With a Little Help from a Friend: A *Shower Calendar* to Save Water

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Abstract
This design case presents and discusses the *Shower Calendar*, a "persuasive" concept for reducing the consumption of water for showering. It starts from a discussion of different types of feedback employed by earlier design cases. Based on this, we designed the *Calendar* concept as an ambient, persistent and individualized feedback. A field study with two families (6 individuals) revealed that the *Calendar* fosters goal setting, comparison, competition, and communication. In addition, quantitative data showed one family to have been more successful in translating the *Calendar's* offer into actual behavior change, i.e., saving water. This highlights that change is not achieved by the product itself (as in automation or regulation), but by the people involved.

Keywords
User experience, experience design, persuasive technology, behavior and attitude change, sustainability

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

General Terms
Human Factors, Design

Introduction
Freshwater is – like any other natural resource – precious. Not surprisingly, there is a growing interest in

products and systems, which aim at reducing our consumption of water and other resources. One domain for this endeavor is the domestic. Labeled as sustainability and eco-minded design, nowadays consumers are confronted with water saving dishwashers and washing machines, automated lighting controls or even more elaborated "smart homes" and "grids." Many of those products seek to reduce energy consumption through increased efficiency or automation. They typically do not involve their users actively beyond the buying decision. But even the buying decision is increasingly replaced by regulation. After the ban of regular light bulbs, the European Union now plans for a regulation of shower heads, which "waste" water.

The ban of particular "bad" products as well as the appreciation of "smart homes" seems to – at least implicitly – assume that people are not willing to actively participate in resource conservation. This is interesting, given the fact that research since the 80ties of the last century shows that direct and indirect feedback of energy consumption has a significant effect in terms of habit change (see [5] for an overview). In addition, there are rising doubts whether, for example, energy efficiency of lighting really leads to a decrease in energy consumption. The opposite may be true due to an increase in general light consumption enabled by more efficiency (see for example http://thebreakthrough.org/blog/2010/09/why_energy_efficiency_does_not.shtml). Consequently, there seems to be a demand for well-designed systems, which keep their users "in the loop" instead of deferring saving to materials, automation, or regulation.

Interactive products are an ideal medium to foster such behavior and attitude change [7]. They offer a wide array of customizable real-time feedback and allow for immediate responses to this feedback. Accordingly, "persuasive technologies" became an important field of research within Human-Computer Interaction. However, available design cases reveal a wide variety of potential solutions, all seemingly based on the similar broad principles, but very different in detail. In other words, while the broad principles remain the same, their *materializations* as products substantially vary. Following the idea of persuasive technologies as "materialized arguments" in a dialog between user and designer [17], these variations will surely impact the "story" told by the product, its perception and ultimately its meaning and its power to change attitude and behavior. Collections of principles, such as feedback, goal setting, comparison [8], are very helpful to generally understand how behavior can be changed. But they neither prescribe nor discuss in detail, how these principles should be met by a concrete product. This makes the exploration of design cases as concrete materializations of underlying persuasive (i.e., psychological) principles worthwhile.

This design case presents and discusses the *Shower Calendar*, a concept for reducing the consumption of water for showering – an interesting application domain for persuasive technologies. Bathing and showering makes up a large part of domestic water consumption, for example, 36% of the total water consumption of a typical German household [18]. Moreover, water consumption provides direct opportunities for saving. A fridge, for example, can't be used less frequently. It is either on or off. There is some potential for saving, such as not putting hot meals into the fridge or buying a new one. But the actual potential for improved behavior is rather small. This is different for water consumption,

which consists of frequent, small acts like showering, dish-washing, and so forth.

We start this case with a detailed discussion of different types of feedback and their potential drawbacks. The impatient reader may directly turn to the subsequent description of the *Shower Calendar* concept and our quantitative and qualitative field study of a functional prototype.

Feedback

From judgmental to ambient

A basic feature of persuasive technologies (and a corner stone of behavioral change in general) is appropriate feedback about resource consumption (see [5]) to create "energy awareness" and to prompt behavioral change. However, feedback can take many different forms. For example, *UpStream* [12] uses a "traffic light"-metaphor. A green light is displayed as long as the consumption is below the average of everything previously measured. When the user is about to exceed the average, the light changes to yellow. It becomes red, if the water has been running for longer than one standard deviation above average. Finally, it even flashes (thereby breaking the "traffic light" metaphor). This type of feedback is rather judgmental. It bluntly categorizes some behavior as "good" (green) and other behavior as "bad" (red), but ignores the possibility that there might be a legitimate reason for using more water. This runs the risk of being too pushy and even unfair, which might rather lead to reactance [2] than change.

