Advancing Digital Behavior Change Interventions by Exploring a Calendar-Based Suggestion System

Ida Damen*
Roy van den Heuvel*
a.a.j.m.damen@tue.nl
r.v.d.heuvel@tue.nl
Eindhoven University of Technology
Eindhoven, The Netherlands

Rens Brankaert
Eindhoven University of Technology
Eindhoven, The Netherlands
r.g.a.brankaert@tue.nl

Steven Vos
Eindhoven University of Technology
Eindhoven, The Netherlands
s.vos@tue.nl

ABSTRACT

Digital Behavior Change Interventions (DBCI) have a pivotal role in reducing lifestyle-related illness, absenteeism, and healthcare costs. Current challenges in designing DBCI are appropriately tailoring interventions and finding new forms of delivery. In this exploratory work, we present the design and evaluation of Tweak, a cloud-based health promotion system that integrates tailored and context-aware health suggestions into the users digital work calendar. Two four-week field studies (N=21) showed how Tweak adapted to changing user profiles and used personal and contextual data to situate suggestions. User insights showed that integration into the calendar stimulated reflective behavior and curiosity and was perceived as easy to use. However, due to differences in calendar use, suggestions could be overlooked. We conclude by discussing implications on how integrated delivery mechanisms can aid the development of future workplace DBCI.

CCS CONCEPTS

• **Human-centered computing** → **Field studies**; **Interactive systems and tools**; *User centered design*; • **General and reference** → *Design.*

KEYWORDS

Office workers, Workplace, Health-Promotion, Context-aware, Field study, Calendar

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*Both authors contributed equally to this research.

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1 INTRODUCTION

The last two decades have seen a growing trend towards health promotion at work [13]. Occupational health promotion has a profound effect on workers' health and well-being, resulting in reduced absenteeism, impaired work performance and lower health care costs [9]. Digital interventions to support healthy behavior, often referred to as Digital Behavior Change Interventions (DBCIs), employ digital technologies such as mobile application technology and sensors to achieve this goal [26]. DBCIs can promote healthy behaviors of office workers in a cost-effective, scalable and personalized way and have therefore attracted growing interest from health promotion practice and research over recent years.

Our understanding of effective design and deployment of DBCIs in context is still limited [17]. As mentioned by Michie et al. (2017), 'we are still mainly in the age of promise rather than delivery'. New experimental designs can advance the potential of DBCIs, for instance by utilizing rich data streams of multiple health factors [17]. Health factors such as physical activity, nutrition and relaxation, combined with contextual factors like the weather and work schedule can be used to tailor interventions to personal preferences and design new strategies to deliver information to users in a more appropriate way. To advance DBCIs, Yardley et al. [26] defined four priority topics based on expert consensus: 1) improvement of effective engagement, 2) enhance methods of analysis for DBCI, 3) tailor interventions for personal and contextual needs, and 4) investigate implementation of DBCIs with new forms of intervention delivery. In this study we focus on the latter two of these priority topics.

Inappropriate timing or interrupting work for health benefits can lead to frustration, people ignoring the intervention or loss of interest in the intervention all together [27]. To improve the timing of interventions it is important to provide more control and autonomy over the interventions [16, 24]. At the same time, providing too much control over an intervention might require too much cognitive load and will limit its use as well [10]. Therefore, timing, control and convenience need to be balanced in the design of DBCIs. Examples of current solutions and strategies can be found in the work of Züger et al. [27] and Park et al. [19]. Their work shows that using natural breaks and computer usage to estimate the timing of an intervention improves the appropriateness of the intervention.

Although current examples of tailored interventions hold great promise, a common strategy of these digital health promotion interventions is to make use of a single parameter, like prolonged sitting [4]. This could lead to a mismatch in individual experiences or

expectations and the intentions of an intervention [3]. To deal with the complexity and the great number of variables that influence health (e.g. relaxation, nutrition, physical activity) and to do justice to individual differences, a multi-component approach to health in DBCIs is needed [21].

To explore new tailoring and delivery strategies with a multi-component approach to health, we developed a calendar-based health promotion system called 'Tweak' (Figure 1). The work calendar is used as a data source for the system as well as a non-intrusive means of delivery. The health suggestions are tailored to personal and contextual factors that change over time. A personal health profile is created on the basis of seven factors that include subjective data such as perceived need for relaxation and sensor-based health data such as step count. The contextual data is based on calendar data and weather information. By combining these data sources, Tweak selects a health suggestion from a predefined list that is most suited to the health profile and contextual data, and seeks a convenient time slot for this suggestion in the workers digital calendar. For example, if a user finds physical activity important, their step count is low, and the weather conditions are good, Tweak schedules an outdoor walking meeting suggestion.

