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# Designing appropriate things: An experiential perspective on the effectiveness of artefacts in contributing to behaviour change

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**Abstract:** Behavioural design is an emergent discipline that aims to harness design's influence on behaviour in an intentional way. However, there is limited knowledge on how to translate knowledge on behaviour and its determinants to specific design properties in ways that can maintain such change. We adopt a user experiential view to discuss the role that artefacts and their materiality play in effectively changing behaviour by introducing the notion of appropriateness, a quality of user-artefact interaction that describes the fitness of an artefact to the user and context that may play a moderating role in effectiveness of a design intervention in contributing to behaviour change. Based on an in-situ exploratory study with two conceptual artefacts we show that this appropriateness could help to investigate the long-term effectiveness of artefacts.

**Keywords:** design for behaviour change; product influence; effectiveness; experience;

## 1. Introduction

Many of the complex issues facing (Western) society these days, such as climate change and obesity, require major transitions to new social practices. Central in these transitions, next to changes in policy and regulations, is the development of artefacts that support new ways of interacting and doing—changes in behaviour. Interventions are generally well able to generate a positive effect in terms of changing behaviour, yet it seems to be much harder to maintain such a change durably (Abrahamse et al., 2005), as the effect of interventions seem to diminish over time (Kwasnicka et al., 2016) and users relapse into old habits and behaviour. Here we encounter terminology that is quite pervasive in the behavioural sciences when describing the relation between people and interventions: users of interventions are often said to *relapse* (Prochaska et al., 1992) to old behaviour, or show low *adherence* (Kelders et al., 2012), *retention* or *compliance* to the intervention. Although these concepts aim to describe the (in)effectiveness of the intervention in properly addressing characteristics of the user in light of the context of use—the tone and character of these



terms ultimately places emphasis on the individual and their (lack of) motivation and responsibility for (not) changing behaviour. However, there may be various other reasons than individual factors that explain for minimal effectiveness, such as narrow problem framing (Schmidt, 2020), neglecting broader social and contextual variables (Glanz & Bishop, 2010), and the influence of the artefact in its material self.

Various disciplinary perspectives, such as sociology (Akrich, 1992; Latour, 1992), philosophy (Verbeek, 2005; Verbeek, 2011) and history (Clarke, 2014), revealed the power of the artefact in social life. Designing this hidden influence of design can help to deliberately redirect our present-day actions in line with individual and collective long-term concerns (Tromp & Hekkert, 2017; Tromp & Hekkert, 2019). Thus not surprisingly given this power of artefacts, design for behaviour change has emerged as a new field of research and practice that aims to harness design's influence on behaviour in an intentional way (Khadilkar & Cash, 2020; Niedderer et al., 2017; Bay Brix Nielsen et al., 2021).

Behavioural design translates knowledge from the behavioural and social sciences (Niedderer et al., 2017), yet current research mostly focuses on translating this behavioural knowledge to mechanisms (Michie et al., 2011) and how we can support that process (Cash et al., 2017; Cash et al., 2020; Fogg, 2009; Tromp & Hekkert, 2019). Although we are talking about *design* for behaviour change, understanding how these theories can inform the specific embodiment of the intervention is an understudied area (Dombrowski et al., 2016). Our understanding of the relation between the formgiving of interventions and how it affects long-term intentional behavioural change is rather limited.

Hence, in this paper we adopt a user experiential view to discuss the role that artefacts and their materiality can play in effectively changing behaviour in the long run by introducing the notion of appropriateness—a quality of user-artefact interaction that describes the fitness of an artefact to the user and context. Thereby we extend the knowledge on product influence by developing a conceptual framework for proactively designing appropriate design interventions.

## 2. Conceptual framework

In this paper we focus on the durable change of habitual behaviour. Contrary to approaches where behaviour change is modelled as a stage-based process (such as Prochaska et al., 1992), we conceptualise behaviour change as the constant negotiation of an old versus a new behaviour. At any given point in time people have a range of behavioural options in a context, which is the result of a complex interaction between rational and impulsive processes (Strack & Deutsch, 2004). Kwasnicka and colleagues explain how each behaviour has behavioural potential, i.e. the likelihood that people will engage in that behaviour, which varies over time as influenced by individual and contextual factors. People are hypothesised to act on the behavioural option with the highest potential (Kwasnicka et al., 2016). It is argued that when behavioural changes are made small and integrated in daily-life where

these changes appear the most natural (i.e., ‘tiny habits’ as in Fogg, 2019), it would increase their behavioural potential.

Yet the artefact plays a role here as well. Since artefacts can *transform perception* by amplifying or reducing some aspects of reality, and *translate action* by inviting or inhibiting certain kinds of behaviour (Verbeek, 2005), they can affect behavioural potential.