Another kind of feedback widely used is positive reinforcement – rewards, points or trophies. *Waterbot* [1], for example, is using positive auditory messages and chimes when closing the tap. It monitors and judges behavior, similar to a punishing and praising dog trainer. Besides the danger of being unnerving, this type of feedback rather externalizes the reasons for behavior. One can submit oneself to *Waterbot* – she will guide me and take on the responsibility. However, to be persistent, behavior and reasons for this behavior have to be internalized. I should change because I want to, not because *Waterbot* says so.

A more subtle road is ambient feedback. The *Power Aware Cord*, for example, visualizes the current uptake of electricity of a connected appliance through glowing pulses, flow, and intensity of light [9]. This is not as judgmental as a traffic light and also may be subtle enough to be ignored, if increased consumption appears legitimate. *Show-me* [11] visualizes the water consumption by a row of LEDs on a bar in the shower cabin (Figure 1).

Figure 1. LED-bar prototype of *Show-me* (left) and a further integrated design solution (right) [11].

For every five liters consumed, an additional LED is switched on. As a consequence, the shower cabin becomes a brighter place with increasing water consump-

tion. While certainly being ambient, this form of feedback seems to beautify consumption rather than to criticize it. Ambient displays must tell an appropriate story, namely one of loss over time rather than gain. Thus, the exact opposite – a decrease in light – may have been much more appropriate in a dialog about the responsible use of a limited resource.

Consumption patterns and a record of change

Feedback in persuasive technologies is not only a matter of awareness of resource consumption at a given moment, but also a matter of awareness of consumption patterns over time. *Show-me*, for example, only displays the amount of water used during one shower. This direct feedback certainly calls for an immediate response. However, the moment the user steps out of the shower, the information is only available in his or her memory. *Upstream* represents earlier behavior only indirectly by the average the traffic light is centered on. However, if the objective is to change behavior, consumption patterns over time have to be made accessible to the users. This calls for a persistent feedback, a record and display of each single act of consumption, of each single shower taken. Only such a record enables users to compare showers taken, and to become aware of improvement or deterioration in water consumption. The potential focus on the trend over time instead of single acts also helps to accept variety in own behavior. Even if one "fails" today (either deliberately, because I earned it, or by inattention), there can be still an improvement overall. This refocus on the overall pattern is a desirable one, given that many prolonged acts of self-control fail because of an underlying "on-off"-model, with one transgression letting the whole effort appear worthless [16].

Individualization and accountability

Mundane acts, such as showering, are embedded in social contexts, such as a family situation or a shared flat. Other than *Show-me* [11], *Waterbot* [1] explicitly uses this social context and addresses the principle of social validation (e.g., [4]) by putting current consumption in relation to the average household consumption. While this anonymous form of social feedback may be generally viewed as more "politically correct" than individualized feedback, it appears less adequate in the present context for at least three reasons. First, it actually reduces the accountability for one's own behavior – the exact opposite of what the conscious use of resources requires. Second, while it may reduce social pressure, and, thus, may be less judgmental, it also reduces the chance of communication among users. However, this social comparison seems important for personal goal setting. Third, failures, which remain anonymous, are certainly more bearable. However, the same lack of individualization may hinder the full relish of a success, which includes feelings of acceptance and appreciation by others.

All in all, we argue for a vague and ambient display, which appropriately maps consumption to a visualization, which avoids the beautification of waste, is persistent (i.e., displays not only water used, but also consumption patterns over time) and individualized. We assume that this combination will encourage the acceptance of responsibility for one's own behavior without feeling coerced by the product. It should also foster communication among its users in a social context, which is surely an important part of the persuasive process. In the following, we discuss the *Shower Calendar* as a potential materialization of the envisioned type of feedback.

