Information Presentation Methods for Setting Achievable and Meaningful Goals on Fitness Apps

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ABSTRACT

Exercise beginners often use recommender systems, such as fitness apps, to form new exercise habits. However, it is difficult for individuals with little training experience to estimate the costs and benefits of the recommended exercise goals and to set appropriate goals for themselves. In this paper, we propose several information presentation methods for recommender systems in the health field to help users accurately estimate the costs and benefits of their exercise goals. Based on Atkinson's theory of achievement motivation, we designed three of information, – the amount of effort required to achieve a goal, the degree to which the goal is achievable, and the benefits obtained from achieving the goal – to encourage users to set effective goals and establish exercise habits. To determine how the proposed methods affect users' motivation to exercise, we conducted an online user study using a Japanese crowdsourcing service. The results suggest that the proposed methods have the potential to motivate users to exercise and promote realistic goal-setting. The findings of this study contribute to the design of exercise goal–setting support systems tailored to individual users.

CCS CONCEPTS

• **Human-centered computing** → *Empirical studies in visualization*; • **Applied computing** → *Health informatics.*

KEYWORDS

motivational theory, UI/UX, explainability of recommender systems, human factor, behavior change

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1 INTRODUCTION

Today, people worldwide have become more interested in exercise than in the past. Exercise is important for maintaining and improving both physical and mental health [13]. According to a report by Precedence Research, a Canadian research company, the global health and wellness market was valued at US $4,436.1 billion in 2020 and is expected to exceed US $7,656.7 billion by 2030 [1].

High motivation is necessary for people to form and maintain new exercise habits. Ways to increase motivation to exercise include engaging in physical activity with peers [9], setting appropriate goals based on one's current physical activity level, and increasing physical activity in stages [14]. However, it is difficult for exercise beginners to set suitable goals for their skill level and physical condition. Therefore, they often set goals that are too high and fail to achieve them. For example, suppose that trainees who usually walk 4,000 steps per day set a goal of walking 8,000 steps per day. Although the health benefits of this goal are numerous, the goal is equivalent to two days of the trainees' usual walking and may thus be unachievable. However, the trainees set such an ill-considered goal because they do not understand their usual walking trends. As a result, they may fail to achieve the goal, their motivation to exercise may decrease, and they may discontinue their training.

One way to set appropriate training goals is to use recommender systems. In recent years, researchers have studied health recommender systems, such as fitness apps, to improve people's lifestyles and promote physical activity [18]. Health recommender systems are expected to play an important role by setting appropriate training goals and suggesting exercise programs optimized for individual exercise trends [17].

Recommending personalized training goals to people who exercise regularly is helpful; however, simply presenting personalized goals based on exercise trends does not allow exercise beginners to fully understand the costs, benefits, and likelihood of achieving these goals. Therefore, beginners may not be sufficiently motivated to achieve the recommended goals. For example, suppose that a fitness app displays the following message to a trainee who usually walks approximately 4,000 steps: "Your recommended goal for today is to walk 6,000 steps." This goal can provide health benefits but is somewhat challenging for the trainee. In addition, the trainee may not be able to estimate the effort required to walk 6,000 steps a day and may not understand the benefits of achieving this goal. As a

[1] https://www.precedenceresearch.com/health and wellness market

result, the trainee may lose motivation to exercise and discontinue training.

It is important to convey the costs and benefits of training goals so that exercise beginners can stay motivated to exercise and establish exercise habits. Atkinson's theory of achievement motivation states that people are motivated by goals that are highly achievable and beneficial [3]. If trainees can understand the costs required to achieve training goals and the benefits gained from achieving these goals, they can judge whether the training goals are reasonable. Consequently, they can increase their motivation to achieve these goals.

