Scale Insensitivity in Calorie Estimation. Working Paper.

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2) Fluctuations and gain aversion

The feedback we get when we stand on a standard scale fluctuates a lot from day to day, for all kinds of reasons that are not intuitively clear to us (salt intake, time of the month, going to the bathroom, etc.). As we move to digital scales, smaller and smaller differences are now measured and presented to us. These tiny changes then become the focus our attention. (I was 158.2 yesterday and today I am 158.6.) Consequently, we are hypersensitive to every small weight change.

Such sensitivity to small changes would not be problematic if it were not for a human bias called "loss aversion"[7]. In the domain of financial decision-making, loss aversion is the finding that the emotional intensity of a loss is much larger than the emotional intensity of an equivalent gain, at a ratio of about 2 to 1. This effect means that emotional intensity of losing $1,000 is of the same magnitude as the emotional intensity of gaining $2,000. In the domain of weight loss, loss aversion is in fact *gain* aversion, causing people to feel the intensity of any weight gain as much higher than the intensity of an equal weight loss. Worse, it means that the overall experience of weighing ourselves ends up being negative even if we don't gain any weight!

Imagine, for example, a situation in which you stay at the same weight for more than a month. Due to random fluctuations, on half of the days you gain some weight and on the other half you lose some weight. On the days you gain weight, you'll be very miserable. On the days you lose weight, you'll be a little bit happy. If the ratio of happiness to misery is 2 to 1, the overall experience will be negative. And this is exactly the reason people stop weighing themselves, thereby losing the advantages of the daily reminder.

3) Fluctuations, confusion and demotivation

There is a broad array of scientific evidence of the difficulty people have learning the relationship between cause and effect when there are unexplained fluctuations in the system. (In statistics, we call this "noise.") In a noisy environment, it is difficult to figure out the consequences for eating better, for eating worse, for doing more and less physical activity and so on. More generally, it is hard to figure out the link between the actions we take and the health consequences that follow.

Systems that have a lot of unexplained fluctuations are inherently confusing and demotivating. For example, imagine that we have had a great day during which we exercised and ate salad, and when we measure ourselves the next day we find that we have gained weight. Similarly, imagine that we had a horrible day during which we ate a huge piece of cheesecake, but when we step on the scale the next morning, we discover that

7 Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent model. *The Quarterly Journal of Economics, 106*(4), 1039-1061. doi:10.2307/2937956

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we lost weight. From a statistical perspective, feedback that is inconsistent with the behavior of the previous day is to be expected when a system has a large component of unexplained fluctuations – but nevertheless such feedback is also confusing and demotivating.

In short, we expect feedback to be highly consistent with our most recent actions. When we act badly, we expect to see deterioration. But when a standard digital scale tells us that we are doing well after a bad day or doing badly after a good day, we not only get confused, but also **<u>demotivated</u>**.

As we already know, although weighing ourselves every day is a good idea in principle, when we consider fluctuations, loss aversion, confusion and demotivation, the story is much more complicated. Using a standard scale, the advantage of reminding and committing to healthier habits is accompanied by the downside of heartbreaking gain aversion, confusion, and demotivation.

When it Comes to Weight Loss, the Menstrual Cycle is a Red Herring

One specific and important fluctuation is, of course, the menstrual cycle. A standard scale reports weight gain without regard to the reasons for it. It is generally expected that women will understand that weight they have gained in the 5-7 days leading up to their menstrual cycle is due to fluid retention, is temporary, and is not caused by any of the actions they took in the previous days. Of course, this is an unrealistic expectation. A more advanced scale would actively take this fluctuation (usually between 1-3 pounds and sometimes up to 5 pounds) and others and subtract them from the underlying weight. After all, if the goal of the scale is to help people understand the relationship between what we do and the health consequences that follow, not accounting for transitional stages such as the menstrual cycle muddies the water.

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OUR PROPOSED SOLUTION

Our solution is a display-free scale that is connected to a mobile app that provides the user with a five-point visual indicator of weight change. With this kind of scale and feedback, it is possible to get a daily reminder without the negative costs that come from uninformative fluctuations (gain aversion, confusion and demotivation). Visually, the system is simple: negative feedback (or weight gain) is reported as light grey (I've gained a little weight) or dark grey (I've gained more weight). Positive feedback, or weight loss, is reported as light blue and a darker blue for more weight loss.

