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Self-tracking and Persuasive eCoaching in Healthy Lifestyle Interventions: Work-in-progress Scoping Review of Key Components

Self-tracking and Persuasive eCoaching in Healthy Lifestyle Interventions: Work-in-progress Scoping Review of Key Components

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Abstract. The combination of self-tracking and persuasive eCoaching in healthy lifestyle interventions is a promising approach. The objective of this study is to map the key components of existing healthy lifestyle interventions combining self-tracking and persuasive eCoaching using the scoping review methodology in accordance with the York methodological framework by Arksey and O'Malley. Seven studies were included in this preliminary scoping review. Components related to persuasive eCoaching applied only in effective interventions were *reduction* of complex behavior into small steps, providing positive motivational feedback by *praise* and providing reliable information to show *expertise*. Concerning self-tracking, it did not seem to matter if more action was required by the participant to obtain personal data. The first results of this study indicate the necessity to identify the needs and problems of the specific target group of the interventions, due to differences found between various groups of users. In addition to objective data on lifestyle and health behavior, other factors need to be taken into account, such as the context of use, daily experiences, and feelings of the users.

Keywords: persuasive eCoaching, persuasive technology, self-tracking, healthy lifestyle intervention, scoping review.

1 Introduction

Unhealthy lifestyle is a major worldwide problem contributing to the burden of disease [1]. In line with various articles [2-4] and the latest definition of health: "*…the ability to adapt and cope…*" [5], we advocate a new approach for enhancing a healthy lifestyle, using self-tracking technology as a methodology to monitor health behavior in combination with persuasive eCoaching. Persuasive eCoaching is defined as the remote and automatic provision of just-in-time tailored feedback for healthy lifestyle management, by enabling users to set personal goals and encouraging to track personal progress towards their goals, adapting the feedback to the usage patterns and context, and encouraging long-term use. Such technological innovations enable new ways for health promotion that could overcome some important obstacles in the uptake of healthy lifestyle interventions [6]. Firstly, self-tracking devices allow tracking an individual's lifestyle pattern more reliably than estimations based on one's personal memory [7-9]. This objective insight into a person's lifestyle pattern provides the essential awareness, which is an important first step to enhance a healthy lifestyle [10]. Secondly, the combination of self-tracking and persuasive technology has the ability to interact 24/7 with users at the right moment with the right personal relevant information [11]. For instance, a virtual coach engine [12] could send a personal feedback message to the user's mobile phone, such as: *'Based on your accelerometer data, you have not been exercising for more than five days. My advice is to plan an activity within two days to accomplish your weekly exercise goal'*. The ability to interact 24/7 with users might positively influence the sustainable use of the health promotion intervention [13-15]. Thirdly, nowadays most people own a device which is applicable for eHealth [2]. Therefore, an automated healthy lifestyle intervention, which does not require trained personnel, can reach many people at low costs [16, 17].

In addition, it is important to acknowledge the challenges in the use of self-tracking technologies in healthy lifestyle interventions. For instance, privacy, trust, and ethics of personal self-tracking data. Concerning privacy, safe storage of personal health data should be assured. To date, personal health data obtained by self-tracking devices are stored on a central server of the supplier [18]. When data are intercepted by third parties, profiling is a risk. Profiling entails that third parties gather, analyze and combine personal data to place a person in a certain category. This could lead to discrimination in the worst scenario, especially when a person is categorized wrongly due to reliability and validity issues of the device [19]. Even if privacy is assured, trust issues could still be present as people might feel uncomfortable with the fact that their data are stored 'somewhere out there' [20]. As it comes to ethics, purpose limitation is an important principle. The purpose of collecting data should be specified, explicit and legitimate. In addition, processing of data should be in accordance with these purposes only. Nowadays, data are stored and gathered without a clear purpose or without a person being aware of personal data gathering [21].

It is clear that persuasive technologies in healthy lifestyle interventions could overcome a few important obstacles, such as the lack of personally relevant feedback, the inadequate timing of support, and issues concerning sustainable use and scalability.

