Supporting Users in Setting Effective Goals in Activity Tracking

Katja Herrmanny, Jürgen Ziegler, and Aysegül Dogangün(✉)

Personal Analytics, Interactive Systems Research Group,
University of Duisburg-Essen, Duisburg, Germany
{katja.herrmanny,juergen.ziegler,ayseguel.doganguen}@uni-due.de

Abstract. In this paper we present the development of the pedometer app *Move My Day* which implements goal setting as its main persuasive design principle. Manual goal input as well as two strategies to support users in setting realistic goals, namely reference routes and personal goal recommendation, were implemented. The proposed algorithm for adaptive personal goal recommendation is designed in a way that it recommends short-term goals considering motivational aspects and gradually raises goals in the long term to meet physical activity recommendations. In a 12 week field study, we investigated the potentials of the two support strategies. Results indicate that about half of the users appreciate goal setting support and that especially personal goal recommendation seems to have potential to support users in setting effective physical activity goals.

Keywords: Persuasive technology · Behavior change support system · Activity tracking · Goal setting · Personalization · Pedometer · Physical activity

1 Introduction

Physical activity plays an important role for a healthy lifestyle as it can prevent and alleviate wide-spread diseases, such as diabetes, coronary heart disease, hypertension or types of cancer. Increasing physical activity is thus a goal frequently addressed in persuasive systems research. One of the core design principles used in these systems is goal setting. According to the goal setting theory [1] pursuing a goal has a motivating effect on performance. To be motivating and effective, goals should be precise, challenging and achievable. Moreover, self-set goals should be preferred over externally assigned goals as they have been shown to be more effective [1]. However, research [2] has revealed that people have problems in setting realistic goals, especially for moderate-intensity physical activity. Also our own research results of an online pre-study ($n = 194$, age: $M = 27$, range = 14–74) showed that participants had problems in estimating realistic goal distances. From these results and findings reported in the literature, it becomes clear that better strategies for supporting users in setting realistic activity goals are required when designing persuasive technologies to increase physical activity.

While from a motivational point of view goals should be challenging and realistic, these goals should also conform to common physical activity recommendations provided from a medical perspective. A key problem is that users start from very different

A. Meschtscherjakov et al. (Eds.): PERSUASIVE 2016, LNCS 9638, pp. 15–26, 2016.
DOI: 10.1007/978-3-319-31510-2_2

initial activity levels. For many users, standard activity recommendations would be too high compared to their current activity level to constitute a realistic next goal. For others, these goals are achievable but may not be challenging. Therefore, we propose an adaptive algorithm that is designed to gradually raise goals in the long term to meet standard activity recommendations, but recommends realistic and motivating short-term goals. The algorithm calculates suggestions of individual step goals for a week.

As an alternative support strategy we suggest reference routes, i.e. usually well-known or user-specific routes or distances which are transformed to the corresponding number of steps aiming at making these goals more precise.

We implemented a pedometer app integrating these strategies as well as the possibility to manually enter goals and investigated the supportive potential of these strategies in an empirical field study.

2 Related Work

Adaptivity of persuasive systems for behavior change is often addressed in research [3–5]. Based on a literature review, op den Akker et al. [6] identified adaptive goal setting, among others, as an important research topic. The authors recommend to define a user-specific, challenging and achievable goal based on the user's prior activity data. However, most activity tracking devices and applications that allow goal setting just assign fixed, non-adaptive goals or provide the opportunity to set a goal without any support. Example applications for assigned goals are the *Houston* system [7], *Fish'n'Steps* [8], and *UbiFit* [9]. An example for user-generated activity goals is an application targeting persons 50 + on a PDA [4] which enables users to set daily and weekly individual goals, but does not provide any goal setting support. Until now, only few approaches provide user-specific, adaptive goals or goal recommendations.

An early approach used a fixed threshold to select a goal level [10]. Users who achieved more than 5000 steps a day as baseline were given 10000 steps as their new goal. Those below 5000 steps were given a goal of 5000 steps a day. Burns et al. [11] also used participants' baseline activity in their application *ActivMon*, measured in the first study week, to define a goal level of 5 % more than baseline activity.

