https://doi.org/10.2352/ISSN.2470-1173.2018.01.VDA-332

FitViz-Ad: A Non-Intrusive Reminder to Encourage Non-Sedentary Behaviour

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Abstract

Advancement in wearable devices has allowed users to easily capture and monitor their physical activity data. There is a growing interest in using the data captured by these devices for self-management of chronic diseases. People with chronic conditions are encouraged by their clinicians to maintain a non-sedentary lifestyle. However, people tend to be forgetful when it comes to non-sedentary behaviours [26, 41]. We have developed "FitViz-Ad", a non-intrusive reminder to encourage people with Rheumatoid Arthritis to maintain a non-sedentary lifestyle. We conducted a study with fourteen healthy individuals to evaluate the feasibility of FitViz-Ad. We did not find any significant increase in participants' non-sedentary behaviour. However, the findings suggest design implications for developing reminders which encourage non-sedentary behaviour and accommodate different lifestyles.

Introduction

In recent years, we have seen a surge in popularity of wearable devices worldwide ranging from wristbands to fitness monitors [52]. With several large technology companies such as Apple, Google and Samsung taking interest in reaching out to consumers with wearable devices [36], it may suggest that wearable devices usage and popularity will keep on growing. Smartwatches and fitness monitor devices are expected to increase in sales from 51.39 million units in 2015 to 91.79 million units in 2017 [52]. Having said that, wearable devices in the market today are generally designed for people with no physical restrictions. For instance, Fitbit and Jawbone UP recommend their users to take 10,000 steps based on recommendations from the National Sleep Foundation and the World Health Organization [10, 14, 21]. This recommended daily step count can be intimidating and may not be a realistic target for people with rheumatoid arthritis (RA) [49].

Moreover, using step count as a way to quantify physical activity might not be appropriate for people with RA because step count only measures the number of steps the user has taken with no regards toward the timespan in which it took to complete those steps. For example, achieving 8,000 steps in only 2 hours is not recommended for people who have not been physically active as doing too much physical activity too rapidly can be counterproductive and can lead to injury [44]. Thus, there is a need for an alternative unit to quantify physical activity for people with RA, one that can encourage an appropriate amount of physical activity in an appropriate amount of time. Also, with evidence suggesting that people tend to be forgetful when it comes to physical activity, it shows that people with RA are in need of tools that can remind them when they should be physically active.

Rheumatoid arthritis (RA) is a type of arthritis that causes swelling and pain in and around the joints through inflammation. RA is also called a systematic disease due to its effect on body systems including the cardiovascular or respiratory systems [1]. With the pain and discomfort caused by this disease, people who have RA may face difficulties with mobility and functional independence which can severely impact the quality of life [18]. In addition, RA is also known to cause anxiety and depression [20]. The treatment for RA focuses on decreasing inflammation, limiting joint destruction and disability so nonsteroidal anti-inflammatory drugs (NSAIDs) are generally prescribed to patients to ease the pain and inflammation while surgery is another option for patients with permanent damage that limits mobility and independence [2, 43]. To successfully manage arthritis disease, patients are recommended to maintain a physically active lifestyle. This recommendation is supported by several research studies that suggest that various forms of exercise and an appropriate amount of physical activity are safe and beneficial for people with RA [6, 12, 33, 37, 43]. people with RA can discuss with their clinicians, doctors and physiotherapists, regarding the appropriate amount of physical activity they can do daily to maintain a physically active lifestyle and improve the quality of life. Recommended physical activity from doctors would provide patients with daily activity goals that they can try to achieve to maintain a healthy physically active lifestyle.

In this paper, we introduce a Chrome browser extension called *"FitViz-Ad"*, a non-intrusive reminder that replaces online advertisements on web pages with reminders to encourage non-sedentary behaviour using data collected by Fitbit. *FitViz-Ad* uses non-sedentary hour unit to quantify physical activity rather than step count. We also present findings from the preliminary study of *FitViz-Ad* and the design implications.

Related Work

In this section, we overview previous studies that were done regarding encouraging physical activity, the effectiveness and popularity of wearable technologies, the roles of self-efficacy and goal-setting in health and fitness and why people have a negative attitude toward online advertisements.

Encouraging Physical Activity

Multiple research studies have focused on different techniques that can encourage people to be more physically active. One of the techniques is the use of gamification to promote physical activity by providing users. These studies generally make use of pedometers combined with a gaming system to try to get people to perform physical activities. Lin, Mamykina, Lindtner, Delajoux and Strub developed a computer game called *"Fish'n'Steps"* which aims to promote exercise and improve users' attitude toward physical activity [24]. In their study, participants' step

counts were recorded and mapped to the growth of a virtual fish living in a virtual tank. The participants' step counts determined the growth of the virtual pet fish as well as its mood. Even though most participants' enthusiasm began to decrease after the first two weeks, Lin et al. noted that results from the study showed the value of encouraging physical activity rather than providing negative reinforcement when the users fail to meet their goals. They also noted that most participants had established new routines for leading a healthy physically active lifestyle after the first two-week period.

Other studies have focused on using encouraging messages to promote physical activity. Mutsuddi and Connelly's work make use of text messages to send encouraging messages for people to be physically active [7]. Mutsuddi and Connelly expanded on previous short-term studies that explored the use of text messages to encourage and help to manage chronic disease and physical activity [15, 32, 34, 47]. The messages that were sent to participants ranging from motivational message to congratulatory message when participants have reached their goals. Results from the study showed that text messages proved to be an effective way of encouraging physical activity among young adults in the long run. Similar to Mutsuddi and Connelly's work, FitViz-Ad was designed to promote and support physical activity among people with RA by displaying congratulatory message on the reminder when the user completes his/her daily activity goal and remind the user when he/she is behind the daily activity goal.