In this study we aim to expand the body of knowledge on the design and implementation of DBCIs by exploring new forms of delivery and ways of adapting to changing user needs. Our contribution is twofold. First, we present a novel design: Tweak, as an example of how to use the calendar as a means of delivery for tailored health suggestions. Second, we implement and evaluate Tweak to understand how to use personal data, contextual data and the existing work calendar to tailor health suggestions to the work schedule and personal health differences. We discuss design considerations for the development of DBCIs for health to improve engagement and integration in daily work practice.

2 INTERVENTION DESIGN

In the development of Tweak as an occupational health-promotion tool, a multidisciplinary group of designers, health professionals, developers and potential users worked collaboratively on the design of Tweak. After several work sessions, this group formulated the following design requirements for the intervention design; 1) The design should conveniently time interventions fitting to the users work routine, 2) the design should have a multi-component approach to health and 3) the design should be adaptive to individual variation and changes over time.

2.1 Tweak design concept

Tweak is a health promotion tool that delivers one 'healthy behavior' suggestion a day as an *event* in the Outlook calendar of an office worker (Figure 1). The calendar serves as the output modality (i.e. daily suggestion) as well as an input modality (i.e. for contextual data). As a calendar provides a representation of a workers' schedule and their routines, it can offer rich contextual data [11, 20]. This contextual data, like the amount of meetings in a day, is important for the timing and personalizing of an intervention. However, in most interventions obtaining this type of data requires time and effort of the user [14]. By automatically taking existing appointments and blocked time slots into account, Tweak aims to limit this additional effort and maximise convenient timing of suggestions.

In 2016, Huang et al. [11] studied the role of integrating visualizations of quantitative health data into a calendar. Their research shows that the effort to gather and integrate data should be minimized for the user. An important self-declared limitation in their study was the fact that they built their own calendar instead of using an existing calendar system. An example of an integrated health suggestion system is Google Goals [7], a planning feature using Google Calendar. It allows for setting personal health goals, and finding the right time to schedule these events. It does not, however, allow for more exploratory behavior in trying out new healthy habits nor use a multi-component approach to health.

In line with the Do Something Different approach [6], Tweak aims to the let users explore new healthy habits during their workday. To provide users with a diversity of suggestions, Tweak offers one short and actionable suggestion every day, selected by the system from the suggestion database. This database is comprised of 46 suggestions (Table 1) and is based on expert consultation with health professionals. Following the work of [8, 21], Tweak aims to tailor the selection and delivery of these suggestions through the use of various data inputs. This data stream is comprised of a combination of sensor-based and subjective data and uses four different data sources, namely 1) survey data, 2) activity tracker data, 3) weather data and 4) Outlook calendar data.

The subjective data sources consist of two online surveys conducted during the onboarding of participants and a weekly automated short survey to collect user preferences. The two online onboarding surveys gathered information on seven health parameters; energy, motivation, resilience, physical activity, sedentary behavior, nutrition and relaxation. These parameters are based on a delphi study on vitality by Strijk et al. [23] and the work of Proper et al. [22]. The automatically generated weekly survey, collected preferences on usage, relevance of the suggestions and whether users wanted to receive similar suggestions. For the sensor-based data, a wearable fitness tracking sensor (Fitbit) was used to measure physical activity and sedentary behavior. The user health profiles were adjusted daily, by combining the weekly survey data and the continuous sensor-based data.

2.2 Technical realization

Tweak is created as a cloud-based data collection and processing system that gathers data from the following connected services: Fitbit (physical activity (PA)/ sedentary behavior (SB)), Jotform (Survey), and Cronofy (Outlook). It also retrieves weather information from WeerOnline.nl. The collected data is stored and used as input values for the component scores that inform the user profile. Tweak uses existing norms such as physical activity guidelines [25] to ascertain how well a user is doing and what type of suggestion is appropriate. The selection of the suggestion is based on the state of the user profile at the end of every day. Components with the highest scoring values will determine which type of suggestion is delivered to the user. For example, if a user has been sitting too much last week, there is a higher likelihood that the user will receive a physical activity related suggestion. In addition, the user profile