### 2.1 Effectiveness and efficacy

The effectiveness of an artefact in changing behaviour is dependent on its ability to increase the behavioural potential of the desired behaviour across time and contexts of use. First, when discussing effectiveness, it is important to differentiate between the *efficacy* and the *effectiveness* of an intervention. Efficacy is a measure of the performance of the design to produce its intended effects in ideal settings, as opposed to the effectiveness which is the extent to which the design produces these effects under real world conditions (Courneya, 2010; Skivington et al., 2021). In regular user testing the situation is often ideal: people may be motivated to or obliged to use the intervention. This results mostly in insight into the efficacy and not in the eventual effectiveness of the intervention in the real world.

### 2.2 Appropriateness

The ability of an artefact to co-shape relations between people and their world is not an intrinsic property of the artefact itself, but is determined by the way people engage with them in a concrete context of use (Verbeek, 2005). Due to the *multistability* of things, the way people interpret and act upon a design may vary from person to person, place to place and time to time. According to Simon (1996) “fulfilment of purpose or adaptation to a goal involves a relation among three terms: the purpose or goal, the character of the artefact, and the environment in which the artefact performs”. This touches upon the artefact’s *fitness* or suitability to the context for which it is designed and used in.

Hence we argue that to understand the eventual effectiveness of a design to contribute to a durable change in behaviour we have to introduce the notion of appropriateness as the experiential variable that moderates the ability of an intervention to achieve the desired effect (see Figure 1).

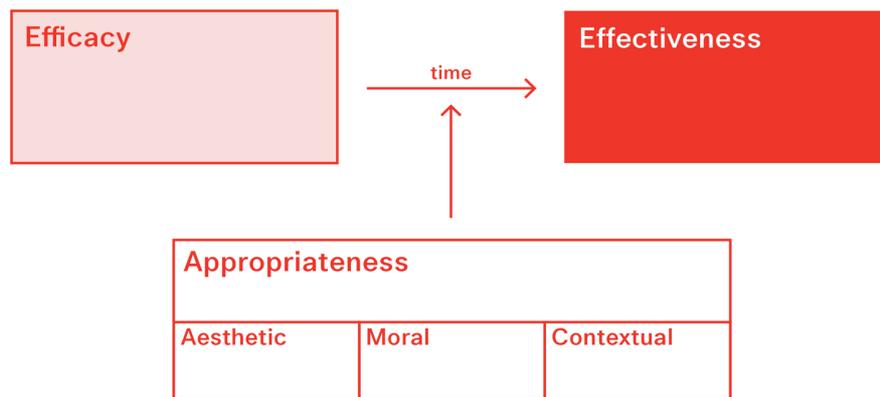


Figure 1. Conceptual framework that shows the moderating role of appropriateness in the eventual effectiveness of designs in changing behaviour

Here—in the context of design for behaviour change—we differentiate between three types of appropriateness, *aesthetic*, *moral* and *contextual* appropriateness. We will now briefly discuss these three types and illustrate them with an example.

### Aesthetic appropriateness

A first factor to consider when assessing the appropriateness of an intervention is its aesthetics. Aesthetics, coming from the Greek word *aesthesis*, involves the sensory perception and understanding of our world. Following this conception, aesthetics involves more than just the visual and material qualities of the artefact (Verbeek, 2005). Given the increase in number of smart and intelligent products, the term ‘aesthetic interaction’ is introduced to also refer to quality of the dynamics in giving form to the embodied, social and ethical dimensions of the relationship people have with products (Ross & Wensveen, 2010). Here the aesthetics of an artefact can produce instrumental value. Given the particular function of designs for behaviour change, a key principle is that artefacts are considered more beautiful if they bring about a maximum effect with minimal means (da Silva et al., 2016), as “we derive aesthetic pleasure from experiencing things that require little effort, yet allow us to push forward” (Berghman & Hekkert, 2017). Hence, aesthetic appropriateness refers to the quality of user-product interaction in bringing about aesthetic pleasure in supporting behaviour change.

To illustrate this aesthetic (in)appropriateness, we present the two interventions shown in Figure 2. Both have the same intention to reduce the number of displaced garbage bags, and do so by addressing the principle that people do not want to trash spaces that are neat and well-cared for. Yet in the embodiment of this principle, design choices are made which affect the appreciation of the design intervention. The left intervention places fake grass and hedges around the container, while the right one uses planters with real vegetation thereby associating the design with acting sustainably. The intervention with vegetation achieves the intended effect by also introducing preferable side-effects such as aiding in climate

adaptation, potentially boosting civic engagement and social cohesion—while the intervention with fake flowers introduces even more plastic into the situation.