Moreover, because weight maintenance is an important and useful goal by itself, we set up the middle category of our scale to celebrate no changes. With a digital scale, it is impossible to stay the same weight from one day to the next. A standard digital scale will always show daily fluctuations, because it measures weight with high precision. When users stay within one standard deviation of their norm, we report back to them that nothing has changed (in our interface it is depicted as green) and that they should feel successful.

The hypothesis is that by using average weight over time, we can provide a better sense of progress and a clearer understanding of the relationship between cause and effect. Furthermore, we can take away the negative outcomes (gain aversion, confusion, and demotivation) of reporting unexplained fluctuations.

Our scale is also set up to measure body fat percentage. After all, when people lose weight, there are two potential ways to do this, through reducing body fat, or losing muscle mass. Ideally a weight loss system would help people lose body fat, not muscle mass.

Personalized weight-loss assistance

One more point: In our attempt to drive behavior change, another potentially useful path is to give users specific advice on behavioral changes that they should make. For this reason, in the same app that reports weight outcomes, we ask users to give us information about their personal environment. We ask them how their kitchens are set up, how far the nearest grocery store is, how they get to work, etc. Then, based on their specific environments, we send them daily missions. These missions –personalized to the user's circumstances– are intended to help them make small, positive changes. For example, our system will provide suggestions for a healthier shopping list (we tend to eat what we have at home), for a different breakfast (once we get used to something, it becomes our default and we stick to it), for rearranging the pantry (so that unhealthy food will be kept in hidden shelves), etc.

STUDY & RESULTS

Design

We have several pilots implemented with the same design around the country which have been running for over a year with similar results. For this particular pilot, we carried out a randomized controlled trial conducted with the employees of a large company across four company sites. We randomly assigned participants to one of three conditions. All three conditions received a Shapa scale with no display and access to the Shapa app. In the first condition (the control group), participants saw on the app their weight in pounds every time they stepped on the Shapa scale. In the second condition (the basic Shapa experience), they received the Shapa 5-point feedback mechanism in the app. In the third condition (the full Shapa experience), they received the Shapa 5-point feedback mechanism, and they also received daily missions. The study lasted 12 weeks in the spring/summer of 2017.

Participants

We recruited participants by emailing employees at four sites of a large company. The company's human resources office sent them an email offering them the option to sign up for an innovative weight-loss program. The four company sites were in Ferguson and Farmington, Missouri; Tyler, Texas; and Great Falls, Montana. 645 people participated. Ninety percent of participants were female and 67% of them were obese. Their average age was 40 years old. Seventy-two percent of participants were Caucasian, 22% African American, 2% Hispanic, 1% Native American, 1% other and 2% preferred

not to answer. Three people were removed from the study because of external influences on their weight. During the study, one had gastric bypass surgery; one was on a medically supervised diet pre-weight-loss surgery; and one was taking diuretics.

Results

Main outcomes: Those who participated in the full Shapa experience (seeing their weight change via the 5-point feedback mechanism and receiving daily missions) lost the most weight. Their average weight loss was 0.61% of their weight per month, compared to 0.57% weight loss per month in the basic Shapa experience group. This is in contrast to the control group, who used a standard scale and this group lost no weight, in fact, they gained 0.91% of their body weight per month ($F(2, 259) = 1.55$, $p = .08$).
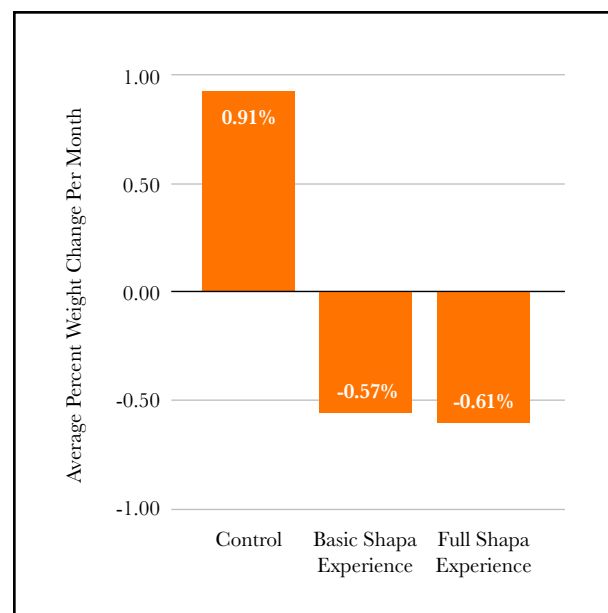
Other results: Using independent samples t-tests, there is a significant difference and moderate effect size when testing the control group vs. the full Shapa experience group, ($t(241) = 2.19$, $p = .03$, $d = 0.48$), as well as when testing the control group against the combined basic and full Shapa experience groups, ($t(278) = 2.21$, $p = .03$, $d = 0.48$).