Why Online Advertisements are Annoying

Online advertisements are used to gain the user attention with the purpose of selling a product or a service. However, there are numerous negative impacts when online advertisements are distracting or annoying. Annoying ads may backfire and cause users to distance themselves from the advertiser's brand or doubt its reputations. A marketing research by Yoo and Kim suggested that users are less likely to remember highly annoying ads [53] and actively ignored stimuli like annoying ads are evaluated less favourably [45]. With many users perceive online advertisements as annoying, it might increase the use of ad-blocking software [11, 23] like Ad-Block extension which has more than 100 million active devices using the extension [1].

Goldstein and colleagues conducted three empirical studies to investigate the economic cost of annoying ads to publishers and the cognitive impact of annoying ads to users [16]. The authors first conducted a preliminary study to identify ads that the users find more or less annoying, then they conducted a field experiment to find out the amount of money the publishers pay for advertisements. Lastly, the authors conducted a mouse-tracking study to understand the effects of online advertisements on the reading processes. Results showed that annoying ads increased task completion time which also led to slightly lower accuracy on reading comprehension questions. It was also shown that users tend to notice annoying ads and complain about them and they are also more likely to abandon the sites with annoying ads.

Design Principle

We opted to use online advertisements spaces on websites to deliver the messages to the users because many people often find online display advertisements to be annoying as well as interfering with the browsing experience [16, 17]. Unlike system generated notifications that use audio and/or visual distractions to get the user's attention, *FitViz-Ad* would silently replace online advertisements with reminders on the webpage that the user is visiting and the reminder would stay there until the user moves to another page. With this, we hope that the users' daily tasks would not be disrupted and they would be more inclined to be physically active as they would not feel that physical activities are demanding daily chores. We approached this concept by building FitViz-Ad as a browser extension which is capable of gathering data and manipulating webpage's content on the user's local machine.

FitViz-Ad was developed as a non-intrusive personal reminder system to help support and motivate rheumatoid arthritis patients to complete their daily activity goals. A daily goal is prescribed for patients by clinicians or doctors in a form of 'non-sedentary hour'. Doctors define how many minutes in an hour that a patient should spend moving about. A given hour is non-sedentary when an X number of minutes in an hour contains more than 10 steps. This X number of minutes should be defined by the doctor which deemed to be appropriate amount for the patient. The threshold of 10 steps was established to ignore minutes where Fitbit captures false steps.

Since most Internet users have a negative attitude toward repetitive online advertisements [5, 31, 51], we decided to transform the online advertisement space into a space that contains relevant information that would be useful to the user on a personal level. FitViz-Ad reminds people with RA when they should be physically active by replacing online advertisements on the website with reminders about the patient's progress toward completing his/her non-sedentary goal (Figure 1).

Wearable Technologies for Monitoring Physical Activity

Another question that we needed to answer in this work is collection of the user's physical activity data and feed the data to FitViz-Ad. Due to the popularity and availability of pedometers, we decided to use Fitbit trackers to collect physical activity data due to its popularity and availability. Pedometers, similar to Fitbit, have also been widely used in various physical activity related studies. Bravata and her colleagues published a systematic review of using pedometers to increase physical activity and improve health [4]. Bravata et al. concluded from the study that there was an association between the use of pedometers and the significant increases in physical activity and decreases in body mass index and blood pressure. Pedometers are also used as an intervention for encouraging physical activity in various studies. The procedure of a pedometer intervention usually involves giving the participants pedometers to wear every day for a set period of time. Catrine Tudor-Locke stated in her study that used pedometers as an intervention that "pedometers are practical, accurate and acceptable tools for measurement and motivation in physical activity" [50]. Tudor-Locke also noted that even though the universal goal of 10,000 steps/day seems to be widely accepted, such goal should be approached with caution. The author suggested a better approach in which one's baseline values, specific health goals and sustainability of the goal in one's everyday lifestyle should be considered to personalize one's step goals.

We share Tudor-Locke's concern in which we believe that

[1] See `https://adblockplus.org/`

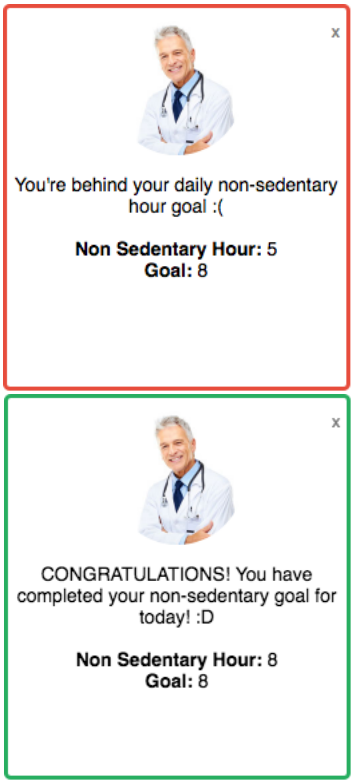

Figure 1. *FitViz-Ad's reminder that replaces online ads on webpages. The reminder on the left is generated when the user is behind the non-sedentary goal milestone while the right one is generated when the user's non-sedentary goal is achieved.*

10,000 steps might not be suitable for everyone. Thus, like Tudor-Locke's suggestion, we have implemented FitViz-Ad to be customizable in terms of the daily goal for the user. When FitViz-Ad would go to clinical study phase in the future, people with RA that are to be recruited would have their health goals and lifestyle consulted with a clinician or doctor to identify appropriate daily goals that they should aim for.