*Figure 2. Intervention that aims to reduce displaced garbage bags by placing plastic grass and hedges around the container (left) or real vegetation (right) (source: interventions were encountered in the real-world, pictures by the authors)*

### **Moral appropriateness**

A distinguishing feature of artefacts in the context of behavioural design is that they can be seen as rhetoric devices, as “the designer, instead of simply making an object or thing, is actually creating a persuasive argument that comes to live whenever a user considers or uses a product as means to come to an end” (Buchanan, 1985; Buchanan, 2001). Products can afford certain courses of action through their form (Gibson, 1979; Norman, 1988). In how such influence is experienced, salience (how explicit is the intervention in promoting behaviour?) and force (how free are people to act differently?) are put forward as important dimensions (Tromp et al., 2011). These dimensions of the experience of influence are the ones that we deem crucial to understand the moral appropriateness of behavioural designs, as it revolves around the key concern whether people feel autonomous in their actions. We argue that moral appropriateness moderates effectiveness, since explicit and restricting behavioural interventions may be experienced as paternalistic, and may even cause reactance (Brehm, 1966).

To illustrate moral (in)appropriateness we take the concept of ‘shared space’ for the design of road layouts (Figure 3). Where traditionally the design of roads and crossings relies on elements that limit freedom, in a ‘shared space’ design most traffic fixtures, barriers, signs and markings are removed to create an open public space where pedestrians, cyclists and cars can freely interact. The rationale behind this is that by providing more freedom the traffic situation will be more unclear and unpredictable. This ‘unsafe’ situation will lead to more alert and careful traffic behaviour. Here, design choices such as using clinker bricks instead of asphalt or the placement of benches reinforce social norms of what is (un)acceptable traffic behaviour.



Figure 3. ‘Shared space’ design of a road crossing where there is no clear demarcation between areas for pedestrians, cyclists and cars—as well as no signs and traffic lights, thereby tapping into road users own responsibility to look out for others (source: Fietsberaad, CC BY-ND 2.0)

### Contextual appropriateness

A design intervention is not introduced into a vacuum, but instead in an existing system of other elements. In the words of Buchanan (2019) we must recognise that:

“a system is an organic whole, a functioning relationship of elements that seeks to fulfil particular needs and aspirations, and it is apparent that the forms and wholes around us are nested in a larger and larger wholes that must be understood for design to be successful.” (p. 97)

In other words, we need to consider the fit between the ‘subsystem’ of the design and its relation to the greater whole in order for the design to be appropriate on a contextual level and able to resist any contextual influences.

As the intervention is introduced in the system world at large it interacts with elements as inserted by ‘others’. These contextual influences can be (relatively) perpetual or transient. Perpetual contextual influences affect the effectiveness structurally. For instance, Western et al. (2021) show for digital interventions aimed at making people more active that those interventions can be efficacious for people with a high socioeconomic status (SES) whereas for people with a low SES there is minimal effect. One of their suggestions that could explain this phenomenon is that people with a high SES may have more opportunities to act on intervention feedback due to more free time, priorities, resources and supportive social and physical environments. In other words, for people with high SES the intervention is more context appropriate. Contextual influences can also be of a transient nature, depending on the specific space and time. In daily life various social practices, both within and between people, intersect and interact with each other, where in certain cases (in)compatibilities between these practices influence the acceptance of artefacts used in that practice (Uhde & Hassenzahl, 2021).

To illustrate contextual (in)appropriateness we turn to Welding Works (Figure 4), a welding course for young people who dropped out of school in disadvantaged neighbourhoods. Instead of just offering them an education in welding, the programme is designed in such a way that it takes the specific context of these young people and their neighbourhood into account. For example, the course teaches these youngsters to design, construct and weld fences to be used in reconstruction areas in their neighbourhood. By providing additional functions such as a place to sit or play football during construction work, these fences aim to engage people with the construction and thereby an increased acceptance of change. Additionally, the process taps into street culture by letting the maker ‘tag’ the fence before placement—fostering ‘ownership’ which could stimulate relatives to visit the fence to admire the result.

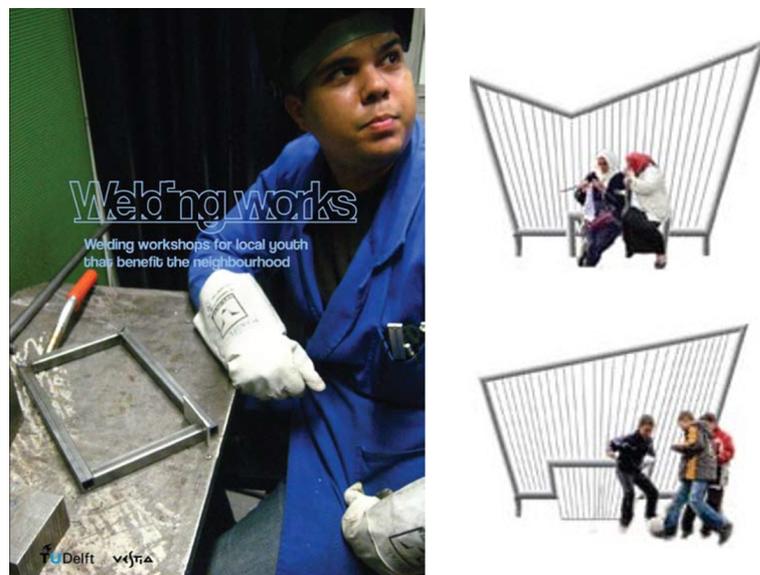


Figure 4. *Welding works, a course for disadvantaged youth where they weld construction fences that provide sub-functions which benefit the neighbourhood, in turn engaging with the construction and decreasing resistance to change in ‘social identity’ of the neighbourhood (source: Inga Villerius)*

