Opportunities and Challenges of Behavior Change Support Systems for Enhancing Habit Formation: A Qualitative Study

Abstract

The formation of healthy habits is considered to play a fundamental role in health behavior change. A variety of studies on Health Behavior Change Support Systems (HBCSS) have been conducted recently, in which individuals use such systems to influence their own attitudes or behaviors to achieve their personal goals. However, comparatively much less research has been devoted to studying how the users of these systems form habits with the help of HBCSS, or to understanding how to design these systems to support habit formation.

Objective: The objective of this article is to study HBCSS user experiences regarding habit formation through an intervention study targeted at establishing a healthier lifestyle. This study also aims to map habit formation stages, as suggested by Lally and Gardner, with the Persuasive System Design (PSD) model. The application domain is the prevention of metabolic syndrome, in which 5% weight loss can significantly reduce the prevalence of the syndrome.

Methods: This study employs a web-based HBCSS named Onnikka, a lifestyle intervention designed for the prevention of metabolic syndrome for participants who are at risk of developing a metabolic syndrome or are already suffering from it. The system under investigation was designed according to the principles of the PSD model and Behavior Change Support System framework. Lally and Gardner's research on the stages of habit formation were used to study the extent to which the Onnikka system was able to enhance the development of new habits. A total of 43 Onnikka users were interviewed for this study during and after a 52-week intervention period. The research approach employed here was hermeneutics, which leans ontologically toward the social construction of reality, gained through language, consciousness, and shared meaning. In addition, the system's login data and participants' weight measurements were utilized to build an interpretation of the results.

Results: The findings of this study suggest that IT habits appear to have a strong linkage with use adherence, whereas lifestyle habits did not seem to be directly related to the 5% weight loss among study participants. Moreover, habit

formation stages provide a possible explanation for why self-monitoring, reminders, and tunneling were perceived as especially valuable features in this study.

Conclusions: For sustainable weight management, holistic e-health interventions are required, and the PSD model offers a practical approach for designing and developing them. Recognizing the stages of habit formation provides additional valuable guidance for designing systems that help shape an individual's habits.

Keywords: Behavior Change Support Systems; e-health; Persuasive Systems Design; Habit formation; IT habit; Interpretive research. [1]

1 Introduction

Obesity is a growing health problem worldwide, and is associated with numerous comorbid health conditions [1]. The mean body mass index (BMI) as well as overweight have increased globally since 1980, and most countries are in need of new policies and interventions in this regard [2, 3]. In the United States, the most common weight-loss strategies include a restricted number of calories, a reduced amount of fat, and an increased amount of exercise, which apply to approximately 50% of weight losers [4]. Maintaining weight loss is challenging [5], as a change in physical activity or diet is normally insufficient to maintain weight loss; a more complete change in lifestyle appears to be necessary for this purpose [6]. However, even moderate weight loss can significantly reduce the risk of health problems like cardiovascular disease, and with a 5% reduction in body weight there is a significant improvement in glycemic control for diabetics [7, 8, 9].

Several studies have presented the potential of web information systems supporting weight loss and weight management [10, 11, 12, 13, 14]. According to

[1] Abbreviations:
HBCSS: Health Behavior Change Support System;
e-health: Delivery of health services via remote telecommunications. In this case, a web information system;
PSD model: Persuasive Systems Design model.

the International Telecommunication Union's statistics [15], in 2017, Internet penetration was already at 48% of the world's population. However, web-based interventions still have only a relatively small effect on health behavior on a global scale [14], e.g. in Kaipainen et al.*'s* [16] study, only 25% of individuals who registered to the intervention website returned to the follow-up surveys, and therefore the effect of their intervention is possibly overestimated. Over a decade ago, Eysenbach [17] argued that the greatest challenge when developing comprehensive systems for health informatics is the sparse amount of knowledge regarding how individuals use, process, and interact with health information. Even today, Eysenbach's claims appear to be valid.

Brouwer et al. [18] presented how a large variety of behavior change techniques and strategies are being used for various lifestyle behaviors. Oinas-Kukkonen [19] maintained that despite using behavioral theories in developing health interventions, the system itself is often described so poorly that it can even be considered a black box. He proposed a related concept, known as Behavior Change Support Systems (BCSSs), highlighting "*autogenous and voluntary approaches in which people use information technologies to change their own attitudes or behaviors through building upon their own motivation or goal."* [19, p. 1227]. A great number of weight loss and weight management applications have been introduced, both in research and in practice, but research reporting on user experiences, actual outcomes, and how these two relate to each other continues to be scarce. Moreover, in most cases, the software features of such applications, including their persuasive features, have not been thoroughly reported. Nevertheless, persuasive design is important, since it has been shown to affect the adoption of HBCSSs [20] and adherence to it [21]. According to Sharpe et al. [22], lack of user engagement hinders the full potential of digital weight management interventions.

The remainder of the article is structured in the following manner. The second section describes the main idea underlying the Persuasive Systems Design (PSD) model by Oinas-Kukkonen and Harjumaa [23]. The third section concentrates on the actual web-based intervention that was created for the research project

addressed in this article. Thereafter, the methodology used in this study and the habit stages introduced by Lally and Gardner [24] are discussed. The main sections then present the results of the study at hand and the implications of these results for both research and practice.

2 Persuasive Systems Design Model

Oinas-Kukkonen [19] has introduced multiple theoretical frameworks that can be directly utilized for conducting research on technological behavioral change interventions, and he provides references to 14 distinct behavior change related models or theories. In his vision, the design of HBCSSs needs to address technological issues, the quality of information, personal goal-setting, and social environments; HBCSSs often must be always available and take into account global and cultural issues with a multitude of beliefs and habits; HBCSS do not merely collect and transform information, but support their users to change their behavior for the better; HBCSS aim to influence their users and therefore they are fundamentally persuasive. By definition, HBCSS do not use deception or coercion to persuade its users [19].

The Persuasive Systems Design (PSD) model introduced by Oinas-Kukkonen and Harjumaa [23] is one of the centerpieces in this research area and has been used vastly in the research [25, 26, 27, 28]. The PSD model [23] suggests (1) a set of seven postulates regarding persuasive systems, (2) analysis of the intent, event, and strategy of persuasion, and (3) defines potential system features for BCSSs:

(1) Oinas-Kukkonen [19] underlines that before considering persuasive features or analyzing the context, the designer should obtain a deeper understanding of persuasion on a postulate level. These postulates are not detailed instructions, rather they should be thought of as the main statements of system design. For example, the postulate "*Persuasive systems should aim at being both useful and easy to use*" has its foundation on the determinants of the Technology Acceptance Model (TAM) by Davis [29]. If a system is difficult to use and is not perceived as useful, it is probably not going to be persuasive either. Three of the PSD model postulates are based on findings in psychology. For example, the postulate

"*Direct and indirect routes are key persuasion strategies*" derives from Petty and Cacioppo's [30] Elaboration Likelihood Model (ELM). The postulate argues that a user who carefully evaluates the content of the persuasive message can be approached by the direct route, but a user who is less thoughtful may be persuaded through the indirect route, where simple cues or stereotypes can be useful [23].