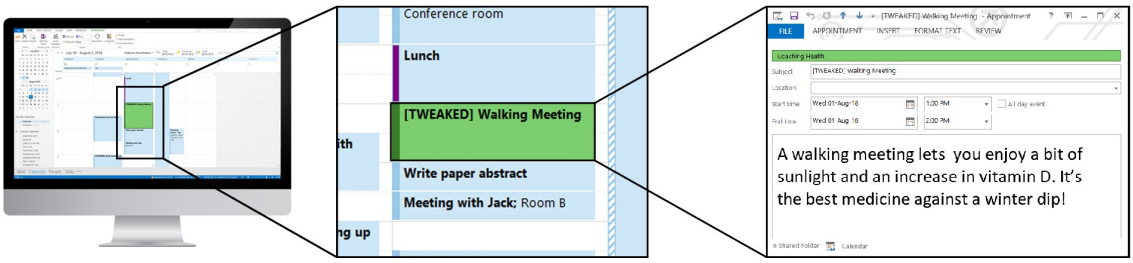

Figure 1: Implementation of a Tweak suggestion in the Microsoft Outlook calendar

values are adjusted weekly by means of a 5-minute weekly survey. This survey is generated based on the events that were pushed to the user that week, sent by email, and responses are logged in the database. By means of the Cronofy API a relevant health suggestion from the pre-defined suggestions database is pushed as an 'event' to the Microsoft Outlook calendar of the user. The selected health suggestion is placed into the user's calendar to fit their schedule and in line with specific suggestion time limitations, such as lunch suggestions between 11.00h and 13.00h. Like a normal calendar appointment, the Tweak-suggestion has a specific duration, title and body text (Table 1). The user can choose to execute, reschedule, or delete the event. Depending on the individual personal calendar settings, people will receive a reminder of the Tweak-suggestion before the event is scheduled. Additionally, if people have set up their work calendar on their mobile phone, they can receive a phone notification as well.

3 STUDY DESIGN

3.1 Participants

Two four-week field studies with a total of 21 participants were conducted in two different office settings in the Netherlands. The first study (A; N=9) was carried out at the university of the researchers, to ensure quick detection and correction of possible technical errors. The second study (B; N=12) was conducted at the office of a major construction company. The inclusion criteria were; (1) no more than six leave days during the study, (2) self-reported sedentary time equal or exceeding 75% of their working hours, (3) full-time employment and (4) willing and able to wear a Fitbit and use the Fitbit app. Staff from the department of the researchers in study A were excluded from participation. Study A consisted of project officers, PhD-researchers and professors. Participants in Study B were business developers, project managers and trainees.

3.2 Procedure

The study procedure was identical in both studies and consisted of 1) Introduction session and distribution of Fitbits, 2) use of Tweak system, and 3) semi-structured exit interviews. Two weeks prior to the use of Tweak, all participants received an instruction booklet detailing the study planning, technologies used and privacy policy including a consent form. Furthermore, all participants were asked to start wearing a Fitbit (Charge HR2) to reduce possible novelty effects.

The four week field tests started with 'on-boarding' to the Tweak system. On the Tweak website, participants were asked to log in, complete two digital surveys and authorize the Fitbit and Cronofy API connection. The surveys assessed a baseline health profile as input for the system. During this process the researchers were present for additional information and support. A short weekly phone call was made to all participants to check for any technical errors or questions. In addition, a weekly survey was submitted to ascertain the perceived relevance of the suggestions. This survey was automatically adjusted to the received suggestions and labels, and also fed back into the Tweak system to adjust the users profile. Feedback from the surveys and phone calls were collected.

After using Tweak for four weeks participants were subjected to a semi-structured exit interview. Then, all participants were asked to return to the website for 'off-boarding'. Here, users were guided to disconnect their Fitbit and calendar and all participants completed the same digital surveys as during 'on-boarding'. The results of these surveys were used to generate a personal overview for the participants. As compensation for the time and effort, participants were allowed to keep the Fitbit.

3.3 Data collection and Analysis

The data gathered in this study consisted of 1) the system usage data, 2) survey data, 3) field notes of the 5 minute phone calls and 4) audio recordings of the semi structured interviews. All data was anonymized, and no data was shared with third parties. The semi-structured interviews focused on the user experiences and engagement of Tweak. The interview started with the open question: 'How did you experience the use of Tweak?', after which several follow-up questions were asked concerning calendar use, timing, content of the suggestions, Fitbit use and improvement points. All interviews lasted between 35 and 60 minutes, were recorded and transcribed verbatim. The transcripts were coded and analyzed using MaxQDA Analytics Pro by thematic analysis using an inductive approach. First, two researchers used independent initial open coding to analyze a first interview, after which they formed consensus on the coding scheme. With this coding scheme, all other transcripts and feedback from the calls were coded. Quotes used in this paper were translated from their native language to English.