Self-Efficacy & Goal-Setting

It was argued that stable factors like age, gender and environmental barriers each predict lower physical activity. In contrast, enjoyment of exercise, social support, self-efficacy and autonomous motivation predict higher physical activity [48]. Self-efficacy is one's belief in his or her own capabilities in performing a specific behaviour [3]. It has been shown that self-efficacy predicts higher physical activity among people with RA [30]. Various interventions were developed to increase self-efficacy for physical activity. These interventions usually involve encouraging patients to set their personal physical goals with plans on how they can achieve their goals [25].

One of the key points of self-efficacy for physical activity is to have a realistic goal that one can achieve consistently, goal-setting. Similar to self-efficacy, numerous studies investigated the use of goal-setting to encourage physical activity. Consolvo et al. studied individual's responses to goal-setting in their persuasive technologies to encourage physical activity [8]. In their study, they explored individual's reactions to goal sources (i.e., who should set the goal) and goal timeframes (i.e., the timeframe that an individual needs to achieve the goal). They reported that most participants would prefer to set their own goals. Consolvo et al. also implemented goal-setting into their *UbiFit* which required participants to set their own weekly physical activity goal [9].

On the other hand, it is important to consider how goal-setting can be exploited to encourage people with RA to be physically active. Allowing them to freely set their own goals can be dangerous [27, 28] because individuals can make false inferences based on the data collected. For instance, a person with RA might risk getting an injury by increase his/her physical activity goal without consulting a professional because he/she is confident in achieving the goal.

Conforming with these findings, we incorporated goal-setting into *FitViz-Ad* by allowing doctors to set the goals for the patients. Should they wish to change their activity goal, doctors or clinicians should be consulted before they can do so. Their connection and regular dialogue with doctors should be maintained to ensure that appropriate goal is prescribed.

Implementation

In this section of the paper, we discuss the design and implementation of FitViz-Ad which introduces its functionalities and the technicalities of the work.

Daily Milestones

FitViz-Ad functions on Chrome browser by accessing user's Fitbit physical activity. Each patient needs an active Fitbit account which is also used to login to FitViz-Ad. FitViz-Ad automatically fetches data from Fitbit every 15 minutes without requiring any action from the user. The extension can potentially remind the patients up to 5 times a day, starting from 10 AM to 10 PM with a 3-hour interval between each reminder (10 AM, 1 PM, 4 PM, 7 PM and 10 PM). This approach was implemented to minimize the distraction that the user might experience and we wanted the reminder to show up at specific times where it could be beneficial for the users. For instance, the 4 PM reminder can provide the user with a progress report at the end of a workday. If the 4 PM reminder shows the user behind his/her daily goal, the user may opt to choose a different and longer route home to catch up with the daily goal.

To achieve this, the non-sedentary daily goal prescribed by the doctor is divided by 5 to compute the milestone for each segment. For example, if the patient is prescribed to complete 10 non-sedentary hours per day, FitViz-Ad would then remind the patient to have 2 non-sedentary hours completed by 10 AM. On the reminder, there is an image of the patient's personal doctor or clinician to provide a personal touch in which the patient can feel assured that his/her progress is monitored by the same clinician or doctor that follow their condition. In the case of the study presented in this paper where participants did not have a personal doctor, a stock image of a doctor[2] was used instead (Figure 2). The patient can see the non-sedentary progress that he/she has completed and the goal that needed to be achieved at any time by

[2]Image from `https://i.pinimg.com/236x/d6/93/2e/d6932ee213a513a6c5c14568b4dd1b3d.jpg`

clicking on the FitViz-Ad extension.

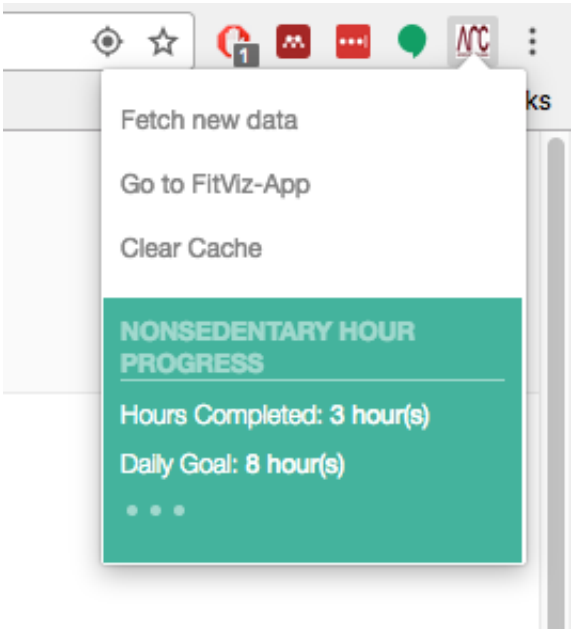

Figure 2. *Clicking on the extension on Chrome displays the progress that the user has made for the current day and the user's daily goal. The 2 circles at the bottom of the dialog represent the completed non-sedentary hour (on hover, they show the exact hour that the patient was non-sedentary).*

Remind and Encourage

When the user's local time reaches one of the preset reminder time, FitViz-Ad checks and compare the current non-sedentary hour completed and the milestone that is required for that segment. It then replaces online ads with reminders on websites based on 4 different scenarios:

1. If the user's current non-sedentary hour is lower than the computed milestone. For instance, if at 10 AM the user has not completed any non-sedentary hour, FitViz-Ad would generate a reminder to remind the user that the user should have had completed 2 non-sedentary hours by 10 AM, the user now should try to compensate the missing non-sedentary hours by the next milestone.
2. If the user's non-sedentary hour is 3 hours more than the prescribed non-sedentary hour goal, meaning that the patient has completed more non-sedentary hour than the prescribed limit.
3. If the user has achieved his/her non-sedentary goal. FitViz-Ad would generate a congratulation message to the user and inform the user that he/she has completed the required non-sedentary goal. We hope that the message can motivate patients to maintain their achievements in the long run.
4. If the user is only one hour shy of completing his/her non-sedentary goal while there are only 3 hours remaining in the day. FitViz-Ad would generate an encouragement message informing the patient that there is only one more to be completed.