The *Shower Calendar*

Description

The *Shower Calendar* consists of display installed in the shower (Figure 2, see also http://www.youtube.com/watch?v=AHezdVxbi7M for an extended video figure). Users identify themselves by pressing a button. A large dot of the user's personal color appears at the current date in a calendar-like matrix. The dot represents 60 liters. This amount is roughly based on an estimated consumption of 20-40 liters per day and person in Germany [19]. We took the average and added 30 liters to allow for more extreme consumption situations. We further added a "free" amount of four liters before the dot starts to get smaller. It then shrinks until the user either stops the water or the full amount of 60 liters has been spent. In the latter case, the dot is very small, but still a visible record of this shower taken (Figure 3, detail). The free amount of four liters was introduced to avoid possible frustration. Otherwise the visualization would never be visible to a full extent, because showering without using any water is impossible. The amount itself is based on the first authors experience while trying to achieve a comfortable feeling of cleanliness with a minimum of water. A series of ten showers resulted in an average of four liters used.

Design rationale

The dot was used as a fuzzy, ambient representation of the amount of water used per shower. It became smaller with consumption to communicate the limitedness of resources.

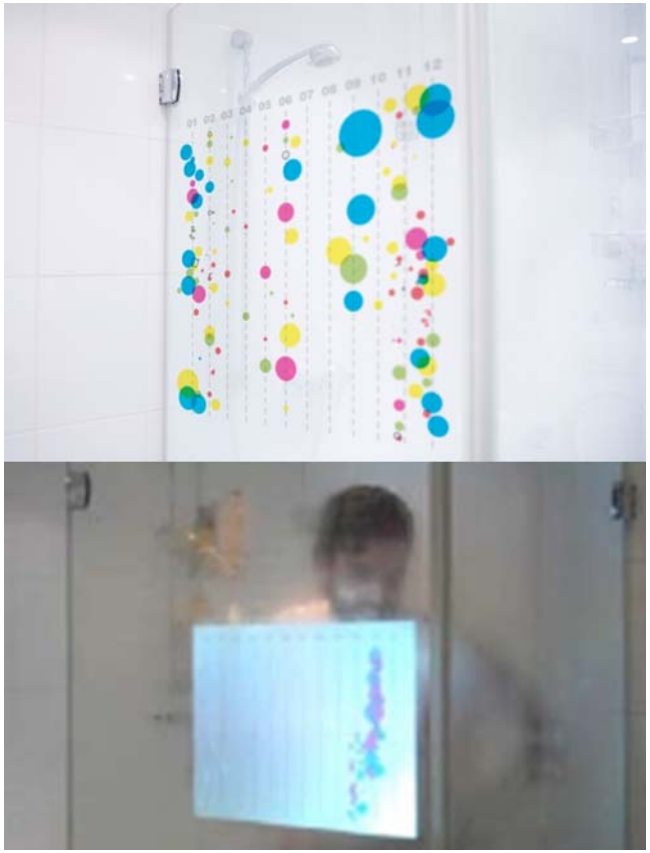

Figure 2. *Shower Calendar* in the bathroom (concept and video still from http://www.youtube.com/watch?v=AHezdVxbi7M).

The dots are arranged in a calendar-like matrix, a well known pattern for recording and monitoring over longer periods. The different colors identify different people, thereby providing an individualized feedback over time.

However, the color is arbitrary, no names or nick names are displayed. It requires an explicit communication among users to determine individuals ("Who has blue?"). In addition, the whole process requires an initiation by pressing a button. On the one hand, this allows for an explicit commitment, which will increase awareness *per se*. On the other hand, it allows for cheating (e.g., showering without initiation of the system, "identity theft"), which clearly communicates the active role of the users themselves and the role of the calendar as a tool for self-help and not as a watchdog. There is no point in cheating, if you want to change yourself. All in all, the display is designed in a way that beautifies reduced consumption of water and the participation of all family members through an emerging, colorful pattern (Figures 2 and 3). The cabin becomes more colorful day by day, which is a more implicit and more lasting reward than any immediate chime or later trophy (as suggested by [1]).

Prototype

The functional prototype of the *Shower Calendar* consisted of a flow meter, a micro-controller board, a number pad, a computer, and a screen (instead of an integrated screen in the shower cabin or a projection) (see Figures 4 and 5). The flow meter was installed between the faucet and the flexible tube of the showerhead. For each liter the computer decreased the colored dot on the screen. The number pad was connected to the computer. All electronic equipment was outside the shower. Each user got assigned a button at the number pad. The screen displayed all different dots at each day for one year. The screen was placed within sight, so that users were able to keep track of the current dot during showering.