However, there is, to our knowledge, no review study that combines self-tracking, persuasive eCoaching and influence on healthy lifestyle. An overview of essential components of self-tracking and persuasive eCoaching for enhancing a healthy lifestyle is needed to make the most out of modern technologies. Also, it is worthwhile to have knowledge about components in such interventions that might contribute to failure in the promotion of a healthy lifestyle. Therefore, this study focuses on the identification of key components of existing healthy lifestyle interventions combining self-tracking and persuasive eCoaching by means of a scoping review. The key components that we are aiming to map include elements of the intervention for self-tracking and persuasive eCoaching features, and challenging and stimulating factors in the broad sense that might influence the effectiveness of these interventions. The scoping review method fits well with the purpose of this study, as it allows to get a relatively quick overview of key concepts of this new and very rapidly evolving research area by including all relevant resources of information [22]. The main research question of this scoping review is: *"What are key components of (in)effective healthy lifestyle interventions using self-tracking and persuasive eCoaching?"*.

This paper describes the first study of the 4-year overarching project 'Quantified Self @Work' focusing on the development of a workplace health promotion intervention combining self-tracking and persuasive eCoaching. The rest of this paper is organized in the following way. Next, we describe methods and data analysis of the first study. Then, preliminary results are presented. Finally, we discuss research challenges in the domain of self-tracking and persuasive eCoaching based on our preliminary findings, as well as our future research plans.

2 Methods

Throughout the 'Quantified Self @Work'-project, the CeHRes Roadmap is applied [13]. This Roadmap is a holistic and systematic approach for developing and implementing eHealth interventions. This study is a part of the first phase called 'contextual inquiry', which aims at identification of key stakeholders, including end users, and establishing essential requirements for the new intervention to successfully enhance a healthy lifestyle [23]. These stakeholders include 'everyone who affects or is affected by the eHealth intervention' [24]. To efficiently identify needs and problems from a stakeholder's perspective, it is necessary to gain state-of-the-art knowledge regarding the key components of existing healthy lifestyle interventions combining self-tracking and persuasive eCoaching.

The scoping review was conducted in accordance with the York methodological framework by Arksey and O'Malley [22], including the following steps: 1) identifying the research question, 2) identifying relevant studies, 3) study selection, 4) charting the data, 5) collating, summarizing, and reporting the results and 6) consultation. The additional recommendations on conducting a scoping review by Levac and Colquhoun et al. [25] were followed.

2.1 Identifying Relevant Studies

Pubmed, EMBASE, PsycINFO, and Scopus were the databases of choice. Pubmed and EMBASE were chosen due to their wide coverage of scientific journals. In addition, PsycINFO fitted the specific topic of this scoping review and Scopus is multidisciplinary focused which has led to the identification of studies outside of the medical field, such as engineering. The search query consists of three components: 1) self-tracking, 2) persuasive eCoaching and, 3) healthy lifestyle intervention. Related keywords were identified by searching for MeSH and EMTREE terms, synonyms, keywords of relevant articles, using PubReMiner and self-determined search terms. Inclusion criteria were publications between the year 2013-2016, English or Dutch language, and publications of journal articles. This specific time period is chosen due to the fact that smart sensor and self-tracking technology is evolving rapidly. To get an overview of the latest developments in this field, we have chosen to include publications between 2013-2016. Exclusion criteria were reviews, study populations outside the age range of 18-66 years, and paper-based or personally reported tracking. As this is a work-in-progress paper, these inclusion and exclusion criteria are not definite as the scoping review methodology allows post hoc decisions of inclusion and exclusion criteria [22].

To identify additional relevant studies, the reference list of highly relevant articles were screened and science conference papers from important conferences were hand-searched.

After uploading citations into the bibliographic software package Endnote, two researchers independently decided upon the further inclusion of publications based on, respectively, title, abstract and full-text articles.

2.2 Charting the Data

Together with an expert team, a data-charting form was created that includes: study characteristics (author, year of publication, study design, participants, measuring instruments, variable of interest, secondary outcomes, effectiveness, study quality), intervention characteristics (short description of the intervention, including: foundation/theory used, objective of the intervention, implementation, design (co-creation, testing/usability, medium of technology), setting/country in which the intervention was implemented, duration, self-tracking component(s), persuasive eCoaching component(s), and adherence), reported advantages and limitations of the intervention according to the authors of the reviewed article and advantages and limitations of the intervention according to the reviewer.

Effectiveness was coded according to the framework by Morrison et al. [26]. An intervention was coded more effective when the intervention had statistically significant better results on the majority of outcomes, was at least as effective as the comparison intervention and/or was more effective than waiting lists or no intervention control group. Less effective interventions included interventions which were significantly effective in the minority of outcomes, not necessarily as effective as comparison groups and/or more effective than waiting lists or no intervention control group.

