

Designing Online Social Networks to Motivate Health Behaviour Change

by

Noreen Kamal

B.Sc., The University of Calgary, 1994
M.A.Sc., The University of British Columbia, 1997

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Abstract

Eating nutritious foods and being more physically active prevents significant illnesses such as cardiac disease, stroke, and diabetes. However, leading a healthy lifestyle remains elusive and obesity continues to increase in North America. We investigate how online social networks (OSN) can change health behaviour by blending theories from health behaviour and participation in OSNs, which allow us to design and evaluate an OSN through a user-centred design (UCD) process.

We begin this research by reviewing existing theoretical models to obtain the determining factors for participation in OSNs and changing personal health behaviour. Through this review, we develop a conceptual framework, **Appeal Belonging Commitment (ABC) Framework**, which provides individual determinants (**Appeal**), social determinants (**Belonging**), and temporal consideration (**Commitment**) for participation in OSNs for health behaviour change.

The **ABC Framework** is used in a UCD process to develop an OSN called *VivoSpace*. The framework is then utilized to evaluate each design to determine if *VivoSpace* is able to change the determinants for health behaviour change. The UCD process begins with an initial user inquiry using questionnaires to validate the determinants from the framework (n=104). These results are used to develop a paper prototype of *VivoSpace*, which is evaluated through interviews (N=11). These results are used to design a medium fidelity prototype for *VivoSpace*, which is tested in a laboratory through both direct and indirect methods (n=36).

The final iteration of *VivoSpace* is a high fidelity prototype, which is evaluated in a field experiment with clinical and non-clinical participants from Canada and USA (n=32). The results reveal positive changes for the participants associated with a clinic in self-efficacy for eating healthy food and leading an active lifestyle, attitudes towards healthy behaviour, and in

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the stages of change for health behaviour. These results are further validated by evaluating changes in health behaviour, which reveal a positive change for the clinical group in physical activity and an increase in patient activation. The evaluation of the high fidelity prototype allow for a final iteration of the **ABC Framework**, and the development of design principles for an OSN for positive health behaviour change.

Preface

All of the work presented henceforth was conducted in the Media and Graphics Interdisciplinary Centre (MAGIC) at the University of British Columbia, Point Grey campus. All experiments and associated methods were approved by the University of British Columbias Behavioural Research Ethics Board [certificate #H10-02050].

An earlier version of Chapter 3, Sections 3.1 and 3.2 has been published [N. Kamal, S. Fels, K. Ho. (2010) Online social networks for personal informatics to promote positive health behavior. In *The Second ACM SIGMM Workshop on Social Media (WSM2010)*. Oct 25-29, 2010. Firenze, Italy. 47-52.]. I was the lead investigator, responsible for all major areas of concept formation, literature review, literature consolidation, as well as manuscript composition. K. Ho was involved in the early stages of concept formation. S. Fels was the supervisory author on this project and was involved throughout the project in concept formation and manuscript composition.

An earlier version of Chapter 3 and portion of Chapter 7 (Section 7.3) has been published as a book chapter [N. Kamal, S. Fels, M. Blackstock, K. Ho. (2013). *The ABC's of Designing Social Networks for Health Behaviour Change: The VivoSpace Social Network*. In E. Kranakis (ed.), *Advances in Network Analysis and its Applications*. Volume 18, 232-248. Springer Berlin / Heidelberg]. I was the lead investigator, responsible for all major areas of concept formation, literature review, experimental design, data collection and analysis, as well as manuscript composition. K. Ho was involved in the early stages of concept formation. S. Fels was the supervisory author on this project and was involved throughout the project in concept formation and manuscript composition. M. Blackstock provided edits to the manuscript.

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Dedication

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Chapter 1

Introduction

1.1 Motivation

The importance of a nutritious diet and an active lifestyle has been found to be central to a healthy population, which contributes to lower healthcare costs for a nation and better quality of life for its citizens. Specifically, eating nutritious foods can reduce advancement of and prevent the occurrence of chronic diseases [6]. Being more physically active for as little as 30 minutes every day has been found to result in overall better health and prevent illness [86]. Diet and physical activity can also help prevent vascular diseases such as cardiac disease and stroke, which are the leading causes of death and disability respectively [65]. Cardiac disease such as myocardial infarction (heart attack) has been linked to diets that have high caloric value and contain high saturated and trans fat in combination with low physical activity [14]. Similarly, preventable causes of stroke have been linked to obesity, physical inactivity, and diets high in cholesterol and trans fat [41]. Furthermore, obesity has shown a marked increase over the past generation [34], and related chronic diseases such as type 2 diabetes is reaching epidemic numbers in some populations [124].

The current delivery of healthcare focuses on symptom management rather than prevention and self-management, and calls are being made to reframe health to include self-management [28]. Self-management of personal health has been shown to achieve positive health outcomes in both healthy people and those with chronic conditions [15, 32, 117]. Not surprising, governments have invested significant resources to promote healthy lifestyle among its population. Governments around the world have adopted mandatory

nutritional labelling to help their citizens understand the nutritional value for the packaged foods. However, there are limitations with this approach, as labels are not available on all foods such as fruits and vegetables and often they are difficult to understand [108].

Despite greater medical and scientific knowledge, North Americans continue to be more obese due to poor diet and a sedentary lifestyle. A significant factor in health outcomes is one's close and distant social networks [18, 68]. One's social networks can be used to improve health behaviour through facilitating social integration and social support [18]. Further, mortality and morbidity is reduced by being more socially connected, and social supports can promote better health by providing a sense of belonging and building self-efficacy [12].

Studies have realized the benefits of social connection by designing social technologies for health and weight management. Social technology has been shown to increase social support for individuals afflicted with a particular condition. The conditions studied include diabetes [71–73], ACL (Anterior Cruciate Ligament) [70], ALS (Amyotrophic Lateral Sclerosis) [37], cancer [17, 109], HIV [45], and menopause [107]. Furthermore, the dynamics of social activity for weight management was “unpacked” by finding the taxonomy of peer involvement including supportive involvement and passive involvement (such as social norms) and observed patterns of interaction such as (un)disclosure [69].

We have also seen social connection through websites and other web enabled technology have had an explosion of engagement and use, namely in use of Online Social Network (OSN) services such as Facebook[®]. OSNs are the most popular activity on the internet with 82% of the world's online population using OSNs, and users of the internet use OSNs more than any other website category, as it accounts for 19% of all time spent online [19]. Additionally, social (network) games delivered through OSNs have had a surge in popularity with Zynga's[®] Mafia Wars, FarmVille and CityVille having 60 million daily active users; furthermore, the user demographics for these social (network) games are changing to include more women than men and users over 40 years old rather than teenagers [1]. However, we need to

be cautious in using these large OSN services for our health needs, as issues of sharing private health information on such a large social network service does not make sense [78].

We design an OSN for positive health behaviour change to address the issues with increasing obesity and sedentary lifestyle in an effort to develop new technical solutions for prevention of illness and self-management of one's personal health. By using the OSN as a basis for design we hope to harness the engaging potential of OSNs to ensure use of the technology. However, we consider the audience by designing an OSN for small social network groups to change health behaviour.

1.2 Research Goals

The overarching purpose of this research is to use a theoretical foundation to design and evaluate an OSN for positive health behaviour change. To achieve this, we develop a conceptual framework that guides the design and evaluation of OSNs for health behaviour change. The conceptual framework takes into consideration participation in OSNs and motivation for changing health behaviour. The importance of engaging users to use a system is critical to ensure participation; for this reason, we analyze and make use of existing theoretical models for use of OSNs. Similarly, there has been decades of research in health psychology and social psychology, which has yielded numerous theoretical models for health behaviour change. We distill these theoretical models into a conceptual framework that guide a user-centred design process (UCD) for designing an OSN to change health behaviour. The conceptual framework also guides the evaluation of the prototypes to determine if the factors from the theories are being influenced by the OSN, which yields the final design principles. In our theoretical approach to designing an OSN for health behaviour change, we will refer to the *determinants* of health behaviour, which refers to the many *factors* that combine to affect the health behaviour of individuals, and in particular we are referring to the social environment as well as individual characteristics and behaviours [121].

Thesis Goal 1: Distill existing theoretical models for participation in OSNs and health behaviour change into a conceptual framework.

We review the literature for existing theoretical models that provide the factors that influence users to participate in OSNs, which includes use of other social media since OSNs are relatively new. Similarly, we review existing theoretical models for health behaviour. Through the distillation of these theoretical models, we develop a conceptual framework that collates similar themes in a manner that can be translated into the design of OSNs for health behaviour change.

Thesis Goal 2: Design a series of prototypes and evaluate the design that is interpreted from the theoretical conceptual framework.

A series of prototypes are developed through a UCD process to evaluate the interpretation of the design features that are abstracted from the conceptual framework. All the prototypes are evaluated using the theoretical determinants from the conceptual framework: paper prototypes are evaluated through interviews; medium fidelity prototypes are evaluated through lab experiments; and the high-fidelity prototype is evaluated using field experiments. The purpose of the prototypes is to test the validity and effectiveness of the interpretation of the framework to the design of these prototypes. Furthermore, the conceptual framework will be iterated based on the results of the evaluation of these prototypes.

Thesis Goal 3: Develop design principles for OSNs to motivate health behaviour change.

Finally, design principles are developed for OSNs to motivate positive health behaviour change. The design principles are developed iteratively through the evaluation of the prototypes with the overall objective to influence the determinants that promote use of OSNs and promote positive health behaviour change.

1.3 Research Approach

The goals of the research are met through a modified UCD approach. A UCD process typically takes into consideration initial user inquiry and iterative prototyping with increasing fidelity for a particular design [105]. We modify this design process by embedding a theoretical grounding to the inquiry. The conceptual framework that is developed through a distillation of theoretical models informs both the design as well as the points of inquiry for the evaluation of each phase of the UCD process. The cyclical nature of this approach links the disconnect that occurs between the interpretation of the conceptual framework into a design, and the evaluation allows for a comprehensive evaluation of the ability for the OSN to change health behaviour by evaluating the effects articulated by the conceptual framework. Figure 1.1 shows a pictorial representation of the research approach. This figure shows how the conceptual framework interacts with the traditional UCD process [54].

1.3.1 Literature Review of Theoretical Models

The research begins with a literature review of existing theoretical models. Two domain of theoretical knowledge are reviewed. First, the literature from Human-Computer Interaction (HCI), communications, and social psychology are reviewed to find theories that explicate the determining factors for participation in OSNs. Designing an engaging OSN that encourages use is the main reason for obtaining an understanding of the determinants that influence use of OSNs. Therefore, the engaging aspect of OSNs can be harnessed to ensure use and lead to health behaviour change. Second, the literature from health psychology and social psychology are reviewed for existing theories on health behaviour change. The determinants for health behaviour change are taken from the review of theoretical models.

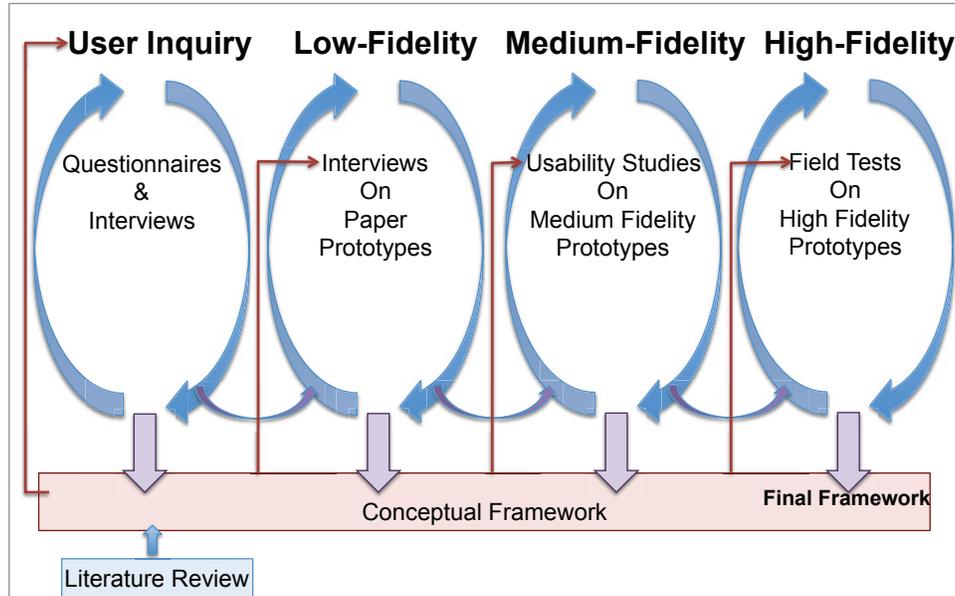


Figure 1.1: The research approach is a user-centred design process that is modified with a theoretical foundation. The conceptual framework is used for the design as well as the evaluation of the OSN.

1.3.2 Development of a Conceptual Framework

Following the literature review of the existing theoretical models, the determinants for both use of (or participation in) OSNs and health behaviour change are distilled to create a conceptual framework. This framework combines these determinants to unpack how OSNs can be designed to motivate health behaviour change. Interaction between the determinants for use of OSNs and health behaviour change are hypothesized in the initial development of the conceptual framework. These interactions help to define the design of OSNs, as certain design features of the OSN can possibly lead to change of health behaviours. The conceptual framework is applied to the design of an OSN system, and the evaluation allows the conceptual framework to be iterated so that the interactions between the determinants for use and the determinants for health behaviour change can be validated.

1.3.3 Initial User Inquiry

Initial user inquiry is conducted through both questionnaires and interviews to obtain a better understanding of people's motivations to use OSNs and change health behaviour. The points of inquiry for the questionnaire and interviews are from the conceptual framework. The purpose of this initial user inquiry is to understand the strength of determinants from the conceptual framework, and how each determinant can be operationalized in the design of an OSN. Furthermore, the user inquiry provides a better understanding of the determinants when specifically applied to OSNs, as this technology is relatively new, and the theories that are reviewed are more broadly applicable to different social medias such a online communities. The questionnaire obtains responses from a broad population to better understand the differences between gender, age groups, and ethnic groups, so that the design principles that are developed can focus on those determinants that are more generally applicable. The purpose of the interviews is to obtain a richer understanding of the determinants from the conceptual framework.

1.3.4 Development and Evaluation of Paper Prototypes

Paper prototypes are developed based on the results of the initial user inquiry and the conceptual framework. The paper prototypes are designed by developing initial design interpretations of the conceptual framework. They are evaluated through one-on-one interviews. The point of inquiry are once again the determinants for use of OSNs and health behaviour change from the conceptual framework, as well as inquiry into the usability and general thoughts on the prototype. The results from the evaluation provide a rich interpretation of how well the prototype meet the determinants for use of the OSN and health behaviour change; furthermore, the results also provide thoughts for how the prototype can be improved.

1.3.5 Development and Evaluation of a Medium Fidelity Prototype

A medium fidelity prototype is developed from the results of the evaluation of the paper prototypes. The medium fidelity prototype provides the key interactions, which allows the prototype to be tested in a laboratory. The prototype is evaluated for usability and for its ability to engage user of the OSN as well as for its ability to change health behaviour. Once again the points of inquiry are based on the conceptual framework, and both direct and indirect methods is used to extrapolate the ability for the design to gain an engaged user base and change health behaviour. Direct self-reports are used for certain determinants that can be reliably evaluated in this manner; however, indirect methods of inquiry are utilized for those determinants that cannot be reliably collected through self-reports. The results from the laboratory evaluation is used to develop a fully functional high fidelity prototype.

1.3.6 Development and Evaluation of a High Fidelity Prototype

A fully functional high fidelity prototype is developed by iterating the design of the medium fidelity prototype based on the results of the evaluation. The purpose of the high-fidelity prototype is to evaluate the prototype in a field experiment to determine actual engagement in the OSN determined through use of the prototype and its ability to change health behaviour. The field evaluation also uses the conceptual framework to directly determine if the prototype was able to influence any of the determinants from the conceptual framework, as this theoretical foundation can infer that by changing these determinants, health behaviour will also change. The field experiment is conducted with a number of socially connected groups, which are both clinical and non-clinical as well as loosely connected and tightly connected. The clinical groups are from clinics that promote wellness and healthy lifestyles, and efforts are made to include control groups, so that the efficacy of the prototype beyond the interactions with the clinic can be evaluated. Pre-,

mid-, and post-questionnaires are developed from the conceptual framework. Pre-questionnaires are used to assess current health behaviours. Mid- and post-questionnaires are used to understand how specific design features of the prototype influenced health behaviours. The evaluation yields: 1) an overall understanding of the prototype's ability to change health behaviour; 2) how different social groups used the prototype; and 3) to what extent the prototype influenced the determinants from the conceptual framework. Furthermore, the results allow for the conceptual framework to be iterated. The interactions between the determinants for use of OSNs and the determinants for health behaviour change are validated through the evaluation of the high fidelity prototype.