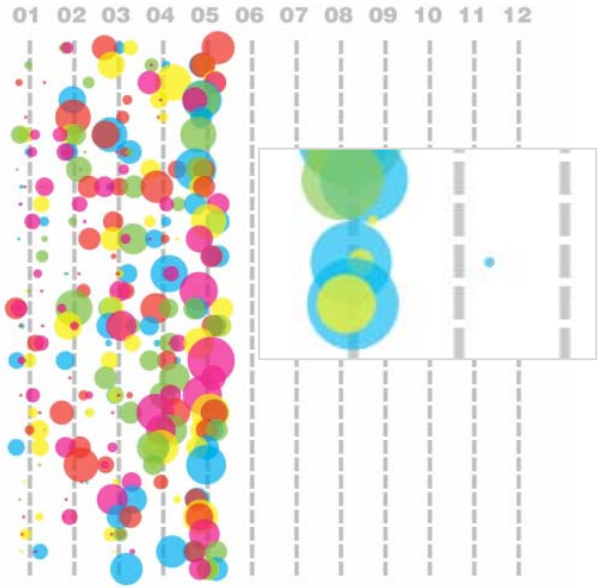

Figure 3. Dots displayed in a calendar-like matrix. Each column represents a month, each line a day. The detail shows the left-over of using more than 60 liters (small blue dot on the right).

Study

Two families participated in the study, each consisting of three individuals. Family 1: 50-year-old mother (P1.1), 55-year-old father (P1.2), 20-year-old son (P1.3). They lived in a single-family house in a small German city (62.000 residents). Family 2: 50-year-old mother (P2.1), 20-year-old son (P2.2), 14-year-old son (P2.3). They also lived in a single-family house in the same city as Family 1. Both families were of a German middle class, non-academic background. The son of Family 1 was in an educational program. The younger son of Family 2 attended public school. The older son was about to begin

his studies. Participants were asked to use the *Shower Calendar* in their daily life for a period of one month (31 days). The prototype of the *Shower Calendar* was placed in the families' bathrooms. The study started mid June 2010.

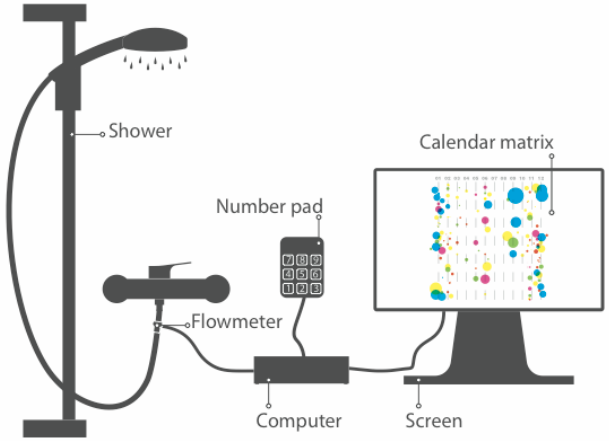

Figure 4. General setup of the functional prototype.

The *Shower Calendar* was briefly introduced to the participants. This covered aspects, such as the personal login before every shower, the differently colored dots, and the amount of water a dot represents. However, participants were not "educated" about water consumption in general or strategies to save water. Naturally, both families considered resource conserving as a positive and worthwhile aim. However, they neither invested a lot of money nor time into it so far.

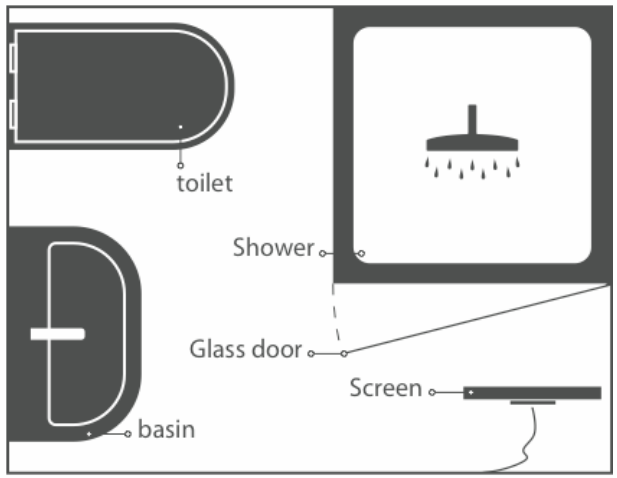

Figure 5. Specific setup of the functional prototype in Family 2's bathroom.