4 RESULTS

4.1 System Usage

Of the 24 initial participants, 21 participants (11 Male, 10 Female) completed the four-week field studies. In the first field study (A) (age M=33, SD=12.8), two participants dropped out due to technical errors and one due to medical reasons. Based on the lessons learned

Component	Header Text	Body Text	Timeslot	Duration
Physical Activity	Take the Stairs	Taking the stairs is a healthy and sporty activity. How many stairs can you take today? Set a realistic goal for yourself.	8.00-18.00	5-10 min.
Sedentary Behavior	Hours of Sedentary Behavior	Variety is good for a dynamic work routine. Try to use an exercise ball today.	8.00-10.00	30 min.
Energy	Map activities	What costs the most concentration? Make a top 5.	8.00-18.00	5-15 min.
Motivation	Do not disturb	Close your mailbox for a while to work without distraction.	8.00-16.00	15-60 min.
Resilience	New route	Occasionally breaking habits can help you manage stressful situations. Try taking a new route home today.	13.00-18.00	15-60 min.
Nutrition	Enough water	Fill a bottle of water.	8.00-10.00	15-60 min.
Relaxation	Muscle Tension	Flex all your muscles for 3 seconds and relax again	8.00-18.00	5 min.

Table 1: An overview of the components and one suggestion example per component

in the first study, small technical adjustments such as permission issues, were made to the Tweak system. All twelve participants of the second study (B) (age M=30, SD=8.1) completed the study.

A total of 295 suggestions were deployed during the study period, of which 108 suggestions were tried by the participants. Of the 119 deployed suggestions in the first study (A), 76 (63.9%) were considered relevant by the users and 39 (32.7%) were also executed. The second study (B) deployed 176 suggestions, of which 89 (50.6%) of the deployed suggestions were considered relevant and 69 (39.2%) were tried (Figure 2). It is important to note that suggestions were counted by their primary component, but can be labelled with multiple components. Therefore, users with a high relaxation score, could receive a motivational suggestion with relaxation as a secondary label. In general, from this data, we can see that suggestions to increase physical activity (with primary label) were sent out most, while suggestions on nutrition were deployed the least. By continuously integrating different subjective and sensor-based parameters, Tweak could accommodate to the differences in health profiles and the changes over time (Figure 3). As exemplified in figure 3, P11 received suggestions on physical activity and sedentary behavior at the start (high scores), which changed to more suggestions related to relaxation and resilience towards the second half of the study.

From the interviews it became clear that participants appreciated suggestions that they could follow-up easily. The actionability and the conciseness of the suggestions were considered essential. B11 illustrates this: *"It's the little things you're on the lookout for. The ones you can apply easily during your regular work"*(B11). Actionable suggestions were often seen as suggestions focused on increasing physical activity, such as *"Standing meetings can be a way to interrupt long-term sedentary work. Is this a meeting that you could have while standing?"*

Although users often made a distinction between actionable suggestions and informative suggestions, they did not directly link the suggestions to the different health components of the user profiles. A number of users did report that they noticed the type of suggestions that were deployed changed based on the weekly feedback they gave. One interviewee stated that: *"I finally personalized it [Tweak] in such a way that in the third week, I really got the actionable suggestions. However, in the fourth week, I only got the same suggestions and then I thought 'that's a shame, they should have placed new suggestions into it again'."* (A12)

4.2 Diversity evokes curiosity

A common view among participants was that the health suggestions in their calendar triggered their curiosity. The title of a suggestion served as a first trigger, and as a moment of choice for users to assess its usefulness and relevance. If a certain title evoked their curiosity, participants wanted to read on and check the full description on a detailed level given in the body text of the calendar suggestion. On the contrary, in some cases if a title of a suggestion was not appealing enough for participants, they were inclined to ignore the suggestion and not look at the details. Opinions differed among the participants, whether repetitions in the health suggestions should be avoided. Some of the participants felt that the actionable suggestions could be repeated over several sequential days. However, the majority of the participants did not appreciate repetitiveness in suggestions send to them. A common view was expressed by participant B7; *"You want to receive new things. If you get the same suggestion again after a week, you've already done it and you feel like you do not have to do it again."* In contrast to the participants of study A, the participants of the second study (B) worked together in the same building. This resulted in more comparative behavior in the latter group. One of the participants of the second group (B10) expressed that, especially at the start of the study, people would walk up to each other and discuss the suggestions they got. They would also compare the number of steps taken or sets of stairs climbed. This effect wore off over time, as it became 'normal' to receive suggestions.