In this study, we design and evaluate goal presentation methods that enable trainees to determine optimal exercise goals or themselves (i.e., goals that provide solid benefits at realistic costs) when using a recommender system to set walking exercise goals. The presentation methods are inspired by Atkinson's theory of achievement motivation [3]. We focus on the following three factors to design training goal presentation methods:

- The amount of effort required to achieve a training goal
- The degree to which the goal is achievable
- The benefits obtained from achieving the goal

For example, suppose that for a person who usually walks between 4,000 and 5,000 steps, the system recommends a walking goal of 6,000 steps by analyzing that person's exercise trends. The system then recommends the goal of walking 6,000 steps with the following message: "To achieve 6,000 steps, you need to walk 10 minutes more than usual."

We have examined the effect of the goal presentation methods on people's motivation to walk through online crowdsourcing experiments. The contributions of this paper are as follows:

- To enable trainees to estimate the costs and benefits of goals recommended by recommender systems, we propose goal presentation methods based on Atkinson's theory of achievement motivation.
- The results of the online crowdsourcing experiments suggest that presenting the amount of effort required to achieve a goal and the benefits obtained from achieving that goal can increase people's motivation to exercise.
- The results also suggest that presenting the degree to which the goal is achievable can encourage people to set realistic goals.

2 RELATED WORK

2.1 Recommender system for health support

Various researchers have studied recommender systems to help people maintain their health and improve their exercise habits. Rabbi et al. proposed MyBehavior, a smartphone app that learns users' physical activities and eating behaviors and recommends information to help the users achieve healthier lifestyles [10]. In addition, Feely et al. proposed a recommender system for professional marathon runners that recommends training menus and predicts race times [4]. Jung et al. reported that a flexible margin between achievement and failure may reduce the loss of motivation if goals are not achieved [5]. Wijnalda et al. proposed the IM4Sports system, which aims to improve people's sports performance by playing music that matches their preferences [16]. In addition, Yue et al. surveyed recommender systems in the health field and reported that it is important to increase user acceptance of recommended goals [18]. In the present study, we design additional information to be displayed with the recommended goals to enable users to estimate costs and benefits when using recommender systems in the health field.

2.2 Explainability of recommender systems

The use of recommender systems is expanding in fields other than the health field, and there have been many attempts to enable people to understand the reasons for the decisions made by recommender systems. Andres et al. designed an explainable artificial intelligence (XAI) system for humanitarian aid planning to effectively assist refugees [1]. In addition, Maltbie et al. developed an XAI tool for predicting combined sewer overflow events in urban sewage treatment organizations [6]. Ohama et al. studied a method to predict customer personality traits using financial transaction records to improve the explanatory potential of their artificial intelligence model [8]. Existing studies on XAI recommender systems aim to provide users with information to understand the basis for the predictions and artificial intelligence model behavior to demonstrate the validity of the recommendations [7]. In the present study, we propose a system that clearly communicates the costs and benefits of the exercise goals suggested by a recommender system. This allows users to choose appropriate exercise goals to improve their health and fitness.

2.3 Importance of goal–setting

Researchers have reported that appropriate goal–setting improves people's health and increases their physical activity. For example, Stuifbergen et al. reported that specific exercise goals for women with multiple sclerosis contributed to increased physical activity [14]. In addition, Ries et al. demonstrated that specific goals for exercise and diet for low-income women in rural North Carolina allowed them to achieve improvements in their physical activity and eating habits [11]. Furthermore, Shlits et al. reported that concrete goals have a more positive impact on improving diet and physical activity than vague goals [12]. In this study, we propose several information presentation methods to assist users in setting appropriate goals to increase their physical activity

3 CONCEPT

This study aims to help individuals who wish to form a new exercise habit (i.e., walking) set appropriate goals using a recommender system. We assume that the recommender system has already determined the recomemended exercise goals based on the users' past exercise trends. On this assumption, we examine methods for presenting the costs and benefits of the recommended goals with the aim of making it easier for users to evaluate and select appropriate goals.