An intervention was coded ineffective when no improvements were observed on any of the outcomes and/or the intervention was not more effective than waiting lists or no intervention control group.

Self-tracking components were extracted according to the following components: the specific device, use of the specific device, validity of the device, measurement outcome of the device, required action by the participant to obtain health behavior data, duration of wearing the device and presentation of summary data.

Components of persuasive eCoaching were extracted according to the Persuasive System Design (PSD) model [11]. The PSD model has been applied by previous studies [14, 27] to systematically categorize persuasive eCoaching components of eHealth interventions under the following categories: primary task support, dialogue support, system credibility support, and social support. These categories contain more specific concepts such as tailoring or rewards. Content of the communication was only coded when the communication was provided by technology without the inference of humans, complying with the use of the PSD model in the review of Kelders and Kok et al. [14].

The data extraction form was tested for consistency of use by means of five relevant articles by the two independent researchers.

2.3 Collating, Summarizing and Reporting the Results

By means of qualitative research methods, all data related to components of the data extraction form were coded and analyzed with the qualitative software packaged ATLAS.ti version 7.5. A qualitative analysis method was chosen as we were most interested in the process of how and why components in interventions are effective or not [28]. Descriptive numerical summary and thematic analysis were performed to identify key components including self-tracking components, persuasive eCoaching components and challenging and stimulating factors of (in)effective healthy lifestyle interventions combining self-tracking and persuasive eCoaching. The descriptive numerical summary resulted in an overview of the frequency of a self-tracking or persuasive eCoaching component in more effective, less effective and ineffective interventions. In addition, by means of thematic analysis, main themes were identified on challenging and stimulating factors.

2.4 Consultation

The final step 'consultation' is planned as an interactive discussion with researchers and experts from several fields during the workshop on Behavior Change Support Systems (BCSS 2016): Epic for Change, the Pillars for Persuasive Technology for Smart Societies. Input for this discussion are the preliminary results of this scoping review. The aim of this consultation is to bring meaning and applicability of the results to a higher level by getting insights into other perspectives concerning preliminary results, beyond the perspectives of the research team [22, 25]. Participants in the

workshop will be asked for permission to record the discussion. This recording will then be transcribed and analyzed within ATLAS.ti.

3 Preliminary Results and Discussion

The search resulted in 297 publications. After the title selection, 181 publications remained. For this preliminary scoping review, seven relevant publications[29-35] were selected on the basis of abstracts, which revealed inclusion of all three components: self-tracking, persuasive eCoaching, and healthy lifestyle. During the writing of this work-in-progress paper, consensus between the two researchers (AL and HO) on the abstract selection had to be reached, based on the inclusion criteria. From these seven publications, six publications[29-32,34,35] were applicable for the descriptive numerical summary analysis as these studies tested the effectiveness of an intervention combining self-tracking and persuasive eCoaching. Two out of these six publications showed more effectiveness[29,31], one showed less effectiveness[32], and three showed ineffectiveness[30,34,35]. A summary of the extracted data on interventions characteristics is shown in Appendix A, Table 1.

The seventh publication comprised a qualitative study on the usability of self-monitoring and provision of feedback by mobile devices among HIV-patients and mothers[33]. For the purpose of this scoping review, we extracted only information on the usability by mothers as we are aiming for the development of a healthy lifestyle intervention in which users will mostly comprise healthy adults.

It is important to note that only a few publications are included in the analysis which limits our ability to provide statements on key components in (in)effective interventions. However, a few prudent trends can be presented.

3.1 Key Components of Persuasive eCoaching

Firstly, more effective interventions[29,31] made an effort on reducing complex behavior into simple tasks, defined as the persuasive component *reduction* by the PSD model [11], unlike less effective[32] and ineffective interventions[30,34,35]. For example, Adams and Sallis et al.[29] applied this component by setting personal goals based on extending the average steps the participant performed during the past nine days in order to eventually reach the ultimate goal of 10.000 steps during five or more days a week. In addition, *praise* (e.g. providing positive motivational feedback [11]) was a persuasive component more and less effective interventions[29,31,32] had applied whereas ineffective interventions did not[30,34,35]. Finally, the component *expertise* only appeared in more effective interventions[29,31]. Expertise refers to the provision of reliable information to show knowledge, experience, and competence of the system [11]. No components were observed that might have affected ineffectiveness of the interventions.