### 2.3 Designing appropriate behavioural interventions

In reality, aesthetic, moral and contextual appropriateness of course interact. For instance, we can imagine that interventions that are highly aesthetically appropriate and less morally and/or contextual appropriate can still be effective. As such, our conceptualisation of appropriateness aims to lay a foundation for a more complex understanding of the experienced influence of behavioural designs. Importantly then, is how this conceptualisation of appropriateness can support the *formgiving* of behavioural designs to make them more effective. Tromp and Hekkert (2017) discern five variables that affect how product influence is experienced: the *origin of influence* (source of influence, reasons for influence), *mechanism of change* (strategy) and *manifestation of design* (medium, style). Although all five variables relate to appropriateness, our focus is on those variables that

change through formgiving. We see *formgiving* as the process in which designers manipulate the physical and/or digital properties, such as size, shape, texture, material, and colour. Together these form the artefact's *materiality*, the way the artefact is experienced through its material properties and conveys its functional, aesthetic and symbolic characteristics (Wiberg et al., 2013; Rozendaal et al., 2018). Hence, we argue that formgiving primarily affects the variables *medium* and *style* (see Figure 5).

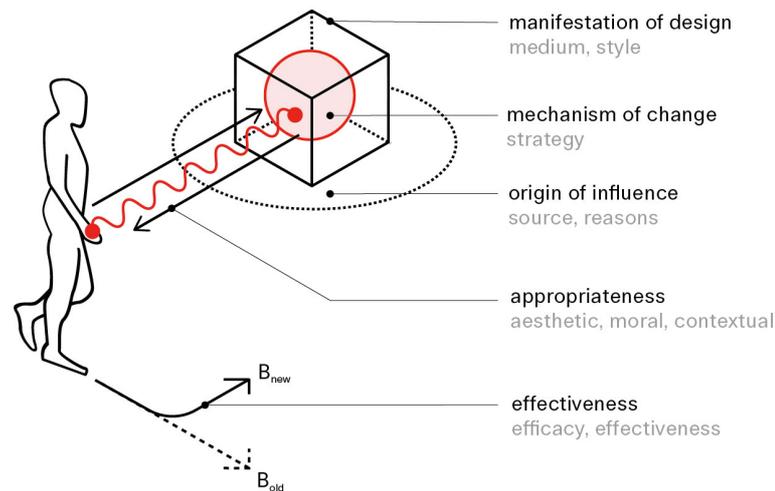


Figure 5. Through interacting with their manifestation interventions allow for the effective transmission of the active ingredients (mechanism) to target individual and contextual factors that lead to an increase in behavioural potential of the desired behaviour

### 3. Exploratory user study

To investigate the conceptual framework—the relationship between the formgiving of the behavioural intervention, its appropriateness, and its effect on behaviour—we adopted a research-through-design approach (Stappers & Giaccardi, 2017). We performed an exploratory and qualitative field study for which we developed two design interventions that stimulate people to take charge of their bedtime routines and improve sleep hygiene. We aimed to elicit insight into the role that the material form of behavioural interventions plays in changing routine behaviours by diverging in terms of their *medium* and *style* while keeping the *mechanism* the same.

#### 3.1 Context and design goal

To increase the potential demands that the context can have on interaction with the designed interventions we chose to conduct our explorations in rich, everyday environments with many intersecting practices, such as in this case the context of the home. We focus specifically on sleep behaviour, as there people often have various conflicting behavioural options (such as *go to bed on time* or *watch another episode of a TV series*). We aimed to design interventions that make people more aware of their sleeping behaviour—in order to increase the behavioural potential of going to bed as planned. We operationalised this

design goal as adopting *regular* and *consistent* sleep and wake times. Given this goal we selected a combination of a goal setting and self-commitment strategy as the mechanism.

### 3.2 Intervention design

The two design interventions (Figure 6) that embody this goal setting and self-commitment strategy are a bedside lamp and a chatbot (installed on a mobile phone). The artefacts were designed as objects that could be bought or downloaded by people who need help in enacting their intention to adopt better sleep routines. The design interventions are two variations of the same mechanism, where similar functionality such as setting the desired bedtime, receiving notifications once it is time to go to bed and helping people take some time to unwind before actually falling asleep are embodied in a different medium and style. We selected and designed these manifestations of design based on their hypothesised (in)appropriateness to the situation, for instance by using a phone as a medium to be used in the bedroom.