A smartphone application developed by King et al. [12] allows users to type in their weekly activity goal or choose among three suggested goals based on health recommendations. The suggested goals increase week by week, provided the previous week goal has been reached. Otherwise, a lower goal is recommended.

The persuasive system *Move2Play* offers a personalized recommendation of a training plan [13]. It bases on a user model, a domain model and the common recommendation of 10000 steps a day. The user model contains information e.g. on the user's fitness and active time slots. The domain model contains data e.g. about the current day, the user's age and sex. The author does not mention how this data is considered in the recommendation nor describe the concrete algorithm.

Also the virtual training system *MOPED* [14] implements user-specific and adaptive recommendations in terms of specific exercises. Therefore, a user model was initialized with manually entered information about sex, age, weight etc. During usage, further data are added such as fitness test results and historical training data such as exercise level or frequency as well as the user's heart rate. Based on these data, recommendations for the exercise count and speed of the concrete exercises are calculated.

3 Move My Day

We developed the pedometer App *Move My Day* to investigate our research question. Three versions with different functions were developed as described in Sect. 4.1. (Three additional versions were developed for another investigation that is not topic of this paper.) Goal setting is the predominant persuasive design principle. Permanent graphical and textual feedback indicates the progress towards the goal (see Fig. 1). In another view a list of selectable goal components is presented, i.e. distances used as goals or sub-goals. The app allows for goals consisting of more than one component. Moreover, the app contains views for recording reference routes (see Sect. 3.1), for typing in goals, and for viewing one's personal history. History includes records, average steps per day and week as well as statistics of the previous days and weeks. In another view, the app offers the opportunity to manually correct the step number counted by the system. This function was integrated to obtain valid data also in case of special situations e.g. when the smartphone's battery was exhausted or the user forgot it at home that day.

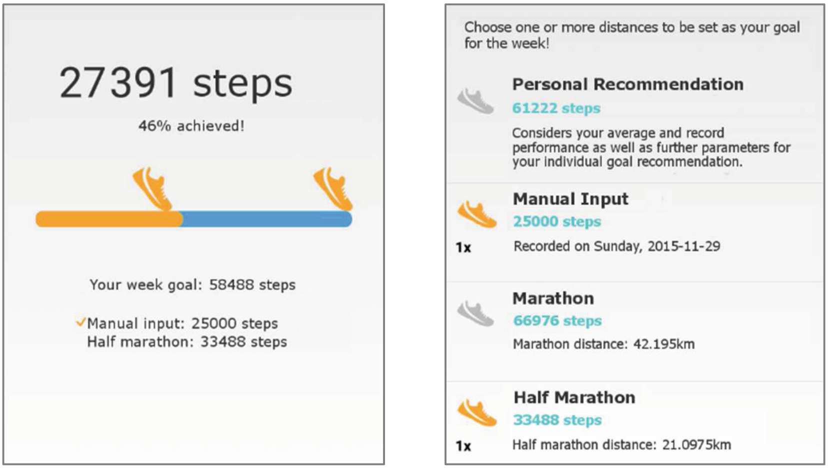

Fig. 1. Screenshots of the home view and goal selection of the pedometer app *Move My Day*

Goals are set for one week starting on Monday. They are not assigned automatically, but are set by the users themselves, however, supported by the app. The app provides three different ways to set a goal– two of them implement support strategies, one is unsupported. First, goals can be chosen from a list of pre-defined reference routes which are described in the following section. These reference routes are provided to make goals more concrete and conceivable than just numerical step counts. Second, as an alternative to reference routes, *Move My Day* provides a personal goal recommendation that is updated each Monday. Its calculation is based on historical user data, general health recommendations, as well as on motivational aspects and is described in detail in Sect. 3.2. Third, users can type in their goals manually, without any support of the app. It is possible to combine different types of goal components into one goal. However, in some study conditions not all of the three methods are available (see Sect. 4.1).