According to the theory of achievement motivation proposed by Atkinson, the motivation to succeed is defined by the following formula [3]:

$$Motivation = f(Ms, Ps, Is) \tag{1}$$

Here, *Ms*, *Ps*, *Is*, and f represent the strength of motivation toward success, the expectation of success, the incentive for success, and the interaction relationship between the variables, respectively. From the theory of achievement motivation, we believe that it is important for people to feel that the personalized exercise goals suggested by a recommender system are easy to achieve and important for improving their health. If users feel that the recommended goals are difficult or insignificant, they may lose their motivation to exercise. Therefore, when recommending exercise goals, we expect that visualizing their benefits and the probability of achieving them can help users select appropriate and motivational goals.

In this study, our proposed system focuses on three aspects of the goals suggested by recommender systems to walking exercise trainees: the amount of effort required to achieve the goal, the degree to which the goal is achievable, and the benefits obtained from achieving the goal. The first factor (i.e., the amount of effort required to achieve the goal) refers to the amount of exercise required for the trainee to achieve the target walking steps. Our system presents the amount of effort as the walking time based on the correspondence between the number of steps and the distance for an average person. Figure 1(a) demonstrates that to achieve the target of 4,000 steps, trainees must walk for 10 minutes in addition to their usual walking time. This information can help trainees intuitively understand the effort required to achieve the target number of steps.

The second factor (i.e., the degree to which the goal is achievable) refers to the trainee's probability of achieving the target number of steps. Our system estimates this probability based on the trainee's exercise logs and presents this information to the trainee. Specifically, the degree to which the goal is achievable can be calculated as the probability of walking more than the target number of steps based on the posterior distribution of the walking steps estimated from the trainee's exercise logs. Figure 1(b) presents an example in which the recommender system estimates and presents a probability of 70% of achieving the goal of 4,000 steps. This information can help trainees intuitively and concisely understand the difficulty of achieving the target steps.

The third factor (i.e., the benefits obtained from achieving the goal) refers to the health benefits gained by the trainees when they achieve the target steps. This paper focuses on two types of benefits: weight loss and disease prevention. Regarding weight loss, the system suggests how much fat can be burned if the trainee achieves the target number of steps every day for one month. The weight loss (F) is calculated by the following formula:

$$F = METs \times w \times t \times 1.05 \tag{2}$$

where *METs* is the exercise intensity, w is the user's body weight (kg), and t is the walking time (h). In general, adults spend 1.05 kcal energies per kilogram body weight at their resting state. Therefore, we take 1.05 into consideration in the above formula.

Regarding disease prevention, the system suggests the types of diseases that can be prevented if the trainee achieves the target steps. The disease prevention effect of walking is determined by referring to a study by Aoyagi et al [2]. According to Aoyagi et al., if the total number of daily walking steps is above a certain threshold, then walking has a preventive effect against several diseases. For example, Aoyagi et al. reported that walking 5,000 steps can prevent dementia and heart disease, while walking 7,000 steps can prevent cancer and arteriosclerosis. Figure 1(c) demonstrates that achieving the goal of 4,000 steps can help prevent depression, while Figure 1(d) indicates that 1 kg of fat can be burned by achieving the goal of 4,000 steps. This information aims to help users understand the benefits that can be obtained by achieving their target steps.

By presenting the above three types of information with different recommended target step options, trainees can decide whether the recommended exercise goals are achievable and important to them and can determine which goals are more appropriate.

Table 1: Participant demographics

	Number	Ratio
Total participants	204	
Sex		
Male	125	61.3%
Female	79	38.7%
Other	0	0.0%
Age		
Under 18	0	0.0%
18–29	13	6.4%
30–39	60	29.4%
40–49	91	44.6%
50–59	31	15.2%
60–69	7	3.4%
Over 70	2	1.0%
Exercise habits		
No ongoing exercise	71	34.8%
Previously exercising on an ongoing basis	47	23.0%
Currently exercising on an ongoing basis	86	42.2%

4 USER STUDY

We examined whether our proposed information presentation methods based on the theory of achievement motivation increase users' motivation for walking exercise through an online crowdsourcing survey. This survey was conducted in Japanese on December 23, 2021.