Figure 6. The two design interventions, an interactive bed lamp (left) and a chatbot (right), that aimed to harmonise sleep schedules by going to bed at a consistent time during the week

The first design is an interactive bedside lamp that uses self-dimming, gradual lighting and sounds to indicate sleep and wake times. The lamp is a portable cylinder shaped lamp (Figure 6, left) that because of its symmetric shape can be interacted with through several movements like shaking and turning (Figure 7). The lamp is battery powered so that it can be carried around the house, for instance as a night lamp when going to the toilet or to receive ambient bedtime notifications in the living room.

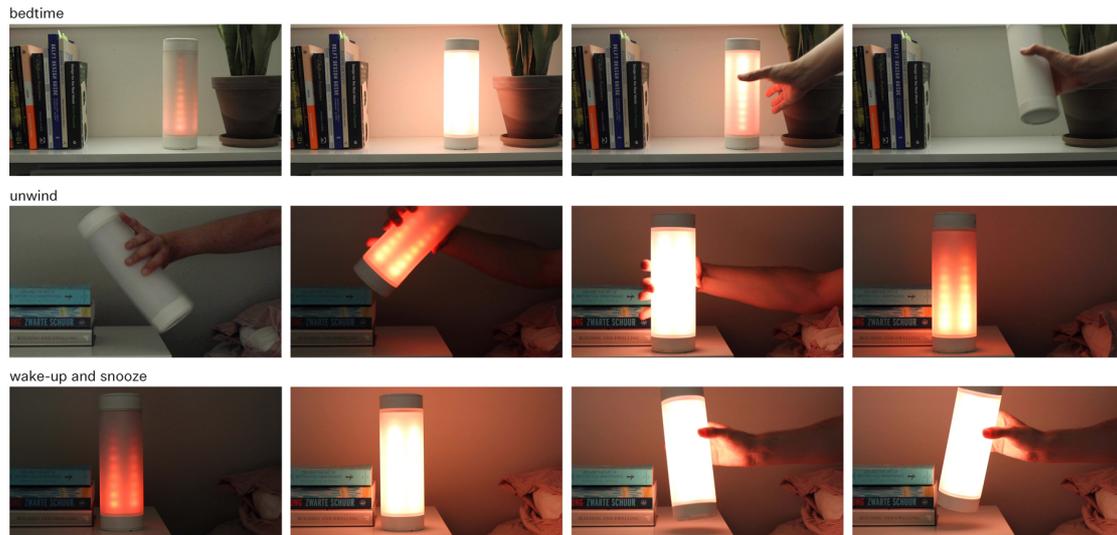


Figure 7. Stills from a video showing some of the light effects and movements, such as picking up (top), turning (middle) and shaking (bottom), for controlling the bed lamp. For the full video see <https://tinyurl.com/cyesx3jd>

The second design is a chatbot on your smartphone (Figure 6, right) with a conversational interface (see Figure 8). The chatbot uses notifications and messages to indicate sleep and wake times. The user interacts with the bot through messaging via predefined options in the chat app. The bot communicates in an overly positive, light-hearted and supportive way, using for instance emojis and GIFs, when to go to bed and to wish you good night. The bot sends notifications via the phone, and will follow-up repeatedly if there is no response.

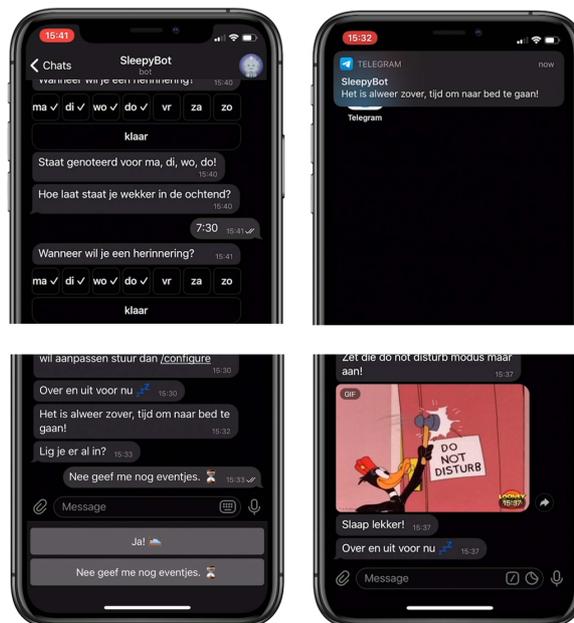


Figure 8. Selections of the user interface showing various interactions with the chatbot. For the full video see <https://tinyurl.com/h6tdts34>

### 3.3 Procedure, data collection and analysis

The two conceptual artefacts were evaluated in a three-week field study with two participants who each received one of the artefacts. Both participants were motivated to engage in the study since they experienced tension between wanting to sleep enough and engaging in various other activities, especially as the study was carried out during a work-from-home period.