Table 1: Different messages that are displayed to users to remind them about their non-sedentary hour progress based on different conditions.

Scenario	Message
If the user's current non-sedentary hour is lower than the required milestone for non-sedentary goal	You're behind your daily non-sedentary hour goal
If the user's non-sedentary hour is higher than non-sedentary goal.	You've gone over your goal today! You shouldn't complete more non-sedentary hours than what you doctor prescribed.
If the user has achieved his/her non-sedentary goal.	CONGRATULATIONS! You have completed your non-sedentary goal for today!
If the user is 1 hour away from completing his/her non-sedentary goal.	You're almost there! Only 1 hour left to be completed to achieve your non-sedentary daily goal!

For each of the scenario, the user will see a different message based on their non-sedentary hour progress (Table 1).

Non-Intrusive Reminder

To avoid interfering with the patient's daily life, FitViz- Ad silently replaces online advertisements with reminders on the web page that the user is visiting. FitViz-Ad identifies third-party advertisements like *Google AdSense* and copies the size of the advertisement. FitViz-Ad then generates a reminder and replaces the advertisement found on the page with a reminder with the same size as the original advertisement. FitViz-Ad performs this task without reloading the page which avoids interrupting the user's current task. It can also identify advertisements that are shown on popular websites including Facebook, YouTube, StackOverflow and Amazon.ca/.com etc. Some of these websites have their own business programs where they manage their own advertisements with designated advertisement spaces [13,42] in which FitViz-Ad was programmed to find those designated advertisement spaces. If FitViz-Ad cannot identify or find any ads on the page, it would generate a reminder and place it in the top right corner of the page that the user is currently visiting.

Moreover, to avoid interfering with the user's browsing experience, when the user is on track to completing their non-sedentary daily goal, FitViz-Ad wouldn't generate a reminder on the page if the following conditions are met:

1. If the user's non-sedentary hour is equal or more than the computed milestone that is required for that segment, meaning that the patient in on track to complete his/her goal for that day.
2. If user's non-sedentary hour is far lower than the non-sedentary goal and it is not possible for the patient to catch

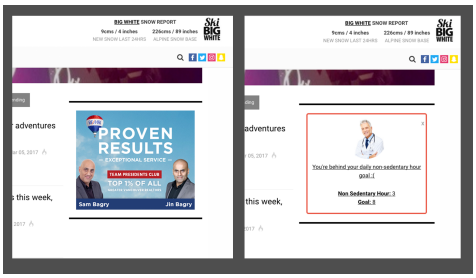

Figure 3. *FitViz-Ad replaces an advertisement on the page with a reminder by copying its dimension.*

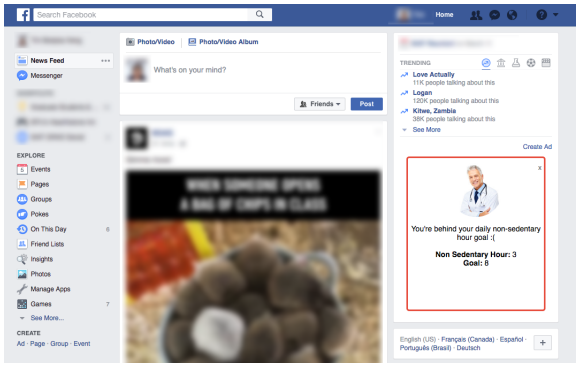

Figure 4. *FitViz-Ad places a reminder on the user's Facebook page. The reminder replaces the advertisements or pages that Facebook tend to suggest to the user.*

up within the day. For example, if the user's non-sedentary goal is 10 hours and by 7 PM the user has only completed 3 non-sedentary hours, FitViz-Ad does not remind the user because it is not possible for the user to catch up given the fact there are only 5 hours remaining in that day and there are still 7 more non-sedentary hours to be completed.

Evaluation

We conducted a 2-week usability study in Summer 2017 to evaluate the effectiveness of FitViz-Ad in reminding users to be physically active.

Participants

We recruited 14 participants (7 males and 7 females) using a snowball sampling technique where we shared our study advertisement with contacts across a number of social media platforms (e.g., Facebook and LinkedIn). Participants recruited ranged between the age of 20 and 37. In this study, we'd refer to our participants as P1, P2, P3 and so on to protect their identities. To diversify our sample, we selectively recruited undergraduate students, graduate students and full-time professionals. Two participants were graduate students in either a Masters or PhD program, three were undergraduate students, seven were full-time professionals who have sedentary jobs and two preferred to not disclose information about his/her occupation. Each participant received 20 CAD as compensation for their participation in this study.

Limitation

Due to limited resources, we opted to conduct a short 2-week usability study with healthy people who do not have RA. Because the concept of using non-intrusive reminders by replacing ads on websites is a new idea and not tested, we wanted to use this early evaluation to understand how general users feel about this non-intrusive reminder concept. This evaluation can provide us with a foundation to improve FitViz-Ad before future clinical studies with people living with RA.