3.2 Key Components of Self-tracking

Firstly, it did not seem to matter if more action was required by the participant to get the personal data into the system. Participants of the more effective interventions were asked to perform the most effort, e.g. personally calculating and importing weekly averages concerning steps as input for the system. Secondly, no clear trend is observed in the way summary data is presented between effective interventions and ineffective interventions. Thirdly, all interventions in which the duration of self-tracking was performed longer than three months were more or less effective[29,31,32]. Table 2 in Appendix B displays a summary of self-tracking and persuasive eCoaching components in more effective, less effective and ineffective interventions.

3.3 Challenging and Stimulating Key Components

From the thematic analysis, adherence and usability appeared to be main themes.

Adherence. Adherence refers to "the extent to which individuals experience the content of an intervention" [14]. Overall, adherence to the usage of self-tracking devices was high[29,34,35]. Among participants who did not adhere to usage of the self-tracking device, Adams and Sallis et al.[29] investigated the reasons. These reasons mainly referred to aesthetic reasons: the self-tracking device did not fit with the wardrobe or participants did not like to wear the self-tracking device. One publication reported on adherence to a website-based intervention[31]. Although a high percentage of the participant made use of the website for advice (86%), the intervention group was more likely to drop-out than the comparison group (which comprised no intervention at all). A suggestion was made to explain this by the fact that the website did not contain many interactive features which made it less attractive to return to the website[31].

Usability. The participants in the qualitative study[33] reported goal-setting, monitoring progress, and problem-solving support as main components of an intervention that would make the intervention interface attractive. Goal-setting can be a helpful tool in *tailoring*, a persuasive component of the PSD model [11]. Information can be tailored to the needs and interests of the participant when the system is aware of the goal a participant is aiming for. In addition, monitoring progress by means of self-tracking was also an important feature mentioned by the participants, comprising healthy adults, in the usability evaluation in the study by Bickmore and Schulman et al.[30]. However, the mothers from the qualitative study found it important that the effort of self-tracking was in balance with its added value, for example, guidance by the system in the problem-solving process[33]. To expand on this, just receiving summary data about their health behavior was not perceived attractive[33], although the comparison of presentation of summary data between effective and ineffective interventions did not reveal a clear trend. The mothers preferred to receive more in-depth information showing patterns[33], which can be accomplished by reducing efforts of the participant to discover these patterns, and, therefore, making it easier for participants to perform

the intended behavior and reach goals. This relates to the persuasive component *reduction* in the PSD model [11].

In addition, the acceptable number of messages per day was around 3-4 times according to participants in the qualitative study[33]. However, it was important that content was divergent and participants could decide at what time they would receive messages[33]. The latter can be seen as a personalized service and is, therefore, a form of the persuasive component *personalization* of the PSD model [11]. The number of acceptable messages per day contrasts to reportings by participants in the study of Wang and Cadmus-Bertram et al.[35], in which three text messages per day were too many. This difference might be explained by the fact that the content of the messages was not tailored in the intervention of Wang and Cadmus-Bertram et al.[35].

Other findings on usability where that differences existed between studies concerning preference of the platform for the intervention. The mothers reported to prefer a cell-phone application[33] in contrast to the study by Haggerty and Huepenbecker et al.[32], in which a website was more in favor than a cell-phone application among obese women with endometrial cancer. In addition, resulting from the usability study of Bickmore and Schulman et al.[30], the virtual coach was perceived as a suitable application type for the participants, especially because of her nice and personal appearance, relating to the persuasive component *social role* of the PSD model. Users indicated that the virtual coach was someone participants could relate to, which links to the persuasive component *similarity* of the PSD model. In addition, participants believed that *reminders* helped them to attain their goal[30]. A persuasive component that was not perceived as stimulating was *social comparison*[33], the ability to compare your self-tracking data with others according to the PSD model [11]. Finally, the participants in the qualitative study[33] reported that they were not so concerned with privacy issues. A password for the app would even be a burden to interact with the app[33].

4 Conclusion and Future Research

This paper presents preliminary results of the scoping review into the identification of key components of existing healthy lifestyle interventions using self-tracking and persuasive eCoaching. Although we acknowledge the fact that identification of key components on the basis of only a few studies was frail, we presented some prudent trends.