A single-case reversal design was used in which participants serve as their own control. We did this to gain insight into the efficacy of the intervention and to contrast qualitative statements by participants with quantitative data (resulting from product-interaction and an embedded sensor system that was deployed for the entire study period, further detailed in van Arkel, 2020). In the second week participants received the prototype, which they lived with for a week. After seven days of use the prototype was retracted from their situation, and we performed semi-structured retrospective interviews to gain insight into how participants experienced the behavioural intervention using the same interview protocol for both designs. This interview protocol specifically questioned each individual type of appropriateness through questions such as “Did the prototype make you do things that you initially would not have done? How did that make you feel?” (eliciting responses on moral appropriateness). The interviews were transcribed to text and following the coding scheme in Table 1 coded on the occurrence of the respective elements in the statements by participants.

Table 1. Coding scheme operationalising the elements in the conceptual framework for analysing the semi-structured interviews

Code	Coding definition
Efficacy	<ul style="list-style-type: none"> <li>• Statements that give insight into the user’s perspective on changes in their behaviour</li> <li>• Statements related to the mechanism of the design intervention</li> <li>• Statements related to the use of the design intervention</li> </ul>
Aesthetic appropriateness	<ul style="list-style-type: none"> <li>• Statements that show an aesthetic appreciation of the artefact</li> <li>• Statements that relate the effect to the aesthetic qualities of the artefact (maximum effect with minimal means)</li> </ul>
Moral appropriateness	<ul style="list-style-type: none"> <li>• Statements that indicate friction between the user’s values and the influence as exerted by the artefact</li> </ul>
Contextual appropriateness	<ul style="list-style-type: none"> <li>• Statements that explain the fit between the artefact and the user’s daily life.</li> </ul>

- Statements that indicate how the artefact changed elements in the user's life.

### 3.4 Results

First, we used the data resulting from the embedded sensor system that logged bedtimes during the three week study period and plotted them in relation to the intended bedtime that participants had set as their goal (Figure 9).

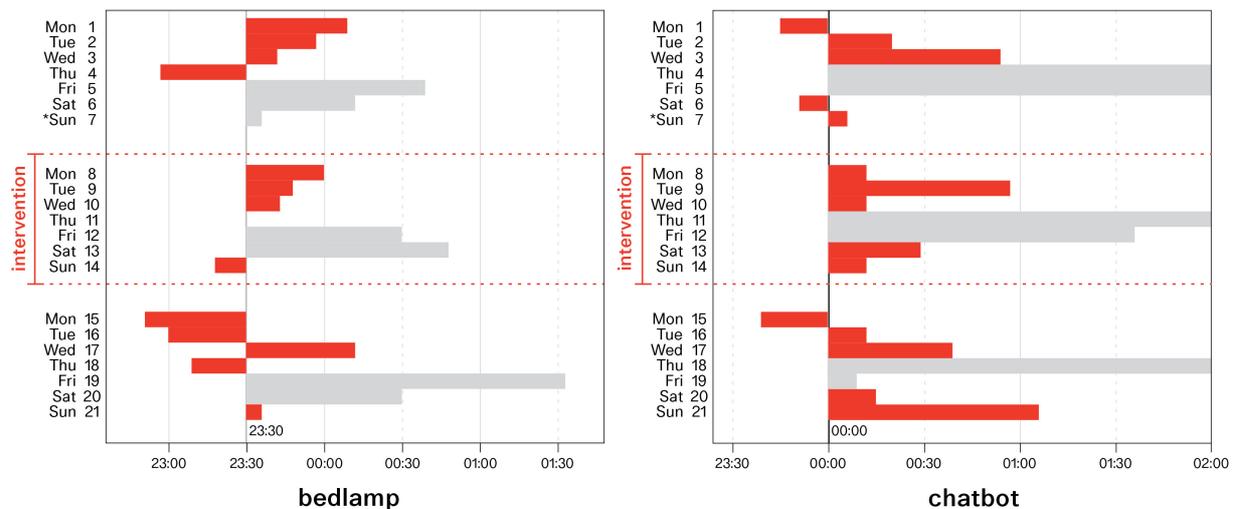


Figure 9. Graphs showing the deviation between estimated bedtimes and the intended bedtime (goal) excluding the weekend (gray bars, for the chatbot some are cut off for clarity)

Based on this quantitative data alone we gained some insight into the efficacy of the interventions, however, we did not gain any insight into the appropriateness of the interventions. Therefore we contrasted the quantitative data with qualitative data from the interviews. First, we approached the results from the interview in a quantitative way. Codes were aggregated to provide total counts of unique statements on the efficacy and each type of appropriateness, and whether they were positively or negatively directed. This resulted in the breakdown in Figure 10.