It should be noted that this study focuses on the evaluation of the information presentation methods, not the accuracy of the exercise goal recommendations. Therefore, we did not use the walking exercise logs of the participants, and conducted the online study under the assumption that the recommended exercise goals were determined in advance.

4.1 Participants

We recruited 207 participants through Lancers, a Japanese crowdsourcing service. We excluded three participants from our analysis because they provided incorrect answers to test questions. Table 1 presents the participant demographics. As illustrated in this table, we analyzed the responses of 125 males and 79 females. We paid 50 yen (approximately US $0.5) to each participant as a compensation. On average, the participants completed the study task in 243 s (approximately 4 min).

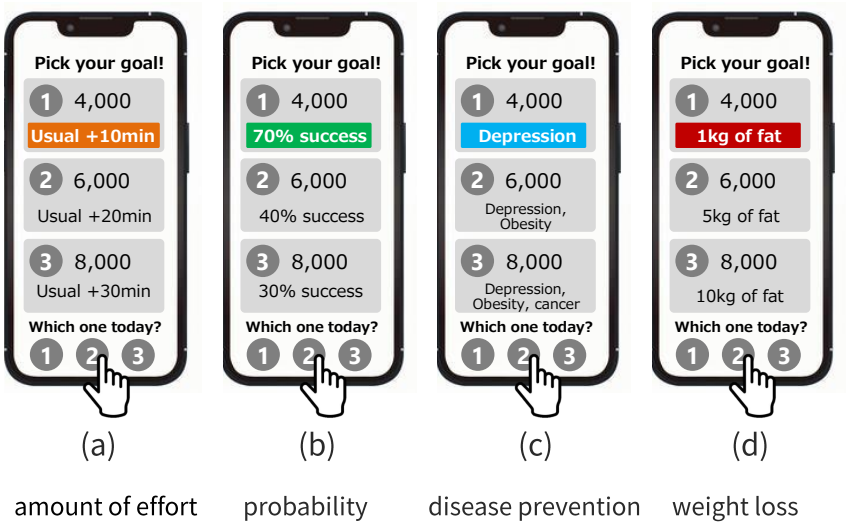

Figure 1: Examples of information presented by the proposed method to promote the user's understanding of the training goals.

4.2 Procedure

The experiment was conducted according to the following procedure. First, the participants read the following scenario:

> *Suppose you want to maintain or improve your health. To form a habit of walking a lot, you set a goal to increase the number of steps per day. After using a pedometer for one week, you found that you walked approximately 5,000 steps to and from your house and work (or school) on weekdays. To set an appropriate walking goal, you asked your sports instructor "I usually walk about 5,000 steps. How many steps a day should I walk from tomorrow?" The instructor then suggested several walking goal options after analyzing your daily walking trend. Please look at the recommended goals listed on the following webpages and evaluate how willing you are to set each goal.*

After reading this scenario, the participants viewed 15 recommended goals in random order. We prepared each of the 15 goals by combining three types of walking goals (6,000, 7,000, and 8,000 steps) and five types of information presentation methods described below (Effort, Prob, Benefit_M, Benefit_w, Control). Figure 2 displays the 15 recommended goals presented to the participants. Participants rated the degree to which each of the 15 recommendation patterns increased their motivation for walking exercise on a 5-point Likert scale.

The participants evaluated the following information presentation methods:

- Effort: walking time required to achieve the goal
- Prob: probability of the walking goal being achievable
- Benefit_M: diseases that can be prevented by achieving the goal
- Benefit_w: amount of fat that can be burned if the target steps are walked every day for one month
- Control: no additional information (only the number of steps)

After evaluating all recommended goals, the participants reported their gender, age, and whether or not they exercised habitually in an exit questionnaire.

5 RESULTS

We examined the effects of the five different information presentation methods on the 204 participants' motivation to exercise. Table 2 presents the mean and standard deviation of the responses to 15 patterns of combinations of five information presentation methods and three target step numbers.