(2) The next element in the PSD model is the analysis of the persuasion context, which consists of identifying the intent of the persuasion, recognizing the persuasion event, and deciding the persuasion strategy [23]. In this phase, a designer needs to take into account aspects like user-dependent features, such as the user's goals, motivation, lifestyle, etc. Further, since new technologies have become available at an increasing pace, the risks and opportunities need to be evaluated thoroughly [19]. The use context itself holds domain-dependent features. In the health domain, this usually involves healthcare professionals in the design process and creating content for the system.

(3) The third main element in the PSD model are the 28 design principles, which are divided in to four categories: the primary task support, dialogue support, system credibility support, and social support [23]. The **primary task support category** comprises persuasive features that aim to reflect users' behavior goals and track their progress toward them. For example, empirical studies have found *self-monitoring* to be prominent in changing physical activity and eating behaviors [22, 31]. This category also includes essential issues, such as disorientation in system use and reducing the individual's cognitive load. Further, the *tunneling* feature guides users through the change process and focuses on the sequence in which the information is presented. The persuasive features in the **dialogue support category** are related to user feedback and human–computer interaction. These principles aim to keep the user active and motivated during the system's use. Several articles have illustrated the value of *reminders* in increasing the effectiveness of web-based health

interventions [14, 21, 32, 33]. **The credibility support category** helps to create greater credibility in the design and, thus, a more persuasive system. An individual should be able to trust the system, accept its advice, and believe that they will be guided to the targeted goal [23]. The **social support category** motivates individuals by leveraging social influence. Technology can support the formation and maintenance of online relationships, which in turn can facilitate social support [34].

2.1 Case Onnikka: Web-based Health BCSS

The current study employs a HBCSS, known as Onnikka, which was designed in the Prevention of Metabolic Syndrome (PrevMetSyn) lifestyle intervention research project for participants who are at risk of developing a metabolic syndrome or already suffering from one. The system was designed at the Oulu University jointly by researchers of internal medicine, information systems, and informatics, following the design principles of the PSD model [23] and BCSS framework [19]. The original architecture of the system has been described in Alahäivälä et al. [35][2].

Onnikka is a web information system that users can access with their personal credentials for a duration of one year. The technological implementation of Onnikka was conducted using technologies that users could access with their desktop devices or mobile phones. Throughout the 52-week intervention period, users received weekly health articles and tasks related to the topic. The information content followed the cognitive-behavioral approach [38]. The aim was to support participants to cope with dysfunctional thoughts that would likely interfere with their behavioral goals and to help their self-efficacy regarding weight monitoring, eating, exercise, and weight loss.

The following key persuasive features were implemented in the Onnikka system:

Primary task support: The core primary task feature of the Onnikka system was *self-monitoring*. Participants could submit entries regarding their weight,

[2] Research findings related to user flow experience [36] and users' perceptions regarding different persuasive features [37] have been published previously in the PrevMetSyn research project.

exercise, mood, and eating habits. They mapped their weight changes in tabular form or as a graph. Further, they could write diary entries with "smileys" to express their emotions during every intervention week. They could also monitor their exercise by submitting entries in which they described the type of exercise, the amount of exercise done, and the level of strain. Participants could also add information to a food diary, which included entries regarding the meal type, description, the eating time, and the place. Additionally, participants could reflect their eating habits by marking the meal as "unnecessary" or "proper". The content of the site followed the persuasive feature of *reduction*. Onnikka simplified a complex behavior into separate themes (nutrition, exercise, etc.), thereby guiding participants to target their behavior change activities to the most relevant topics. A closely related feature to reduction is *tunneling*, a predetermined sequence of information provide, which does not allow a user to deviate from the path while the user is in a tunnel. Here it was implemented as an unchangeable rhythm of providing weekly information content and tasks in which some of users' navigational options were not made available at all times. Participants could browse back over their previous entries; however, new content was not accessible in advance. According to cognitive-behavioral approach, individual needs to process the change actively, which requires sufficient time. In addition, it was necessary to keep the timing of HBCSS similar to all participants, so that the intervention would not be too different for each individual. Moreover, participants could submit their task answers to the system. Additional content was tailored to be visible only to certain individuals based on their behavioral profiles, who were in need of counseling on eating behavior. This feature follows the principle of *tailoring* in the PSD model. Eating hehavior was evaluated using the Three Factor Eating Questionnaire (TFEQ-18, Karlsson et al. [39]). It assesses three dimensions of eating behavior: cognitive restraint (CR), uncontrolled eating (UE) and emotional eating (EE). In TFEQ-18 the results are calculated as a percentage of the highest possible value and it is between 0-100%. If the score for uncontrolled eating (UE) or emotional eating (EE) was in the highest tertile, the participant was categorized as a "participant with problems of eating control." The study participants with highest scores were evenly randomized in all counselling groups. The content of tailored Onnikka

included extra exercises of recognizing and dealing with emotions or risk situations for eating.

Computer-human dialogue support: Following the recommendations of the *praise* feature in the dialogue support category, persuasive messages were conveyed in the weight submission process. Following the persuasion principle of *reminders*, Onnikka sent weekly e-mail messages to users on Mondays, and if they had not yet logged into the system during the week, another message was sent on Thursdays. Further, Onnikka sent weekly tips for good eating behavior to the tailored user group, following the principle of *suggestion.* The system's visual appearance, using photographs of local environments and people were selected based on the persuasive principle of *liking.*

Credibility support: The system provided external links, from which users could *verify* information and gain extra knowledge. Other than this, the persuasion principles in the credibility support category were paid somewhat less attention to, as the participants were rather familiar with the authorities behind the system (university and hospital districts).

Social support: Social support was implemented in the system as a discussion column attached to each weekly health content following the principle of *social learning*. Users could use pseudonyms to anonymously share their thoughts. The homepage indicated the total number of logged participants for that intervention week, which follows the *social facilitation* persuasion feature.

Primary task support	**Dialogue support**	**Social support**	**Credibility support**
Self-monitoring: Weight graph, Food diary, Exercise diary, Mood diary	Reminders: Weekly e-mails to log into the system, followed by another reminder to log in if the user had not logged in by Thursday	Social learning: Discussion forum	Verifiability: Links to external sources
Reduction: Weekly content on separate themes	Praise: Encouraging textual feedback after successful weight-loss performance	Social facilitation: Number of logged users for the current intervention week and the number of comments given shown on the front page	
Tunneling:	Suggestions:		

Unchangeable rhythm of weekly content, exercises, and tips	Tips for good eating behaviors sent to the tailored group
Tailoring: Additional e-mail messages, information content, and tailored exercises for those in need of advice on eating behavior	Liking: Visual appearance of a modern web application, using photographs of local environments and people in the content

Table 1. Persuasive features addressed in this study, following the guidelines of Oinas-Kukkonen [19] and Oinas-Kukkonen and Harjumaa [23].