3.1 Reference Routes

Reference routes represent well-known or self-recorded distances. For instance, one pre-defined reference route is the distance of a marathon converted to an approximate number of steps. Further reference routes refer to the distance between two well-known cities, formula one race tracks, or routes popular with tourists (e.g. Avenue de Champs Élysées in Paris). Varying the area of interest ensures that each user can associate at least some reference routes with a distance. Varying length of the routes ensures that different activity levels can be considered. Moreover, it enables users to either select one single week goal or a number of smaller sub-goals. Besides pre-defined reference routes, users can record own routes, e.g. when making a walking tour. They can be labelled individually and do appear in the reference route list to be chosen as a goal.

3.2 Calculating Goal Recommendations

We implemented an algorithm to calculate weekly goal recommendations considering motivational aspects and standard activity recommendations. As – following Locke and Latham – goals should be challenging and achievable to be motivating, both aspects have been considered in the algorithm. It bases on historical user data, namely the daily mean performance which is a realistic (day) goal and the daily record, which has been proven to still be achievable but challenging. The average of both will be calculated and multiplied with seven to create a challenging but achievable week goal. Using the daily instead of weekly values allows the system to calculate recommendations from the second day of usage and normally leads to more challenging goals.

However, this calculation can also cause too high goals if the record is an outlier. Therefore, we defined a maximum increase of 2000 steps a day based on meta analyses [15, 16] of physical activity intervention studies using pedometers. Analyses showed a mean increase of approximately 2000 steps a day compared to the baseline values. As most studies covered more than one week between baseline and intervention outcome, an increase of 2000 steps can be seen as challenging. However, considering that in the described case the record is even higher, the new goal can still be seen as achievable.

Especially in the beginning of app usage, identical or very similar average and record step counts could hinder increase or lead to an increase that is considered to be too low against the background of the goal setting theory [1]. To avoid this, the algorithm includes a check whether the goal is at least 10 % higher than the average step number. If it is not, the initially calculated goal recommendation will be replaced by the average step count per day plus 10 % and again multiplied with seven to get a week goal. This is a higher increase than Burns et al. [11] suggested to keep the goal challenging.

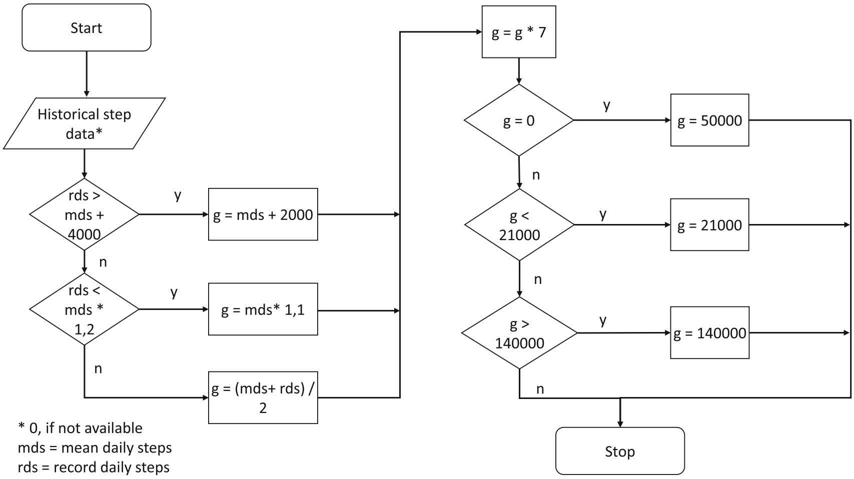

Fig. 2. Flow chart of the goal recommendation algorithm

The algorithm should also consider specific situations. These situations are:

- Historical data are not yet available (cold-start situations).
- The previous step count is unrealistically low (e.g. because usage started the day before, but not in the morning, or the person is far too little active).
- The user has already achieved a high average level that should not raise to unreachable values.