Across all groups, percentage of weight change and percentage of body fat change were significantly related ($r = 0.19$, $p = .002$), but this was not true for the control group on its own ($r = 0.13$, $p = .622$). Weight change and body fat change were significantly related for only the basic ($r = 0.34$, $p = .04$) and full ($r = 0.17$, $p = .013$) Shapa groups. In other words, in the control condition, some of the weight loss could have been attributed to muscle mass loss.

Change in body weight was related to the participant's level of engagement with the scale. Overall engagement was high, with 86.6% of participants stepping on their Shapa scale five times or more per week. Weekly frequency of stepping on the Shapa scale did not significantly differ across treatment groups. Those who received the full and basic Shapa experience stepped on their scales an average of 5 times a week compared with 4 times a week in the control group ($F(2, 259) = 2.15$, $p = .118$).

In addition to these results, correlational results with weight loss across all three conditions showed higher weight loss with higher frequency of app use ($r = -0.007$, $p = 0.917$). This correlation was highest for the full Shapa experience group ($r = 0.025$, $p = 0.6$), lower for the basic Shapa experience group ($r = -0.027$, $p = 0.878$), and lowest for the control group ($r = -0.121$, $p = 0.655$).

The same effect held true when it came to frequency of measurements per week. All three conditions showed higher weight loss with higher frequency of weekly measurements ($r = -0.10$, $p = .116$). This correlation was highest for the full Shapa experience group ($r = -0.08$, $p = .232$) and the basic Shapa experience group ($r = 0.040$, $p = 0.5$) and lowest for the control group ($r = -0.09$, $p = .728$).

Finally, we also asked participants for their subjective assessments of the effectiveness of our approach. Among the participants who received the full Shapa experience, 66% reported that Shapa was influential in their daily decisions around engaging in a healthy lifestyle, compared to 80% in the basic Shapa experience group and to 50% in the control group (95% CI [0.709,-0.909]).

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General Discussion

The problem of weight management is a central challenge for individuals, physicians, the medical system, companies and governments. The question that we intended to answer here focuses on discerning between tools that would help people accomplish better weight management and those that would make people feel annoyed, confused and demotivated. Starting with the notion of reminders[8], we assumed that a scale is a good starting point to help people with their weight challenges. Given our understanding of unexplained fluctuating weight and the principles of loss aversion, confusion, and demotivation, we speculated that the current scale –particularly the current digital scale– is not only *not* helpful, it is, in fact, harmful.

Philosophically, we believe that there are two ways to think about information. The first is for historical accuracy, which means that we need to give people information in high precision. The second is to improve decision-making, which means that the granularity of the information needs to help people make better decisions. In our minds, there is no question that when it comes to weight management, the second approach is the right one.

With these psychological building blocks as our starting point, we set out to build a different scale: Shapa. A scale without a display, coupled with an intuitive feedback-aggregation. A large-scale study with a population of low income and obese individuals showed tremendous potential for the importance of providing information in a way that fits the limitations of our cognitive system, helps us understand the relationship between cause and effect, reduces confusion, and eliminates demotivation.

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8 Fry, J. P., & Neff, R. A. (2009). Periodic prompts and reminders in health promotion and health behavior interventions: Systematic review. *Journal of Medical Internet Research, 11*(2), e16.