1.4 Summary of Contributions

This thesis provides three main contributions to the research domain of Human-Computer Interaction (HCI). An overview of each contribution is provided below, and a detailed discussion of each contribution is provided in the final conclusions in Chapter 8.

Contribution 1: An evaluated conceptual framework that provides the determinants for individuals to use OSNs and change health behaviour. A conceptual framework is derived from theoretical models for use of OSNs and health behaviour change, which provides the determinants for both of these domains. This contribution included a synthesis of the theoretical models to broadly develop the behavioural determinants for use of online social network and health behaviour change that were described in the theoretical models reviewed. For use of OSNs, the theoretical models reviewed were: the *Uses and Gratification Theory*, *Social Influence Model*; *Social Identity Theory*; *Common Bond Theory*; *Common Identity Theory*; *Theory of Organizational Commitment*; and *Behaviour Chain for Online Participation*. For health behaviour change, the theoretical models reviewed were the *Health Belief Model*; *Social Cognitive Theory*; *Theory of Reasoned Action*; *Theory of Planned Behaviour*; *Common Sense Model*; and the

Transtheoretical Model. Interactions between the determinants for use that will lead to health behaviour change are incorporated into the framework. The conceptual framework is evaluated through the experimental evaluation of each of the prototypes. [55, 56]

Contribution 2: Design principles for OSNs to motivate health behaviour change. Design principles are developed for OSNs that motivate positive health behaviour change. These design principles are developed through the evaluation of prototypes using user studies where the points of inquiry are defined by the conceptual framework to determine if the design was able to influence the determinants defined by the framework. This evaluation methodology provides us with an understanding of the design principles that were able to change the determinants that influence health behaviour change, and to iterate design principles that were less effective. [53, 57]

Contribution 3: An evaluated OSN that is able to change health behaviour of users. A working high-fidelity OSN called *VivoSpace* is developed using a UCD process, which is able to change some of the determinants for health behaviour change in its users that are associated with a clinic. [57]

1.5 Thesis Outline

The thesis is organized so that the main contributions are presented up front; however, we begin by first reviewing related works and existing commercial applications in this field of study (Chapter 2). Following the review of the related works, the development of the conceptual framework is described in Chapter 3. We then describe the high fidelity prototype in Chapter 4, which is developed using the UCD process and the conceptual framework; readers can choose to read Chapter 7 prior to Chapter 4 for a chronological flow. Chapter 4 also describes the field experiments that are conducted to evaluate the prototypes. From the results of the evaluation of the high-fidelity prototype, Chapter 5 describes the final iteration of the conceptual framework.

Chapter 6 details the design principles for OSNs for health behaviour change. The full UCD process is described in Chapter 7, which begins with the initial user inquiry in Section 7.1. The Chapter then describes the paper prototypes in Section 7.2 and medium fidelity prototypes in Section 7.3, where we describe the prototypes, evaluation methods, and results for both of these prototypes. Chapter 8 summarizes the work in the thesis and provides detailed descriptions of the contributions. There are also a number of appendices that provide screen captures of the prototypes and evaluation materials that are used in the research.

The conceptual framework and the results from the study of each prototypes have been published as peer-reviewed publications as described in the *Preface* with details of co-authorship.

Chapter 2

Related Works

Technologies for health behaviour change has had significant interest in both the research community and in industry. In particular, technologies that aim to promote physical activity and/or healthy eating behaviour have been designed and evaluated by the research community, and they are being developed by industry.

This chapter will review the research that has been conducted in this area, and do a review of a sample of available commercial applications designed to change health behaviour. We will review the research in *Persuasive Technologies* and HCI communities that have developed prototypes for health behaviour change; a large portion of this research has considered social aspects. We will also conduct a literature review of personal informatics because much of the research and the commercial applications in this field involve the collection and visualization of personal health information such as step counts, calories consumed, and calories expended; therefore, the domain of personal informatics comes into play. Finally, we also review the growing number of commercial applications that are available, and we describe some of the key features of these applications. There is also a brief discussion about gamification, as some of the research prototypes and commercial application have some gaming features. While we review this research, we will look at whether the design and/or the evaluation of the technology took into consideration theoretical models. In particular, we are addressing the call-to-action that was recently put out by the HCI community for greater theoretical foundation and frameworks in designing and evaluating technology for behaviour change [47].

2.1 Persuasive Technology

The design of technologies for behaviour change has been the primary focus of *Persuasive Technologies*, and it was first studied by B.J. Fogg [35]. *Persuasive Technologies* is defined as technology that is designed to change attitudes or behaviours of users through persuasion and social influence, but not through coercion. *Persuasive Technologies* include many concepts including: principle of reduction, which is to reduce complex behaviour to simple tasks; principle of tunnelling to guide users through a process or experience; principle of tailoring to the individual's need, interests, and personality usage context; principle of suggestion to offer suggestions at opportune moments; principle of self-monitoring to eliminate the tedium of tracking performance or status to help people achieve predetermined goals/outcomes; principle of surveillance to observe other's behaviour; and principle of conditioning, which is the use of positive reinforcement to shape complex behaviour or change behaviour into habit [35]. The *Persuasive Technology* community also uses the *Persuasive System Design (PSD)* model in their research, which has three layers: postulates, persuasive context, and design qualities [82]. The postulates are key issues behind the design and they include issues such as: Information Technology is always "on"; people like their views about the world to be organized and consistent; and persuasion is often incremental. The persuasion context includes the intent, the event and the strategy. The design qualities include: primary task support (which includes concepts from [35]), dialogue support, and system credibility.

Persuasive Technology provides a foundation for the design of technologies for behaviour change from the perspective of persuading users to change. However, the research from this community has had little consideration of theories from social science that define behaviour change to address the theoretical gap that Hekler et al. refers to [47]. Furthermore, the community has come under some criticism from the HCI community for not considering the ethical and sociocultural consideration in their models [91]. The perspective of *Persuasive Technology* research has been considered modernist, which has also opened discourse on the acceptance of this approach [123]. Our

approach is not to take sides on this debate, but rather to contribute to both HCI and *Persuasive Technology* areas through a theoretical perspective by developing a conceptual framework for the design and evaluation of OSNs for health behaviour change.

2.2 Health Behaviour Change in HCI

A number of studies have explored technologies from an HCI perspective. Some have looked at technologies from an individual use perspective while others have considered social aspects. Furthermore, some have considered theoretical models for health behaviour change. We will review all of these studies, describe the technical intervention, outline the evaluation methods, and summarize their outcomes. A summary of the related works is shown in Table 2.1, which shows the name of the project or technology developed (listed in alphabetic order), a brief description of its functionality, if there was a social component to the technology, the number of participants and length of the field experiment, and the key outcomes from the evaluation. Overall, this review shows that there has been significant work in this area since 2006 by the HCI research community. Most of the studies considered social aspects and were evaluated in a field experiment with variable outcomes. Furthermore, a handful of these studies considered health behaviour theories to variable extent. We will review these studies in more detail.

2.2.1 Research for Increased Physical Activity

We will first review the works that looked at step count or physical activity generally. The Fish'n'Steps system [64] utilized users' step count with a software application where the growth and happiness of the fish is linked to the step counts; it has a personal version and a shared version, where the size and 'mood' of others' fish was anonymously shared. There was no statistically significant difference in step count between the personal and shared version, but those in the shared group had a better attitude towards exercise. The authors considered the Transtheoretical Model [90] for health behaviour

change to evaluate progression through the stages of change; however, health behaviour theories were not taken into consideration when designing the system. Another important consideration for the Fish'n'Steps' shared version was that the information that was being shared was kept anonymous, so even though the participants knew each other, they did not know who was performing better (or worse) than them. On a final note, the design of this system abstracts the actual personal health information into the growth and happiness of a fish rather than providing direct information.

Similarly, the IMPACT and IMPACT 2.0 system [63] also looked at step count, and it was designed to study the effect of context on personal health information through the design of several prototypes: 1) a paper diary, where users logged their activities, location and people they were with, and they wore an arm band that logs their movement and also a pedometer that displays their step count; 2) the IMPACT 1.0 system, which has a website and pedometer, and the website allowed users to enter contextual information and showed their step counts along with their contextual information; and 3) the IMPACT 2.0 system was a mobile phone with a GPS, which automatically monitors steps and location and this information is displayed on a website. Overall, there was no increase in steps in any of the versions, but users were more engaged in the data through manual entry of context rather than automatic data collection. Behaviour theories were not used in the design and evaluation of this technology.

The Houston system [20] used a pedometer to track step count and share progress towards a goal. The system was evaluated with an individual version and a shared version with a small group of friends. The shared version included seeing progress towards a goal with the ability to comment and send messages. The results revealed a statistically significant difference between the shared version and the individual version for increased step count. Contributing to this result was that the data was not anonymized and the participants in this small group knew each other. Theoretical models were not considered in the design of Houston.

Table 2.1: A summary of studies on design of technologies for health behaviour change. This table lists the name of the application, a brief description of the application, whether social design features were included, the evaluation including the number of participants (p) and length of the study, and the outcomes of the evaluation.

| Name | Description | Social | Evaluation | Outcome |
|-----------------------|---|--------|--------------------------------|---|
| AHPC [88] | Pedometer and website for school aged children with collated data compared between schools. | yes | 1400 children over 3 semesters | Evaluation allowed to better understand introducing ubiquitous technology in school settings. |
| Chick-Clique [114] | Mobile application provides sharing of step counts, visibility of group averages, and text messaging capability. | yes | 7 girls for 4 days | Showed difference but due to confounding factors. |
| Community Mosaic [85] | Mobile and community display for sharing photos and text about food to promote better health. | yes | 43 p for 12 wks | Allowed for an understanding of health promotion through collective action. |
| EatWell [42] | Social mobile phone application to assist African American communities make better food choices, where users share audio recordings of experiences related to food. | yes | 12 p for 4 wks | Allowed for an understanding of promoting health through collective action. |
| Fish'n' Steps [64] | Links participants' step counts to the growth and happiness of a virtual fish. | yes | 19 p for 14 wks | Better attitude towards exercise but no difference in step count. |

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Table 2.1 – continued from previous page

| Name | Description | Social Evaluation | Outcome | |
|------------------------------|--|-------------------|------------------|---|
| Fit4Life [91] | A satirical design of a health system that collects dietary and activity level, shares on social network sites, and provides advice. | yes | N/A | N/A. |
| IMPACT (2.0) [63] | A step count personal informatics system that tests for the influence of context on step count. | no | 49 p for 8 weeks | No difference in step count when context was included or not included. |
| Houston [20] | Pedometer and mobile phone application that has a sharing version and a personal version. | yes | 28 p for 3 mo | Successful in helping participants maintain physical activity. |
| Lifestyle Coaching App. [38] | Smart phone and website version where users log their food and physical activity, set goals and provide a points system for a game experience. | yes | 40 p for 4 wks | No difference. |
| MAHI [71–73] | Mobile application to communicate with one’s diabetic educator. | yes | 49 p for 6 mo | Social support for newly diagnosed [73] else a means to build self-identity [71]. |
| OrderUP! [43, 44] | Casual game where the user is the restaurant owner and they must serve nutritious meals. | no | 12 p for 3 wks | Users become more aware of what foods were healthy. |

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Table 2.1 – continued from previous page

| Name | Description | Social Evaluation | Outcome |
|-----------------------------------|--|-------------------------------------|--|
| Shakra [5] | Mobile phone application infers whether user is still, walking or traveling in a car, and provides and shares the amount of time that the user was active with some competition. | yes 9 p for 10 days | No increase in activity but social and competition aspects were enjoyed. |
| Stepping Up for Health (SUH) [97] | Internet mediated walking program that measures the impact of adding an online community on the walking habits of individuals | yes 324 p for 16 wks | Social group was more engaged and had less attrition. |
| UbiFit [21, 22] | Wallpaper of the users cell phone shows a garden as more physical activity is performed and butterflies as goals are met. | yes 12 p for 3 wk and 28 p for 3 mo | Sharing group met goals more often. |
| VERA [11] | Users take pictures at moments where they make health decisions and provide annotation about the picture's relation to health. | yes 45 p for 2 wks & 44 p for 4 wks | Built group identity and greater accountability. |

The UbiFit Garden system [21, 22] system was also a mobile phone application. UbiFit included: an automatic sensing device that inferred physical activity such as walking, cycling, running, and elliptical trainer; a glanceable wallpaper showed a garden that depicted physical activity and progress towards goals; and an interactive application that allowed for entry, editing and deleting of log entries about the user’s physical activity. Key to the altering garden on the wallpaper was the user’s progress towards weekly goals. This system was based on the Goal-Setting Theory [66], which comes from workplace research, and the model defined motivation through intentions to complete goals. This theory was used throughout the design of UbiFit and its evaluation. The system was evaluated by having conditions that included the source of the goals: self-set, assigned (i.e. by a fitness or medical expert, or national standards), guided (by a medical or fitness expert), and group-set (strangers or social network connected). The other condition was the time frames: fixed week, customizable week, or rolling seven-day window. The qualitative evaluation showed that self-set and group-set goals were most popular, and that variable timeframe had different benefits for different participants [21]. The UbiFit Garden was also designed using additional theories of Presentation of Self in Everyday Life [40] and the Cognitive Dissonance Theory [31] along with the Transtheoretical Model [90] and the Goal-Setting Theory [66]. Four design strategies are revealed: *abstract* as the garden wall paper on the mobile phone; *non-intrusive* access to the data through an easy way that does not obstruct one’s day-to-day tasks; *public* so that it is appropriate to be displayed publicly; *aesthetic* so it looks nice; *positive* to be reinforcing to the user; *controllable* to allow the user to add, edit and delete; and *trending and historical* access to information. The qualitative evaluation linked the theories’ design strategies to the UbiFit Garden [22]. We expand their approach of using theoretical models in the design and evaluation of technology for health behaviour change to the design of OSNs for health behaviour change, and deviate from their methodology by clearly using health behaviour theories to define health behaviour change, and we address the modality (OSNs in our case) through separate theories, which are combined in our conceptual framework.

Stepping Up for Health (SUH) was a large medical trial using a website that provided visualization of ones uploaded pedometer reading, which was studied with and without an online community [97]. The system had participants wear pedometers, whose reading were uploaded to a server and accessed through a website, where they could view their readings, view individualized motivational messages, and set goals. The study involved 324 overweight sedentary individuals with type II diabetes, who used email at least once a day. They were randomized to a group with or without an online community, and the study lasted 16 weeks. The results showed that there was no increase in step-count between the two communities; however, the rate of attrition was lower in the group that had an online community. The second part of this study investigated strategies to increase participation in an online community for studies such as the one described previously, where the number of participants was small and a large portion need to be active contributors rather than “lurkers” [96]. The strategies included having contests for posting and having staff respond to posts to ensure responsiveness. The overall simplicity in the design of this study did not involve the use of theoretical models; however, the contribution of the results informed the benefits of an online community for personal health management to the medical community is an important milestone.

The Shakra system [5] measured physical activity, and it was a mobile phone application that inferred whether the user was active or inactive and facilitated sharing and comparison of the user’s activity level with peers. The study involved 9 participants over 10 days, which included an initial 3 days where the participants enter their current level of activity through a diary type entry. For the week following the initial 3 days, they trained the system for 2 days and used it for the 5-day work week. They were divided into 3 groups with 2, 3 and 4 people in each group, and their activity information was shared within each group. The results of the study found that participants enjoyed seeing their activity level and different participants used it as an awareness tool, a self-monitoring device, and as a competitive game. Theoretical models were not considered in the design and evaluation of Shakra.

The AHPC (American Horsepower Challenge) was an large scale American project, whose aim was to increase physical activity of school aged children aged 9 to 13 years old. AHPC deployed 20 pedometers to 61 schools with over 1400 children using the system over 3 semesters. Each school had a base station, which automatically uploaded step counts, and a website where a school versus school game was displayed using the horserace metaphor. The system was deployed by the Humana Project, and HCI researchers [88] were invited to evaluate it. Their findings provide guidance on introducing ubiquitous computer systems to school settings. No theoretical models were used to design or evaluate AHPC.