To meet these demands, thresholds are used to ensure reasonable overall minimum and maximum values (see Fig. 2). Also, a default value is used to alleviate the cold start problem which exists in the first week of usage. Modelled after the physical activity recommendations of the WHO [17], the default, minimum and maximum values are age-dependent, dividing age groups below 18 years and above. If the user has not entered his or her age, calculation for adults is used. The default goal recommendation for adults in case that no historical values are available is 50000 steps a week. This is above mean step levels former research has identified, but below health recommendations that propagate 10000 steps a day respectively 70000 steps a week [18]. Thus, it can be seen as a challenging but achievable goal for an average person. For children and adolescents, who are recommended much higher levels of physical activity, the default goal is 100000 steps. Unrealistically low goal recommendations, e.g. caused by reasons described above, are replaced by a minimum value of 21000 steps for adults and 63000 steps for children and adolescents. Referring to Tudor-Locke et al. [19] the minimum chosen for adults can be classified as "Limited Activity", which is in the lower range of physical activity but above "Basal Activity". As WHO activity recommendations for persons under 18 years are three times higher than those for adults, the minimum value for children and adolescent has been defined as the one for adults multiplied with three. As maximum values that are implemented to avoid unachievable goals we chose 140000 steps for adults (which is two times the recommendation of 10000 steps a day) and

300000 steps for children and adolescents. In this case, we decided not to multiply the 140000 steps with the factor three as it seemed to be an unrealistic high goal and is consequently not expected to be motivating.

The goals retrieved from the described algorithm are adaptive to the user's current medium-term activity level. In phases with high performance, goals increase whereas they decrease in phases with low performance due to the decreasing mean step number. However, by not using the previous week as other approaches do (see Sect. 2) but the mean and record performance, too high variations from one week to the other are avoided. Goal adaption is therefore very smooth. In the long-term view, the algorithm tends to recommend increasing goals by integrating the record which cannot decrease.

4 Field Study Investigating Goal Setting Support

4.1 Method

We performed a comparative field study to investigate users' preferences regarding goal setting strategies and the supportive potentials of the personal goal recommendation and reference routes. We published *Move My Day* at Google Play Store and promoted the app via press to generate a representative sample. Before downloading, prospective users were informed about taking part in a scientific study by using the app.

Users' app usage behavior was logged and stored on a server for data analysis. Logged data include test condition, created goal components, selected goal components, steps performed, app usage (i.e. opening the app), relevant technical data as well as gender, year of birth and former experience with activity tracking if provided by the user. Besides this information retrieved directly from the app, there were no other types of data collection. Also, there was no direct contact between the investigator and the users. Moreover, no end date of the study was communicated. Users can use the app without time limit. This study design was chosen to get real usage data without any bias evoked by the study situation. When starting the app for the first time, users were randomly assigned to one of three study conditions. The conditions contain either the adaptively calculated goal recommendation, reference routes or both. Additionally, we integrated the opportunity of setting goals manually in all conditions, in order to investigate, if users want to get supported by the app or not. This design decision results in the following conditions:

- Condition Rec + M: This condition included adaptively calculated goal recommendations as well as the possibility to manually type in a goal.
- Condition Ref + M: This condition included the opportunity to choose from reference routes or goals typed in manually.
- Condition Rec + Ref + M: This condition included all three possibilities to set a goal.

4.2 Data Processing and Analysis

The observation period covered 12 weeks. Logged data were filtered to meet our inclusion criteria for a high data quality:

- First usage week was eliminated as we supposed that users would test the functions and select different goal components just to try them.
- If users terminated using the app during the investigation period, also the last incomplete week was eliminated.
- Only weeks of active usage were included in the analysis. Our defined criterion for active usage was opening the app at least seven times a week.
- Further criteria were used to check the trustworthiness of data, especially regarding manual corrections. Criteria include negative step counts resulting from manual corrections, unrealistic high step counts (more than 70000 steps a day), and manual corrections on Sunday with nearly the amount of missing steps for reaching the goal.