3 Research Context and Data Collection

PrevMetSyn is a randomized lifestyle intervention study. The study participants were Finnish citizens from the Northern Ostrobothnia hospital district area. Both male and female participants were of working-age and were either obese or overweight (BMI 27–35). All study participants provided a written informed consent. The study has been approved by the Ethics Committee of the hospital district of Northern Ostrobothnia, Oulu, Finland (decision number 29/2012). The study was registered in ClinicalTrials.gov with the identifier NCT01959763.

A total of 532 voluntary participants were screened and randomized to 6 groups: group counselling (8 times, 2 times or none) with or without the 52-week HBCSS support (users of Onnikka). This study concentrates on the 259 users of Onnikka, who were divided into five different starting groups between March 2013 and March 2014 for practical purposes. Onnikka was not linked with any face-to-face counseling and did not use assistance from health professionals.

The qualitative data for this study was collected from three semi-structured interview cycles. The first data collection cycle was made between June 5 and 7, 2013, when 12 individuals participated in the interviews during intervention week 12. The second set of interviews was conducted with another 12 participants between November 6 and 21, 2013. At the time of the interviews, these participants were in intervention weeks 25–27. The third interview cycle was conducted between September 22 and October 21, 2014; this group contained 20 participants—4 individuals from each of the 5 different starting

groups. In this interview cycle, 9 participants were in between intervention weeks 30 and 52, and for 11 participants the access to the system had already ended, ranging from 2 to 27 weeks since the end of the HBCSS intervention period. One of the individuals ended his participation during the research project; therefore, the interview material includes responses of 43 Onnikka users instead of 44.

The strategy for choosing the interviewees was to have a wide representation of various "voices" [40]. Before the interviews, a wide variety of active and non-active users (2–500, MED = 61) was identified based on Onnikka's login information. Simultaneously, the goal was to keep a balance between females (n = 22) and males (n = 21); and whether or not they had group counseling (2 or 8 times). Participants' ages ranged from 22 to 61 (M = 47.1), their baseline BMI ranged from 27.2 to 34.8 (M = 30.5), and the total number of system logins ranged from 2 to 500 (MED = 61). For Onnikka users, it was recommended to log into the system at least once a week to read the new content that was provided by health professionals. The system's use adherence ranged from 4% to 100% (M = 62%; MED = 71%) among the interviewed participants. Utilizing Onnikka's use information made it possible to select individuals who were at the furthest ends of the system-use customs. For example, participant 42 made 1677 entries in the food diary alone, but contrarily participant 31 had a high adherence level (94%) but rarely used the system's tools (a total of just four entries at the time of conducting the interview). Following Patton's [41] descriptions, this type of sampling method is best described as maximum variation (heterogeneity) sampling, where the goal is to describe and capture central themes that emerge from the heterogeneity.

The following seven guidelines proposed by Myers and Newman [40] were applied when conducting the interviews:

1) *Situating the researcher as an actor*. Before the beginning of the actual interview, the researcher explained the procedure of the interview, how the collected data would be used, and explained how to contact him afterwards. The researcher emphasized that he was neither a health professional nor involved in

the system's coding process, and therefore was a neutral actor with regard to Onnikka.

2*) Minimize social dissonance*. The positioning of the researcher as a neutral actor helped to minimize social dissonance. During the conversation, the interviewer sympathized with the life situation of the participant and openly made corresponding remarks concerning his own life. In Finland, where the interviews were conducted, society is relatively "flat," so no extra preparatory effort was needed to minimize the social dissonance related to, for example, age, gender, or social status.

3*) Represent various "voices."* The strategy for selecting the participants for the interview was to obtain the same number of males and females from all three counseling groups. The aim was also to have the same number of participants who obtained tailored information and those who did not. Before the interview, Onnikka's login information was used to recognize a good variety of both active and non-active users. During the last stages of this research case, separate tools on par with individuals' BMI measurements were used to select participants for interviews.

4) *Everyone is an interpreter*. This study is an interpretive case study, and it holds the idea that the world is socially constructed. Interviewing is a rare event for participants, and collected results should be considered as interpretations rather than indisputable facts.

5) *Use of mirroring in questions and answers*. Even though semi-structured lists of questions were prepared, mirroring was used during the course of the interviews. Mirroring means constructing a subsequent question or comment using subject's words and phrases, which allows to focus on the subjects' world view [40]. The order of questions and their exact wording could vary according to the themes that the participant was describing. Moreover, if the participant had not used certain tools, or he/she had difficulty remembering them, some of the questions were omitted.

6) *Flexibility*. Participants were encouraged to speak spontaneously, and all of those interviewed were given all the time they needed for the interview. The duration of a single interview varied from 25 minutes to almost 2 hours.

7) *Confidentiality of disclosure*. Permission was taken to record the interview before beginning the actual interview. To ensure confidentiality, only research numbers were included in the recordings so that they could be linked with the system's user data. The codes in this study are different from the numbers stored in the recordings.

3.1 Hermeneutic Research

This study is part of the interpretive qualitative research tradition, and it leans heavily on hermeneutics. One of the main characteristics of interpretivism is seeing reality as socially constructed [42]. Participants' answers during an interview are interpretations of their initial motives, and researchers' conclusions from the collected material are interpretations as well, which are made in a certain situational context or from a certain standpoint [43, 44]. Patton [14] argues that this perspective is fundamental in qualitative inquiry and has become commonplace in contemporary social science.

Klein and Myers [42] suggest a set of principles for interpretive field studies, and considered the hermeneutic circle the fundamental principle of interpretivism. Typically this is seen as an overall ontological approach for interpretive studies, and there are only a modest number of studies where hermeneutical approaches have been applied as a research methodology, as Sarker and Lee [45] argue (Karppinen et al. [46] use hermeneutics to study anomalies for non-adoption of BCCS). As a research method, hermeneutics originates from interpreting ancient texts, in which striving to determine the correct understanding of a text led to the recognition that it is practically impossible for humans to retrieve a "true" 100% representation of a text [44]. Subsequently, hermeneutics has been portrayed as the theory of the interpretation of meaning [47, 48]. According to the principles of the hermeneutic circle, the development of an interpretation is an iterative process, where the understanding of the whole occurs through the meaning of the separate parts, and the meaning of separate parts is determined

by the whole [41, 42, 45]. Such an interpretation does not assign equal significance to each word or a "random sample" of words [45]. Yet, hermeneutic interpretation is not intended to replace positivist qualitative research but rather strengthen and complement it (see e.g. [49]). Previously, Trauth and Jessup [50] demonstrated how interpretive analysis is capable of producing new information that could not be found through positivist approaches and novel understanding of evidence even from data that was already analyzed.