The Chick-Clique system [114] was developed to encourage greater activity for teenage girls. This system was a mobile phone application that had groups of 3 or 4 people, where the steps were tracked for each individual and the progress of the group was communicated through text messages. The system was evaluated with 7 teenage girls over 4 days. The questionnaire results revealed that group performance was rated as the highest motivation to increase walking. There were mixed results with respect to increased step-count, which was contributed to external factors and the short length of the study. Once again, no theoretical models were used in the design and evaluation of the system.

2.2.2 Research for Improving Dietary Intake

There have also been many studies that explored technologies to encourage healthy eating behaviour. We start with the EatWell system [42], which was designed for the African American community. It was a mobile audio application, where users created recordings of their thoughts on healthy eating in their communities, and they listened to voice recording of others in their community. They recorded these “voice memories” in one of the following categories: fast food, restaurants, eating at home, grocery stores & markets, and “other”. Critical to this research was that the community being connected were from the same geographic location and the same socioeconomic group. Their evaluation involved 12 participants, who used EatWell for 4 weeks.

The results show that EatWell empowered the community to eat more nutritious meals, and the participants shared their experiences through stories. Theoretical models were not used in the design and evaluation of EatWell. However, we used the design of this study to have connected groups from the same geographic location in our selection of participant groups for our field experiment (described in Section 4.2) because of the importance that it played to the development of community empowerment that resulted from this work.

Building from her work in EatWell, the Community Mosaic system was implemented for the same African American community [85]. Community Mosaic allow for the sharing of photos and texts through a community display at the local YMCA. Although the system was available to anyone entering the YMCA, the study was conducted with 43 participants over 12 weeks. The main finding from this work was to provide a shift in thinking around context in health management and health behaviour change to one of health promotion through collective action. Theoretical models were not used in the design of Community Mosaic, but the the Transtheoretical Model [90] was used to evaluate if any health behaviour change was observed and also to assess the participants' current stage in health behaviour change.

OrderUP!, an other application, was a casual game designed to educate users on the nutrition of meals with a focus on meals for low income African Americans [43, 44]. This work spoke to the importance of cultural relevancy when designing for behaviour change. OrderUP! was a casual game on a mobile phone, where the user was a server in a restaurant, and the goal was to make meal recommendations to customers as quickly and healthfully as possible. The meals were relevant to African American community. The design took into consideration three theoretical models: the Transtheoretical Model [90], the Health Belief Model [94], and the Social Cognitive Theory [10]. OrderUP! was evaluated with 12 participants over 3 weeks, and the qualitative results revealed that the participants gained knowledge about the nutritional value of foods.

The MAHI system was a mobile and website application designed for diabetics [71–73]. The system was a health monitoring application that

provided social interactions with diabetes educators; it included a blood-glucose monitor that was linked to a mobile phone, and it provided the ability to record text notes or questions, take pictures, and make audio notes. These records were linked to their blood-glucose levels, and allowed for asynchronous communication with their diabetes educator. I have included this work in my related works, as much of the records were related to eating nutritious foods that were low in sugar and carbohydrates. The initial study was done with 49 subjects that were recently diagnosed with diabetes, who used MAHI for 4 weeks. MAHI was given to 25 subjects, and the others were assigned to the control group, who also had access to a diabetes educator. The results show that those that used MAHI achieved their diet goals more than those that did not use it; furthermore, by sharing records with their diabetes educators, the users were able to reflect on their diet and be more aware of eating habits [73]. In a second study, MAHI was deployed to 8 subjects (for 12 weeks) who had been diagnosed for five or more years, and the results were very different. There was no behaviour change observed; however, MAHI became a means to construct identities through the entry of records [71]. Theoretical models were not used to design or evaluate the MAHI system.

2.2.3 Research on Health Behaviour Generally

There are several research studies that look at designing technology for health behaviour change more broadly. The Lifestyle Coaching Application was designed to promote both nutritious eating habits and physical activity [38]. This application was deployed as both a mobile and a web version, and it had an individual version and a team version, where the health information was shared between team members and between teams. The Lifestyle Coaching Application allowed users to log their meals and physical activity, set goals and earn points. The results of their study with 40 participants over 4 conditions found that there was no difference in achieving goals and health behaviour; however, the mobile version afforded more consistent usage patterns. The Transtheoretical Model [90] was used in the evaluation to determine the

current stage of behaviour change for the participants; however, health behaviour theory was not used to ground the design in the factors for health behaviour change or to determine if any of the theoretically-based factors changed over the course of the study.

The VERA system was not specifically designed for diet or physical activity, but VERA’s central design principle was “open-ended social awareness” as apposed to prescriptive persuasion to promote positive health behaviour [11]. The authors argue for a theoretical foundation for “open-ended social awareness” based on the Social Cognitive Theory and Presentation of Self Theory. Although all the aspects of the Social Cognitive Theory were not explored, they have taken the *modelling behaviour of others* from the theory as a central guiding principle for their design, and all other aspects of this theory were not considered such as *self-efficacy* and they also did not use the Social Cognitive Theory to design specific features of VERA. The second theory, Presentation of Self, which is not from health behaviour, and it explains how individuals see themselves as actors in social interaction with others. The VERA system was a collaborative photo sharing site, where users took pictures and provided annotations at moments when a user needs to choose between options that had health implications. It was evaluated with a total of 89 participants over two separate deployments. The first deployment had 45 participants recruited with 36 completing the final questionnaire, who used it for 2 weeks. The second deployment had 44 participants with 21 assigned to the control group, and they used it for 4 weeks. The results found that VERA built group identity and individual accountability, but there was confusion among the participants on what was healthy due to the “open-ended” (rather than prescriptive) nature of the system. These results can be attributed to the exclusion of some of the determinants of health behaviour change from the Social Cognitive Theory; for example, determinants such as *knowledge* and *goals* were not considered in the design.

Fit4Life was not an actual system that was deployed, but rather a satirical concept design, which was meant to be a critical review of the direction of persuasive technologies [91]. The Fit4Life’s design was based on Persuasive System Design (PSD) model from the persuasive technology community [82],

which is not based on theories from health behaviour. The work presented three issues in particular: the extent that persuasion can become coercion; the relationship between persuasive computing and cultural trends towards scientific rationalization; and issues around surveillance and the power of data collection over personal experience. From these three issues, Purpura et al. also described the issues with sharing personal health data over large social networks such as Facebook[®] especially if it was automatically posted. The issues that were described with the satirical Fit4Life design could perhaps be overcome by looking at the foundational theories from health behaviour, as we will do in applying our theoretically-based conceptual framework to the design and evaluation of our OSN.

Three other works are important to the design and evaluation of technology for health behaviour change, which do not focus on the design of a particular system, but rather provide insight into the evaluation of such systems [59], provide taxonomy for weight loss to assist with the design of such technologies [69], and use the *Health Belief Model* to provide design strategies for developing games for health [83]. The first work by Klasna et al. explores how to evaluate technologies for health behaviour change due to the complexity of conducting full randomized control trials and their lack of value to HCI research, so in response to these difficulties, they present efficacy evaluations [59]. They discuss the need to do smaller field studies prior to jumping to a large evaluation, which can better uncover design flaws through qualitative data, and tailoring the evaluation to the strategy rather than the end-point of behaviour change; for example, an evaluation can focus on monitoring if the technology is monitoring step-count. This approach does not take health behaviour theories into consideration as we are doing in our approach, but the approach to evaluate the strategy does have some similarity. Specifically, we are using the determinants of health behaviour from the theories in the evaluation of our design to determine if our design is able to change these determinants. Therefore, we can reframe this approach to say that we are evaluating the system based on the overall design strategy, which is the determinants from existing theories.

The second work provides a taxonomy of peer-involvement for weight

management, and its implication for designing social technology through qualitative interviews [69]. This work provides insight into the types of social involvement, which include: passive involvement that is shown to be social norms; proactive involvement, where one takes the lead; supportive involvement; and cooperative involvement. Also of key importance was the discussion around secrecy and disclosure of health information. This work provides significant insight into the design of an OSNs for health, as it shows the importance of passive involvement; in other words, social norms can develop by viewing and sharing data of other people. However, this needs to be balanced by the function to allow the user to have control over what information is disclosed.

Finally, Orji et al. correlated gamer types to determinants of health behaviour from the *Health Belief Model* through a large-scale questionnaire evaluation [83]. This work does not design or evaluate a digital game for health; however, the methodologies are based on the determinants for health behaviour change from the *Health Belief Model*. This strategy of looking at the determinants from health behaviour theory shows the recent move in HCI research towards this methodology, which shows the value in the approach that we are taking.

2.2.4 Personal Health Informatics

Much of the related works and commercial applications are collecting personal health information in some manner. This includes collecting daily step counts, calories burned through various physical activities, calories consumed, and other nutrients. The field of personal informatics is growing both from a research lens and also through a commercial lens, and the *Quantified Self* community is growing [92]. Understanding and reflecting upon one's behaviour through personal informatics is one way to understand that one's health behaviour needs to change. However, the motivation to enter one's health information is often a challenge. For this reason, an exploration of related works in HCI on personal informatics deserves a review, as this will provide an understanding of some of the key challenges and facilitators in

the study of personal informatics.

Understanding personal information especially if it does not fit into existing personal information management systems has been explored, and it was found that the information often is stored in temporary and dispersed locations such as notepad, Post-it[®] notes and temporary text files [13]. Similar work has been done to understand how mobile applications can better support note-taking [23].

The move beyond simply logging personal information into personal informatics was modelled through a stage-based model [62]. This research proposed a 5-stage model for the life-cycle of personal informatics: preparation stage is where people motivate to collect data about themselves; collection stage is where data is collected; integration stage is where information is prepared, combined and transformed; reflection stage is where the user reflects on her/his personal information; and action stage is where people choose what they are going to do with the information.

From these previously mentioned studies it is evident that there are numerous amounts of personal information that are stored in ad-hoc areas and they do not fit into existing personal information management systems. Furthermore, the life logging systems that have been developed require a high level of motivation to use. The lack of motivation to use the systems make them much less useful. None of these studies has combined OSNs, which can provide a method to gain information from others, promote continuous use, and increase the overall usefulness of the system. Furthermore, recent research has found that existing OSNs such as Facebook[®] are being used as an archive of personal information [125].

Other related works include personal informatics and life logging applied to the health domain. The challenge of managing personal health information from health clinics, insurance information, and home information has been explored in [89]. Further work was done to understand the types of *unanchored* information that needed to be managed by cancer patients [58], which found the large diversity in the information that was required to be handled from various locations, cognitive capacities and comprehension limitations. Additionally, the visualization of clinical information was explored using a

horizontal timeline to review personal histories [7, 87].

These health related studies of personal informatics reveals some of the challenges with storing and retrieving information. The studies again did not take the modality of OSNs into consideration; however, it was found that connection with social ties was a key component of managing their disease [58].

2.3 Commercial Applications

The number of commercial applications in the domain of tracking, monitoring and potentially changing one’s health behaviour has increased significantly since I started my doctoral work. Due to the large interest by industry in this domain, a review of the types of commercial applications in this domain deserves some discussion. An overview of a sample of commercial applications is listed in Table 2.2, which provides an overview of whether the listed application includes: automatic sensing such as step-counts; features for encouraging increased physical activity; features for better diet; and any social features.

Table 2.2: A summary of commercial applications for health behaviour change that includes nutritional intake and physical activity.

| Name | Auto Sensing | Physical Activity | Diet | Social |
|----------------------------------|---------------------------------------|------------------------------------|-------------------|---|
| FitBit [®] [33] | Step-counting, sleep quality | Auto sensing and user logs entries | User logs entries | Facebook [®] integration and an online community for discussions |
| Nike+ [®] FuelBand [79] | Measures movement using accelerometer | Through automatic sensing | No | Share on Facebook [®] , Twitter [®] and Path |

Continued on next page

Table 2.2 – continued from previous page

| Name | Auto Sensing | Physical Activity | Diet | Social |
|---------------------|--|---|---|---|
| Withings [119] | Step-count, track activities, sleep quality and monitor heart rate | Through automatic sensing | No | No |
| Lose It! [67] | Integrates with Fitbit®, Nike®+ FuelBand, and others | Through integration with 3rd party devices | User logs food and barcode scanning | Share entries with friends |
| SparkPeople [110] | No | My Fitness tracks activity through user logs | My Nutrition tracks diet intake through user logs | Online community allows for discussion between users |
| MyFitnessPal [76] | No | Log physical activity (calories calculated from database) | Log meals (nutritional information from database) | Facebook® integration, online community, friending and personal messaging |
| Tap and Track [113] | No | No | Log meals (database search) | No |
| DailyBurn [24] | No | Compilation of numerous workouts | Stepwise diet programs | Trainers |
| RunKeeper [102] | No | Track running and set goals | No | Sharing posts and commenting on posts |
| Calorie Count [16] | No | Log activities | Log food | Sharing daily calorie reports with commenting |
| DailyMile [25] | Integrates with Nike+ | Log various activities | No | Sharing and commenting |

As shown in this sample of applications, different applications offer different features. There are a handful of applications that have hardware that allows for automatic sensing of physical activity; further, many of these applications integrate with other systems that provide other features such as social features. Most of these applications provide a personal health informatics feature with other features such a goal setting and rewards such as badges. Generally, the number of applications that are available shows the potential that information and communication technologies offer to the promotion of healthy lifestyle. Furthermore, it signals the importance for HCI researchers to evaluate the design principles that lead to health behaviour change, and my work takes a theoretical approach for grounding the design principles back to the determinants for behaviour change. We also make OSNs central to the design, and expand the theoretical foundation to include the factors that encourage individuals to use OSNs to ensure engagement.

Clearly, there is a need for more research into designing these web and mobile technologies for health behaviour change. We need to be able to assess the ability for a system to affect health behaviour from the theoretical basis, and without doing a large randomized control trials (RCT) that are done to determine the efficacy of a new medical therapy. This same call for new theoretical evaluation methods was also made by Klasna et al. [59] and Hekler et al. [47].

2.4 Gamification

Many of the systems developed for research and for commercial purposes also have some gaming elements to them. For example, the Lifestyle Coaching App has a points system that are visible to the group of user [38], the OrderUP! system is a casual game [44], and the Shakra system also provides competition between its users to encourage more physical activity [5]. Similarly, many of the commercial applications also have gaming features associated with them; for example, FitBit® [33] has a points system and users earn badges when they reach specific point thresholds, and RunKeeper [102] encourages competition by showing how the user is performing against others. Gaming

features appear to be used as a component in the design of technologies for positive health behaviour. For this reason, we will briefly look at gamification.

Gamification is defined as *the use of game design elements in non-game contexts*, and it includes reward features such as points, badges, levels and leader boards [26]. Within this definition, gamification relates to *games* rather than *play*: where a video game's main purpose is to *play* it, an application with gamification refers to *games* in the sense of having rules and competition towards a goal. Another feature of gamification is that *games* is not the central purpose, but rather includes elements of *games*. Finally, gamification uses elements of games in applications that are non-game contexts, and they are used to increase engagement and improve user experience. However, gamification is distinct from serious games in that its gaming features are only part of the design of the application, where serious games' entire purpose is the game but for a serious purpose [51]. The use of gamification in health is also not novel. Gamification and serious games have been used for physical health, cognitive health, social and emotional health [74].

2.5 Summary

The field of HCI research has yielded significant research on the design of technologies for health behaviour change. Many of these works have considered theories [11, 22, 43, 44], and have social features [5, 11, 20, 21, 38, 42, 63, 64, 73, 97, 114]. Additionally, the explosion of commercial applications for health monitoring and health behaviour change are also showing the need to better understand the design principles that lead to health behaviour change.

The related works show the promise of using theoretical models in the design and evaluation of technologies for health behaviour change, and the importance of social aspects in the design. We expand this by developing a comprehensive theoretical approach to both the design and evaluation of an OSN for health behaviour change. In order to better understand engagement, in the next chapter, we review theories that help us to better

understand motivations for using OSNs thus ensuring that the system is used, and secondly, we comprehensively review theories related to health behaviour change to better understand the determining factors that change health behaviour. So the overall approach is that we design for engagement to ensure use, which then can lead to health behaviour change, as the factors for use can interplay with determinants for health behaviour change. Some of the related works used theories from domains outside of health behaviour to design for health behaviour change; however, we will review several theories similar to [11, 22], but we will only use theories related to health behaviour. This will ensure that the factors distilled from the theories are related to specifically health behaviour. By using this theoretical approach, we can begin to address the “Theoretical Gap” in HCI research that was described by Hekler et al. [47], and heed the call for a theoretical basis to the design of technologies for health behaviour change from the medical literature [118]. Our approach will look at changes in the determinants for health behaviour in addition to change in health behaviour because it is difficult to see changes in health behaviour, as was found in most of the works described in this chapter.