4.3 Integration in the calendar is perceived as convenient, but can be overlooked

Most participants perceived the work calendar as an appropriate means to receive health promotion suggestions. The participants saw Tweak as a reminder for healthy behavior at work. As explained by one participant (B11): *"It [healthy behavior] is an important thing, which you often neglect, but through these suggestions, you are aware of it and can deal with it more easily at work"*. Placement of the suggestions in the calendar enabled users to look back and review them as an always-present reminder. As one user illustrates: *"You can also look back: oh yeah, what did I try yesterday? [..] Because it's integrated in your agenda you are constantly reminded of it, and you do not click it away so easily."* (B11). As another participant (B1) clarifies: *"I see the calendar as a kind of memory database, so it fits nicely with that."*. The ability in choosing if and when they could

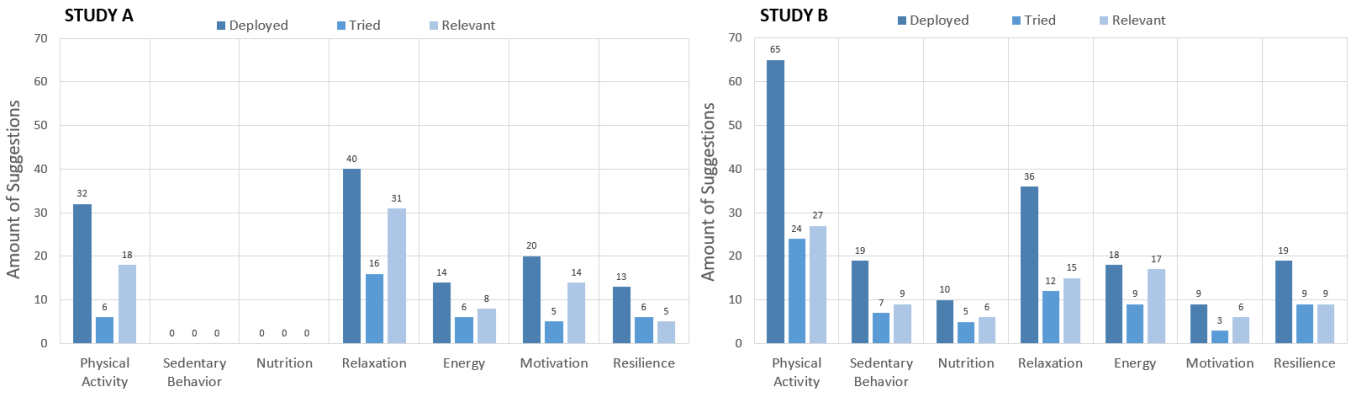

Figure 2: The number of suggestions that were deployed, tried and considered relevant at Location A and B.

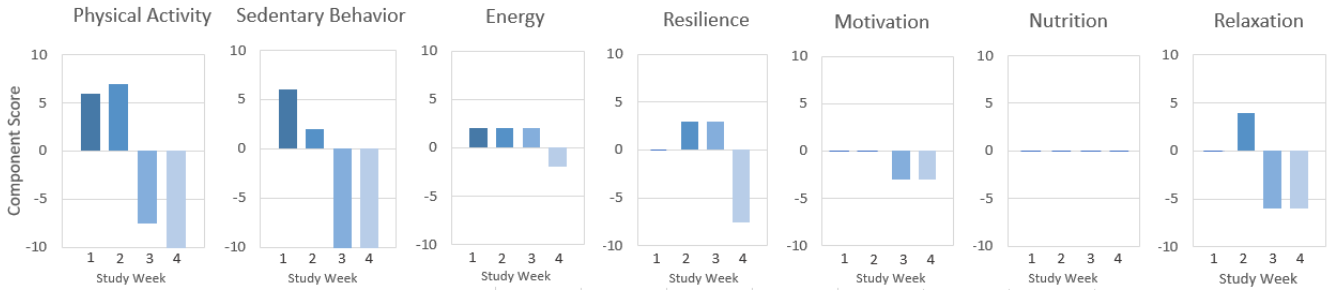

Figure 3: The component scores of P11 (Study B) show a distinctive user profile that changes over time

follow up on a suggestion was considered a key element in that respect, and contributed to a feeling of autonomy.

The use of the calendar also presented challenges. A recurring theme showed that some participants tended to overlook the suggestions. For some participants, this was due to the fact that health suggestions were not distinctive enough compared to regular calendar appointments. As one participant explained: *"Definitely when you have a full agenda, they [the suggestions] will quickly disappear into the background." (B12).* For a number of users, overlooking a suggestion was due to the fact that they did not make frequent or consistent use of their calendar. Especially participants from study A, who indicated to work very individually, had fewer interactions with their calendar, making it less suitable for daily health suggestions.