We need to note that because we do not have data about the participants' general internet usage, we do not know how many reminders participants see each day and the effects it might have had on the study. Currently, FitViz-Ad is only for Chrome browser and does not work on mobile browsers. At this stage of the development, we are keen on targeting those who have sedentary jobs and spend majority of their time in front of computers.

We were also not able to provide each participant with a 1-on-1 consultation with a trained physician to establish a recommended non-sedentary hour goal for each participant at the beginning of the study due to the limited amount of time and resources we had. To overcome this, we worked with trained physicians from *Arthritis Research Canada* to established an 8-hour non-sedentary as an appropriate goal for the participants who do not have any physical restrictions. An hour can be counted as a non-sedentary hour when the participant completes 8+ minutes of walking with each minute consisting of 10 or more steps. This 8+ minutes baseline was put in place by adding the number of minutes (2 minutes) we would like the participants to walk in an hour with a 6-minute error buffer. The 6-minute error buffer was established to counteract with the error that Fitbit misclassifies other activities as walking minutes [35].

Procedure

Before the recruitment process began, interested participants were asked to fill out an online questionnaire asking them basic information about their names, age, occupation etc. They were also asked about their physical activity level and if they have used or currently own a Fitbit tracker. We used the information gathered from this questionnaire to select and diversify our sample.

They were also asked a series of questions to determine their readiness for change in physical activity. Adapted from Prochaska's TTM [38], we asked participants a set of questions [29] about their physical activity level before the start the study and at the end of the study. Prochaska's TTM suggests that an individual change his/her behaviour by going through a number of steps. The 6 steps of change underlined in TTM are:

1. *Pre-contemplation*: Individuals in this stage do not intend to take action in the next 6 months.
2. *Contemplation*: Individuals in this stage intend to take action to change in the next 6 months.
3. *Preparation*: Individual in this stage intend to take action in the immediate future, usually next month.
4. *Action*: Individuals in this stage have lifestyles changed within the past 6 months.
5. *Maintenance*: Individuals in this stage are in the process of maintaining the change to avoid relapse however change processes are not applied as frequently as those in the *action* stage.

Table 2: Scoring for physical activity change

Pre-contemplation:	S1 = No; S2 = No
Contemplation:	S1 = No; S2 = Yes
Preparation:	S1 = Yes; S3 = No
Action:	S1 = Yes; S3 = Yes; S4 = No
Maintenance:	S1 = Yes; S3 = Yes; S4 = Yes

6. *Termination*: Individuals in this stage have zero temptations.

Because we wanted to compare their readiness for change before and after the study, participants were asked to answer 'Yes' or 'No' to these four statements and they are scored based on their responses (Table 2).

1. I am currently physically active.
2. I intend to become more physically active in the next six months.
3. I currently engage in regular physical activity.
4. I have been regularly physically active for the past 6 months.

Selected participants who did not own a Fitbit tracker were provided with a *Fitbit Flex* for the study. They were given an extra week prior to the study to allow them to familiarize themselves with the tracker. During this extra week, they were told to use the tracker however they liked and use this week to familiarize themselves with how Fitbit works.

Each participant was then randomly assigned to one of the two groups, control and treatment group.

- *Control Group*: received a stripped down version of FitViz-Ad which does not replace ads on websites with reminders. Participants can only check their non-sedentary hour progress and the daily goal by clicking on the extension.
- *Treatment Group*: received a fully functioning version of FitViz-Ad with reminders that replace ads on the websites that they visit. Participants can also click on the extension to see their non-sedentary hour progress and daily goal.

Each group participated in a 2-week study period which was divided into two separate phases. We later compared data collected from these two phases.

1. *Baseline Phase*: the first week of the study in which the participants were instructed to only use Fitbit to track their physical activity without using the FitViz-Ad extension.
2. *Intervention Phase*: the second week of the study in which the participants were instructed to install and use FitViz-Ad extension on their primary computer whether it's a work machine, home machine or both.

During these two phases, there were no specific instructions or tasks given to the participants. They were free to go about their usual daily activities and do whatever tasks they normally do. They were only told to try to achieve their non-sedentary hour daily goal of 8 hours.

Data Collection and Analysis

Quantitative data was collected through the Fitbit in which data from the intervention phase was used to compare with the data from the baseline phase. This comparison was to see if there was any significant difference in terms of non-sedentary hour between the two phases. In order to get the non-sedentary hour, step count was collected which was used to calculate the non-sedentary hour for analysis.

Qualitative data was also collected for this study through post-study semi-structured interviews. After completing the 2-week study, each participant was scheduled a semi-structured interview separately. Each interview was between 30-45 minutes long and participants could opt for an in-person interview or a remote interview via Skype. Due to complicated schedules, two participants opted for remote Skype interviews while the rest had in-person interviews.

Results

In this section, we present results from both the qualitative and quantitative side. While the qualitative data is reported from all 14 participants, the quantitative data is reported from 12 of the 14 participants, however. Two of the fourteen participants (from the treatment group) had majority of their data missing from the baseline phase (more than 4 days of missing data) because the participants either forgot to wear their Fitbit trackers or the trackers ran out of battery without them knowing. P03 had 4 days of data missing from the baseline phase and 1 day of missing data from the intervention phase while P04 has 7 days of missing data from the baseline phase and 2 days of missing data from the intervention phase.

Five other participants (three from the control group) had one day of their data missing from the baseline phase because they forgot to wear their Fitbit trackers and/or their trackers ran out of battery. For these five participants, we presented their data of 6 days from the baseline phase and 7 days from the intervention phase. Even with one day of missing data in the baseline phase from the five participants, we are confident that the reported results are reflective of the participants' physical activity level during the study. Thus, the quantitative results that are reported in this paper account for the 12 participants who completed the study.