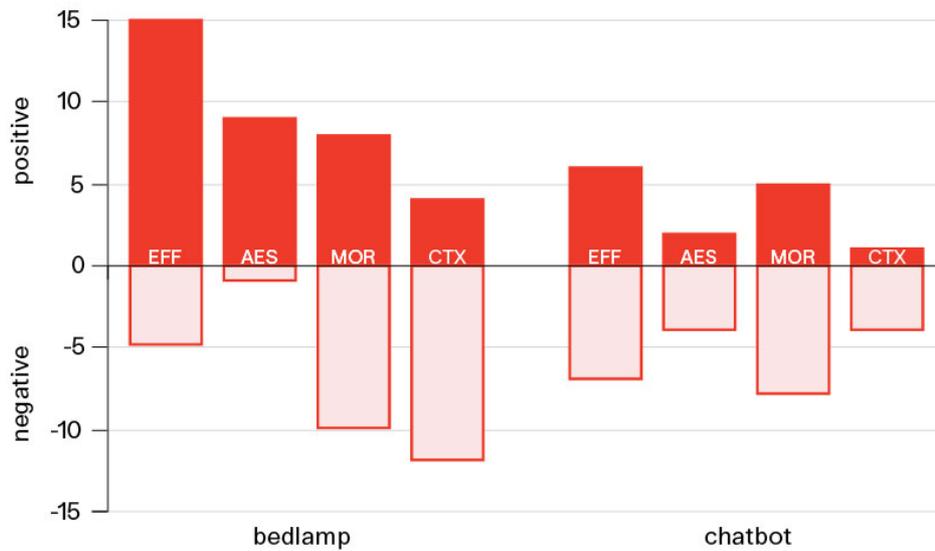


Figure 10. Breakdown of the codes in the interview that indicated efficacy (EFF), aesthetic (AES), moral (MOR) and contextual (CTX) appropriateness, showing the total number and whether they indicated a positive or negative experience of the efficacy or appropriateness

Even though there are inherent limitations to this visualisation of aggregated values, some things do become evident. First, we can see that participants are well able to verbalise their experience of the appropriateness of the intervention's influence and that all three types of appropriateness surfaced in the interview. In both interviews the total number of elements relating to aesthetic appropriateness is lower than for other types of appropriateness, suggesting that this may be harder to explain for participants. We often see that a single statement relates to multiple types of appropriateness, and that asking a question that aims to elicit responses on a particular type of appropriateness may also yield responses to other types.

Taking a closer qualitative look at the interview data reveals a much richer understanding of how specific design properties affected participants' experience of the intervention's influence. We will now briefly describe some of our findings from these interviews, and then reflect on those results.

### Bedside lamp

In general the participant using the bed lamp saw the value in being reminded of their bedtime as a trigger to go to bed. The lamp is quite open-ended in its behaviour, insinuating a course of action instead of prescribing it:

“It helps, but it is still hard to actually do it then. You feel that it is an extra... it helps to be reminded, but then you have to actively think about that it is time to go to bed.”

At the same time the fact that it triggers a moment of reflection actually is quite an effective means to get people to go to bed earlier in a way that does not feel patronising, reflecting moral appropriateness

“Of course it depended on what I was doing, if there were still five minutes left of an episode I would finish it, but if it was still an hour I would stop, otherwise it would be too late”

Yet some elements were considered morally inappropriate as well

“Yes I found that quite annoying as there were cases that I accidentally turned it around and then forgot that I cannot do anything for half an hour. (...) Like you know that that is the way that it is intended, you just want to be in control of that thing”

Some interactions with the lamp were clearly appreciated in an aesthetic way:

“What I really enjoyed was that you can turn it off by turning it (...) The way that it works is just really cool, that when you shake it, it gives a little bit of light and then when you turn it around it turns on. That you can easily use it, without buttons (...) I really like such a lamp, warm light. I love that it is a bit dark and then you have some light, I do think that is quite ‘cosy’”

In terms of its contextual appropriateness an important element that surfaced for the bed lamp is the fact that it has a physical presence, which means it only works when people carry it around and can see it properly:

“Yes, I set it at an early time on purpose, but then I was eating at a friend, so that combination that I set it to go off at 9:30 when I actually was at home at an hour of 10:00, then you are missing out.”

## **Chatbot**

In our testing the chatbot was unable to persuade the participant to go to bed in time. One of the main reasons why the bot did not work for this user was because the intervention was designed with a specific use in mind that did not reflect the context and practices of the participant, showing contextual inappropriateness:

“At least, I couldn’t always respond affirmative that I was already in bed (...) (chatbot) assumed that I do my relaxation in bed, so I always responded negative on the question whether I was already in bed”

Next to that the bot was experienced as morally inappropriate by the participant, as he did not enjoy the patronising feeling he got from the messages he received:

“For instance watching an episode or a movie on tv, and then you just want to finish watching it and it takes a bit longer. (Researcher) And then you received the next message? (Participant) Exactly.”