We focused our study on participants' experiences and actual consumption. Accordingly, we led open, in-depth interviews after the field trial, asking participants to freely reflect on how the experience of showering had become different (or not) with the *Shower Calendar*. To stimulate participants, we prompted them – when necessary – with broad questions, such as "What were your first thoughts and feelings when using the *Shower Calendar*?", "Do you like the *Calendar* and if yes/no, why?", "What do you think is the intention of the *Calendar*?", "Did the *Calendar* influence you and if so, how?", "What do you think about products, which attempt to change your attitudes or behavior?", "Do you care about conserving resources and what do you do for it?"

In addition, we logged the actual amount of water spent per shower to get a complementary, quantitative measure of actual behavior and its potential change.

Experiences

This section summarizes and exemplifies the topics mentioned during the interviews in form of a narrative explication.

Personal goal setting was repeatedly brought up:

"My first thought was how to save additional water. […] Although I believe that my actual shower habits are not that bad." (P1.1)

"Somehow it is about ambition: the ambition to shower less." (P1.3)

However, it seemed important that these goals were set by one self. This allowed for the adaption to situational needs, thereby reducing the feeling of being coerced by the product. Broadly asked by the interviewer, whether the *Calendar* influenced behavior and if so, how, the mother of Family 1 remarked:

"I did not feel coerced to save water. For example, in the last days it was so warm outside that I needed to shower a little longer just for the refreshment." (P1.1)

"I did not feel patronized by the product, because I could always choose for myself, how I wanted to be influenced" (P1.1).

The *Shower Calendar's* design allowed for personal goal setting by providing the size of the dot as feedback about the amount of water consumed. However, this unit is ambiguous, which accommodates various personally meaningful goals. This ambiguity makes the product appear less judgmental. In addition, slightly ambiguous feedback allows for better ignoring the product's feedback in situations in which using more water is felt to be legitimate. The product must allow for these "transgressions" to create the feeling of helping along rather than patronizing or coercing.

An important aspect of goal setting is comparisons. These can be comparisons between one's own achievements over time and those of the others. In Family 1, for example, the mother (P1.1) adopted the role of the admonisher and the son (P1.3) was already known for his water-wasting shower habits. Both were fully aware of those roles.

The son reflected:

"At the beginning everybody grumbled at my small dots. But when they became larger and larger, my parents stopped. I was definitely influenced by them, because we could see each other's dots." (P1.3)

And the mother said:

"We definitely monitored each other." (P1.1)

"My son proudly presented his dot to me: 'Look Mama! Today my dot is even larger than yours'" (P1.1).

A similar theme of social comparison was apparent in Family 2. The mother said:

"I had a look at the dots of the others [her children], just to see whether my children take it seriously" (P2.1)

The possibility to compare also led to competition among family members:

"I definitely monitored the dots of the others. […] There is always a bit of a competition in a family." (P2.3)"

One mother stated:

"My husband always brags of his shower habits 'Soaping like a guy. Shower it off, done!' I wanted to show him that I don't use much water either." (P1.1)

And further:

"At the beginning my husband and I laughed about [our son's] small dots. […] Especially with teenagers and kids it becomes competitive easily." (P1.1)

Also the father mentioned:

"Well, sometimes we laughed about the tiny dots of our son." (P1.2)

But the son took on the challenge:

"It became similar to a game. In the beginning everybody said 'You are the worst, you have the smallest dots'. But in the end, I often had the largest dot." (P1.3)

The *Calendar* also fostered communication. Shower habits became a subject of family discussions:

"In the beginning, we now and then talked about the shower during dinner." (P2.3)

The shower seemed to have a facilitating effect:

"After the installation of the shower, we talked much more about water consumption. Normally, when I point out to my children that they could consume less water, it goes in one ear and out the other. […] But then, [my son] told me about how fast his dots tend to disappear. He was very astonished about it." (P2.1)

Interestingly, the shower became not only a subject among the family members alone, but also among visitors:

"Visitors asked me 'What is it for? Do you have Internet in your bathroom?' I explained it to them." (P2.1)

Much of the shower's effect seems due to its ability to foster communication. It becomes a communicative tool, a tool for gaining insights and a way to make a potential discussion less personal and accusatory. It becomes a "material argument". And it is not taking sides.

Experiences were accompanied by - at least intended - behavioral changes. As one participant reflected:

"One changes behavior, because one knows that there is the dot." (P2.1)

Because of this, people reconsidered and consciously varied their actual shower behavior.