Hermeneutics is a valuable tool for interpreting qualitative data [45] because it makes use of anomalies to gain a better understanding of the information in a particular context [47, 50]. It is fairly common in hermeneutic research tradition that themes and categories change during iterations, and researchers may collect more data between the circles [45]. When all newly gained knowledge is relative to prior understanding, a researcher's pre-understanding is the starting point for a hermeneutic study, and thus it also provides the initial interpretive framework [47]. As Cole and Avison [47] outline, a researcher's prejudices are the basis of the research process. In this research case, the three most essential elements concerning pre-understanding were the BCSS framework [19], the PSD model [23], and the actual system itself (introduced in the previous sections). Theories were used as lenses to explain data rather than to verify the theories themselves or build new ones.

Hermeneutics does not offer explicit guidelines on how to conduct the actual data analysis. Certain researchers use analysis procedures from other methodologies, such as open coding from grounded theory [51] or discourse analysis [52]. This study does not follow any specific methodological school; instead, the general principles of coding and indexing were utilized, which, as stated by Miles and Huberman [53], are the most common practice in qualitative data analysis. All the interviews were conducted via phone, recorded, and transcribed. NVivo 10 software was used to manage codes and categories, but none of the automated classification tools were utilized. Data analysis was conducted by the first author; however, in hermeneutics, it is not uncommon that only one author does the analysis (e.g. [47]). It was considered that the same

author who interviewed participants has the best understanding of transcribed texts. Ability to recognize tones and other subtle vocal cues were perceived important. First and second author had reflection meetings throughout the process of data gathering, analysing the data, and how the synthesis of the findings was made. Especially after anomalous findings from the first interviews, discussions with second author helped to evaluate the decision trail.

During this research case, interviews were conducted in three hermeneutic circles, and interviews were based on an evolving set of (primarily) semi-structured questions. The themes of the questions varied from technology acceptance to flow experience, and from persuasive system features to changes in attitudes and behaviors. Since the questions were prepared in advance, a vast majority of the codes were created prior to the interviews. As Miles and Huberman [53, p. 65] argue, it is wise for a qualitative researcher to create codes more inductively and analyze collected data for empirically driven labels. As Stahl [44] have argued, hermeneutics (as emphasizing understanding) is suited to those social situations that aim to understand human activities, not to predict them.

Onnikka was not developed with the habit formation framework in mind, as the primary aim of the system was to support participants' attitude change. Yet, based on the experience from the first hermeneutic cycle, it appeared that habits could play a role in HBCSS use and in the actual behavior change process. In the following example, the role of habit is rather evident. Sections that were labeled with "habit" codes are underlined, and comments in the brackets represent the interviewer's interpretations.

> ***Interviewer:*** *Has Onnikka been helpful to you when making changes to your lifestyle?*
> ***Participant 11****. Yes, it has. Every time I grab a product* [in a grocery store]*, I start to think if the need for it is real, or is it more of a habit. I think it* [Onnikka] *is a good tool for that. And also when I go to the fridge. When it's* [lifestyle change] *in the*

back of my head somehow, it makes me think, what to choose and what not.

Interviewer: *Have you learnt new things by using Onnikka?*
Participant 11: *Yes, I have. It gives me more understanding. Like if I continue like this, where will it lead me? And kind of also how health and eating are connected. It has been very useful. When I've gotten used to a certain rhythm or pattern, I haven't had to think further. I've been able to just let it go and live my life.*

Interviewer: *Does Onnikka challenge you enough?*
Participant 11: *Yes, it does quite sufficiently. It's not stagnant all the time, and it gives new perspectives when thinking about personal goals. When for instance the topic was exercise, it did help me become more active. Now it's more or less a habit that I just go* [to exercise]*. When exercise is included, it's a good reminder that it's time to be active.*

Two habit-related questions were added for the second and third hermeneutic circles: first, participants were asked if they felt that their use of Onnikka had become a habit; and second, participants were asked whether they still had to struggle with their lifestyle change or whether the new behaviors had become a habit.

Previous studies (e.g., Karppinen et al. [37]) have highlighted the importance of three persuasive features for users of Onnikka: self-monitoring, reminders, and tunneling. Moreover, new weekly content was perceived as a very influential part of Onnikka by many of the participants. However, it has remained unclear why these specific features were perceived so highly among system users.

4 Stages of Habit Formation

Creating a habit plays an important role in health behavior change, as many health goals are reached only by repeated action. Habits are considered to play a

fundamental role in behavior, and the formation of healthy habits may be the key to aid maintenance beyond the intervention period [54]. Although habits are known to affect behavior, promoting habit formation is a relatively novel research area in the health psychology field (24, 54].

In psychology, habits are conceptualized as behavioral patterns enacted automatically in the context in which the behavior has been consistently repeated before [24, 55, 56]. Gardner [54] determines a habit "*as a process by which a stimulus automatically generates an impulse towards action, based on learned stimulus-response associations.*" Gardner [54, p. 4] considers a habit to be an impulsive pathway, where context-behavior associations rapidly and efficiently prompt behavior with minimal forethought. On a reflective pathway are reasoned cognitions, which direct behavior slowly with deliberate effort [54].

Lally and Gardner [24] suggest four stages to achieve automaticity. They consider a habit as a continuum, where automaticity is considered a strength rather than a dichotomy (having or not having a habit). Nevertheless, distinctive stages offer a useful conceptualization from a practical perspective. According to Lally and Gardner [24], for a behavior to change, a decision to take action must first be made. Second, the intention to act has to be translated into behavior. Third, the behavior must be repeated in the presence of the same contextual cues to form a habit. After habit strength peaks, repetition has little impact on habits [57] and, consequently, the fourth stage pertains exclusively to habit formation. The new action must be repeated in a fashion that is conducive to the development of automaticity, which includes creating salient cues for the activity, emphasis on consistency, reducing behavioral complexity, and avoiding extrinsic rewards that have the potential to hinder the habit-formation process [24].

In addition to form a new habit, breaking old habits are important. Despite being motivated to perform a new behavior, when an opportunity arises, many individuals act according to their old habits [24, 56]. It is possible for habitual behaviors to be automatic, yet infrequent [54], and these "implicit habits" offer

one explanation for why behavioral interventions typically yield short-term gains, which are likely to erode as old behaviors re-emerge [54, 58].