In summary, *reduction* of complex behavior into small steps, providing positive and motivational feedback by *praise* and providing reliable information to show *expertise* of the system might contribute to the effectiveness of the intervention as these persuasive eCoaching components were discovered in effective interventions but not in ineffective interventions. The persuasive components *praise* and *expertise* were also acknowledged as important components of an eCoach by respondents in a qualitative study [12]. Concerning self-tracking, it did not seem to matter if more action was required by the participant to obtain objective data into the system. What did seem to matter was the duration of the self-tracking: longer than three months of self-tracking was performed in effective intervention but not in ineffective interventions.

In addition, monitoring progress was mentioned as an important intervention component by users. It appeared that adherence to self-tracking devices was good. Participants reported mostly aesthetic reasons for non-adherence. Other attractive components in such interventions were goal-setting and support in the problem-solving process. Usability issues on the number of acceptable messages per day seemed to depend on relevant content for the user. In addition, the importance of *personalization* in the timing of feedback messages was in line with previous research [12]. This also accounts for the desire of variation in feedback messages and the fact that the virtual coach was perceived as a suitable application type for the participants [12]. Furthermore, differences were observed between studies[29,33] on preference for transmission of the intervention through a cell-phone application or a website. Finally, on the basis of a qualitative study into usability[33], privacy issues were not necessarily an issue for every group of users.

Besides the fact that statements had to be made on the basis of only a few studies, another limitation comprises the data extraction on persuasive eCoaching and self-tracking on the basis of the information described in the article. One can expect that some components are described more comprehensive than other components. For example, feedback is more likely described in detail, such as tailoring feedback to personal needs, than the visualization, such as the provision of images that attracts the user, referred to the persuasive component *liking* of the PSD model [11]. For the full scoping review, we will make an attempt to request screenshots of the intervention by the authors of the reviewed articles.

A third limitation of this scoping review is the restricted ability to make statements about separate components and the impact on effectiveness as components influence each other. This is acknowledged by another review into the effectiveness of online healthy lifestyle interventions [36]. However, the identification of components in effective and ineffective interventions might provide some direction. Based on the results of the full scoping review, future experimental research into the evaluation of isolated components can be advised.

As mentioned above, the knowledge obtained from this scoping review will be used for our next study into the identification of needs and problems from a key stakeholder perspective. Based on the findings of the qualitative study[33], which indicated large differences in preferences between two different populations (HIV-patients vs. mothers), it is useful to put effort into the identification of needs and problems in the specific population of the "Quantified Self @Work"-project: the working population.

Another important challenge for future research into tracking a person's lifestyle pattern using self-tracking devices and persuasive eCoaching, is the attention to other factors (psychological and sociological), besides objective data on health behavior. These other factors need to be taken into account in order to understand, predict and prevent high-risk health behavior (e.g., high stress) [37]. In future research, we will apply a promising method called *'Ecological momentary assessment'* (EMA). EMA can be used to systematically collect data about daily experience and feelings of the users, as well as the context of use, for instance, through a user-friendly smartphone application [38, 39].

Finally, future research should study the issue of privacy, trust, and ethics related to healthy lifestyle intervention using self-tracking and persuasive eCoaching. As indicated by this preliminary scoping review, not all users are concerned about privacy issues[33]. However, one might expect privacy issues within the workplace setting due to the hierarchical relation between employer and employees. For instance, access to personal data by the employer might be issued by the employee as their employer has an indication of activities performed during spare time. This also raises ethical issues. For instance, to which extent is an employer allowed to influence the employee's health behavior or time spent outside working hours. In addition, a risk might exist for judging an employee's capability to perform proper work when health issues are identified. We will collaborate with experts in other multidisciplinary fields within connected projects, in order to account for privacy, trust, and ethics in relation to self-tracking of lifestyle patterns during the development of the intervention.

Appendix A

Table 1. Summary of extracted data on intervention characteristics of included publications.