"I did not actually reduce the duration. To save water, I just turned it off while soaping. […] I don't know, whether I have done this before. But this time, I definitely did it on purpose." (P2.1)

Also the youngest participant pointed out:

"I did not reduce the duration, but I turned the water off while soaping." (P2.2)

In sum, the participants did not feel coerced by the *Calendar*, because it allowed for variability in behavior. Through its fuzzy, ambient feedback participants were encouraged to set personal goals, to compare themselves to others, and to monitor their progress. This could even result in competition. In general, the *Calendar* fostered and facilitated communication within the families. Participants also directly reflected about behavioral change.

Behavior

Figure 6 and 7 shows the *Shower Calendar* of Family 1 and 2 after the test period.

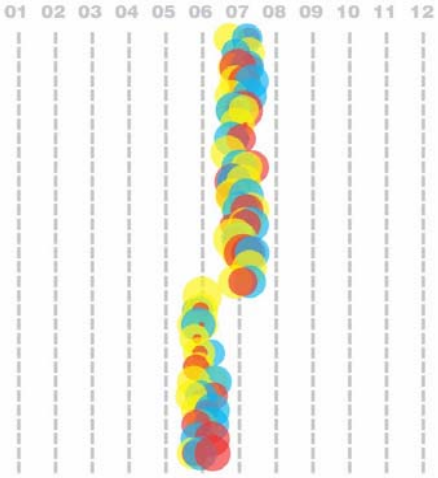

Figure 6. Visualization after test period (Family 1).

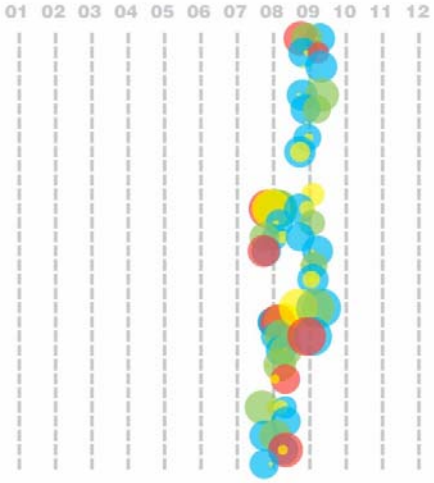

Figure 7. Visualization after test period (Family 2).

To complement the participants' insights with their actual water consumption data, we calculated each participant's average water consumption per shower and the standard deviation (see Table 1).

The most interesting, however, is the change in the amount of water used. To estimate this, we calculated a linear regression for each participant, using time (actually the sequence of measures) as predictor and water consumption per shower in liter as criterion.

For four of the six participants the linear trend was highly (P1.1, P1.2, P1.3) or at least marginally significant (P2.1). For these four, the beta weight was negative, indicating a decrease of water consumption over time. For the two sons in family 2 (P2.2, P2.3) there was no significant linear trend. P2.3 did not change at all. P2.2 even increased water consumption over time. However, this participant only contributed 10 data points (i.e.,

showers) over the 31 days, which leaves the change insignificant.

Participant	n	M [l]	SD [l]	Change (β)
P1.1 (mother)	24	23.9	2.7	-.54**
P1.2 (father)	36	25.0	2.6	-.59***
P1.3 (son)	43	36.4	12.1	-.40**
P2.1 (mother)	21	28.0	2.2	-.40^{m}
P2.2 (son)	10	25.6	3.1	+.52
P2.3 (son)	23	49.4	9.3	-.01

Notes: ^{m}) p<.10, **) p<.01, ***) p<.001

Table 1. Number of showers taken in the 31-day period (n), mean amount of water consumed (M), standard deviation (SD) and the change over time (β).

Beside the linear trend, we checked whether a saturation curve would generally show a better fit to consumption over time. This is, because water consumption while taking a shower is not entirely avoidable (only by not taking a shower at all). Actually, the change of P1.1 and P2.1 (the mothers) was better represented by a logarithmic than a linear function. The shower calendar obviously encouraged them to save water, but after they had reached their personal limit of saving, water consumption remained at a constant level.

Besides the differences in the shape of water consumption over time, there were also significant differences regarding the variability. Levene's test for Equality of Variances showed that variability of water consumption between the six participants was statistically significant, $F(5, 151) = 24.30$, $p < .001$. Especially the son in family 1 (P1.3) showed a highly variable showering behavior.