Effects on Physical Activity

Overall, participants had mixed responses to the effectiveness of FitViz-Ad in reminding them to be physically active.A majority of the participants between the two groups felt that their physical activity level did not change during the week in which they were using the extension. Four participants explicitly stated that their physical activity level remained about the same and they did not feel encouraged to be more physically active than usual.

"Not more so than usual. I mean I have my daily goals anyways that I try to get but I didn't feel anymore encouraged." - P05, graduate student, control group

"Not much. Like for instance, it felt like it was more forced. Like for instance, I would have to force myself to try to exercise, and at that point, I would probably end up exercising not as much as the first week. But I mean like, it might just be because

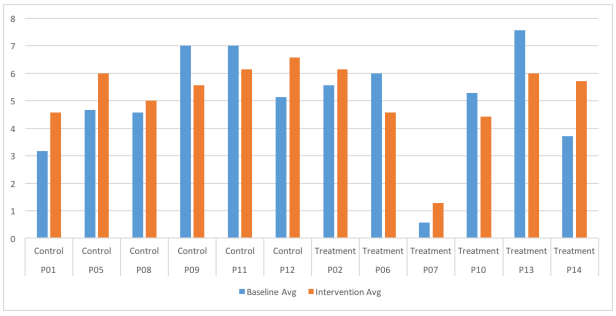

Figure 5. *Comparison of non-sedentary hour completed between the baseline and intervention phase among the 12 participants.*

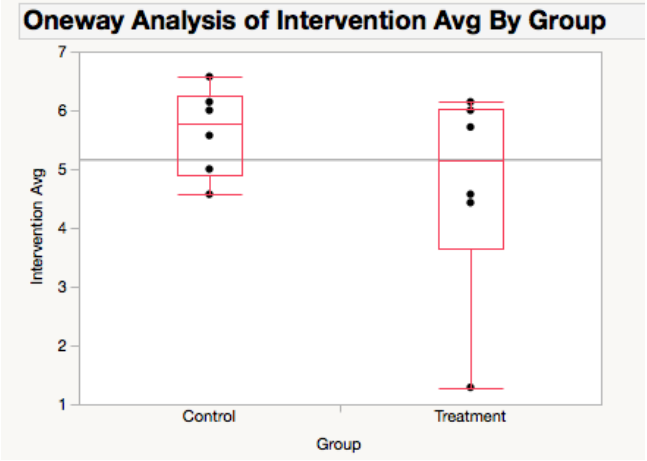

Figure 6. *Mean non-sedentary hour completed among participants across the two groups in the intervention phase*

like it was appearing a lot as well." - P04, full-time professional, treatment group

Two participants, however, stated that they found the extension to be a useful and motivational tool for them to stay non-sedentary. They felt that their physical activity level increased while they were using the extension or at least felt more encouraged to be more physically active.

"Yes, I was more motivated to walk. My physical activity remained the same but like when I was... I usually work 2-3 hours then move a lot, at least in those hours I could move a little bit so I liked that." - P02, full-time professional, treatment group

Through the data collected via the Fitbit trackers, we compared the mean non-sedentary hour completed by the participants during the baseline and the intervention phase (Figure 5). Six participants(four participants from the control group) saw an increase in their non-sedentary hour, however, four other participants(two participants from the control group) saw a decrease. We hypothesized that replacing ads with reminders on websites significantly increases participants' non-sedentary hour. A Wilcoxon test showed no significant difference in non-sedentary hour between the two groups with $W(1) = 32.5$, $Z = -0.965$, $p = 0.295$ (Figure 6).

Physical Activity Awareness

Through the post-study interviews, we also learned that participants felt the extension gave them with self-awareness regarding their physical activity level even though their physical activity level did not change significantly. Six participants stated that they found themselves more aware of their own physical activity level throughout the day. Among the four participants, three were in the control group and three in the treatment group. All of them reported that the extension (either the full version or the stripped down version), they were more aware of their physical activity level during the day. Thus, they had a better understanding of how active they are during their workdays.

"[...] I think awareness was a good one. Without the tool, so when I was just going about my day, when I don't look at the Fitbit notification cause I shut it off, that tells me I walk 250 steps an hour like I'm not aware of how I'm not moving at all. But when I started using the app [extension] and I was working, like it was reminding me on a constant basis that I'm not moving. So I knew... like I was aware and I think it's important to just know and like sometimes 'oh I'm so tired but cause I didn't get up'" - P06, full-time professional, treatment group

"[...] because like it reminds... I'm more conscious about it like about going for a walk or just try to get my 250 steps. Yeah, so I'm more aware of that." - P12, full-time professional, control group

Stages of Change Before and After the Study

Comparing participants stages of change before and after the study, we found that the stage of change of the majority of the participants did not change. However, four participants saw their stage of physical activity changed from the start of the study. P08 changed from Decision/Action stage to Contemplation stage where P10 and P11 changed from Maintenance to Decision/Action and Contemplation to Preparation respectively. We also saw a change in P14, from Contemplation stage to Preparation stage (Table 3).

These changes were mainly due to the change in either work or school schedule for the participants. For instance, P08 happened to start his summer semester where he attended multiple classes which he explained the reason why he wasn't able to be as physically active as before the start of the study.

"[...] you know my schedule right now since I'm taking summer school, I'm a bit constraint to what I can do outside. So just because it's summer, my activity level is a bit lower." - P08, full-time undergraduate student, control group

Similarly, P11's physical activity level changed as she had multiple deadlines to meet during the study. She explained that, because of the increase in her workload, she did not have time to be as physically active as she wanted.

Table 3: Participants' stage of change before and after the study.