5 Results

In this section, we first describe how the responses of individuals in this study map with Lally and Gardner's [54] habit formation stages. Second, we summarize how the individuals perceived the formation of HBCSS use habit and behavior change habit.

5.1 Intention Formation Stage

Participating in this research project was voluntary and free of cost. A total of 12,500 invitation letters were sent to Finnish citizens in the Northern Ostrobothnia hospital district area. Committing to be part of a research project with its baseline measurements was such a threshold for many participants that intention formation was not a critical element when participants obtained access to use Onnikka. In general, participants had high motivation to achieve a lifestyle change when they began to use the system. For some participants, even the thought of being part of the lifestyle intervention study was highly motivating, as the following quotation reveals.

> *P36: "Invitation letter helped a lot. Getting into this kind of* [research project] *is like winning in the lottery."*

The psychological predictors of intention formation have been the focus of several theories [e.g., 59, 60, 61], but they are not emphasized in this study.

5.2 Translating Intention into Action Stage

Decisions are significant predictors of the initiation of behavior, but "intention-translation" is not always perfect. Sheeran's [62] review revealed that among those who intended to engage in a certain behavior, the average rate of performance was merely 47%. This gap can be partially explained by lost motivation to perform the behavior [24]. The duration of Onnikka is unusually long, as new content and tasks are provided by health professionals every week for a total of 52 weeks. For 3 participants out of 43, the "intention-behavior gap" was caused by a loss of the motivation to perform the aimed behavior quite soon

after they had begun using Onnikka. They all experienced not feeling the need to use Onnikka after all, as seen from the following quotation:

> *P34: "I barely got accepted to this research project to begin with. When I attended a group meeting, I realized that I didn't have a weight problem* [when compared to others], *and it really killed my motivation to use Onnikka."*

According to Lally and Gardner [24], volitional (or "post-intentional") factors are the second class of reasons that can explain why people fail to act on their intentions. These factors are related to the ability to put plans into action and remembering them [24]. Most effective cues to act on a plan are distinct events in daily life that are barely missed. Self-monitoring can also be particularly meaningful in requiring reliable evaluations of current behavior, so that differences between current activities and desired behavior can be perceived [24] . A representative example shows how participant 01 began to measure his weight first thing in the morning:

> *P01: Before this, I hadn't really been on the scale in the morning, but now I weigh myself at least once a week, usually more than once, and what is great is that it* [Onnikka] *draws that graph so it's very nice to see it going downwards. Of course, it sometimes goes flat and even upwards, but still it has been dropping down the whole time after I started using it. It's been great to follow it.*

Support is offered to HBCSS users by enabling them to keep up with their lifestyle change by providing them reminders. Even most Onnikka users who were not active users perceived reminders as a positive feature:

> *P25: "There's been quite a bit of everything going on in my life, and the web system has been put on the side for a while. It's in the back of my mind anyway, and because the system reminds me, I at least read the content every week. With the help of Onnikka I get self-control, and I can walk away from tough situations."*

When losing weight, knowing how to deal with a social situation in which high-calorie foods are offered can be extremely difficult. According to Lally and Gardner [24], both action-planning and coping-planning have been confirmed to assist behavior change when used independently or in combination. Participants did describe their plans to change their lifestyles; however, somewhat surprisingly, participants gave only a few concrete examples of how specifically Onnikka had supported their planning.

5.3 Repetition

Repetition often requires continued intrinsic motivation and the support of self-regulatory techniques [24, 31, 63]. In addition, goal-directed actions that generate positive emotions can strengthen commitment to change (Louro et al. 2007), and self-monitoring can be one tool to recognize anticipated outcomes [24]. During the early stages of behavior change, actions that give rise to positive emotions can increase effort, whereas those prompting negative effects are most likely discontinued [24, 57, 64]. As behaviors are repeated and automaticity begins emerging, the initiation of a behavior requires lesser effort and, therefore, participants' satisfaction may be strengthened by focusing on the ease of performance [65]. The Onnikka system itself was perceived as easy to use. Not a single interviewed participant said that the system was too difficult to use. In addition, Sharpe et al. [22] found that ease of use was an important facilitator of enhanced engagement.

During the long span of the intervention, many participants were faced with the situation in which their weight loss had stalled. There were even a few users who seemed to be discouraged by the monitoring of weight after a setback. The following quote is a good example of how positive outcomes can enhance behavior change, and how unexpected obstacles can turn into a downward spiral.

> *P39: I've always been physically active, but this time I also changed my diet. Following the weight curve was very motivating, and in the spring I almost achieved my weight target, from 96 to 80 kilos. I had a medical issue during the summer and couldn't exercise regularly. Paradoxically, I ate more*

despite the fact that I didn't consume energy nearly as much. So I gained more weight, and I haven't gone to the scale since. But now that I can exercise again, and I know how to keep the weight under control, I believe I'll succeed.

In case of facing a setback, one method to help repetition, according to Lally and Gardner [24] is the ability to switch focus to different domains of success when needed. Participant 38 had high self-esteem and was very optimistic despite the fact that she had not lost weight in a year.

P38: I hadn't lost weight when I had my one-year measurement. But my waist has gone smaller and my cholesterol levels are much better. My new habit is to eat more frequently, after every 3 hours. But I still need to restrain myself; my biggest urge is for sugar.

After new behavior has been initiated, self-monitoring can make the compliance with behavioral goals easier [24]. Monitoring can support contextual stability to ensure that individuals are performing the behavior in the same way on each occasion, which in turn helps habit formation [24] . For several participants, it was particularly difficult to progress with weight management in the holiday season.

P31: I felt that my willpower was cracking during the summer. I think my biggest achievement so far was that I survived through it. Every time I noticed that my weight started to rise, I lightened up my diet. If I ate too much during the weekends, I took myself back on track immediately the next week.

The benefits of self-monitoring can be enhanced by providing feedback on performance, which can keep people motivated during the acquisition phase [24 31]. The Onnikka system gave positive supportive feedback whenever the individual submitted his/her weight in the system. However, this praise feature was rarely mentioned by the interviewees if not specifically requested, and its meaning seemed rather trivial for them.

Positive reinforcement can also be promoted by external feedback by having others comment on performance [24]. Participants in Onnikka could make comments on weekly themes and were able to share their thoughts anonymously using pseudonyms. Unfortunately, this feature was used by the participants so scarcely that it barely created any sense of social support among the participants. Five participants perceived lack of social support as one of the key reasons for not using the system throughout the entire intervention period.

Lally and Gardner [24] argue that people who are engaged in behavior change should be provided with support to achieve self-directed changes rather than to follow external instructions. Support for competence and autonomy are hypothesized to interact with each other, thereby making behavior be better internalized [66]. In the current research case, participants were aware of the importance of gaining competence and autonomy in general; nevertheless, our data holds answers that are somewhat contradictory. In Onnikka, there was a section for frequently asked questions, but despite the possibility of receiving information directly from healthcare professionals, some users were disappointed that their recordings in the system were not monitored and commented on by experts. In fact, the commitment to use the system as instructed was often mentioned in positive light during the interviews, and four participants stated that commitment was their primary reason for using the system.