The quantitative data highlights the complexity of families as social entities. All parents showed a significant (P1.1, P1.2) or marginally significant (P2.1) decrease of water consumption over time, while the children either conformed (Family 1) or not (Family 2). This can have manifold reasons, but one is certainly the difference in the assumed underlying wish to be transformed: the children may simply not find it important to reduce their water consumption (e.g., the 14 year old P2.2). Some people are just more ready to change than others [see 6]. Alternatively, the *Shower Calendar's* design may be simply rendered inappropriate for people on early stages of potential behavioral change [10]. This, however, is then the consequence of the deliberate design decision to address people already wishing to change. While the present case is not able to answer these open questions, it still reminds us of the complexity of behavior and attitude change in a social setting and questions approaches, which want to makes us believe in the possibility to influence people in a simple, passive and mechanistic way.

All in all, it becomes obvious that employing principles like goal setting, comparison, competition, or communication cannot guarantee behavioral change. It is rather an offer to change, which has to be actively accepted. While some may view the latter as a serious limitation, we understand a *dialogue* between the *Calendar* and its users as the only acceptable way to change people's behavior and attitudes.

Conclusion

The *Shower Calendar* offers a way to foster awareness of water consumption and communication among family members. This ultimately has the potential to result in behavioral change. Specifically, participants mentioned the *Calendar's* appeal to their ambition to change, which resulted in personal goal setting. Beyond resulting feelings of achievement, competence and control due to the improvement, its "social features" (individualization, persistence) led to communication and competition, and in the case of success, to feelings of popularity and acceptance.

While many of the intended experiential effects became apparent, actual behavioral change was less consistent. Family 1 reduced their water consumption significantly over the 31 days, while in family 2 only the mother showed a marginally significant reduction, the sons did not respond. This highlights a common problem with persuasive technologies. We understand them as "materialized arguments" [17] – dialog partners and mediators rather than educators or watchdogs. Thus, their general design assumes that people have an "inner wish" to change, that is, to transform themselves. Indeed, Fogg [7, p. 15) defines persuasion as the "attempt to change attitudes or behaviors or both (without using coercion or deception)". This emphasizes voluntariness and a certain wish to transform, but it underplays the active participation of the one to be persuaded. The *Shower Calendar* doesn't coerce those who don't want to change. While it embodies a clear objective – to reduce water consumption – it does not continually call the user's behavior into question. We believe this to be an important attitude in the design of persuasive technologies. Regulation and automation may promise more success in terms of water saved, but according "products" might be experienced as patronizing, judgmental, or inhumane. Instead of providing a meaningful, stimulating and positive context for conservation, it may become rather loaded with negative experiences and emotions. And if coerced, people will definitely find a different outlet for their need to indulge.

The problem that arises from this view, however, is the question of how we should evaluate persuasive technologies? We cannot claim to create products that foster change if we cannot actually demonstrate change. This carries the danger of arbitrariness, a "whateverism", where every idea is good, even if this goodness cannot be demonstrated. The present case attempts to avoid this. It understands the product as a theory (see [3], [21], [14]), which has to be developed out of the discussion of previous theories (i.e., products), which has to be plausible in itself, and which makes expectations explicit. In addition, we must not only focus on change itself, but also on the experiences accompanying this change. The objective is not only to demonstrate and maximize change in behavior and attitude, but to reveal boundary conditions, and to make change a worthwhile experience.

In the present case, we could demonstrate that the *Shower Calendar* did not coerce but fostered communication and competition in both families. However, Family 1 was more successful in translating this offer into behavioral change. This reminds us of the fact that change is not achieved by the product itself (as in automation or regulation) but by the people involved. In this sense, we prefer talking about *Transformational Products* rather than persuasive technologies. Transformational products offer ways for self-improvement and support people in their wish to transform (see [20], [13], [15]), but do so by emphasizing the active role of the individual in the

process. This active role is crucial. There is simply a difference between changing the behavior of somebody and enabling somebody to change herself.

The experiences participants reported can be traced to the *Shower Calendar's* specific characteristics and features. No immediate reduction of water-consumption without its direct feedback; no goal setting, comparison, communication, and competition without persistent and individualized feedback. No positive feelings without the careful design of a non-judgmental, non-coercive feedback. This highlights the intimate relationship between the detailed, formal design and resulting effects. While broad principles, such as goal setting and feedback, are important guides, their translation into a material form is crucial. Case studies, such as the present and those cited, enable the specific critical discourse and the concrete empirical exploration of abstract principles and their materialization. This makes them worthwhile.

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