Unfortunately, due to technical problems some data was not stored for some data sets resulting in further exclusions. Furthermore, we removed combined goals (i.e. goals consisting of more than one type of goal component) from statistical comparison of the support strategies as no clear allocation is possible. As there is a naturally high variation in step performance and goals, statistical methods considering such variance had to be chosen. Therefore, we focus on descriptive data, effect sizes and report confidence intervals for better interpretation of the results. As there is an ongoing debate about the informative value of significance testing, we also provide results of significance tests for the sake of completeness.

4.3 Results

Sample. After the described exclusions, a sample size of 79 participants (27 male, 34 female) and 206 weeks remained. Mean age was 47 years (n = 62, min = 12, max = 72). 18 participants didn't indicate their age or sex. Asked about previous experience with activity tracking (at least one month during the last year), 12 indicated to have experience, 50 were unexperienced and 17 did not indicate any experience information.

Investigation of Used Goal Components. We first investigated the number of subgoals, a goal consisted of. Mostly, a goal included one component (142 times), followed by two (34 times), three (14 times), four (9 times), seven (6 times), and five (1 time). In condition Ref + Rec + M users could choose between all three types of goal components. 48 % of set goals were entered manually whereas for 44 % a support strategy was used (ref. route: 24 %, personal rec.: 20 %). 8 % were combined goals. Also in condition Rec + M most goals were manual inputs (64 %), followed by recommendation (31 %) and combined goals (5 %). In condition Ref + M most goals were supported by reference routes (65 %), 39 % were unsupported inputs and 6 % combined goals. Notably, all reference routes in all conditions were predefined ones. Even though users recorded own routes, they were not set as goals.

Investigation of Steps Per Week. We compared the steps users took per week between the three conditions as well as between the types of goal. Results are presented in Tables 1 and 2. Participants in condition Rec + Ref + M achieved higher performance than those in condition Rec + M and Ref + M, however with high standard deviation. Calculation of effect size showed a small effect

(η^2_{part} = .024). Difference is statistically not significant ($F(2, 75) = 0.699$, $p = .500$). Comparing the number of steps taken between the different types of set goals, highest performance was found for goals based on recommendation followed by reference routes and manual input. Analysis shows a small effect and no statistical significance ($F(2, 100) = 1.486, p = .230, \eta^2_{part} = .018$).

Table 1. Descriptive results of achieved steps per week, grouped by condition

Condition	n	min	max	M	SD	95 % CI
Rec + M	50	2730	98424	36954.08	27346.47	29182.30 - 44725.86
Ref + M	39	913	70288	34378.62	18216.04	28473.66 - 40283.57
Rec + Ref + M	36	591	95428	44361.81	30877.15	33914.48 - 54809.13

Table 2. Descriptive results of achieved steps per week, grouped by used type of goal

Type of goal	n	min	max	M	SD	95 % CI
Recommend.	9	4145	80133	42195.67	26702.71	21670.15 - 62721.19
Ref. Route	28	591	70288	35462.86	22439.32	26761.80 - 44163.92
Man. Input	41	913	92783	31774.44	25923.79	23591.88 – 39957.00

Investigation of Set Step Goals. Set goals were also compared between the conditions and the types of chosen goals. Mean goals were very similar for all study conditions (see Table 3). For all conditions they comply on average with common physical activity recommendations. Regarding the type of goal the targeted steps also comply with physical activity recommendations for personal recommendation and reference routes. For manual input they are slightly below (see Table 4).