Chapter 3

The ABC Conceptual Framework

We review both theories for using OSNs and theories for health behaviour change. The theoretical models for use of OSNs are presented in Section 3.1 and the theoretical models for health behaviour change are presented in Section 3.2. Each theoretical model is summarized, and the determinants for motivation are collated and categorized from all the models in each of these two domains into the conceptual framework that is described in Section 3.3. Our work in the development of the conceptual framework includes the collation of the determinants from the theories into common determinants.

3.1 Theories for Use of OSNs

Several theoretical models can be applied to understanding the motivations for participation in OSNs: *Uses and Gratification Theory*, *Social Influence Model*, *Common Identity Theory*, *Common Bond Theory*, *Social Identity Theory*, *Organizational Commitment Theory*, *Behavior Chain for Online Participation*, and *social network threshold*. Many of these theories are rooted in social psychology or occupational psychology; however, they were selected for inclusion because they have been applied to understanding participation in online communities and in some cases OSNs. Since OSNs are a relatively new phenomenon, theoretical models for motivations for use of OSNs have not yet been extensively developed. Therefore, we include theories that have been applied to participation in online communities to define the determinants of use; however, the user inquiry evaluation described in Section 7.1 of Chapter 7

will evaluate the efficacy of these determinants when applied to OSNs.

3.1.1 Uses and Gratification Theory (UGT)

The *UGT* originates from communications research. Initially, this theory provided a theoretical approach in defining the motivations for using traditional mass media such as newspapers, radio and television [101], and generally is recognized to be a sub-tradition of media effects research [75]. It has received renewed interest because of its applicability to telecommunications, computer-mediated-communication [27, 101] and the internet [84]. It has also been applied to online communities [27, 60], and more recently uses and gratification was also studied to understand the motivations for using Facebook[®] [52, 111]. The *UGT* aims to understand why people use a specific media and the gratification that they receive from it. Table 3.1 shows a synthesis of the literature from 6 key studies [27, 52, 60, 84, 101, 111]. These studies were chosen because they applied the *UGT* to computer-mediated communications, internet, online communities, and OSNs. The left column on Table 3.1 shows the common terminology that we have assigned based on the original term from the various sources that have overlap with this term. The common term was collated from all 6 studies. The right column shows the original term used in the source study and the citation from the study or studies that used that terminology. For example, the first row in Table 3.1 shows that three papers [27, 60, 84] used the term *Entertainment*, and other papers had similar determinants such as *Diversion* and *Pass time*; therefore, our common terminology of *Entertainment* includes a broader interpretation that includes *Diversion* and *Pass time*. The first determinant listed is *Entertainment*, which stems from enjoyment of playing or interacting with others. The second determinant is *Social Enhancement*, which is a value that one ties to one's status within social peers. Next is *Maintaining Interpersonal Connectivity*, which refers to a user's desire to use OSNs to sustain contact with their friends and family. *Self-discovery* occurs when self-knowledge is obtained through social interaction. The next determinant is *Get Information*, which is an instrumental purpose like receiving information, and the flip-side

Table 3.1: The collation of the determinants from various sources of the Uses and Gratification Theory into a common terminology.

| Determinant | Determinant from Literature |
|--|---|
| Entertainment | Diversion [101], Pass time [84], Entertainment [27, 60, 84] |
| Social Enhancement | Social utility [101], Interpersonal utility [84], Social enhancement [27, 60] |
| Maintaining Interpersonal Connectivity | Social utility [101], Interpersonal utility [84], Maintaining interpersonal utility [27, 60], Social connection [52, 111] |
| Self-discovery | Personal identity [101], Self-discovery [27, 60] |
| Get Information | Surveillance [101], Information seeking [84], Purposive value [27], Get information [60], Content [52, 111], Social network surfing [52, 111], Social investigation [52, 111] |
| Provide Information | Purposive value [27], Provide information [60], Status updating [52, 111] |
| Convenience | Convenience [84] |
| Shared Identities | Shared Identities [52, 111] |

of this is the determinant to *Provide Information*, which is democratized with online communities and OSNs compared to previous media. *Convenience* is another determinant, which provides an understanding of why people would choose to use the Internet as opposed to read the newspaper, or socialize via an OSN service as opposed to meet in person. The final determinant listed on Table 3.1 is *Shared Identities*, which was referred to by [52, 111], as these studies were directly based on the uses and gratification of Facebook[®]. *Shared Identities* occurs as one constructs one's identities through the use of an OSN and relates to others through shared interests and values. For ease of reference to the definition of the determinants, Table 3.2 defines the common terminology for the determinants from the *UGT*.

3.1.2 Social Influence Model

The Social Influence Model was developed by [27], and it expands on the UGT determinants that are described above to include the variables related to social influence. This theory includes the individual value perceptions

Table 3.2: Definition of the common terminology for the determinants collated from the Uses and Gratification Theory

| Determinant | Definition of Determinant |
|--|--|
| Entertainment | Enjoyment from playing or interacting with others including the desire to pass time or diversion from other activities |
| Social Enhancement | Value tied to status among social peers |
| Maintaining Interpersonal Connectivity | Sustain contact with friends and family |
| Self-discovery | Self-knowledge obtained through information received and social interaction |
| Get Information | Obtaining any information, content, and knowledge including information about their social connections |
| Provide Information | Any information that is shared on an OSN; for example, through status updating |
| Convenience | Ease of access to friends and information |
| Shared Identities | Construction of one's identity and relating to others through shared interests and values |

that are derived from the UGT (*purposive value, self-discovery, maintaining interpersonal connectivity, social enhancement, and entertainment value*); however, it goes further to explain the social influence variables that come from the individual value perceptions. These social influence variables include: *Group Norms, mutual agreement, mutual accommodation* and *social identity*. The *Group Norms* is the main determinant is the Social Influence Model that leads to *Mutual Agreement* and *Mutual Accommodation*. In a similar manner, *Social Identity* is the main determinant that eventually leads to *Sense of Belonging*. These socially-based determinants are listed in Table 3.3, which also shows the determinants for other theoretical models that are described below.

3.1.3 Social Identity Theory

The *Social Identity Theory* [112] does not specifically describe the determinants for use of OSNs or online communities; however, this theory was foundational to the *Social Influence Model* [27]. Therefore, we will describe it in more detail. The *Social Identity Theory* is rooted in social science and

social psychology in particular, and it describes behaviour within a group and between groups. When two or more groups exist, individuals within a group find, create and define their place in these networks. The behaviour is described by the *Social Identity Theory* by four concepts: *Social Categorization*, *Social Identity*, *Social Comparison*, and *Psychological Distinctiveness*. *Social Categorization* is the ordering of social environment in groupings of persons in a manner that is meaningful to the subject. *Social identity* is part of an individual's self-concept which derives from his knowledge of his membership of a social group(s) together with the emotional significance attached to that membership. *Social Comparison* describes individuals within a group comparing themselves to those of another group through both similarities and differences, which leads to *Psychological Distinctiveness*, where those of one group feel that they are unique to those of another group. These socially-based determinants are also listed in Table 3.3. The definition of the common terminology that we have collated from the theories for use of OSNs is shown in Table 3.4.

3.1.4 Common Bond Theory

The *Common Bond Theory* was applied to the design of online communities by [95]. This theory describes when individuals within a group feel a bond-based attachment, which is a connection to the individuals within the group rather than to the group as a whole. The main behavioural determinants from the *Common Bond Theory* are the following: 1) *Social Interaction with Others* provides opportunities for people to get acquainted, to become familiar with one another and to build trust; 2) *Personal Knowledge of Others* allows opportunities for self-disclosure that are both a cause and a consequence of interpersonal bonds; and 3) *Personal Attraction Through Similarities* is when people like others who are similar to them in preferences, attitudes, and values.

Table 3.3: The collation of the socially based determinants for using OSNs into a common terminology.

| Determinant | Determinant from Literature |
|--|---|
| Social Categorization | <i>Social Categorization</i> : Common Identity Theory [95], Social Identity Theory [112], Social Influence Model [27] |
| Interdependence | <i>Interdependence</i> : Common Identity Theory [95] |
| Social Comparison | <i>Intergroup Comparisons</i> : Common Identity Theory [95]; <i>Social Comparisons</i> : Social Identity Theory [112], Social Influence Model [27]; <i>Psychological Distinction</i> : Social Identity Theory [27, 112] |
| Social Interaction with Others | <i>Social Interaction with Others</i> : Common Bond Theory [95] |
| Personal Knowledge of Others | <i>Personal Knowledge of Others</i> : Common Bond Theory [95] |
| Personal Attraction to Others Through Similarities | <i>Personal Attraction to Others Through Similarities</i> : Common Bond Theory [95] |
| Social Identity | <i>Social Identity</i> : Social Identity Theory [112], Social Influence Model [27] |
| Sense of Belonging | <i>Sense of Belonging</i> : Social Influence Model [27, 112] |
| Group Norms | <i>Group Norms, Mutual Agreement, Mutual Accommodation</i> : Social Influence Model [27] |

3.1.5 Common Identity Theory

The *Common Identity Theory* is the other side of the coin for the *Common Bond Theory*, and it too was applied to the design of online communities by [95]. This theory describes when individuals within a group feel an identity-based attachment, which is when individuals identify with a group as a whole, and people in the group are interchangeable. The main behavioural determinants from the *Common Identity Theory* are the following: 1) *Social Categorization* creates group identity merely by defining a collection of people as members of the same social category; 2) *Interdependence* is when group members are cooperatively interdependent; and 3) *Intergroup Comparisons* is when individuals define and categorize themselves as members of a group and compare themselves with other groups. These socially-based determinants from both the Common Bond and Common identity theory are shown in

Table 3.4: Definition of the common terminology for the socially based determinants for use of OSNs.

| Determinant | Definition of Determinant |
|--|--|
| Social Categorization | Ordering of social environment in groupings of persons in a manner that is meaningful to the subject such as a shared interest |
| Interdependence | Group members are cooperatively interdependent |
| Social Comparison | Individuals define and categorize themselves as members of a group, and compare themselves with other groups |
| Social Interaction with Others | Opportunities for people to get acquainted, become familiar, and build trust |
| Personal Knowledge of Others | Opportunities for self-disclosure that are both a cause and a consequence of interpersonal bonds |
| Personal Attraction to Others Through Similarities | Occurs when people like others who are similar to them in preferences, attitudes, and values |
| Social Identity | Individual's self-concept which derives from his knowledge of his membership of a social group |
| Sense of Belonging | An individual's feeling that she/he have a place within a group |
| Group Norms | The ability for behaviours of individuals in a group to be adopted by others in the group |

Table 3.3. Once again, the definition of the common terminology that we have collated from the theories for use of OSNs is shown in Table 3.4 for ease of access to the definition for the socially based determinants.

3.1.6 Theory of Organizational Commitment

The *Theory of Organizational Commitment* originates from the domain of occupational psychology [4], and it has been applied to online communities by [60]. This theory describes the types of attachment that individuals would have to an organization (or an online community), which then explains the reasons that they continue to stay within that group. These attachments describe the behavioural motivations for commitment. The first attachment is called *Affective*, which refers to when individuals stay in an organization because they want to. Individual's have an emotional attachment, where

they identify with the organization or online group. The second attachment is called *Continuance*, which refers to when individuals need to stay because they perceive a lack of alternatives and cost of leaving. The final attachment is *Normative*, which refers to when individual stay because they feel a sense of obligation to remain. *Normative Attachment* can occur when individuals join an online community or OSN because everyone else is on the system.

3.1.7 Behaviour Chain for Online Participation

The *Behaviour Chain for Online Participation* describes the temporal stages for use of online communities [36]. The model has three stages of use. First, the user needs to discover or find the site, *Discovery Stage*. The second stage is *Superficial Involvement*, where the user decides to try the site and she/he gets started. The final stage is *True Commitment*, which is when new habits are created through frequent use of the site and contribution to its content.

3.1.8 Social Network Threshold

The final theoretical model that is important to describe is *Social Network Threshold* [98, 116], which describes the adoption of innovations through influence of one's social networks. Indeed, these innovations can be health habits. The adopter categories include: early adopters, early majority, late majority and laggards. This theory will not be incorporated directly into the conceptual framework; however, the adoption categories should be kept in mind when creating OSN for health behaviour change, as it can provide a good means to understand individual's adoption of the OSN. The reason for not incorporating the adoption categories into the conceptual framework is because they do not explain motivation for adoption, but rather that adoption of innovation and technology occurs at different times for different people; the motivations for which are defined by the other theoretical models described in this chapter. For this reason, we felt that the adoption categories did not add any motivational factors, which is the basis of the conceptual framework.

3.2 Theories for Health Behaviour Change

The theoretical models reviewed for understanding health behavior change are: *The Health Belief Model*, *Social Cognitive Theory*, *Theory of Reasoned Action*, *Theory of Planned Behavior*, *Common Sense Model*, and *The Transtheoretical Model*. Although there are other models for health behaviour change, we feel that the theoretical models we used are most widely accepted and used. For example, these theoretical models with the exception of the *Health Belief Model* have been reviewed and comprehensively compiled by [104]. Further, the *Health Belief Model* has been used by [43] for designing persuasive technologies for health behaviour change. As we review these models, we will refer to the *determinants* of health behaviour, which refers to the many factors that combine to affect the health behaviour of individuals, and in particular we are referring to the social environment as well as individual characteristics and behaviours [121].

3.2.1 The Health Belief Model (HBM)

HBM originates from the 1950's by a group of social psychologists at the US Public Health Service to understand disease prevention through inoculations and uptake of screening tests, and it has been used extensively to understand health behaviour in numerous studies [99]. HBM is based on understanding health behaviour change from the perspective of preventative health behaviour to self-management of chronic diseases [50]. This model has 4 key determinants for health behaviour change. The first is *Perceived Susceptibility*, which refers to personal feeling of vulnerability to a condition and perceptions of the risk of contracting a condition. The second determinant is *Perceived Severity*, which relates to feelings concerning the seriousness of contracting an illness, and it includes evaluations of both medical/clinical consequences and possible social consequences. The third determinant is *Perceived Benefits*, which relates to the effectiveness of various actions available in reducing the disease threat, so the willingness to accept the recommended health action only if it is perceived as feasible

and efficacious. The final determinant from the *HBM* is *Perceived Barriers*, which refers to an individual's perceived "cost" of the treatment, which can include expense, danger, discomfort, inconvenience, and time consumption. These 4 determinants are individually-based determinants that relate to an individual's perception of a certain health behaviour. The individually based determinants for the *HBM* and the other theoretical models described below are listed on Table 3.5. *HBM* also has a socially-based determinant, *Cues to Action*, which is external stimulus that can include media awareness campaigns and reminders [50]. Socially-based determinants such as *Cues to Action* are listed in Table 3.7. The definition of the common terminology for the individually based and socially based determinants that we developed through the collation of all the theories for health behaviour change is listed in Tables 3.6 and 3.7 and 3.8 respectively. However, there are limitations to this theory due to its origins in the uptake of immunizations, as the determinants from this theory are most applicable to these examples. When we combine the determinants with other the other theories in Table 3.5, these limitations are minimized as the determinants are linked to broader definitions from theories that are more focused on diet and physical activity behaviours.

3.2.2 The Social Cognitive Theory

The Social Cognitive Theory holds that behaviour is determined through expectancies and incentives, and of key importance is self-efficacy to changing health behaviour [10, 100]. *The Social Cognitive Theory* was first drawn from the *Social Learning Theory* by [100], which describes 4 determinants for health behaviour change. The first determinant is *Expectancies About Environmental Cues*, which is an individual's beliefs about how events are connected. The second determinant is *Expectancies About Outcomes*, which is the consequences of one's own actions, opinion about how individual behaviour is likely to influence outcomes. The third determinant is *Expectancies About Self-Efficacy*, which is an individual's own competence to perform the behaviour needed to influence outcomes. The fourth determinant is *Incen-*

tives, which is the value of the outcome of health behaviour change, which can be health, appearance, approval, economic gain or other consequences.