When the bot did not receive a response (a message sent by the user to confirm something) the bot would continue firing messages:

“The prototype was quite impatient in the sense that it very often asked things. It was quite pushy, and at a certain point time it just thought ‘forget it’, and then it stopped after asking a few times”

Apart from showing friction on a moral level this statement also shows a (negative) aesthetic appreciation of the tone of voice of the intervention. Next to that the messages of the bot were also interpreted differently as intended: when the bot said ‘good night’, the participant interpreted it as if the bot gave up.

### Reflection on the cases

Both interventions seem to have the effect that it reminds participants of their intention of going to bed on time, yet do not always support in turning that intention into action. We can see that both the *medium* and the *style* affected this. Using a physical object as a lamp requires the user to be close in order to notice the influence exerted. Selecting a phone as the medium has the upside of often being close to people so that they will likely not miss notifications. At the same time, smartphones connect to other practices such as browsing social media, which can afford to easy dismissal of those notifications instead of acting upon them, or result in the bot’s messages being experienced as intrusive during those other practices. Moreover, as both interventions are either an add-on to a practice (the chatbot) or add new actions to an existing practice (moving your night lamp around) without being a central part of the practice of sleeping, it can be quite easy to simply ignore them.

The way that influence is embodied in the specific style also impacts the eventual effect. Ambient notifications allow users to make their own decisions resulting in less moral friction, however, only imply a certain course of action which can be interpreted at the user’s leisure. At the same time text messages may seem specific and clear, yet can also be interpreted in different ways by users, for instance as supportive or patronising. Being able to set a single bedtime for the whole week may stimulate you to be more consistent, but can also trigger annoyance as you have to reset your bed and waketimes throughout the week when you have to adapt your bedtime for specific circumstances.

## 4. Discussion

In this paper we adopted a qualitative and exploratory approach to the evaluation of the framework by designing two behavioural design interventions that were evaluated in-situ with two participants. Here it is important to note that the goal of our field study was not to evaluate whether behaviour actually changed, or how effective the interventions were in achieving that, but to gain an understanding of the role that design properties have on the experienced appropriateness of behavioural intervention as a way to inquire into long term effectiveness.

In our explorations we showed that we are able to interview people about their experience of the influence, and that it provides results that allow us to put the efficacy data into perspective in relation to how it could develop in the future. However, as we combined quantitative time-series data with qualitative retrospective data in a relatively small study

period the results are rather limited. For instance, our evaluation of the appropriateness mostly relies on the retrospective interview data as opposed to the sensor data. Further research is needed to investigate whether different data collection strategies, such as experience sampling, can provide better ‘in-the-moment’ understanding of appropriateness and the experience of influence.

In this study we did not systematically and empirically investigate the relations between the style, medium, efficacy, effectiveness and appropriateness, hence we cannot make claims on the validity of our framework as that would require more rigorous empirical validation. We see our explorations and framework as an initial step towards the formulation of a design theory of product influence which should be further refined through formal theory building and testing cycles (Cash, 2018).

Next to that we acknowledge that to understand whether the intervention can bring about durable behaviour change requires bringing in more complexity—going beyond studying single user-artefact relations—as multiple interventions are likely to be required to even render a change in behaviour. And next to contextual influences on the interaction, when viewing interventions as events in systems (Hawe et al., 2009; Maier & Cash, 2022) introduction and use can lead to various emergent and feedback effects in the wider system. Here, inquiring into the appropriateness of interventions may be a way to probe this complexity. It allows to highlight specific elements where the experience of influence is critical and needs to be addressed, and gives insight into the conditions under which an intervention can or cannot fulfil its purpose—thereby acknowledging that there are no one-size-fits-all solutions and identifying opportunities for other interventions.

At the same time, from the results of our explorations we can already see some value of the framework in its current state. The framework can help in making more deliberate choices when it comes to the formgiving of behavioural design interventions, for instance in selecting the most appropriate medium or in shaping specific design properties that inform the style. Furthermore, we can apply the framework in the design and evaluation iterations of behavioural design interventions to improve their functioning; thereby building evidence in a relatively cost-effective and low-effort way for the long-term effectiveness of these interventions.

## 5. Conclusion

In this paper we focused on the role of artefacts and their materiality in contributing to durable behaviour change. Instead of framing the relation between artefacts and people in terms of *adherence*, *retention* or *compliance*, we conceptualise it as a reciprocal relationship where artefacts need to exhibit a certain *fitness* to their user and context as well. For this we introduce the notion of appropriateness as a concept to bring in the experience of influence in ways that could help to investigate the long-term effectiveness of things in changing behaviour.

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