Table 3. Descriptive results of set goals, grouped by condition

Condition	n	min	max	M	SD	95 % CI
Rec + M	55	3500	200000	56159.27	38062.04	45869.66 - 66448.88
Ref + M	85	8	220789	55659.46	42905.84	46404.88 - 64914.03
Rec + Ref + M	66	1770	345456	53745.38	55145.24	40188.99 - 67301.77

Table 4. Descriptive results of set goals, grouped by used type of goal

Type of goal	n	min	max	M	SD	95 % CI
Recommend.	30	21000	97398	52412.87	21658.91	44325.30 - 60500.44
Ref. Route	71	3031	220789	58959.63	46988.02	47837.75 - 70081.52
Man. Input	92	8	200000	45589.48	33199.60	38714.04 - 52464.92

As mean goals are of limited informative value when investigating if realistic goal setting can be supported, further analysis focused on the difference between actually set goals and a reasonable goal. Based on goal setting theory [1], a reasonable goal should be challenging and achievable. However, there are large inter-personal performance differences. Goals that seem high or even not achievable for one person might not even be challenging for another. Thus, we investigated deviation of set goals from an individually realistic level. This level was estimated by the steps actually reached.

Comparing the mean deviation values between the different types of goals shows that performance was overestimated in all groups (see Table 5). Highest deviations are revealed for combined goals, lowest for goals based on the personal recommendation. This is a small effect (η^2_{part} = .018). A Kruskal-Wallis test shows that differences are statistically not significant ($\chi^2(2) = 2.27$, $p = .322$).

Table 5. Descriptive results of deviations (pos. and neg.) between estimated realistic performance and set goals, grouped by used type of goal

Type of goal	n	min	max	M	SD	95 % CI	Mean rank
Rec.	9	-32089	30083	-5396.56	20201.27	-20924.63 - 10131.51	47.89
Ref. Route	28	-85527	41399	-12180.25	28826.70	-23358.08 - -1002.42	47.64
Man. Input	41	-172566	27783	-17361.44	32306.63	-27558.67 - -7164.21	39.88

Comparing the step count deviations ensures a uniform level of deviation. However, additionally we compared the percentage deviations from the realistic goal level in order to consider highly varying goals and performances. Therefore, we calculated the absolute value of mean percentage differences between the estimated realistic performance and set goals (see Table 6) and compared them between the types of goal. Again, we found a small effect (η^2_{part} = .046) and no significance ($F(2, 75) = 1.807$, $p = .171$).

Table 6. Descriptive results of the absolute value of percentage deviations between estimated realistic performance and set goals, grouped by used type of goal

Type of goal	n	min	max	M	SD	95 % CI	Mean rank
Rec.	9	10.21	406.63	75.17	125.80	22.77 – 176.94	40.22
Ref. Route	28	0.06	10105.92	764.54	2267.26	52.33 – 1752.71	36.39
Man. Input	41	0.91	1093,32	162.79	228.81	80.48 – 254.19	41.46

Realistic goal setting might not only be supported when participants make use of a type of goal component. Also just offering these types of goal component could have a supportive effect on manually entered goals. Therefore, we compared the deviations for the manually entered goals of all conditions. As Table 7 shows, differences between goals and estimated realistic level as well as standard deviations are obviously lower in condition Rec + Ref + M than in the other conditions. For condition Ref + M descriptive analysis shows a slightly lower negative mean value and lower standard deviation than for Rec + M. For this comparison between the study conditions a Kruskal Wallis test revealed a significant effect ($\chi^2(2) = 9.40$, $p = .009$). Effect size is medium-ranged (η^2_{part} = .104). Post hoc testing indicates a significant difference between Rec + M and Rec + Ref + M ($p = .041$) as well as Ref + M and Rec + Ref + M ($p = .012$).

Table 7. Descriptive results of deviations (pos. and neg.) between estimated realistic performance and manually entered goals, grouped by condition

Condition	n	min	max	M	SD	95 % CI	Mean rank
Rec + M	20	-172566	27783	-21018.15	39976.46	-39727.71 - -2308.59	19.00
Ref + M	10	-60739	10274	-28474.50	25241.67	-46531.30 - -10417.70	15.00
Rec + Ref + M	11	-19803	23069	-610.09	10301.07	-7530.44 - 6310.26	30.09