A number of users reported that their calendars were not always a completely accurate representation of the planning of that day. As one participant explains; *"Sometimes unexpected things happen in my planning that I don't put in my calendar."* (B3). Users therefore expressed that they were not able to execute the suggestion at that moment. While some users ignored the suggestion giving at an inopportune moment, others indicated that they rescheduled the suggestion; *"If it's a bit quieter, then you can say, I'll move it forwards or backwards" (B3). Other interviewees remarked that they took up the suggestion at another time, without rescheduling it.*

4.4 Reflection on planning and work schedule

In all cases, the interviewees reported that Tweak made them think about the applicability and relevance of the suggestions. According to the majority of the users the suggestions offered a moment of reflection. Some participants assessed the relevance of a suggestion in the moment and accepted or rejected it on the spot. For example, one participant received a suggestion to walk during a phone call. However, because the participant did not receive a phone call during the time slot in which the suggestion was placed, he did not deem the suggestion relevant. Others took up the suggestions as something they could try out at the moment it was suggested, but also translate it to different moments during their workday. For some, the suggestions served as a trigger to see how it could be extended to other actions or settings. As illustrated by (B12): *"The suggestion that you can walk up to someone instead of emailing was nice. I then thought 'how can i use that in other contexts?' On my phone.. I'll just turn off the notifications or put my phone away."* (B12).

Some interviewees argued that the daily and weekly questions were a good moment for reflection, while others felt these questions could become tedious. The people who liked the questions seemed to appreciate the informative suggestions better in comparison to the people who did not like the daily and weekly questions. Particularly revealing is how the use of Tweak resulted in reflection upon participants' personal planning and work routine. Commenting on the calendar integration, one of the interviewees remarked: *"The agenda is just a mirror of yourself, but it is not completely accurate.*

And that was immediately the biggest frustration I had. That is not so much a point for Tweak, because you cannot do anything about that, but more painful to yourself, so you are not yet as organized as you think you are, because your calendar is not quite accurate." (A12).

5 CONCLUSION AND DISCUSSION

In this study we present Tweak, a calendar-based health suggestion system. With the development and field evaluation of Tweak (N=21) we address two current challenges in existing Digital Behavior Change Interventions (DBCI) for health promotion; 1) using new forms of delivery for the implementation of DBCIs and 2) tailoring interventions to address individual and contextual needs. This explorative work shows that the creation of adaptive, multi-component user health profiles in DBCI can help to deliver tailored suggestions *(Design consideration 1)*. The digital calendar was perceived as convenient, evoked curiosity and stimulated reflection on one's own calendar and work schedule, and can therefore be used as an appropriate means for delivering health suggestions *(Design consideration 2)*. People use their digital calendars differently and this research reveals opportunities for individual focused interventions.

The suggestions were not always perceived as convenient and were sometimes overlooked, since the calendar is not always an accurate representation of a user's day. This is in line with the work of [15], who found that calendars often include a multitude of reminders and 'placeholders' events. In future studies, it might be interesting to iterate on suggestion-timing to fit the individual better, for instance by scheduling suggestions when the user opens their calendar. Furthermore, future work could also incorporate more complex information that is present in the calendar, such as the different types of meetings and their social nature *(Design consideration 3)*. To facilitate social engagement, the calendar could automatically change group-based calendar-events to more 'active' locations (e.g. walking meetings [5]). Furthermore, the outlook accept/decline functionality could provide an unobtrusive feedback mechanism to inform and improve tailoring.

A challenge that remains is balancing a multi-component approach to health in DBCI. Despite the importance of a multi-component approach in DBCIs [3, 21], there is little consensus which factors, or in what proportion, should steer these types of interventions [8]. In our study, several iterations were needed to balance the continuous Fitbit data stream with the survey data to create a fair distribution between these input sources for the user profiles. In line with Michie et al. [17], we argue that further work is needed on balancing different personal health variables over time in DBCIs *(Design consideration 4)*. As the necessary set of components and contextual factors may vary depending on the time and context in which the intervention is placed [8], other time dependent data-sources to increase personalization could therefore be explored. Furthermore, tailoring these interventions to better suit individual situations contributes to a more persuasive design [12].

Although the study focused on using new forms of delivery and tailoring health suggestions, we also reviewed the adherence rates. The proportion of suggestions executed by the users of Tweak was 32.7% (study 1) and 39.2% (study 2). This percentage is lower compared to prompting software such as Superbreak [18] (65.5%), Breaksense [1] (41.9%) and Time for Break [16] (40%). However, when comparing to approaches that focus on a more open-ended and explorative approach to increase healthy behavior, such as Do something Different (DSD) [2] (15-20%), the acceptance rate of Tweak is slightly higher. One reason for lower rates compared to the aforementioned prompting software could be the use of personally set goals. Interventions with a more open nature and a range of different suggestions such as Tweak, may require more behavior flexibility of its users [6]. This could lead to lower adherence rates to the suggestions *(Design consideration 5)*. Future studies could look more detailed at possible confounding factors related to the adherence and the effects on healthy behaviors over a longer period of time.