The *Social Cognitive Theory* was studied by Bandura et al. [10], who further developed the *Social Learning Theory* and found 6 core determinants for health behaviour change:

1. *Knowledge* is an individual's need to know the health risks and benefits of different health practices.
2. *Perceived Self-Efficacy* is an individual's own competence to perform the behaviour needed to influence outcomes and the individual's ability to exercise control over one's health habits. *Perceived Self-Efficacy* can be influenced vicariously through others, which allows for social modelling and building of social norms.
3. *Outcome Expectation* is about the expected cost and benefit for certain behaviour. There are three forms of this: *physical outcome expectation* is the pleasurable and aversive effects of the behaviour and any losses or benefits from it; *social outcome expectations* is the social approval or disapprovals of the behaviour from one's social connections; and *self-evaluative outcome expectations* is one's own reaction to the behaviour and health status.
4. *Goals* include proximal and distal goals, and they need to be concrete plans and include strategies to realize them. This factor builds accountability.
5. *Perceived Facilitators* include social and structural factors, and social approvals and social supports can be facilitators. They incorporate the value of the outcome of health behaviour change, which can be health, appearance, social approval, or economic gain.
6. *Perceived Impediments* is the opposite of perceived facilitators, and they also include both social and structural factors.

The individual and social determinants are listed on Tables 3.5 and 3.7 respectively, with the definition for the determinant shown in Tables 3.6 and 3.8 respectively.

Table 3.5: The collation of the individually based determinants for health behaviour change into a common terminology

| Determinant | Determinant from Literature |
|---|--|
| Knowledge | <i>Perceived susceptibility</i> to adverse health outcomes and <i>Perceived severity</i> of current health behavior: Health Belief Model [50]; <i>Knowledge of health risks and alternative health behaviour</i> : Social Cognitive Theory [10, 100] |
| Expectations about outcomes | <i>Perceived benefit</i> of specific health behaviours: Health Belief Model [50]; <i>Expectations about outcomes</i> : Social Cognitive Theory [10, 100] |
| Expectations about self-efficacy | <i>Expectations about self-efficacy</i> : Social Cognitive Theory [10, 100]; <i>Perceived behavioural controls</i> : Theory of Reasoned Action [2] |
| Goals | <i>Distal and proximal goals</i> : Social Cognitive Theory [10, 100]; <i>Proximal goals as targets</i> : Common Sense Model [61] |
| Perceived facilitators | <i>Sociostructural factors</i> (facilitators): Social Cognitive Theory [10, 100]; <i>Individual incentives</i> : Social Learning Theory [100]; |
| Perceived barriers | <i>Perceived barriers</i> : Health Belief Model [50]; <i>Sociostructural factors</i> (barriers): Social Cognitive Theory [10, 100] |
| Attitude | <i>Attitude</i> : Theory of Reasoned Action [3, 106] and Theory of Planned Behaviour [2]; self-evaluative outcome expectations: Social Cognitive Theory [10, 100] |
| Interaction between emotion and cognition | <i>Interaction between emotion and cognition</i> [61] |

3.2.3 The Theory of Reasoned Action (TRA)

TRA is rooted in social psychology, and it suggests that a person’s behavioural intention depends on the person’s *Attitude* about that behaviour and *Subjective Norms* [3, 106]. *Subjective Norms* refer to one’s perceived expectations from their social connections along with intention to follow with these expectations. *Attitude* is much more dependent on one’s personal feelings towards the behaviour. The combination of these two determinants, *Attitude* and *Subjective Norms*, make up *TRA*. The individually-based determinant (*Attitude*) can be found in Table 3.5 (definitions listed in Table 3.6), and the socially-based determinant (*Subjective Norms*) can be found in

Table 3.6: Definition of the common terminology for the individually based determinants for health behaviour change

| Determinant | Definition of Determinant |
|---|---|
| Knowledge | The necessity to know the health risks and benefits of different health practices including an individual's perceived susceptibility to poor health outcomes and the perceived severity of the outcomes |
| Expectations about outcomes | The expected cost and benefit for certain behaviour |
| Expectations about self-efficacy | An individual's own competence to perform the behaviour needed to influence outcomes and the individual's ability to exercise control over one's health habits |
| Goals | Includes both proximal and distal goals, and they need to be concrete plans that include strategies to realize them |
| Perceived facilitators | Structural factors that assist health behaviour, and it incorporates the value of positive health behaviour such as health, appearance and other individual incentives |
| Perceived barriers | Structural factors that impede positive health behaviour such as lack of time |
| Attitude | An individual's feelings towards specific health behaviours |
| Interaction between emotion and cognition | An individual's emotional reaction to illness combined with their knowledge about that illness |

Table 3.7 (definitions listed in Table 3.8) along with determinants from other theoretical models.

3.2.4 The Theory of Planned Behaviour

The *Theory of Planned Behaviour* [2] is an extension of *TRA* [3, 106], which was iterated to incorporate will power. The need for a new theory was made necessary by *TRA*'s limitation in dealing with behaviours over which people have incomplete volitional control. Therefore, the three main determinants for health behaviour change based on the *Theory of Planned Behaviour* are the following: 1) *Attitude Towards Behaviour* is similar to the determinant in *TRA*, and it includes one's salient beliefs towards the behaviour and subjective

evaluation of the behaviour; 2) *Subjective Norms* refers to normative beliefs about whether groups approve or disapprove of a certain behaviour again similar to TRA; and 3) *Perceived Behavioural Controls* deals with the presence or absence of requisite resources and opportunities, and these beliefs are often based on past experiences. The *Theory of Planned Behaviour* also has another determinant, *Moral Norms*, which is different from subjective norms or normative pressures. *Moral Norms* refers to personal feelings of moral obligation or responsibility to perform, or refuse to perform, a certain behaviour. These determinants are lists in Tables 3.5 and 3.7. Once again for easy reference, the definition of the common terminology for the individually based and socially based determinants for health behaviour change are listed in Tables 3.6 and 3.8 respectively.

3.2.5 The Common Sense Model

The *Common Sense Model* is a framework that describes behavioural processes involved in adaptation to episodes of physical and psychological disorders, and integrates both individual (cognition and affect/emotion) and social (and contextual) factors [61]. The *Common Sense Model* has three main determinants: 1) importance of *Proximal Goals as Targets* for self-regulation; 2) *Coherence and Maintenance*, which is influenced by the individual, their culture and support from their social network; and 3) *Interaction between Emotion and Cognition*, which refers to one's emotional reaction to illness combined with their knowledge about that illness. The first and third determinant are listed in Table 3.5; however, the second determinant is a temporal determinant that fits with the stages of change that is described by the *TTM* below.

3.2.6 The Transtheoretical Model (TTM)

TTM shows the stages of health behavior change, and the determinants to move between the stages [90]. *TTM* has been used in the HCI literature for the design of persuasive technologies (e.g. [22, 43, 46]). *TTM* is based on temporal factors that describe health behaviour change. *TTM* presents

Table 3.7: The collation of the socially based determinants for health behaviour change into a common terminology

| Determinant | Determinant from Literature |
|--|---|
| Environmental cues | <i>Cues to action:</i> Health Belief Model [50]; <i>Environmental cues:</i> Social Learning Theory [9, 100]; <i>Environmental re-evaluation:</i> Transtheoretical model [90] |
| Subjective norms | <i>Social outcome expectation:</i> Social Cognitive Theory [10, 100] <i>Subjective norms:</i> Theory of Planned Behaviour [2]; <i>Moral norms:</i> Theory of Planned Behavior [2] |
| Self-efficacy (vicariously through others) | <i>Self-efficacy</i> vicariously through others: Social Cognitive Theory [10, 100] |
| Sociostructural facilitators | <i>Sociostructural facilitators:</i> Social Cognitive Theory [10]; <i>Helping relationships:</i> Transtheoretical Model [90] |
| Sociostructural barriers | <i>Sociostructural barriers:</i> Social Cognitive Theory [10] |

the stages of change: *Pre-Contemplation*, *Contemplation*, *Preparation*, *Action* and *Maintenance*. The model also states that individuals can revert back to a previous stage at any time. *TTM* also provides processes by which one moves from one stage to another; the processes to move from *Pre-Contemplation* to *Contemplation* are *Consciousness Raising*, *Dramatic Relief* and *Environmental Reevaluation*; the process to move from *Contemplation* to *Preparation* is *Self Reevaluation*; the process to move from *Preparation* to *Action* is *Self Liberation*; and the processes to move from *Action* to *Maintenance* are *Contingency Management*, *Helping Relationships*, *Counter Conditioning* and *Stimulus Control*. There are also limitation to the *TTM*, as its origins are from smoking cessation, which has clearly defined stages of change; however, it has been applied more broadly to diet and physical activity by health and HCI researchers, but it is understood that the stages of change are less clear in changing one's diet and activity level.

Table 3.8: Definition of the common terminology for the socially based determinants for health behaviour change

| Determinant | Determinant from Literature |
|--|--|
| Environmental cues | External stimulus that raises awareness of poor health behaviour |
| Subjective norms | One's perceived expectation of health behaviour from their social connections along with intention to follow these expectations, which includes the need to receive social approvals |
| Self-efficacy (vicariously through others) | One builds their perceptions of their own ability to change their health behaviour through social modelling |
| Sociostructural facilitators | Social facilitators such as obtaining help and encouragement from others, as well as receiving social approval from others |
| Sociostructural barriers | Social barriers to good health occurs due to poor health influencers |

3.3 The Appeal Belonging Commitment (ABC) Framework

The literature review as described in Sections 3.1 and 3.2 reveals 14 theoretical models: 8 describe the motivations for using OSNs and 6 describe the motivations for changing health behaviour. Three dimensions emerged when we reviewed and collated the determinants from the theories for use of OSNs and health behaviour change. The first dimension includes all the individually based determinants for both use of OSNs and health behaviour change that are listed in Tables 3.1 and 3.5 respectively, which we call **Appeal**. The second dimension includes all the socially based determinants for both use of OSNs and health behaviour change that are listed in Tables 3.3 and 3.7 respectively, which we call **Belonging**. The third dimension is labelled **Commitment** and includes the following: 1) temporal stages for use of OSNs from the *Behaviour Chain for Online Participation* model (described in Section 3.1.7) and for health behaviour change from *TTM* (described in Section 3.2.6), and 2) attachments for use of OSNs from the *Theory of Organizational Commitment* described in Section 3.1.6.

Together these dimensions provide the foundation for the **Appeal Belonging Commitment (ABC) Framework** illustrated in Figures 3.1 and 3.2, which fully describes how OSNs can be used to motivate health behaviour change. The **ABC Framework** is a synthesis of the determinants from these two domains into three dimensions. It shows that health behaviour change and use of OSNs are complex and are defined by a multitude of factors that have significant interplay between the determinants for the use of OSNs and motivating health behaviour change. The only theoretical model from Section 3.1 that has not been included in the **ABC Framework** is the adoption categories described by the *Social Network Threshold*. Even though the adoption of OSN and new health behaviours can likely be described by the adoption categories of the *Social Network Threshold*, this theory does not show how an individual would use the OSN, but rather shows how an OSN would be adopted through a population group. The **ABC Framework** explains how the determinants for use of OSNs interplay to influence the determinants for health behaviour change. The interplay connections are based on the face value of the definition of the determinant, and it will be evaluated through the design of the OSN as described in the research approach, Section 1.3.

3.3.1 Appeal

The individually based determinants for both the use of OSNs and health behaviour change make up the **Appeal** dimension of the framework. The **Appeal** dimension is shown in Figure 3.1 in red. The individually based determinants for use of OSNs is shown in the boxes outlined in red (the first seven determinants from the *Uses and Gratification Theory*), and the individually based determinants for health behaviour change (listed in Table 3.5) are shown in the solid red boxes. The interplay between the determinants is shown by the lines that connect the determinants of these two domains, which is based on the face value of the definition of the determinants. The application of the individually based determinants for use of OSNs and the interplay with the individually based determinants for health behaviour

change is described below:

1. *Get Information* can include information about the nutritional content of meals and the energy expenditure of physical activity. Furthermore, the information can include the definitions for nutrients and information about the outcomes of consuming certain nutrients. This information can be obtained by first *Providing Information* about what an individual ate and physical activity completed. By obtaining information about nutritional content of meals and energy expenditure of physical activity, it allows an individual to build their health *Knowledge*, which provides motivation to understand her/his health behaviour and also provides the ability to understand what healthy choices exist. *Get Information* can also change their *attitude* about good health behaviour, as seeing information about specific behaviour may show that certain behaviour is beneficial to her/his health, which is a meal or activity that she/he enjoys.
2. *Self-Discovery* can be facilitated by the information that is provided, as described above. An individual obtains a better of understanding of her/himself through providing health information and reviewing the nutritional information that is obtained through the OSN. This in turn then can also change her/his *attitude* about a specific behaviour (as described in item 1), and also change her/his *Expectations about their Self-Efficacy*, as she/he builds her/his confidence in being healthy by allowing her/him to see the nutritional value of certain meals consumed or physical activity that they have completed.
3. *Maintain Interpersonal Connectivity* can facilitate the **Belonging** determinant of increasing an individual's *Expectations about Self-Efficacy vicariously through others*. By viewing the capabilities of her/his social connections, she/he can also increase their own confidence in her/his own capabilities.
4. *Social Enhancement* determinant interplays initially with the determinant to *Provide Information*, as individuals would be motivated to provide their health information to increase their social standing among their friends or social connections on the OSN. Subsequently, *Social Enhancement* will also interplay with the health behaviour determinant of *Goals*, as individuals will be motivated to complete health goals and share this achievement to enhance their social standing within the OSN. Finally, *Social Enhancement*

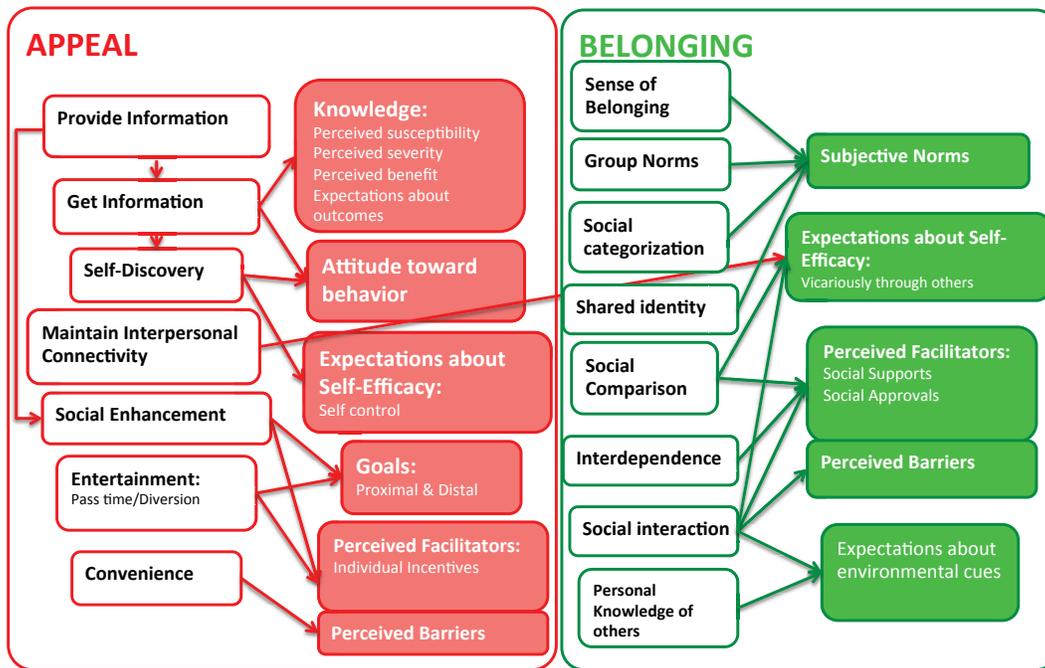


Figure 3.1: ABC Framework showing the Appeal dimension in red and Belonging dimension in green. The determinants for use of OSNs is shown in the boxes with no fill and the determinants for health behaviour change is shown in the filled boxes. The interplay between these two domains is shown by lines connecting the boxes.

also provides *Individual Incentives* to share healthy behaviour, so individuals appear in good standing with their OSN connections.