4.4 Discussion

When having all three opportunities of goal setting, participants used supported and unsupported goal setting equally. When just one support strategy was provided, users preferred manual goal input or reference routes, depending on the study condition. Personal goal recommendation was used less than the other opportunities, but still in 20-31 % of set goals. Obviously it is a matter of individual preference whether users want goal setting support or not and which strategy they like. Regarding reference routes only predefined ones were selected although participants had used the recording function. Taking a deeper look at the recorded routes showed that step numbers were very low and thus not suitable for week or day goals. Labeling of these routes, e.g. “Home to work”, indicates, that people used the recording function to evaluate the step number of their everyday routes. Considering that the observation period did not cover holiday time, it seems plausible to assume that there was not yet much opportunity to record suitable routes (e.g. a longer walk, or a hiking trip). Thus, investigating the use of personal reference routes remains an interesting research aspect for long-term evaluation.

The absolute goal levels did not differ substantially between the study conditions, whereas deviations between personally realistic and actually chosen manually entered goals did. The significant medium-sized effect indicates that adding both supportive strategies, reference routes as well as personal recommendation, to the manual goal provides larger support in goal setting than just one of these opportunities even when these components are not selected.

When comparing absolute goal levels between the types of set goals, those based on reference routes were apparently the highest, those on manual input the lowest. However, evaluating how realistic these goals were, shows a unified picture: Goals based on personal recommendation obviously had lowest mean deviation between goals and estimated realistic goal level as well as lowest standard deviation for all calculations (absolute difference and percentage difference), indicating that the personal recommendation has most potential in supporting users in setting realistic activity goals. Goals based on reference routes do not seem superior to manually entered goals regarding user support. Although there is no statistically significant effect, at least descriptive differences between the achieved steps are in accordance with this tendency as highest performance was achieved when using the personal recommendation. In general, naturally high inter-personal variation regarding goals as well as step performance makes valuation of statistical significance difficult. However, descriptive data, found small effects and a unified picture regarding the different calculations indicate, that the found differences might not be random effects.

5 Conclusion and Limitations

We presented the app *Move My Day* which implements goal setting as its core persuasive design principle. Two strategies to support users in setting realistic goals, namely reference routes and personal recommendation calculation, as well as manual goal input were implemented. In a 12 week field study, we investigated the potentials of these supportive strategies. Results show that users set goals with and without support equally, if all types of goal setting are provided. Reference routes were the preferred support strategy, but also the personal recommendation was used. However, on average the chosen goals that based on personal recommendation tended to be more realistic than goals from other sources and might have led to descriptively higher performance.

Even though the found effects are not strong, results indicate that many users appreciate being supported in goal setting and that personal recommendation based on the described algorithm might have a supportive influence in realistic goal setting. When defining goals by manual input, providing reference routes and personal recommendation as additional supportive information seems to be most effective. However, in order to investigate users' acceptance and preferences regarding the type of goal setting and the influence of just offering support on manual goal input, in our study design all conditions additionally contained the possibility of unsupported goal setting. For further investigation it would be interesting to only provide one opportunity of goal setting per condition and have a larger sample size, to alleviate comparison of the strategies. However, for the design of activity tracking technologies we recommend integrating manual input as well as goal setting support, ideally user-adaptive.

Regarding self-recorded reference routes, long-term data will reveal if people use them for their goals and if they are effective in supporting realistic goal setting.

Although the developed algorithm for personal goal recommendation shows promising results, there might be limitations for long-term use. In long-term use, the algorithm will get more and more insensitive to new records or variations in the mean performance. Possibly it will be necessary to neglect older information units in order to remain the flexibility of the algorithm, which is topic of our further evaluation. We also plan to differentiate days of work, holiday and illness to improve the recommendation. We will investigate these aspects in a long-term analysis of the ongoing study.