Study	Intervention, comparison intervention and population	Effectiveness	Self-tracking components	Persuasve eCoaching components
Adams and Sallis et al.[29]	Intervention: A one-day goal was presented every day on an n^{th} percentile criterion over the past (valid) nine days. This resulted in a goal that was higher than the daily average of the nine days. Participants received a short message (<160 characters) every 9 days by email or mobile phone, based on the participant's preference. Feedback messages were never negative and were tailored to the successfulness of the person in reaching goals. In addition, participants received points for uploading data and accomplishing goals. These points could be exchanged for items and services. Comparison: Participants in the comparison group were motivated by a static goal (10,000 steps each day) and static feedback messages. Population: Inactive overweight adults.	More effective	Device: Omron HJ-720ITC pedometer (OMRON Healthcare Europe B.V., Hoofddorp, the Netherlands). Effort by participant: Daily sending of steps. Summary data: No summary data were sent to participants. Duration wearing: Daily for 170 days	Tailoring Praise Rewards Reminders Expertise Reduction
Bickmore and Schulman et al.[30]	Intervention: "The ontology-based design approach is used to develop an animated conversational agent that plays the role of a health counselor that can promote both physical activity (ACT) and fruit and vegetable consumption (DIET) through a series of	Ineffective	Device: Omron HJ-720ITC pedometers (OMRON Healthcare Europe B.V., Hoofddorp, the Netherlands).	Tailoring Social role Similarity Reminder Personalization

Table 1 *(Continued).* Summary of extracted data on intervention characteristics of included publications.

Study	Intervention, comparison intervention and population	Effectiveness	Self-tracking components	Persuasive eCoaching components
Bickmore and Schulman et al.[30]	simulated conversations with users on their home computers." Feedback is tailored to participant's pedometer data. The intervention of interest in this scoping review: ACT. Comparison: As this study included a 4-arm randomized trial, the comparison interventions were the interventions other than the ACT-intervention: DIET, ACT-DIET, and no intervention. Participants: Adults somewhat motivated to change health behavior (precontemplation or contemplation phase of the Transtheoretical Model).		Effort by participant**:** Weekly upload of data from the pedometer. Summary data: The virtual coach shows the participants their progress with the steps chart every time they had a conversation with her. Duration wearing: Daily for 60 days	Suggestion Tunneling
Compernolle and Vandelanotte et al.[31]	Intervention: Participants in the intervention received computer-tailored step advice based on their self-tracking data. The advice consisted of three parts: 1) a general introduction, 2) personalized feedback including a scheme how to reach the goal of 10,000 steps per day with their referenced increase per week (1000 or 500 steps), 3) recommendations and suggestions how to increase daily step counts. Comparison: Participants in the control condition did not receive an intervention.	More effective	Device: Omron HJ-203-ED pedometer (OMRON Healthcare Europe B.V., Hoofddorp, the Netherlands). Effort by participant: Calculate daily average each week and recording non-walking activities and activities when the pedometer was not worn. Summary data: Progress feedback was provided by comparing the previous step level with the current	Tailoring Reduction Suggestion Tunneling Expertise Praise Personalization

Table 1 *(Continued).* Summary of extracted data on intervention characteristics of included publications.

Study	Intervention, comparison intervention and population	Effectiveness	Self-tracking components	Persuasive eCoaching components
Compernolle and Vandelanotte et al.[31]	Participants: Employees who were not physically active during the day.		step level. In addition, a chart was presented with bars for the previous number of steps, the current number of steps and the ultimate goal comprising 10,000 steps. Duration wearing: Daily for 90 days	
Haggerty and Huepenbecker et al. [32]	Intervention: 3-5 daily personalized text messages were sent to the participant. "The messages included different types of interaction, such as encouraging statements and yes/no or multiple choice questions. The SMS engine used data (rules, participant information, the day of the week, behavioral topic, etc.) to determine the appropriate SMS to send to each user." WiFi scales from Withings were used for self-tracking. Comparison intervention: Counseling by an interventionist. Data of the Withings WiFi scale was used as input for the counseling. Participants: Obese women (BMI $\geq$ 30 kg/m^2) with endometrial cancer.	Less effective	Device: WiFi scale Withings (Withings, Inc., Cambridge, MA, USA) Effort by participant: Weekly sending of weight. Summary data: It is not clear if participants in the intervention group receive summary data. In the comparison group, the WiFi scale graphed participants' weights through an internet platform. Duration wearing: Unclear. Intervention duration was 180 days.	Praise Personalization Suggestion Tailoring

Table 1 *(Continued).* Summary of extracted data on intervention characteristics of included publications.