Participant	Pre-Study	Post-Study
P01	Maintenance	Maintenance
P02	Maintenance	Maintenance
P03	Contemplation	Contemplation
P04	Contemplation	Contemplation
P05	Maintenance	Maintenance
P06	Maintenance	Maintenance
P07	Contemplation	Contemplation
P08	Decision/Action	Contemplation
P09	Maintenance	Maintenance
P10	Maintenance	Decision/Action
P11	Contemplation	Preparation
P12	Maintenance	Maintenance
P13	Contemplation	Contemplation
P14	Contemplation	Preparation

Self-Efficacy & Goal-Setting

Building on Knittle et al.'s work regarding goal-setting [22], we asked participants what they think about the 8-hour non-sedentary goal that we have set for them and if they would like to set their own goals. 13 of the 14 participants agreed that being able to set their own goals would allow them to have a more realistic target as some of them found that 8 minutes of walking in an hour to complete an hour of non-sedentary was very difficult for them to achieve.

Four participants also stated that failing to hit their daily non-sedentary hour goal was discouraging for them and that they started to lose interest in the extension after a few days. Participants in the intervention group mentioned that they found the doctor's image on the reminders annoying as they failed to complete their goals and the reminders kept popping up on their browsers. Toward the end of the study, they began to either ignore or close the reminders when the reminders showed up. They agreed that it would have been better if the goal given to them was easier to achieve and the goal would increase over time when they consistently achieve the goal.

"I think figuring out your average and then pushing ten percent a week or something like that or whatever the number is; just having incremental, doing better than what you were previously doing is probably a lot better than some arbitrary number of steps or the number of hours or whatever it happens to be. Whereas like the Carrot app is a good example of doing a baseline for two weeks and then kind of doing the progression that way" - P10, full-time professional, control group

"[At first] I thought 'oh, interesting guy!' but then he started like showing at my screen then I think because I got used to him, I didn't notice as much afterwards. So even if he popped up, I was like right away 'X' (clicking X to close the reminder)" - P06, full-time professional, treatment group

Another participant mentioned that if the goal could be set according to his schedule so he could have a lower non-sedentary goal on his inactive days and high non-sedentary goal on his active days. He believed that being able to achieve his goals this way could be more motivating for him to be physically active.

"I think it's more on if it was built around my schedule or since my schedule isn't fixed right now it could be anything so if I could select from like today is gonna be a day I go shopping or I go for some interview or something so I will be out for a while and I could set a goal that matches how long I will probably be out versus when I am home that I am not going to do much activity so if I could set my goals myself then it would be better and more motivating that way." - P07, treatment group

P01 believed that the extension should be able to have pre-set goal for the user however it should also allow users to set their own goals. He believed that an option for both would accommodate users who prefer to have pre-set goals as well as those who prefer to set their own goals.

"I think there should be option for both. Like you know, maybe some people don't want to tinker around with that. You know, maybe people who don't like messing around with their, you know, things on their phone but I'm pretty tinkery." - P01, full-time undergraduate student, control group

Intrusiveness

We also asked participants from the intervention group if they found the popup reminders to be intrusive and distracting. We got mixed responses from the participants. Two participants mentioned that they found the extension intrusive where three other participants said the reminders were not disruptive and they were fine with the popup reminders.

"[...] So, like I think the first day I installed it, or the second day, I didn't really see any ads. But then after Wednesday or so, on the third day, I kept seeing it on everywhere actually haha. so I think near the end of it, it did get a little bit intrusive because it was appearing in places that I wouldn't even normally think that it would appear in. Like for instance, there were a couple of company internal sites that it would just appear on the side of, in the top corner." - P04, full-time professional, treatment group

On the other hand, one of the participants noted that she found the extension to be less intrusive than the Fitbit's vibration feedback because she spends majority of her time in front of computer and it's less intrusive because the visual feedback wasn't distracting.

"Less intrusive. I can shut it(the extension) off. I mean I can shut this(Fitbit) off too but it's like if I shut it off then I shut it off forever, whereas the computer one at least it's only while I'm on the computer which is, I guess, the most important part of

the day to be reminded to get up" - P06, full-time professional, treatment group

Three remaining participants in the treatment group were neutral regarding the intrusiveness of the extension. They believed that there were scenarios where they found the extension to be intrusive and there were scenarios where the popup reminders were acceptable and useful for them which made them aware of their physical activity. For example, P07 stated that he felt that the intrusiveness of the extension depended on the size of the ad that it was replacing, the bigger the ad, the bigger the reminder, thus the more intrusive it was.

"When it appears on the top-right corner it's fine but, like when I'm watching YouTube it sometimes appears and it's a really big bar on the top-center part, and it pushes everything down. That one is a bit intrusive." - P07, treatment group

During the interview, participants were also asked to rank between 3 types of feedbacks, audio, visual and haptic feedback, in terms of their intrusiveness. Eight participants agreed that audio feedback would be the most intrusive where it can be very disruptive when they are working. There was a split in agreeing which feedback is the least intrusive with four participants in favour of visual feedback while four other participants were in favour of haptic feedback.

"So I'm thinking if you're working in an office setting, you visually see something, you can click it away whereas if you have something like sound, it's quite... It could be like if it's a long beep then it's quite annoying and then you have to click so it's more annoying. And then the vibration, you can't stop it right away, you have to wait till all the vibration done." - P12, full-time professional, control group

"I guess the most intrusive would be the noise cause people gonna hear that around you, then the vibration then the pop-up[visual], I don't find that intrusive." - P09, full-time professional, control group

Another participant believed that the intrusiveness of the feedback depends on the task that the user is currently performing. For instance, if the user is relaxing away from the computer, the audio feedback would be the most distracting whereas the visual feedback would be distracting if the user is working on his/her computer.