References

1. Locke, E.A., Latham, G.P.: Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. Am. Psychol. **57**(9), 705–717 (2002)
2. Saini, P., Lacroix, J.: Self-setting of physical activity goals and effects on perceived difficulty, importance and competence. In: 4th International Conference on Persuasive Technology (Persuasive), pp. 33–39. ACM Press, New York (2009)
3. Hawkins, R.P., Kreuter, M., Resnicow, K., Fishbein, M., Dijkstra, A.: Understanding tailoring in communicating about health. Health Educ. Res. **23**(3), 454–466 (2008)
4. King, A.C., Ahn, D.K., Oliveira, B.M., Atienza, A.A., Castro, C.M., Gardner, C.D.: Promoting physical activity through hand-held computer technology. Am. J. Prev. Med. **34**(2), 138–142 (2008)

5. op den Akker, H., Jones, V.M., Hermens, H.J.: Tailoring real-time physical activity coaching systems: a literature survey and model. User Model. User-Adap. Inter. **24**(5), 351–392 (2014)
6. op den Akker, H., Klaassen, R., op den Akker, R., Jones, V.M.; Hermens, H.J.: Opportunities for smart & tailored activity coaching. In: 26th IEEE International Symposium on Computer-Based Medical Systems (CBMS), pp. 546–547. IEEE Press (2013)
7. Consolvo, S., Everitt, K., Smith, I., Landay, J.A.: Design requirements for technologies that encourage physical activity. In: SIGCHI Conference on Human Factors in Computing Systems (CHI), pp. 457–466. ACM Press, New York (2006)
8. Lin, J.J., Mamykina, L., Lindtner, S., Delajoux, G., Strub, H.B.: Fish'n'Steps: Encouraging physical activity with an interactive computer game. In: Dourish, P., Friday, A. (eds.) UbiComp 2006. LNCS, vol. 4206, pp. 261–278. Springer, Heidelberg (2006)
9. Consolvo, S., Klasnja, P., McDonald, D.W., Avrahami, D., Froehlich, J., LeGrand, L., Libby, R., Mosher, K., Landay, J.A.: Flowers or a robot army? In: 10th International Conference on Ubiquitous Computing (UbiComp), pp. 54–63. ACM Press, New York (2008)
10. Bickmore, T.W., Caruso, L., Clough-Gorr, K.: Acceptance and usability of a relational agent interface by urban older adults. In: CHI 2005 Extended Abstracts, pp. 1212–1215. ACM Press, New York (2005)
11. Burns, P., Lueg, C., Berkovsky, S.: Activmon: Encouraging physical activity through ambient social awareness. In: CHI 2012 Extended Abstracts, pp. 2363–2368. ACM Press, New York (2012)
12. King, A.C., Hekler, E.B., Grieco, L.A., Winter, S.J., Sheats, J.L., Buman, M.P., et al.: Harnessing different motivational frames via mobile phones to promote daily physical activity and reduce sedentary behavior in aging adults. PLoS ONE **8**(4), e62613 (2013)
13. Bielik, P.: Personalized training plan recommendation and activity tracking for a healthier lifestyle. Bull. ACM Slovakia **3**(4), 39–40 (2011)
14. Buttussi, F., Chittaro, L.: MOPET: A context-aware and user-adaptive wearable system for fitness training. Wearable Comput. Artif. Intell. Healthc. Appl. **42**(2), 153–163 (2008)
15. Bravata, D.M., Smith-Spangler, C., Sundaram, V., Gienger, A.L., Lin, N., Lewis, R., Stave, C.D., Olkin, I., Sirard, J.R.: Using pedometers to increase physical activity and improve health: a systematic review. JAMA **298**(19), 2296–2304 (2007)
16. Kang, M., Marshall, S.J., Barreira, T.V., Lee, J.O.: Effect of pedometer-based physical activity interventions: A meta-analysis. Res. Q. Exerc. Sport **80**(3), 648–655 (2009)
17. World Health Organization: Global recommendations on physical activity for health (2010). http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf?ua=1
18. Choi, B.C.K., Pak, A.W.P., Choi, J.C.L.: Daily step goal of 10,000 steps: A literature review. Clin. Invest. Med. **30**(3), 6 (2007)
19. Tudor-Locke, C., Johnson, W.D., Katzmarzyk, P.T.: Accelerometer-determined steps per day in US adults. Med. Sci. Sports Exerc. **41**(7), 1384–1391 (2009)