5.4 Automaticity

Lally and Gardner [24] note that, traditionally, it has been assumed that if performance is highly rewarding, the likelihood that a behavior is repeated is high [67], and habits develop only if rewards are received for each repetition. Conversely, recent studies have shown that providing notable and tangible rewards for behavior can undermine intrinsic motivation, and extrinsic rewards enhance habit formation only when they do not become the goal of behavior [24, 68]. Participants in the PrevMetSyn research project did not get any rewards for participating. Almost all interviewed participants did not report having any extrinsic rewards of their own to honor their weight loss either, and those who

did, had moderate rewards (e.g., glass of wine, smaller-size trousers, sport equipment).

Lally and Gardner [24] emphasize that simple activities are easier to automate than complex behaviors. In the flow of everyday routines, behaviors are often linked together in "chunked" sequences, so that the completion of one activity cues the next [29]. Several Onnikka users were unable to find space for the use of HBCSS in their flow of daily activities:

> *P24: "I have a three-shift job, I'm a single mother, and I have a lot of hobbies. I'm a very diligent person, so if I forget to use Onnikka, I feel miserable. Sometimes I panic when I realize how quickly the week has gone."*

Individuals had the entire week to read the weekly content and submit their self-monitoring entries, and therefore the system was not believed to be too time consuming. Surprisingly, a lack of time to utilize the system to the full was a rather common argument for not using Onnikka, and six participants indicated that this was the main reason that they did not use the system. Paradoxically, respondents were not criticizing Onnikka's unchangeable rhythm, which follows the principle of persuasive feature tunneling; rather, they perceived tunneling as a valuable system feature.

> *P02: "The invitation to partake in this research came at a very opportune moment because I knew that the risks of getting sick were high. My life is really hectic, so I'm able to concentrate on this since there's this scheduling. Now I'm doing the things that I should have done much earlier. Appointed meetings, or answering the questions [in Onnikka] makes it easier to focus on things. - - I log in to Onnikka couple of times a week. I check my weight weekly and write my thoughts there. And I also mark my exercise there. - - The surest way to succeed would be not having any social life… living in a bubble. The trick is how to cope with the exceptions and making your lifestyle change ongoing."*

Lally and Gardner [24] discuss whether the role of the uninterrupted performance of behavior is a necessary condition for habit formation. Armitage's [70] study showed how exercise habits develop over a 12-week period, and it was found that lapses in performing the behavior predicted poorer future performance. Lally et al. [57] found that one missed opportunity did not have an impact on habit formation. In our research case, only participant 31 identified interrupted performance as a reason for not continuing to use the system. It may also be that uninterrupted performance did not have a significant impact in such a long intervention period. In Onnikka's long 52-week ICT intervention period, there were only a few participants who used the system every week throughout the year, and occasional breaks were not perceived as critical.

5.5 Breaking Unwanted Habits

Onnikka enabled individuals to break their old habits by helping them to raise awareness of their everyday choices and eventually build healthier habits through repetition. Lally and Gardner [24] argue that an appealing solution to break old habits is to remove the individual from any environment that cues unwanted habitual responses. In addition, reminders in the environment are a useful tool to help people remember their plans, if placed appropriately [71]. Among Onnikka users, only a few mentioned placing reminders in their environment:

> *P32: "Onnikka is a very important reminder and supporter. I have three kids, so when they've gone to bed, having late night snacks while watching TV has been my way to relax. Now I put a glass of water on the sofa's armrest to remind me of my behavior change project."*

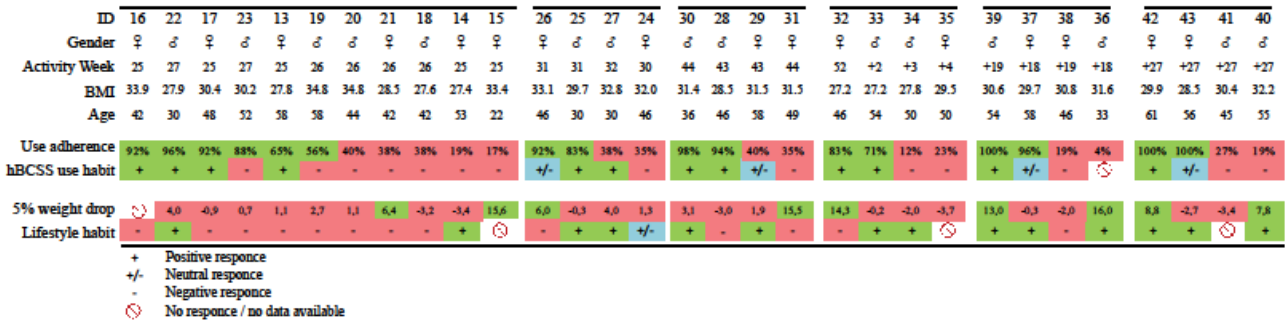
However, eventually, rather than trying to forever avoid cues that trigger unwanted habits, new alternative responses are needed [24, 72]. Vigilant monitoring offers an effective way to inhibit unwanted habits by paying attention to potential slipups, which involves the "don't do it" thought process [45, 62]. Self-monitoring was often perceived as an effective way to inhibit unwanted habits among Onnikka users.

P42: As a pensioner, I had plenty of time to use Onnikka, and I typed what I ate every day for a whole year. If I had to add a chocolate bar there, I couldn't look myself in the mirror.

5.6 Experiences of HBCSS Use Habits and Lifestyle Habits

For the last phase of this study, the weight results for the twelfth month were collected, and Onnikka's use data for the entire intervention period were collected. The possibility of using weight information and system use activity served as new lenses of interpretation. Onnikka users were recommended to log into the system at least once a week to read the provided content. In Figure 1, participants with 100% adherence logged into the system at least once a week throughout the entire 52-week intervention period. Figure 1 presents details on the participants interviewed in the second and third interview circles (total 31).

Figure 1. Responses to habit formation from the second and third interview cycles



When selecting the participants for interviews, the aim was to find the same number of active and inactive users. Therefore, it must be noted that the coloring of use adherence in Figure 1 does not present a threshold found in the literature, where the system use would have been found to be particularly beneficial. The system's use adherence ranged from 4% to 100% (M = 62%; MED = 71%) among the interviewed participants. A total of 15 respondents had less than 50% system use adherence, from which all but one participant said that using Onnikka never became a habit. Individuals who had over 50% adherence claimed almost the exact opposite: 11 participants out of 16 claimed that using Onnikka was more or less a habit for them.