Study	Intervention, comparison intervention and population	Effectiveness	Self-tracking components	Persuasive eCoaching components
Tabak and Vollenbroek-Hutten et al.[34]	Intervention: The physical activity data obtained by the accelerometer were shown on the mobile phone in a graph showing both the current activity and the activity the participant is aiming for (10,000 steps per day). Feedback messages included "(1) a short summary of activity behavior and (2) advice on how to improve or maintain the activity behavior." Comparison: Usual care which mostly included weekly (group) training sessions at the local physiotherapy practices. Population: Patients diagnosed with COPD	Ineffective	Device: Accelerometer MTx-W sensor (Xsens Technologies, Enschede, The Netherlands). Effort by participant: Nothing. Summary data: The smartphone showed the measured activity cumulatively in a graph, together with the cumulative activity the users should aim for. Duration wearing: A minimum of four days a week, from waking till 22.00 hours, during 28 days.	Tailoring Suggestion Normative influence
Wang and Cadmus-Bertram et al. [35]	Intervention: This study tested the utility of a wearable sensor/device and short message service (SMS) text-messaging prompts to increase PA. The messages were sent automatically without tailoring. Comparison: Self-monitoring with Fitbit One only. Participants: overweight and obese adults.	Ineffective	Device: Fitbit One (Fitbit Inc., San Francisco, CA, USA) Effort by participant: Daily upload of data from the activity tracker. Summary data: Participants received summary feedback by the Fitbit application. The Fitbit application is	Personalization Suggestion

Table 1 *(Continued).* Summary of extracted data on intervention characteristics of included publications.

Study	Intervention, comparison intervention and population	Effectiveness	Self-tracking components	Persuasive eCoaching components
Wang and Cadmus-Bertram et al. [35]			capable of showing a graph with the number of steps per day, week, month or year and the intended goal. Duration wearing: Daily for 42 days.	

Appendix B

Table 2. Persuasive eCoaching and Self-tracking components by the effectiveness of the intervention.

Persuasive eCoaching or Self-tracking component	**More effective (studies n=2)**	**Less effective (studies n=1)**	**Ineffective (studies n=3)**
Persuasive eCoaching (n=frequency of component in studies)	Expertise (n=2) Personalization Praise (n=2) Reduction (n=2) Reminders Rewards Suggestion Tailoring (n=2) Tunneling	Personalization Praise Suggestion Tailoring	Normative influence Personalization (n=2) Reminder (n=1) Similarity Social role Suggestion (n=3) Tailoring (n=2) Tunneling
Self-tracking – Device	Omron HJ-720ITC pedometer (OMRON Healthcare Europe B.V., Hoofddorp, the Netherlands) Omron HJ-203-ED pedometer (OMRON Healthcare Europe B.V., Hoofddorp, the Netherlands)	WiFi scale Withings (Withings, Inc., Cambridge, MA, USA)	MTx-W sensor accelerometer (Xsens Technologies, Enschede, The Netherlands) Omron HJ-720ITC pedometer (OMRON Healthcare Europe B.V., Hoofddorp, the Netherlands) Fitbit One (Fitbit, Inc., San Francis-co, CA, USA)

Table 2 *(Continued*). Persuasive eCoaching and Self-tracking components by the effectiveness of the intervention.

Persuasive eCoaching or Self-tracking component	**More effective (studies n=2)**	**Less effective (studies n=1)**	**Ineffective (studies n=3)**
Self-tracking – Effort by participant	Daily sending of steps. Calculate daily average each week and recording non-walking activities and activities when the pedometer was not worn.	Weekly sending of weight.	Nothing. Weekly upload of data from the pedometer. Daily upload of data from the activity tracker.
Self-tracking – Presentation of summary data	No summary data were sent to participants. Progress feedback was provided by comparing the previous step level with the current step level. In addition, a chart was presented with bars for the previous number of steps, the current number of steps and the ultimate goal comprising 10,000 steps.	It is not clear if participants in the intervention group receive summary data. In the intervention group, the WiFi scale graphed participants' weights through an internet platform.	The smartphone showed the measured activity cumulatively in a graph, together with the cumulative activity the users should aim for. The virtual coach shows them their progress with the steps chart every time they had a conversation with her. Participants received summary feedback by the Fitbit application. The Fitbit application is capable of showing a graph with the number of steps per day, week, month or year and the intended goal.

Table 2 *(Continued).* Persuasive eCoaching and Self-tracking components by the effectiveness of the intervention.

Persuasive eCoaching or Self-tracking component	**More effective (studies n=2)**	**Less effective (studies n=1)**	**Ineffective (studies n=3)**
Self-tracking – Duration	Daily for 170 days. Daily for 90 days.	Unclear. Intervention duration was 180 days.	A minimum of four days a week, from waking till 22.00 hours, during 28 days. Daily for 60 days. Daily for 42 days.

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