The complexities of social dynamics (e.g. due to the differences in work environment) that emerged from our field study with Tweak also warrant caution with regard to privacy and diversity *(Design consideration 6)*. First, health suggestions reflect a certain health state of the user, sharing suggestions with others opens up questions on privacy. This is especially true if calendars can be read by others. Second, people can have wildly different health profiles. While social engagement can be a powerful driver for healthy behavior at work, socially focused suggestions that use a particular component might not be suitable for everyone. These issues require further investigation in the design of DBCIs.

With Tweak, we showed how integrated delivery mechanisms such as the digital calendar can be leveraged to tailor health interventions for personal and contextual needs and offer a new perspective on DBCIs. Based on two four-week field studies, we derived the six aforementioned design considerations for future designers and researchers of DCBI to consider.

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REFERENCES

[1] Scott A. Cambo, Daniel Avrahami, and Matthew L. Lee. 2017. BreakSense: Combining Physiological and Location Sensing to Promote Mobility during Work-Breaks. In *CHI '17 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 3595–3607. https://doi.org/10.1145/3025453.3026021

[2] N. Charlton, J. Kingston, M. Petridis, and B.C. Fletcher. 2017. Using Data Mining to Refine Digital Behaviour Change Interventions. In *Proceedings of the 2017 International Conference on Digital Health - DH '17*. 90–98. https://doi.org/10.1145/3079452.3079468

[3] C. Chung, N. Jensen, I. A. Shklovski, and S. Munson. 2017. Finding the Right Fit. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*. 4875–4886. https://doi.org/10.1145/3025453.3025510

[4] A.A.J.M Damen, J.G. Brombacher, C. Lallemand, R.G.A. Brankaert, A.C. Brombacher, P.J.V. van Wesemael, and S. Vos. 2020. A Scoping Review of Digital Tools to Reduce Sedentary Behavior or Increase Physical Activity in Knowledge Workers. *International Journal of Environmental Research and Public Health* 17, 2 (1 2020), 499. https://doi.org/10.3390/ijerph17020499

[5] A.A.J.M. Damen, C. Lallemand, R.G.A. Brankaert, A.C. Brombacher, P.J.V. van Wesemael, and S. Vos. 2020. Understanding Walking Meetings: Drivers and Barriers. In *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/3313831.3376141

[6] Ben (C) Fletcher, Jill Hanson, Nadine Page, and Karen Pine. 2011. FIT – Do Something Different. *Swiss Journal of Psychology* 70, 1 (1 2011), 25–34. https://doi.org/10.1024/1421-0185/a000035

[7] Google. 2016. Google Goals. https://www.blog.google/products/calendar/find-time-goals-google-calendar/

[8] E. B. Hekler, S. Michie, M. Pavel, D.E. Rivera, L.M. Collins, H.B. Jimison, C. Garnett, S. Parral, and D. Spruijt-Metz. 2016. Advancing Models and Theories for Digital

Behavior Change Interventions. *American Journal of Preventive Medicine* 51, 5 (2016), 825–832. https://doi.org/10.1016/j.amepre.2016.06.013

[9] Ingrid J.M. Hendriksen, Mirjam Snoijer, Brenda P.H. de Kok, Jeroen van Vilsteren, and Hedwig Hofstetter. 2016. Effectiveness of a Multilevel Workplace Health Promotion Program on Vitality, Health, and Work-Related Outcomes. *Journal of Occupational and Environmental Medicine* 58, 6 (6 2016), 575–583. https://doi.org/10.1097/JOM.0000000000000747

[10] K. Höök. 2000. Steps to take before intelligent user interfaces become real. *Interacting with Computers* 12, 4 (2000), 409–426. https://doi.org/10.1016/S0953-5438(99)00006-5

[11] Dandan Huang, Melanie Tory, and Lyn Bartram. 2016. A Field Study of On-Calendar Visualizations. In *Proceedings of Graphics Interface 2016*. 13–20. https://doi.org/10.20380/GI2016.03

[12] Maurits Kaptein, Panos Markopoulos, Boris de Ruyter, and Emile Aarts. 2015. Personalizing persuasive technologies: Explicit and implicit personalization using persuasion profiles. *International Journal of Human-Computer Studies* 77 (5 2015), 38–51. https://doi.org/10.1016/J.IJHCS.2015.01.004

[13] P. Klasnja, S. Consolvo, and W. Pratt. 2011. How to evaluate technologies for health behavior change in HCI research. In *CHI '11 Proceedings of the SIGCGI Conference on Human Factors in Computing Systems*. 3063. https://doi.org/10.1145/1978942.1979396