The answers related to behavior change as a new lifestyle habit were surprising. From among nine respondents that managed to lose 5% of their weight in a year,

only four stated that their new lifestyle was an automated habit at the time of the interview. Naturally, in these answers, it has to be taken into account that for the most part, the interviews were conducted in different time periods, and—for example in the intervention weeks 25–27—participants generally seemed to still be struggling with their lifestyle change. Another unexpected founding is that 10 participants expressed that they reached automaticity regarding new lifestyles at the time of the interviews but were not able to lose 5% of their weight at their 12th month measurements.

6 Discussion

Self-monitoring tools, reminders and tunneling appeared to offer support to commit to the intervention. Lally and Gardner's [24] stages of habit formation were used to categorize the findings of this study. As evident from Lally and Gardner's [24] habit formation methods, self-monitoring and reminders work in multiple stages. This might be one explanation for why self-monitoring and reminders were perceived as rather valuable in this research case, and why empirical studies have found them to play a prominent role in changing physical activity and eating behaviors [31]. Interventions not including self-monitoring have been found to be significantly less effective than interventions with monitoring [31]. Text messages have been found to increase physical activity when compared to control groups who did not receive reminders [73]. It must be noted that in our study, reminders and tunneling were valued also by interviewed participants who were not able to achieve 5% weight loss after the intervention period [37]. Moreover, new weekly content was perceived as a very influential part of Onnikka by many of the respondents. The provision of frequent updates is important, a finding that is also supported by the reviews of Brouwer et al. [18] and Kelders et al. [21]. Even though not a separate persuasive software feature, "frequent updates" are related to the fourth design postulate of the PSD model [23], namely that "persuasion is often incremental."

Our results imply that system use adherence and HBCSS use habits are related; however, perceived lifestyle habits did not appear to completely resonate with the actual 5% weight loss among participants. For many respondents, a new lifestyle implied a behavior change in one particular area; for example,

participants 37 and 43 stated that they select healthy food ingredients without being conscious of it anymore, participants 29 and 33 stated that exercising has evolved to the level of automaticity for them, and participants 34 and 36 said their eating habits are now healthy (smaller portions and regular eating times to avoid binge eating). According to Lally and Gardner [24], performing multiple behaviors in response to one cue can diminish the possibilities that any response will become habitual [74]. If many behaviors can be used to achieve a goal, the association between the goal and any one behavior is reduced [24]. With the Onnikka system, users also experienced the opposite problem in that one behavior was often not sufficient to achieve a goal, but multiple behaviors were required to do so. This can be one explanation for why participants' perceived lifestyle habits did not appear to resonate with their actual 5% weight loss. The reported automaticity often concerned only one area out of many that would have required weight management. HBCSSs designed to achieve a complete lifestyle change could help its users to switch their focus to different areas when needed.

Onnikka did not offer much social support, which clearly influenced the user experience for some participants directly. Maher et al. [75] discovered that health-focused online social networks can be effective, but approximately 50% or more of users who sign up do not remain for the entire duration of the intervention, and engagement is generally low for those who do stay. Maher et al. [75] speculates that a drawback of health-focused online social networks is that they attract motivated individuals who were already motivated to change their health behavior. Sharpe et al. [22] argue that the type of social support may differ depending on user characteristics. Our results seem to agree with Lehto et al. [32] and Krukowski et al. [76], who indicate that in online communities, peer support gains importance in the maintenance phase. It takes time for new users to develop an affective commitment to the community [32], and it is unfortunate that users are not able to garner social support when they are in need of it.

6.1 Implications for Practice

According to our results, in addition to self-monitoring and reminders, tunneling is also a very influential HBCSS feature and should not be overlooked when

designing e-health interventions. This is an noteworthy finding especially since in their analysis of widely used weight-loss websites Lehto and Oinas-Kukkonen [77] found that tunneling had not been utilized.

Participants encouraged to perform a health-promoting behavior regularly in unvarying contexts were shown to have an increased habit-related automaticity [57, 65]. Our results show how challenges in everyday life often are a part of the reason e-health users do not have the capacity to participate fully in the behavior change process. Therefore, e-health designers should not only focus on the repetition of a behavior, but also provide a means to settle the actual use context.

Lally and Gardner [24] underline that simple activities are easier to automate than complex behaviors. It is challenging to achieve a comprehensive lifestyle change, and Lally and Gardner [24] suggest large task boundaries as the best point to insert a new habit; however, task completion needs to have a salient cue to increase the chance of a new planned behavior to be performed [71]. People make the most action slips at the interface between the end of one behavior and the initiation of another, presumably because the link to the next action is not strong [24]. A few studies have been conducted to examine the Kairos-moment persuasion of the user at the best possible moment (e.g. [78]). Our results underline that the question of recognizing the best moment for persuasion merits further study. In the future, HBCSS could identify a person's idle time, suggest healthy activity, and create a salient cue for the formation of this new habit. With the help of smartphones, HBCSS can already support aspects like coping with food cravings at the moment of need. It appears rather evident that modern HBCSSs should be designed first to be mobile-friendly. Another question is whether it is reasonable to build different applications for different mobile platforms or to develop web-based interventions that can be used with all devices.

Table 2 summarizes the key methods of habit formation following Lally and Gardner's [24] study; these are aligned with Oinas-Kukkonen and Harjumaa's [23] PSD model concepts. The table is an attempt to find cossesponding element from the PSD model, with what certain habit stage could be achieved in the Lally

and Gardner's [24] framework. The PSD model [24] includes key elements of habit formation, and it can be a useful design aid to enhance the automaticity of a behavior, even though it is not aimed at habit formation per se.

Stages of habit formation, subcategories (Intention formation not included)	**Corresponding construct in the PSD model**
Translation of intention into action (only volitional/post-intentional categories included in the table)	
Remembering intended action	
Action and coping planning	Rehearsal (F)
Reminders and cues for the enactment of a plan	Reminders (F)
Self-monitoring	Self-monitoring (F)
Promotion of repetition	
Satisfaction regarding the experience	
Positive experience of a new behavior	Ease of use and usefulness (P)
Attaining anticipated outcomes	Self-monitoring (F)
Different domains of success	Route (C, the Strategy)
Enhancing intrinsic motivation	
Connection with others	Social support (F; includes multiple features from this category)
Competence and autonomy	Autogenous technology (C, the Intent)
Positive feedback	Praise (F)
Self-regulatory strategies	
Planning, particularly coping planning	Rehearsal (F)
Self-monitoring	Self-monitoring (F)
Supporting the development of automaticity	
Enhancing intrinsic rewards	Rewards (F)
Consistency	Tunneling (F)
Reducing behavioral complexity	Reduction (F)
Creating salient cues	Route (C, the Strategy)
Breaking unwanted habits	
Discontinuing exposure to unwanted habit cues	Use context (C)
Reminders in the environment	Reminders (F)
Programming alternative responses	Rehearsal (F)
Self-monitoring	Self-monitoring (F)

Table 2. Habit formation methods adapted from Lally and Gardner [24] and the corresponding constructs of Oinas-Kukkonen and Harjumaa's PSD model [23]. (P = Persuasion Postulate, C = Persuasion Context, F = System Feature.)