"It really depends on the task I am doing at the time. So If I am working on something on my computer then something pops up on the screen, then the visual one would be the most distracting. If I am relaxing or anything then a loud sound would be the most distracting. I don't think the tactile feedback is strong enough to be that distracting. I think much of the time if it's tactile I might even miss it if it's using the Fitbit to do the notification that is." - P07, treatment group

Discussion

The results of this study helped us understand how participants felt about the reminders that replace ads on websites as this is quite a novelty idea. Even though participants in the intervention group did not significantly improve their non-sedentary hour compared to those in the control group, this study helped us learn about physical activity awareness, their attitude toward personal goal-setting and the intrusiveness level of various feedback options. In this section of the paper, we discuss the design implications that can be drawn from this study as well as relating a number of discussion points back to some of the previous work that we mentioned earlier.

Findings from this study appeared to show that participants from the control group completed more non-sedentary hours than the intervention group though there was no significant difference between the two groups. This can be affected by multiple factors that we did not account for in the study. Because we did not control the physical activity that participants performed and they were randomly assigned into the groups, it could have been that participants that happened to be in the control group were generally more physically active even without the intervention. Weather and work/school schedule might have also have been other factors. As reported by a few of the participants, warm sunny days allowed them to go out and be more physically active than wet rainy days and some might have a busier work/school schedule than others. With all these uncontrollable factors, we were not able to significantly distinguish the results between the two groups. This shows that longer studies with larger sample size are needed to further evaluate the effectiveness of non-intrusive reminder. Future studies should also consider grouping participants based on their physical activity level prior to the study.

Given that majority of our participants believed that audio feedback is the most intrusive type of feedback for reminders, we believe that FitViz-Ad extension's use of visual feedback is appropriate and not too intrusive that would interrupt the user's current task. However, we understand that what to be displayed on the reminder should be improved in terms of the image and the message that was displayed. The use of a different image or visual representation could be more useful and effective than a generic doctor's image. It should also be noted that a number of participants stated that the repetitive display of the same image became annoying for them and they started to lose interest in the reminder and started to ignore the reminders. Participants also did not talk much about the message on the reminder as they tend to close or ignore the reminders when they saw the doctor's image and did not get to read the message left for them. Thus, future designs for reminders should consider using a variety of visual elements that can help provide useful information as well as a variety of messages to encourage or congratulate the user when a goal is achieved. Even though this is a short study, we believe that if appropriate messages were used like Matsuddi and Connely's work [7] positive results can be achieved. The balance between the graphics and the message displayed should also be considered so that the users would spend time reading the encouraging message left for them.

Based on the insights we gathered from our participants, we think that it is worth exploring the use of different type of feedbacks. Even though a majority of the participants felt that audio is the most intrusive type of feedback, some others felt differently based on their workplace environment or the task that they were doing. Developers should consider providing options for participants to pick the type of reminders based on their needs as well

as providing an option to mute the reminder for a period of time. This point was brought up by one of the participants that experienced the reminders popping up during one of his presentations in which he suggested that an option to mute the reminder would be really helpful.

Like Knittle et al. found in their study [22], participants wanted to have an option to set their own goal which they believed would help them establish a more realistic goal to aim for. However, given that the extension target users would be people RA, we believe that there should be a balance in how much control the user has in goal-setting as pointed out by Plasqui [37]. Future implementation of similar physical activity reminders should consider providing the control of goal-setting to both the user and the professional physician or doctor. For instance, the physician or doctor can prescribe a daily goal of 8 non-sedentary hours however the user can set an easier goal to start with like 2 non-sedentary hours per day and once the user consistently achieves that goal, the extension can slowly increase the goal to 3 or 4 hours. With this approach, we believe it can help the user easing into the habit of achieving the goal by starting with something that is achievable for the user, thus preventing the user from losing interest by failing to achieve his/her daily goal.

We also have to acknowledge that our study was only a 2-week long study and it might not be sufficient to change someone's lifestyle. Multiple of the studies [7,19,22,24,46] mentioned in this paper spanned across a long period of time (more than 3 months) which yielded somewhat positive results regarding the change in one's lifestyle. With more resources, we could expand on this study to be a longer study as well as recruiting more participants in different physical activity levels.

Conclusion and Future Work

In this paper, we introduced FitViz-Ad, a non-intrusive Chrome extension reminder aimed to support and motivate people with rheumatoid arthritis to be physically active. We presented the design principles behind FitViz-Ad and its implementations. We also reported the results of the 2-week study conducted with 14 healthy participants to understand what the users think about the concept of replacing ads with reminders on websites. We discussed some of the findings that were found from the study and possible design implications for future implementations for reminders or similar tools related to physical activity.

Even though the results did not show that the reminders help increase participants physical activity level, we managed to gather a number of insights into how a reminder should be designed to suit users with different lifestyles. For future work, we aim to use the results we got from this study to refine FitViz-Ad before conducting a clinical study with people who are currently living with rheumatoid arthritis. Another aspect that we would like to explore in future iterations is Gamification [24, 39, 40] and point system among a social group in which users can be rewarded with points by completing their goals and compete with other users. This point was only briefly discussed by one of the participants however we feel that it is a very important feature that could provide the users with a reward system.

Acknowledgements

Development work for this project was supported by NSERC (RGPIN/05739-2016). This study was funded by Canadian Institutes of Health Research (CIHR) grants (funding reference numbers: CEH - 126527, and THC-134235). Support from The Arthritis Society (SOG-14-110) is also gratefully acknowledged.

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