[14] B.Y. Laing, C. M. Mangione, C. Tseng, M. Leng, E. Vaisberg, M. Mahida, M. Bholat, Eve Glazier, D. E. Morisky, and D. S. Bell. 2014. Effectiveness of a Smartphone Application for Weight Loss Compared With Usual Care in Overweight Primary Care Patients. *Annals of Internal Medicine* 161, 10_Supplement (11 2014). https://doi.org/10.7326/M13-3005

[15] Tom Lovett, Eamonn O'Neill, James Irwin, and David Pollington. 2010. The calendar as a sensor: Analysis and improvement using data fusion with social networks and location. In *UbiComp'10 - Proceedings of the 2010 ACM Conference on Ubiquitous Computing*. 3–12. https://doi.org/10.1145/1864349.1864352

[16] Y. Luo, B. Lee, D. Yvette Wohn, A. L. Rebar, D. E. Conroy, and E. Kyoung Choe. 2018. Time for Break: Understanding Information Workers' Sedentary Behavior Through a Break Prompting System. In *CHI '18 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 1–14. https://doi.org/10.1145/3173574.3173701

[17] S. Michie, L. Yardley, R. West, K. Patrick, and F. Greaves. 2017. Developing and Evaluating Digital Interventions to Promote Behavior Change in Health and Health Care: Recommendations Resulting From an International Workshop. *Journal of medical Internet research* 19, 6 (2017), e232. https://doi.org/10.2196/jmir.7126

[18] D. Morris, A.J. B. Brush, and B. R. Meyers. 2008. SuperBreak: Using Interactivity to Enhance Ergonomic Typing Breaks. In *CHI '08 Proceeding of the SIGCHI conference on Human Factors in Computing Systems* -. 1817. https://doi.org/10.1145/1357054.1357337

[19] C. Park, J. Lim, J. Kim, S.-J. Lee, and D. Lee. 2017. "Don't bother me. I'm socializing!": A breakpoint-based Smartphone notification system. *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW* (2017), 541–554. https://doi.org/10.1145/2998181.2998189

[20] G. Paruthi, S. Raj, N. Colabianchi, P. Klasnja, and M. W. Newman. 2018. Finding the Sweet Spot(s). *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 2, 1 (3 2018), 1–17. https://doi.org/10.1145/3191761

[21] Kevin Patrick, Eric B. Hekler, Deborah Estrin, David C. Mohr, Heleen Riper, David Crane, Job Godino, and William T. Riley. 2016. The Pace of Technologic Change: Implications for Digital Health Behavior Intervention Research. *American Journal of Preventive Medicine* 51, 5 (11 2016), 816–824. https://doi.org/10.1016/J.AMEPRE.2016.05.001

[22] K.I. Proper, I. Bakker, K. van Overbeek, B. Bergstra, M.W. Verheijden, M. Hopman-Rock, and W. van Mechelen. 2005. *Naar een gericht BRAVO-beleid door bedrijfsartsen.* Technical Report April. TNO-VUmc. 1–129 pages.

[23] J.E. Strijk, G.C.W. Wendel-Vos, H.S.J. Picavet, H. Hofstetter, and V.H. Hildebrandt. 2015. Wat is vitaliteit en hoe is het te meten? Kerndimensies van vitaliteit en de Nederlandse Vitaliteitsmeter. *Tijdschrift voor gezondheidswetenschappen* 93, 1 (2015), 32–40. https://doi.org/10.1007/s12508-015-0013-y

[24] S. Van Dantzig, G. Geleijnse, and A. Van Halteren. 2013. Toward a persuasive mobile application to reduce sedentary behavior. *Personal and Ubiquitous Computing* 17, 6 (2013), 1237–1246. https://doi.org/10.1007/s00779-012-0588-0

[25] WHO. [n.d.]. World Health Organisation. https://www.who.int/dietphysicalactivity/global-PA-recs-2010.pdf

[26] L. Yardley, B. J. Spring, H. Riper, L. G. Morrison, D. H. Crane, K. Curtis, G. C. Merchant, F. Naughton, and A. Blandford. 2016. Understanding and Promoting Effective Engagement With Digital Behavior Change Interventions. *American Journal of Preventive Medicine* 51, 5 (2016), 833–842. https://doi.org/10.1016/j.amepre.2016.06.015

[27] M. Züger, W. Snipes, C. Corley, A. N. Meyer, B. Li, T. Fritz, D. Shepherd, V. Augustine, P. Francis, and N. Kraft. 2017. Reducing Interruptions at Work. In *CHI '17 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* -. 61–72. https://doi.org/10.1145/3025453.3025662