Analysis of covariance revealed significant differences in the factor of information presentation methods when the factor of target steps was used as a covariate ($F(4, 2, 784) = 73.4$, $p < 0.001$). Furthermore, as indicated in Table 2. the larger the number of target steps, the lower the average motivation scores of the participants to achieve the goal regardless of the information presentation method. Table 3 presents the results of multiple comparisons of the factor of information presentation methods using the Benjamini–Hochberg false discovery rate test [15]. We observed significant differences between Effort and Control, Prob and Control, Benefit_m and Control, and Benefit_w and Control ($p < 0.001$). As illustrated in Table 2, Effort, Benefit_m, and Benefit_w tended to have significantly higher mean motivation values than Control.

At the goal of 6,000 steps, the list of the methods in decreasing order of their motivation scores is following: Effort(4.26), Benefit_w(4.09), Control(3.90), Benefit_m(3.88). At the goal of 7,000 steps, the list of the methods in decreasing order of their

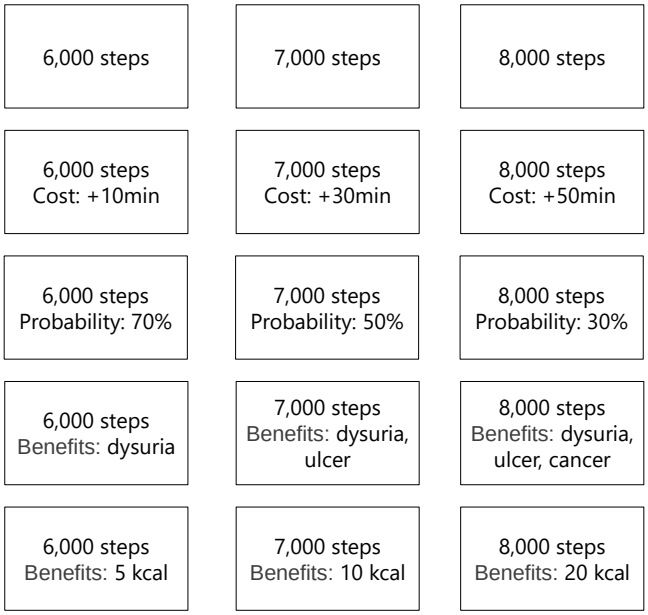

Figure 2: A total of 15 recommended goals presented to participants in the survey. 15 goals were obtained by combining three different goals (6,000, 7,000, and 8,000 steps) and five types of information presentation methods (four information presentation methods based on the theory of achievement motivation and one information presentation method based only on the number of steps).

Table 2: Mean and standard deviation of motivation scores for walking exercise for different presentation methods. Participants responded on a 5-point Likert scale (1: not at all motivated to walk, 5: very motivated to walk).

	Target steps		
Methods	**6,000**	**7,000**	**8,000**
Control	3.90 (1.03)	3.52 (0.99)	2.84 (1.11)
Effort	4.26 (0.86)	3.58 (1.04)	3.47 (1.12)
Prob	3.46 (1.18)	2.88 (1.13)	2.67 (1.14)
Benefit$_m$	3.88 (0.91)	4.06 (0.90)	3.76 (1.02)
Benefit$_w$	4.09 (0.97)	3.91 (1.03)	3.60 (1.09)

motivation scores is following: Benefit$_m$(4.06), Benefit$_w$(3.91), Effort(3.58), Control(3.52). At the goal of 8,000 steps, the list of the methods in decreasing order of their motivation scores is following: Benefit$_m$(3.76), Benefit$_w$(3.60), Effort(3.47), Control(2.84).

In addition, as illustrated in Table 2, Prob tended to have a significantly lower mean motivation score than Control. When the number of steps was large, the difference between the mean motivation scores of Control and Prob greatly decreased.