5. *Entertainment* determinant can be designed into an OSN by adding gamification elements to one's health *goals*, so that individual's earn points or badges for successful completion of their goals. Furthermore, these features provide incentives for healthy behaviour, which builds *Perceived Facilitators*.
6. *Convenience* of an OSN is provided by storing health information rather than an individual having to read nutritional labels and keep track of nutritional intake and energy expenditure, which can reduce *Perceived Barriers* to changing health behaviour.

3.3.2 Belonging

The **Belonging** dimension of the **ABC Framework** consists of the socially-based determinants for use of OSNs and health behaviour change that are listed on Tables 3.3 and 3.7 respectively. The **Belonging** dimension is shown in Figure 3.1 in green. The socially-based determinants for use of OSNs is shown in the boxes outlined in green, and the socially-based determinants for health behaviour change is shown in the solid green boxes. The interplay between the determinants is shown by the lines that connect the determinants of these two domains. The application of the socially-based determinants for use of OSNs and the interplay with the socially-based determinants for health behaviour change is described below:

1. As users in an OSN start to develop a *Sense of Belonging* with their online group, their health behaviours will normalize to that of their social connection; in other words, *Subjective Norms* in health behaviour will develop.
2. *Group Norms* will build within an OSN, and this will also build *Subjective Norms* in health behaviour if the OSN displays the health behaviour of their social connection. This includes moral norms where poor health behaviours will be frowned upon by one's social networks.
3. *Social Categorization* will allow users of the OSN to feel that they are a part of a group, which will build *Subjective Norms* in health behaviour within the group.
4. For the same reasons as items 1, 2 and 3, *Shared Identity* will also develop *Subjective Norms*.
5. *Social Comparisons* will allow one to see what others are capable of with respect to their health, which will allow one to build *Self-Efficacy Vicariously Through Others*, which is also promoted through *Maintaining Interpersonal Relationships* as described by in Section 3.3.1's item 3. Additionally, *Social Comparison* builds *Perceived Facilitators* by individuals wishing to obtain *Social Approvals* from their peers for good health behaviour.
6. *Interdependence* will also allow social supports to develop, which will build one's *Perceived Facilitators*, where one's social connections provide support to the individual to continue to maintain healthy behaviour.

7. *Social Interaction* can allow a multitude of changes to occur through dialogue and shared experiences:
 - (a) *Environmental Cues* can be discussed and acted upon;
 - (b) *Self-Efficacy Vicariously Through Others* explains one's confidence that is built;
 - (c) developing methods to overcome *Perceived Barriers*;
 - (d) adoption of others' strategies and encouragement builds *Perceived Facilitators*.
8. *Personal Attraction to Others* will also allow individuals to see their own behaviour in comparison to others, which may allow *Environmental Cues* to action to happen.

3.3.3 Commitment

The third dimension of the **ABC Framework** is **Commitment**, which includes temporal stages for both use of OSN and health behaviour change, and attachment categories for use of OSN. **Commitment** dimension is shown by Figure 3.2, which shows the stages of health behaviour change from the *TTM* as described in Section 3.2.6, the stages of use for OSN are from the *Behaviour Chain for Online Participation* as described in Section 3.1.7, and the attachment categories are from the *Theory of Organizational Commitment* as described by Section 3.1.6. This dimension does not have interplay, as we saw in the **Appeal** and **Belonging** dimensions, but rather the **Commitment** dimension describes a user's commitment and journey while using an OSN for health behaviour change. The orange line shown on Figure 3.2 depicts an example journey through the use of an OSN for healthy living: this user discovered the OSN and started using it for normative motivations, perhaps her/his friends were using it, and she/he is in the pre-contemplative stage of changing her/his health behaviour, but as she/he uses the system more, she/he moves from continuance attachment to affective attachment to the system and starts to contemplate, prepare and take action on her/his health behaviour. This example is by no means the ideal state. A user's motivation for commitment (the attachment) may remain static unless

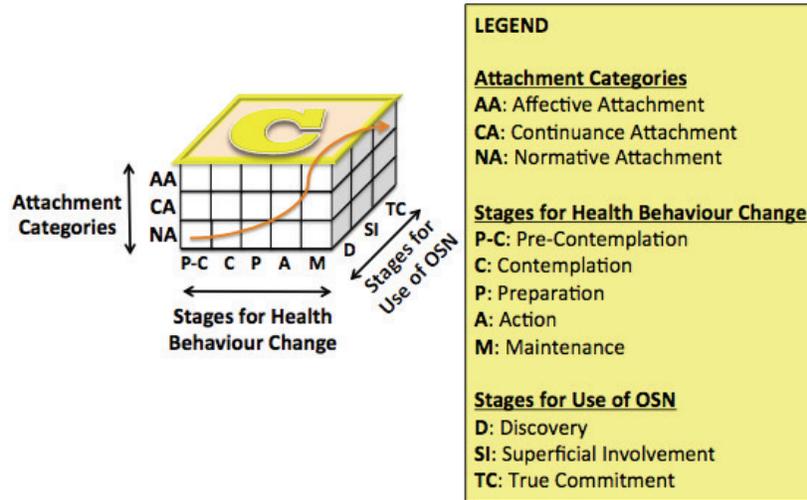


Figure 3.2: The **Commitment** dimension of the **ABC Framework** showing the stages and attachment categories showing the stages of health behaviour change, the attachments categories of OSN, and the stages for use of OSN. The orange line indicates an example journey for a user through the temporal stages and attachment categories.

there are changes to the design that would allow more *Affective Attachment* to develop. Furthermore, a user may not require the use for the OSN to maintain acquired positive health behaviour, and may choose to stop using the system, but remain committed to healthy living.

The **Commitment** dimension of the **ABC Framework** allows an understanding of why users would be committed to the use of an OSN, and it describes the temporal stages of use and health behaviour change. The **Commitment** dimension allows a designer of an OSN to better understand that stages do exist and design elements can be developed to lead to committed behaviour.

3.3.4 Using the ABC Framework

The **ABC Framework** provides the behavioural determinants for using OSNs and how they can influence health behaviour change. This framework can now be used to extrapolate design guidelines for OSNs for health be-

haviour change. Specifically, each of the determinants for use of OSNs and health behaviour change can be abstracted into design guidelines for OSNs designed to change health behaviour.

The **ABC Framework** can then be used to evaluate the OSN. The determinants from the framework form the points of inquiry for evaluating the design of the OSN. For example, users of the OSN are asked about their *self-efficacy* or capability of eating nutritious foods and being physically active. Similarly, users are asked about their motivation for using the OSN such as *to get information*. This evaluation allows for clarity on which determinants of the **ABC Framework** were adequately met in the design, and which design principles need to be iterated to obtain better alignment with the framework.

Finally, the **ABC Framework** can also be validated through the evaluation of the OSN. The users are asked which design features contributed to specific determinants for health behaviour change, which evaluates the interplay between the determinants for use of OSN and the determinants for health behaviour change. The evaluation of actual health behaviour change from clinical measures is used against the **ABC Framework** to validate the framework. This validation should yield change in health behaviour if there are changes in the determinants for health behaviour change from the framework. The use of the **ABC Framework** is summarized in Figure 3.3, and it includes the design and evaluation of the OSN for health behaviour change and the validation of the framework.

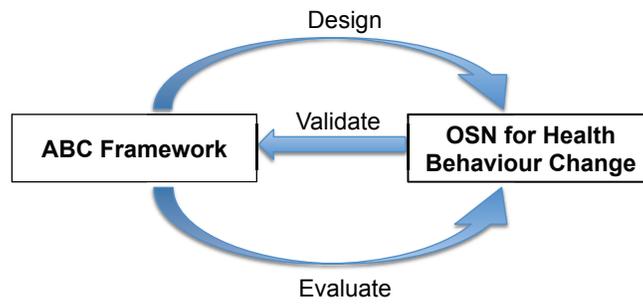


Figure 3.3: A graphical representation for the use of the **ABC Framework**, which includes the design and evaluation of the OSN for health behaviour change and the validation of the framework.

Chapter 4

The *VivoSpace* Prototype: An OSN for Health Behaviour Change

We designed a high-fidelity prototype of an OSN designed to change health behaviour through a UCD process augmented by the **ABC Framework**. This methodology, as described in Section 1.3, is deployed to design the OSN called *VivoSpace*. The full UCD process is described in Chapter 7, which describes in chronological order details for how the high-fidelity prototype was designed. Chapter 7 can be read prior to reading this chapter to obtain a full chronological understanding of the design iterations of *VivoSpace*. However, the main contributions for this research were obtained from the high-fidelity prototype, so the design and evaluation of the high-fidelity prototype is presented in this chapter with details of the UCD design and evaluation presented in Chapter 7.

The UCD process began with an initial user inquiry (Section 7.1), which was done through online and paper questionnaires with 104 adults from diverse age and ethnic groups and through in-person interviews with 11 adults. The main purpose of the initial user inquiry was to validate the determinants for use of OSNs in the **ABC Framework** because the determinants were derived from theories that were mostly applied to user participation in online communities and are rooted in social psychology, communication and organizational psychology as described in Section 3.1. The initial user inquiry also inquired about the respondents' thoughts on their health. The results of the initial user inquiry showed strong agreement with the **ABC**

Framework, and it showed that different populations groups have different motivations for using OSNs, which allowed us to design the initial paper prototype to exploit the determinants with the most overlap between the various groups.

The paper prototypes were designed using the **ABC Framework**, and the information obtained from the initial user inquiry about the determinants that had the strongest agreement across age and ethnic groups. Section 7.2 describes the design and evaluation of the paper prototypes. The paper prototypes were evaluated through in-person one-on-one interviews with 11 adults. The results revealed that the personal health informatics feature and the dashboard resonated the most with the users; however, the design needed to provide better gamification features.

The results from the evaluation of the paper prototypes was used to develop the medium fidelity prototype for *VivoSpace*. The design and evaluation of the medium fidelity prototype is described in detail in Section 7.3. The medium fidelity prototype was an interactive prototype that was evaluated in multiple laboratory experiments using both direct and indirect methods with 36 adults. The evaluation of the medium fidelity prototype for *VivoSpace* provided significant information on how the design should be iterated to ensure engagement and health behaviour change. The weakest aspect of the design was that it did not provide enough motivation to *provide information*. Additionally, the gaming features of the medium fidelity prototype were too complicated, so the design was simplified by providing a points systems, where users are rewarded with minor points for using the system and major points for completing goals.

The results from the evaluation of the medium fidelity prototype allowed us to design the high-fidelity prototype for *VivoSpace*. The design was modified so that users are rewarded for using the system as well as for completing goals as part of the gaming features. Furthermore, the gamification features were modified, so that users level-up through a 10-level game with each level revealing a new character. This simplifies the gaming features that add to the *entertainment* motivation to use *VivoSpace* as well as allows for *perceived facilitators* toward health behaviour change. Users are able to see

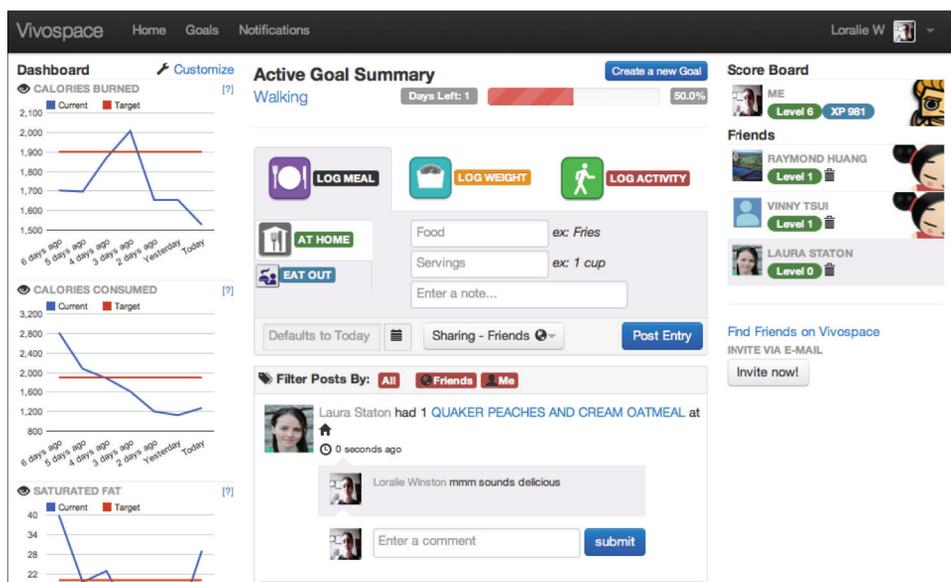


Figure 4.1: Main home page of VivoSpace showing the Dashboard on the left; the goals summary, log entry, and news feed in the middle; and friends with game progress on the right.

the level of their friends providing motivation to use the system for *social enhancement* and *group norms*, which potentially builds *perceived facilitators* through individual incentives and builds *subjective norms* to make positive health behaviour changes. *Goals* are central, and users are rewarded with points for successfully completing their goals. Further simplifications were made to the design, and the number of pages were reduced to just a few. The main home page (shown in Figure 4.1) includes the dashboard on the left side; the goals summary at the top; the status update entry and the newsfeed is in the middle; and the game points and levels is displayed on the right. The other pages include the goals page that allow the user to see details about each goal and create new goals, and the profile page where users can change their profile picture, update the visibility of charts on their dashboard and set nutrient targets, and control personal security such as allowance to change their password.

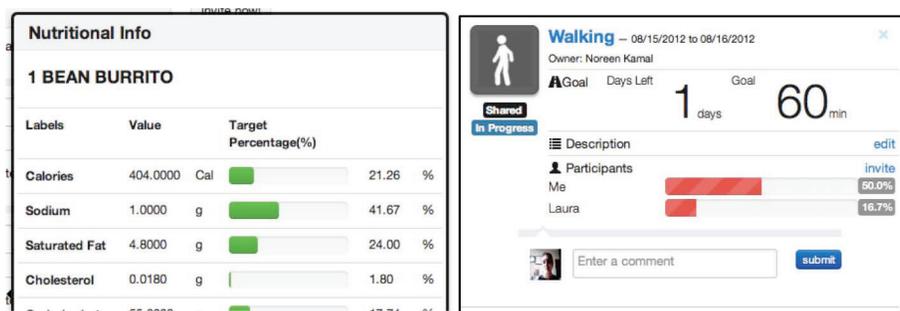


Figure 4.2: Left: the nutritional content of a meal is displayed when the logged meal is clicked. Right: goal details show the users and participating friends progress towards the goal target.

4.1 Design of High Fidelity Prototype

The high fidelity prototype was developed using PHP and MySQL within the CodeIgniter application framework. Twitter[®]'s Bootstrap [115] was used for the user interface elements and Doctrine PHP libraries were used for the database abstraction layer. Furthermore, *VivoSpace* incorporated Wolfram—Alpha[®]'s application programming interface (API) [120] to obtain nutritional information for meals and caloric expenditure for physical activities logged. When the API could not return the nutritional information, a site administrator entered the correct information based on web searches, which can eventually be crowd-sourced. The high-fidelity prototype was tested with seven individuals using a cognitive walk-through prior to the field experiment described in this chapter.