With regard to the stage of automaticity, our results are consistent with Lally and Gardner's [24] idea that extrinsic rewards are not necessary for habit formation.

6.2 Implications for Research

In the BCSS framework, Oinas-Kukkonen states that a sustainable behavior change occurs only through an attitude change [19]. This notion is supported particularly by two widely used theories, namely the theory of reasoned action (TRA) [59] and the theory of planned behavior (TBP) [79]. However, during recent years in the area of health psychology, cognitive theories have claimed to fall short empirically [58] and have also faced fierce criticism. According to

Schwarzer [61], the reasoned action approach is inadequate, as it does not take into account processes involving behavior change. McEachan et al. [80] found that the TPB is a considerably poor predictor of behavior in longitudinal study design, when participants are not students and when the outcomes are measured objectively instead of using self-reported results. Sniehotta et al. [81] radically demand "retiring" the TPB. Despite the critics' claims, intentions do not need to be believed to be a counterpoint to automaticity. According to Gardner [54], a habit can be considered a mechanism that cues conscious decision-making, which in turn prompts behavior, rather than manages the procedural enactment of behavior. Similarly, when battling with old unwanted lifestyle habits, Lally and Gardner [24] argue that programming alternative responses to cues brings the decisions to consciousness. Neuroimaging studies suggest that when multiple responses are activated simultaneously, the prefrontal cortex—which is involved in the deliberative direction of actions—is activated [82, 83]. The ability to exert self-control is important, and when a person is pondering between two options, designers of health interventions should ensure that intentions to perform new behaviors remain prioritized at the decision point [84]. This remark incisively indicates why persuasion is highly important for HBCSSs. Despite the development of the BCSS framework and PSD model [19, 23], there is still rather little understanding of how HBCSS users experience habit formation, and explicit suggestions for developers on how to support habit formation via the use of HBCSSs are also few.

While habit formation can be hypothesized to help behavior change, it is nonetheless possible for people to lose weight without necessarily forming a habit. The ultimate question of the true nature of behavior change also merits more attention, as it will profoundly impact the design and study of future HBCSSs.

According to our results, it appears that for some of the participants the mere participation in a structured intervention was more important than the content of the intervention. In this study, for several individuals, the familiarity of the system and foreseeable schedule appeared to reduce the cognitive load and made it easier to commit to the desired lifestyle change process. The need for

supporting competence and autonomy is not a clear-cut issue in this study. According to our findings, many system users were rather content to follow external instructions, while some had hoped for even stricter intervention by professionals. Although self-determined behavior change is the natural goal of HBCSSs, our results suggest that there is a vast grey area between independence and compliance that requires further study. It can be hypothesized that the "Doctor´s order," that is, a prescription similar to an exercise prescription will increase adherence. Thus, in the future, we will seek to recruit healthcare centers with different patient profiles (urban, suburban, rural). Patients who are considered to be at high risk will be randomized and given either normal group counseling if at all available or a prescription.

Patterns observed	Theoretical implications	Practical implications
BCSS use habits combined with persuasive features of self-monitoring, reminders, and tunneling can help users to commit	Self-monitoring and reminders work in multiple habit formation stages, which can be one explanation why features were perceived so valuable by participants	Tunneling feature should not be overlooked when designing BCSSs
Perceived lifestyle habit did not resonate with 5% weight loss among participants	The true nature of behavior change merits further research	When a person is pondering between opinions, intervention should ensure that new behaviors remain prioritized at the decision point
A lack of time to utilize the system was common argument for not using Onnikka	Studying persuasion context is an important research area	System design should not focus merely on repetition, but also find ways to construct space for a healthy lifestyle
Participants were less likely to use the system if it did not fit into their daily routines	Best moments for persuasion is understudied area	In the future, HBCSS could identify a person's idle time, suggest healthy activity, and create a salient cue
For some individuals the mere participation was more important than the content of the intervention	Enhancing commitment and consistency can reduce participant's cognitive load	Prescription of an intervention might increase adherence

Table 3. Patterns observed and theoretical and practical implications based on these findings

6.3 Limitations

There are multiple limitations in this study. Onnikka was not originally built according to habit formation stages and, therefore, it is practically impossible to ascertain whether some of the methods were left unmentioned in the interviews because they were not perceived as being meaningful or they were not implemented in HBCSS sufficiently effectively. Moreover, there are many ways to study system use adherence in addition to login activities (e.g., time spent in the system, posts, page views). Finally, Lally and Gardner's [24] study was not

referred to in every detail, which leaves room for future research; for example, the importance of personal goal setting is not discussed in this study. Further, the terms and concepts between the frameworks introduced in Table 2 are not identical. This leaves room for further research to reconcile these models and to create unified approach. The reliability of results could also be questioned because only one coder analyzed the data set.

7 Conclusions

This study offers greater insight into how HBCSSs could help in breaking unwanted habits and foster a healthier lifestyle among individuals. Understanding lifestyle habits is important, as habits prompt behavior with minimal cognitive resources and can be beneficial in health behavior maintenance.

In this qualitative study, a HBCSS named Onnikka, designed according to the PSD model [23] and the BCSS framework [19], was used as a research medium. A total of 43 interviews were conducted to study users' experiences with regard to the system, and participants' weight measurements were utilized to interpret the results. The research approach employed was hermeneutics, which leans ontologically toward the social construction of reality, gained through language, consciousness, and shared meaning. Lally and Gardner's [24] conceptualization of habit formation stages was used as a lens of interpretation. Lally and Gardner's [24] work provides a possible explanation for why self-monitoring, reminders, and tunneling were perceived as particularly valuable features in this research study.

According to the results of this study, habits play a dual role in health BCSSs. Use habits appear to have a strong link with system use adherence, which in turn may produce better health outcomes for individuals. Perceived lifestyle habits did not appear to resonate with the actual 5% weight loss among participants in this study. A complete change in lifestyle is often necessary to achieve sustainable weight loss, which in turn requires holistic e-health interventions. As a BCSS's core aim is to impact individuals' lives and help them manage lifestyle changes, more studies on the use of BCSSs in their actual contexts are necessary

to discover how different persuasive strategies can help people achieve healthier lifestyles in practice.

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9 Conflicts of Interest

The authors are part of the research team that developed Onnikka, the behavior change support system. The system has been developed solely for research purposes, without any commercial interests.

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