6 DISCUSSION

As described in Section 5, Effort, Benefit$_m$ and Benefit$_w$ led to significantly higher mean motivation than Control. When presenting the walking time required to achieve the goal, the diseases that can be prevented by achieving the goal, and the amount of fat that can be burned if a the target steps are walked every day for one month, participants were able to understand more concretely the effort required to achieve the goal and the benefits of walking exercise. Consequently, they were motivated to exercise more actively than when only the target number of steps was presented. Presenting the amount of effort required to achieve the target number of steps suggested by a recommender system and the benefits of achieving those steps may thus increase users' motivation to exercise more so than presenting only the target number of steps.

In contrast, Prob led to significantly lower mean motivation scores than Control. This result indicates that presenting the

Table 3: Statistical significance for multiple comparisons (significance levels are *: 0.05, **: 0.01, ***: 0.001).

Comparison combinations	*p-value*
control - effort	***
control - Prob	***
control - Benefit$_m$	***
control - Benefit$_w$	***
Benefit$_m$ - effort	*
Benefit$_m$ - Prob	***
Benefit$_m$ - Benefit$_w$	0.608
Benefit$_w$ - effort	0.121
Benefit$_w$ - Prob	***
effort - Prob	***

probability of the walking goal being achievable may have helped participants understand the difficulty of the goal and be more careful in setting exercise goals than when only the goal was presented. As illustrated in Table 2, the mean difference in motivation scores between Control and Prob was much lower at 8,000 steps compared than at 6,000 and 7,000 steps. This result indicates that if large number of target steps is presented, users can understand the difficulty of the goal without seeing the success probability, whereas when a small number of goal steps is presented, users have difficulty estimating the difficulty of the goal without seeing the success probability. The results of this study thus suggest that presenting the success probability makes it easier for users to understand the difficulty of small and medium exercise goals, but not large exercise goals. Therefore, presenting the degree to which a goal is achievable may lead users to be more cautious about their exercise goals than when they see only the recommended target steps.

We focused on the amount of effort required to achieve the goal steps and the degree to which the goal steps is achievable to help users understand the difficulty of the recommended exercise goals. However, the results of the study indicated that Prob led to a significantly lower mean motivation score than Control, whereas Effort led to the opposite result: a significantly higher mean motivation score than Control. Presenting the amount of effort required to achieve the goal may have provided participants with not only insights into the difficulty of the exercise goals but also hints on how to achieve the goals. In contrast, since the degree to which the goal is achievable presented only numerical information, it conveyed only the difficulty of the goals.

In summary, the results of this study suggest that the presentation of exercise goals based on the theory of achievement motivation has the potential to increase users' motivation to exercise and to help them carefully assess the difficulty level of the their goals.

This study has several limitations. The first is the evaluation index. Presenting the amount of effort required to achieve a goal and the degree to which the goal is achievable aimed to help participants carefully judge the difficulty of the recommended exercise goals. To verify this aim, a simple index of the motivation to exercise would be insufficient. Our study results suggested that the degree to which the goal was achievable reduced participants' motivation to exercise. However, we should have examined whether the participants were able to carefully evaluate the goal difficulty level in our study.

Furthermore, it is necessary to verify the combination of the presentation methods. In our study, we presented one presentation method at a time to the participants and verified the effectiveness of each method. Therefore, we did not examine the effect of combining multiple presentation methods. For example, it is necessary to investigate users' willingness to exercise when they can see both the necessary effort to achieve their goals and the achievability of the recommended exercise goals.

Another limitation of our study is that the proposed methods have not been sufficiently validated through user experiments using real data. We plan to conduct a long-term user study to verify how our proposed methods influence people's motivation to exercise and contribute to the formation of exercise habits.

7 CONCLUSION

In this study, we proposed information presentation methods to help people examine the costs and benefits of goals suggested by a recommender system. Our aim was to help people set more appropriate exercise goals for themselves. We examined whether the proposed methods contributed to increasing users' motivation for walking exercise via an online crowdsourcing experiment. The results suggested that the proposed methods have the potential to motivate users to exercise and promote realistic goal–setting.

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