VivoSpace has three main components: logging, goals, and a personal dashboard. The main home page of *VivoSpace* is shown in Figure 4.1. Users have the ability to log their meals, physical activity and weight. After users log their meals, the nutritional content of the meals is available when they click on the name of the food (Figure 4.2 left). Similarly, when they log a physical activity, the calories burned information is available. Users have the ability to make a log private or to share it with their social network. The newsfeed shows the log entries for themselves and their friends. The shared log entries allow for commenting between the individuals in the user's

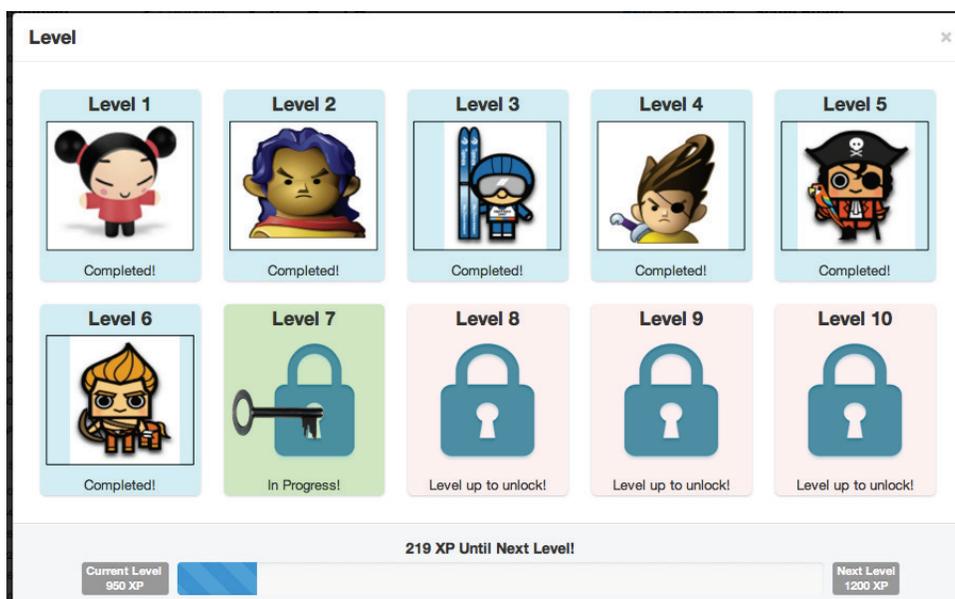


Figure 4.3: The user’s progression through the 10-level game showing the characters that have been revealed at each level and how much they have progressed through the current level.

social network. The historical trends for calories consumed, calories burned, and each nutrient is charted on the dashboard, which is always visible on the left side of the home page. Users can customize their targets for each of the nutrients or use the defaults, which are based on US and Canadian national standards. Users also have the ability to create concrete proximal goals from a library of goals such as *walk for 60 minutes over 2 days*, or *eat 35 g of fibre over 3 days*. Users can invite friends to participate in their goals with them. The goal progress is shown on the home page, and details for the goal are shown when the user clicks on the goal (Figure 4.2 right). *VivoSpace* also provides the following gamification features: users earn small experience points (XP) by using *VivoSpace* and major experience points for successfully completing goals. Users progress through 10 levels with each level requiring more points to advance to the next level. Furthermore, each level reveals a new character. Users can view their progression through the level and the characters that have been revealed by clicking on their name

on the scoreboard that is on the right side of the main screen. Figure 4.3 shows the pop-up that appears when the user click on their name on the scoreboard that shows all the characters that have been revealed for each level achieved. The gamification design was based on personal conversations with Ayogo Games [8]; however, they did link well with the determinants from the *ABC Framework*; specifically, they linked with *Social Enhancement* and *Social Comparison*. Screen captures of the high-fidelity prototype can be found in the First Appendix.

4.1.1 Mapping Design Elements to the ABC Framework

The design element of the high fidelity prototype can be mapped to the determinants of the **ABC Framework**. The UCD process (as described in Chapter 7) where the points of inquiry are based on the theoretical foundations of the **ABC Framework** have allowed to better interpret the translation of the determinants from the framework into the design elements for this high fidelity prototype. Table 4.1 maps the determinants for use of OSNs from the **Appeal** and **Belonging** dimensions of the **ABC Framework** to design elements of the high fidelity prototype for *VivoSpace*.

Table 4.1: Mapping of the determinants for use of OSNs from the **ABC Framework** to the design elements in *VivoSpace*'s high fidelity prototype.

| Determinant | Design Elements |
|---------------------|---|
| Provide Information | Information is provided through logging of meals, physical activity, and weight, and through commenting on friends' entries. |
| Get Information | Nutritional information is obtained for each log entry, and historical information is available on the dashboard. |
| Self-Discovery | Ability to see the nutritional value of foods eaten and caloric expenditure for physical activity combined with the historical trends on the dashboard allow the user to discover their health behaviour. |

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Table 4.1 – continued from previous page

| Determinant | Design Elements |
|--|---|
| Maintaining Interpersonal Connectivity | Social connection is provided through the ability to comment on friends' log entries and participate with friends on goals. |
| Social Enhancement | Social enhancement is provided by: 1) visibility into the level achieved by one's friends; 2) visibility into the shared meals of one's friends; and 3) participating with a friend on a goal and seeing their progress towards the target. |
| Entertainment | The gaming features include the accumulation of experience points and advancement through 10 levels. |
| Convenience | Obtaining the nutritional value of foods and caloric expenditure of physical activity, and also having a historical storage of one's nutritional information provide convenience of access to personal health information. |
| Sense of Belonging | Viewing the newsfeed of others' activities, commenting on others' activities, and participating in group goals. |
| Group Norms | Participating in goals with others allow users to see what others are doing to mimic behaviour. |
| Social Categorization | Group goals will allow users to categorize themselves based on activities. |
| Shared Identities | Through the sharing of one's meals and physical activity, and allowing friends to comment on these entries can provide the ability to learn about others with similar interests. |
| Social Comparison | Viewing friends' meals and physical activity allows user's to compare themselves to them, and also seeing friends's progression through the 10 levels. |
| Interdependence | Building helping relationships through commenting features and group goals. |
| Social Interaction | Commenting on shared activity posts (meals, physical activity, and weight). |
| Personal Knowledge of Others | Developed by viewing the shared activity posts of friends, participating with friends on goals, and interacting through comments on the shared posts. |

In a similar manner, the determinants for health behaviour change from the **Appeal** and **Belonging** dimensions of the **ABC Framework** are mapped to design elements in the high fidelity prototype of *VivoSpace* as shown in Table 4.2. The **Commitment** dimension of the **ABC Framework** does not have determinants, and there are no design elements that reflect the temporal aspect of use and health behaviour change; however, this will be evaluated in the field experiment evaluation of the high fidelity prototype.

Table 4.2: Mapping of the determinants for health behaviour change from the **ABC Framework** to the design elements in *VivoSpace*'s high fidelity prototype.

| Determinant | Design Elements |
|----------------------------------|--|
| Knowledge | Knowledge is obtained through the nutritional value for logged meals and caloric expenditure for logged physical activity. Information about the definition of each nutrient is available through a help link beside the name of the nutrient. |
| Attitude Towards Behaviour | Rewards through points and game levels can allow users to have new motivations for healthy behaviour and change attitude toward it, and conversation about activities through the commenting feature can allow users to develop new attitudes. |
| Expectations about Self-Efficacy | Seeing historical log entries and charts of nutrients consumed on the dashboard shows one's capability to eat healthy and be physically active. Also seeing the log entries of others builds self-efficacy vicariously through others by social modelling. |
| Goals | Proximal goals can be created and they are always visible at the top of the homepage. Distal goals are achieved through the charts (on dashboard) displaying historical trends and targets. |
| Perceived Facilitators | Visibility of foods and physical activities of others provide the ability to mimic others behaviour, and the commenting feature on shared entries provides dialogue for encouragement. The gaming features provide motivation to complete the goals. |

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Table 4.2 – continued from previous page

| Determinant | Design Elements |
|--------------------------------------|---|
| Perceived Barriers | The commenting feature on shared log entries can provide dialogue with one’s friends to overcome barriers. |
| Subjective Norms | Built by viewing others activities, participating in goals with others, and viewing the game level of others. |
| Expectation about Environmental Cues | The environmental cues can change health behaviour by seeing what others are doing for their health. |

4.2 Evaluation

The high fidelity prototype of *VivoSpace* was evaluated through field experiments with small social network groups. We chose to evaluate this prototype with small social network groups to build on previous work that suggest that sharing personal health information on a large social network does not make sense due to privacy concerns [78, 91]. Large OSNs such as Facebook® can prevent people from sharing posts, as the connections are diverse, and a person may not feel comfortable disclosing their health information to everyone on a large OSN; furthermore, the design of *VivoSpace* is based on posting comprehensive meal and physical activity information, which can easily grow large, so if one’s OSN is large the newsfeed would become unmanageable.

We also evaluated different types of groups, and we focused on clinical and non-clinical groups. By clinical groups, we looked at patients associated with the same primary care clinic that focuses on wellness. The non clinical group is not associated with any clinic but is closely tied; in other words, they have good knowledge of each other. We review the study methods next, which include a description of recruitment methods, details of the study participants, and a description of the measures used in the evaluation.

4.2.1 Methods

Recruitment and Participant Overview

We recruited a total of 35 participants from three different settings including clinical and non-clinical settings. For the clinical groups, we considered patients that are associated with the same clinic, share the same geographic location, and are generally from the same socioeconomic status, as was found to be important by Grimes et al. [42].

The first group of participants from a clinical setting was recruited from a primary care clinic in suburban Chicago, which has a focus on wellness and weight loss. A total of 22 participants were recruited by sending an email through the clinic's patient portal. Half of the participants were randomly assigned to the control group and the other half to the experimental group. The participants in the experimental group used *VivoSpace* during the 3-month study period, while participants in the control group did not use *VivoSpace*. The reason for having a control group was to mitigate newly acquired health behaviours from association with the clinic.

The second group of participants from a clinical setting was recruited from an integrative medical centre in Vancouver, Canada. This clinic provides a focus on prevention and partnership between physician and patient. Participants were recruited from their medical-group-visit patients, where patients meet with a physician as a group, so they already take advantage of social aspects to good health. A total of 3 participants were recruited from this clinic. The small number reflects the limited number of patients that take part in the medical group visits, and it means that we could not have a control group for this clinic. The participants were recruited through direct email contact from the clinic.

The non-clinical group of participants was a close-knit group of colleagues at a small software gaming company in Vancouver Canada, where all the employees have good knowledge of each other. A total of 10 participants were recruited by directly asking the employees of the company. The company has a total of 35 employees. A control group would have been ideal for the non-clinical group to ensure that any changes that were found was not due

to being involved in an experiment; however, this group was not associated with a wellness or integrative medical clinic, so the effects of that association does not need to be determined through a control group. For this group, the results from the pre-questionnaire (see Section 4.2.1) provide evaluation of their health without *VivoSpace*.

A total of 35 participants were recruited from three groups: Chicago clinic (11 in experimental group and 11 in control group), Vancouver clinic (3), and the non-clinical group from the Vancouver gaming company (10). Out of the 22 participants recruited from the Chicago clinic 3 dropped out prior to the end of the study. One was in the experimental group, and the other two were in the control group. Table 4.3 shows an overview of the remaining participants from all three groups. Overall, there is a bias towards women. Furthermore, the participants from the non-clinical group were younger than those from the clinics, and this group ranked their health better than those from the clinics. The determination of whether individuals were of normal weight, overweight, or obese was done by calculating the body-mass index from the weight and height information that the users provided, and using standard definition of these weight categories from the body-mass index [77]. Furthermore, there was not enough variability among the participants in ethnic identity and the overall sample size was too small to conduct any analysis based on age, gender and ethnic identity, as was done during the UCD process as described in Chapter 7, and in particular during the initial user inquiry (described in Section 7.1). Therefore, we will evaluate the results based on clinical and non-clinical groups, and not conduct any further analysis on gender, age, and ethnic identity.

Participants from each group were asked to friend each other, but there was no friending across the groups, so that we could evaluate the social dynamic within each group. All participants received a \$50 honorarium.

Measures

All participants completed a pre-questionnaire prior to the start of the study, a mid-questionnaire after 4 weeks, and a post-questionnaire after the 3-month

Table 4.3: An overview of the participants recruited for the field experiment showing gender distribution, age, obesity, and their rank of their healthiness (1-6 Likert Scale, 1=very unhealthy, 6=very healthy).

| Group | Male (n) | Female (n) | Mean Age (range) | SD age | Over-weight (n) | Obese (n) | Mean Health Rank |
|-----------------------|----------|------------|------------------|--------|-----------------|-----------|------------------|
| Chicago Clinic (exp) | 2 | 8 | 48.15 (24-76) | 17.3 | 2 | 5 | 2.9 (SD=1.3) |
| Chicago Clinic (cntl) | 0 | 9 | 58.22 (29-68) | 11.8 | 4 | 3 | 3.9 (SD=1.0) |
| Vancouver Clinic | 0 | 3 | 48.00 (44-57) | - | 1 | 0 | 3.0 |
| Non-Clinical | 4 | 6 | 32.60 (20-46) | 7.4 | 3 | 0 | 4.6 (SD=0.9) |

study period. The questionnaires had the following measures: 1) current health behaviour; 2) Patient Activation Measure (PAM[®]); 3) determinants from the **ABC Framework** for health behaviour change; 4) determinants for use of *VivoSpace* from the **ABC Framework**; 5) linkage between design elements and determinants for health behaviour change; 6) usage data for *VivoSpace*; and 7) thoughts on the design of *VivoSpace*. Details about each of these measure is described below:

1. All questionnaires (pre-, mid-, and post-questionnaires) for both the experimental and control groups include the first set of questions that inquired about health behaviour. These questions included: inquiry into the height and weight to obtain a body-mass-index to assess if the participant was overweight or obese; the number of salads, vegetables, fruits, French fries, and potato chips that they ate in the past week; and the number of times they walked, performed cardio exercise, and other physical activity in the past week. The current stage in health behaviour change from the Transtheoretical Model was also inquired, as was done by [20, 64, 68]. The Transtheoretical Model defines the stages of change as pre-contemplation, contemplation, preparation, action, and maintenance [90].
2. Similarly, all questionnaires included the Patient Activation Measure (PAM[®]) [48, 49]. The PAM[®] is a validated clinical measure to assess an individual's knowledge, skill, and confidence in managing one's health. PAM[®] is a unidimensional, probabilistic Guttman-like scale developed using Rasch methodology [93, 122]. PAM[®] is measured through a 22-item questionnaire [49], and

- later into a short form 13-item questionnaire [48]. We have used the full 22-item questionnaire in this experiment because the long-form questionnaire is more comprehensive.
3. Third, we inquired about the determinants for health behaviour from the *ABC Framework* in all the questionnaires and for all the groups. *Knowledge* was evaluated through a 10-question multiple-choice test on the meaning of nutrients to assess knowledge. They included questions such as, “What foods have the highest fiber content?” The answers included: a) whole wheat breads, beans, and vegetables; b) any breads and cereal grains; c) whole wheat bread and meats; and d) all of the above. The determinants for health behaviour was also inquired through 5-point Likert style questions that asked for the level of concurrence on statements that mapped to the factors from the **ABC Framework**. For example, the statement for *perceived self-efficacy* for eating nutritious foods stated, “I am capable of eating highly nutritious foods and resisting unhealthy foods.” The 5-point Likert questions ranged from “strongly disagree” (1) to “strongly agree” (5). All questionnaires and both the experimental and control group was given these questions with the objective to determine if there was any change in these determinants after 4 weeks and after 3 months.
 4. Fourth, the mid- and post-questionnaires for those participants in the experimental groups (those participants using *VivoSpace*) had 5-point Likert questions for the determinants for use of OSNs from the **ABC Framework**. These questions objective was to determine, which determinants for use of OSNs correlated most strongly and least with the user’s motivation to use *VivoSpace*.
 5. Next, the mid- and post-questionnaire for the experimental group also inquired about which design features of *VivoSpace* contributed to the determinants for health behaviour change from the **ABC Framework**. For example, after the afore mentioned Likert question on perceived self-efficacy, other 5-point Likert statements inquired concurrence with, “I was able to learn about my capabilities by logging my meals on *VivoSpace*.”
 6. Usage data was automatically collected via the *VivoSpace* system. The usage data for each user included the number of log entries made, the number of

- entries that were shared, and the number of comments made.
7. Finally, the mid- and post- questionnaires for the experimental group included open-ended qualitative questions to obtain general thoughts on *VivoSpace* and how it can be improved to motivate use and health behaviour change, and specific responses for how it can promote the determinants from both theories more effectively.

All questionnaires can be found in the Second Appendix.

4.2.2 Results

The results cover the following: 1) whether the incorporation of the **ABC Framework** into the design encouraged use of *VivoSpace*; 2) whether the incorporation of the **ABC Framework** led to an increase in the self-reports of the determinants for health behaviour change from the framework; 3) and if there was any observed change in health behaviour at the end of the 4 weeks and at the end of 3 months. Analysis includes statistical comparison of pre-, mid- and post questions as well as qualitative analysis of open-ended free form questions.

Use of *VivoSpace*

The use of *VivoSpace* varied substantially over the first 4-week period, and then dropped off considerably by the end of the 3-month study period. All 23 participants that were using *VivoSpace* created an account and friended others from their network group. The participants from the non-clinical group (Vancouver gaming company) used it more than those from the Chicago clinic, which can likely be attributed to this group's ease with technology. One participant from the Vancouver clinic used the system the most. Table 4.4 shows an overview for usage of *VivoSpace* for all three groups for the first 4-week period and for the entire 3-month study period. The non-clinical group was less inclined to share their entries than those from the clinical groups. The comments included: encouragement about the post, "good job!" and "Woot!"; additional information about the food or activity entered,

Table 4.4: Overview for usage of *VivoSpace* for all three groups, includes the mean and range of log entries made, disclosure of log entries, and total comments made for each group.

| Group | Mean # of log entries | Min-max # of log entries | % private log entries | Total # of comments |
|-----------------------|-----------------------|--------------------------|-----------------------|---------------------|
| Chicago Clinic @ 4wks | 18.3 (SD=27.4) | 0-83 | 2.2% | 20 |
| Chicago Clinic @ 3mo | 18.9 (SD=27.09) | 0-83 | 2.6% | 20 |
| Vancvr.Clinic @ 4wks | 93 (SD=161) | 0-279 | 1.1% | 19 |
| Vancvr. Clinic @ 3mo | 101 (SD=174) | 0-302 | 0.9% | 22 |
| Non-Clinical @ 4wks | 54.6 (SD=63.3) | 2-184 | 59.2% | 24 |
| Non-Clinical @ 3mo | 63.9 (SD=78.5) | 2-210 | 63.4% | 24 |

“Santa Cruz organic added to Perrier”; or their feeling about the activity, “I love Thai food, yum”.

The usage data reveals that after the first 4 weeks participants either stopped using *VivoSpace* or they reduced their usage considerably. The drop in usage of *Vivospace* from when usage was collected at 4 weeks and then at 3 months varied between the groups. The non-clinical group had 4 participants, who used the system after the initial 4-week period. The number of additional log entries after the initial 4-week period for the 4 participants from the non-clinical group were 2, 51, 14, and 26. Only one participant from the Chicago clinic used it after the initial 4-week period, and this participant made an additional 3 log entries. Finally, one participant from the Vancouver clinic used it after the initial 4-week period, and this participant made an additional 23 entries. In summary, most of the participants did not use *VivoSpace* after the initial 4-week period, and those who did use it reduced their entries to 8% - 50% of the log entries they made in the initial 4-week period. Furthermore, all the participants stopped using *VivoSpace* after the 3-month study period. This speaks to the level of engagement that the design of *VivoSpace* afforded. There was initial engagement in the use of *VivoSpace*; however, that engagement did not last beyond 4 weeks. We investigate this further by reviewing the questionnaire responses of the determinants for use of OSNs based on their motivation to use (or not use) *VivoSpace*. These responses will inform the strengths and weaknesses in the design of *VivoSpace*

based on the **ABC Framework**.

Determinants from ABC Framework for Use of OSNs

Appeal We will first evaluate the results for the **Appeal** determinants for use of OSNs from the mid- and post-questionnaires. These results show the participant's perception of *VivoSpace* based on the **Appeal** determinants from the **ABC Framework**. The results of the 5-point Likert responses for all three groups are shown in Table 4.5. The strongest factors for motivating use were to *Provide Information* and *Self-Discovery* for all groups. Although the Likert response for to *Get Information* was a bit lower with mean of 2.88 in the post-questionnaire, the qualitative responses showed that they did use it to receive information; for example, "I liked watching my vitamin consumption over time" (P9). The motive, *Maintain Connectivity*, rated low amongst participants. This is likely due to usability issues with the design, as the newsfeed would easily fill up, and it was difficult to find comments that were made. This is evident in the following qualitative response, "there was no way to tell you that a user commented on your news item so often it would require a ton of scrolling to discover that this is the case." (P10). The Vancouver clinic had one active user, who was the heaviest user of *VivoSpace*. She continued to use it on a daily basis despite the fact that she did not have the full social experience of *VivoSpace*. This user had some mistrust in the nutritional and energy expenditure information that was provided by *VivoSpace*, "I'm not sure how accurate the nutritional and calorie burning info was, and I think that more detailed information would need to be made available for it to be useful" (P31). With respect to *Self Discovery*, she said, "It was interesting to be accountable; it made me think more about it" (P31). Interestingly, the Chicago Clinic rated higher in all the determinants after 3 months, as compared to the 4-week point. Since use after 4 weeks was very minimal, these answers were likely based on reflection of the *VivoSpace* system. In contrast, the non-clinical group rated lower on most determinants except *Self Discovery*.

Table 4.5: Mean values for results from the mid- and post-questionnaires’ 5-point Likert scale responses for **Appeal** determinants for use of OSNs, based on their motivations for using *VivoSpace*.

| Group | Provide Information | | Get Information | | Self Discovery | | Maintain Connectivity | | Social Enhancement | | Entertainment | | Convenience | |
|---------------------|---------------------|-------------|-----------------|-------------|----------------|-------------|-----------------------|-------------|--------------------|-------------|---------------|-------------|-------------|-------------|
| | mid | post | mid | post | mid | post | mid | post | mid | post | mid | post | mid | post |
| Chicago Clinic | 2.86 | 3.33 | 1.57 | 3.17 | 2.43 | 3.33 | 2.00 | 2.67 | 1.71 | 2.5 | 2.14 | 2.83 | 2.17 | 3.5 |
| Vancouver Clinic | 3.50 | 2.50 | 2.50 | 2.00 | 3.50 | 2.50 | 2.00 | 1.00 | 3.00 | 2.50 | 3.50 | 2.50 | 2.50 | 2.00 |
| Non-clinical | 3.00 | 2.38 | 2.67 | 2.88 | 3.11 | 3.86 | 2.67 | 2.57 | 2.78 | 2.00 | 2.44 | 2.38 | 2.33 | 2.50 |
| Overall Mean | 3.00 | 2.75 | 2.22 | 2.88 | 2.89 | 3.47 | 2.33 | 2.40 | 2.39 | 2.25 | 2.44 | 2.56 | 2.29 | 2.81 |

Belonging The **Belonging** determinant from the **ABC Framework** for use of OSNs were also inquired in the mid- and post-questionnaires was *Shared Identity* to show the participant’s perception of *VivoSpace*’s ability to build social motivations to use *VivoSpace*. The results of the 5-point Likert responses is shown in Table 4.6. Interestingly, *Shared Identity* was strong only for the loose social connections of the clinical groups, and especially strong for the Chicago clinical group. The qualitative responses for the Chicago clinic revealed sentiment for the *Shared Identity* motivational factor; such as, “I liked being supportive to like minded people achieving goals” (P32). The other **Belonging** determinants were not inquired through the 5-point Likert self-report questions because they are determinants that cannot be accurately collect through self-report; for example, *Sense of Belonging* is an emotion that is hard for an individual to be aware of; similarly, *Social Categorization*, *Social Comparison*, and *Group Norms* are determinants that individuals may not be aware of. They can, however, be observed through usage patterns on *VivoSpace*, and generally the social features such as commenting and group goals were not used extensively, so additional motivators need to be added to the design to promote the **Belonging** determinants for use of OSNs.

Table 4.6: Mean values for results from the mid- and post-questionnaires' 5-point Likert scale responses for *Shared Identity* determinant for use of *VivoSpace*.

| Group | mid | post |
|---------------------|-------------|-------------|
| Chicago Clinic | 2.86 | 3.33 |
| Vancouver Clinic | 3.00 | 2.50 |
| Non-Clinical | 2.22 | 2.14 |
| Overall Mean | 2.55 | 2.67 |

Commitment The temporal attachments and usage of *VivoSpace* based on the **Commitment** dimension of the **ABC Framework** can be observed through the usage patterns. Only 3 users of *VivoSpace* developed habitual use, and this only lasted for the first 4 weeks of the study. The bulk of the users (12) were superficial users of *VivoSpace*, and the remaining 7 users did not get past the discovery phase. The attachments to *VivoSpace* can be inferred as being *Normative* especially as the users were participating in a research study. For the few users who were initially heavy users of *VivoSpace*, the initial attachment may have been *Affective*; however, this did not last for the entire 3-month study period.

Change in Determinants from ABC Framework for Health Behaviour

All the determinants in the **ABC Framework** for health behaviour change were enquired through the pre-, mid-, and post-questionnaires using 5-point Likert scale questions. The responses from these questionnaires were compared through repeated measures ANOVA statistical analysis for the following groups: Chicago clinic experimental, all-clinical experimental, Chicago clinic control, and non-clinical. By experimental, we mean those participants that were using *VivoSpace* and not assigned to the control group. The “all-clinical” experimental group includes the responses from both the Chicago clinic and the Vancouver clinic. The responses from the Vancouver clinic could not be compared on its own due to the small of number of participants in this group. The responses from the Chicago clinic

experimental group and the all-clinical experiment group were compared with the Chicago clinic control group to determine if there were changes associated with use of *VivoSpace* beyond association with the clinic.

Knowledge The first **Appeal** determinant for health behaviour change in the framework is *Knowledge*. This determinant was quantitatively inquired through several means. The first way was 10 multiple choice questions that tested knowledge about nutrition and benefits of being physically active. There was no statistically significant difference found between the pre-, mid-, and post-questionnaires. Self-reports on knowledge was also inquired through 5-point Likert questions on perception of knowledge of nutritional value of foods, outcome expectation of diet, outcome expectation of physical activity, perceived susceptibility of healthy behaviour to avoid illness, and perceived susceptibility of healthy behaviour to live longer. None of these yielded statistically significant difference between the pre-, mid-, and post-questionnaires for all study groups including the control group. All participants generally scored well on the 10-question multiple choice test as well as the self-reports on the 5-point Likert questions, which likely contributed to not seeing any change in this determinant. The additional inquiry on which aspects of the *VivoSpace* design contributed to an increase in knowledge, outcome expectation, and perceived susceptibility yielded strong agreement that the design features that mapped to the *get information* determinant for use of OSNs with the mean Likert responses of 3.2 in the post questionnaire. The open-ended qualitative responses showed that some participants felt that *providing information* also contributed to increasing *knowledge*.

Attitude Towards Behaviour The second **Appeal** determinant for health behaviour change is *Attitude Towards Behaviour*. The results from the 5-point Likert questions that asked for agreement on enjoyment in eating healthy food and participating in physical activity. The results reveal no statistical significance for change in attitude between the pre-, mid-, and post-questionnaire for eating healthy food, but does show statistical significance in a change in attitude for participating in physical activity for

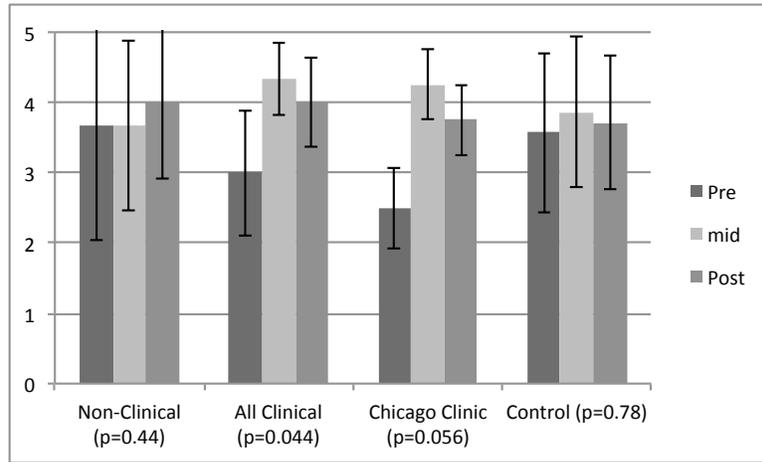


Figure 4.4: The mean values from the results of the 5-point Likert responses for *attitude towards physical activity*; the error bars indicate standard deviation, and the statistical significance for repeated measure ANOVA is shown on the x-axis.

the clinical group and not the control group. Figure 4.4 shows the results from the 5-point Likert responses for *attitude towards physical activity* with the statistical significance for each group shown on the x-axis. The non-clinical group did not see any significant change in attitude for physical activity either. The statistical significance for all the participants that were associated with a clinic is 0.044 with the main effects being between the pre- and mid-questionnaire results ($p=0.031$) using the Bonferroni post-hoc analysis. Although the results from the Chicago clinical group did not reveal statistically significant results, the mean difference between the mid- and pre-questionnaire results of 1.75 for the Chicago group is greater than the mid- and pre-questionnaire results of 1.33 from the All Clinical group. The reason for not reaching statistical significance is likely due to the small sample size. Post-hoc analysis of main effects for the Chicago clinical group show a strong significant effect between the pre- and mid-results of 0.018. The *attitude* towards physical activity for these two group did drop slightly from the mid- to post-questionnaire results; however, it did not drop to as

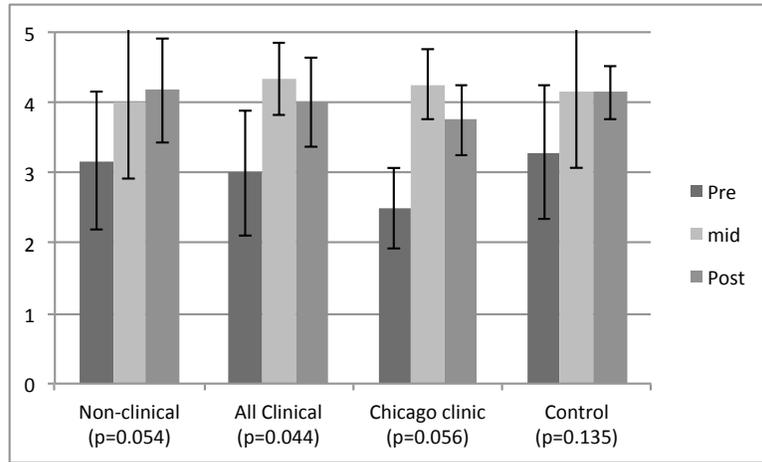


Figure 4.5: The mean values from the results of the 5-point Likert responses for *self efficacy in eating healthy foods*; the error bars indicate standard deviation, and the statistical significance for repeated measure ANOVA is shown on the x-axis.

low as the pre-questionnaire results (before using *VivoSpace*), which shows that some of the possible benefits of use were maintained after use of the tool. These results show that a tool such as *VivoSpace* holds benefit towards changing attitude toward physical activity for patients associated with a clinic, but not for those not associated with a clinic. Further, the use of *VivoSpace* augments the benefits of being associated with the clinic, but association with the clinic alone does not affect attitude towards physical activity, because the control group did not see the same benefit. The design features that contributed to this change in attitude was also inquired, and there was only mild agreement that *getting information* from *VivoSpace* contributed to a change in attitude (mean value from the 5-point Likert question was only 2.7), and the qualitative responses did not reveal any other design feature or determinants for use that contributed to a change in attitude.

Self-Efficacy The next **Appeal** determinant for health behaviour change is *Self-Efficacy*. The results from the 5-point Likert questions that inquired about one’s *self-efficacy to eat healthy foods* showed a statistically significant difference for the all clinical group (p=0.044) with the main effects being once again between the pre- and mid-questionnaire results. There was also a strong trend towards significant results for the non-clinical group (p=0.054) and the Chicago clinic group (p=0.056) with the large mean difference being the Chicago clinic group of 1.75 between the mid- and pre-results compared to 1.33 (between mid- and pre-) for the all clinical group and 1.0 (between post- and pre-) for the non-clinical group. Once again the reason for not showing statistical significance for the Chicago clinic group may be due to the small sample. Figure 4.5 shows the mean Likert responses for each group for the pre-, mid-, and post-questionnaire results for *self-efficacy to eat healthy food*. The results of the main effects in the post-hoc analysis for each group is shown in Table 4.7. For the clinical groups, we are seeing some reversion back after use of *VivoSpace* ended; however, self-efficacy does not return to as low as the results from the pre-questionnaire results. In addition to *self-efficacy in eating healthy food*, the questionnaires also inquired about the participant’s *self-efficacy in performing physical activity*. The results are shown in Figure 4.6. Statistically significant results were revealed for the all participants associated with a clinic (p=0.035) with the main effects having a significance of 0.018 between the pre- and post-questionnaire results. Similar trends can be seen in the Chicago clinic, but statistical significance was not reached due to the small sample size. The

Table 4.7: Post-hoc analysis results for each group showing the main effects for *self efficacy in eating healthy foods*.

| Group | Significance | Observed effect |
|----------------|--------------|-----------------|
| Non-Clinical | 0.035 | pre- and post- |
| All Clinical | 0.031 | pre- and mid- |
| Chicago Clinic | 0.018 | pre- and mid- |
| Control | none | N/A |

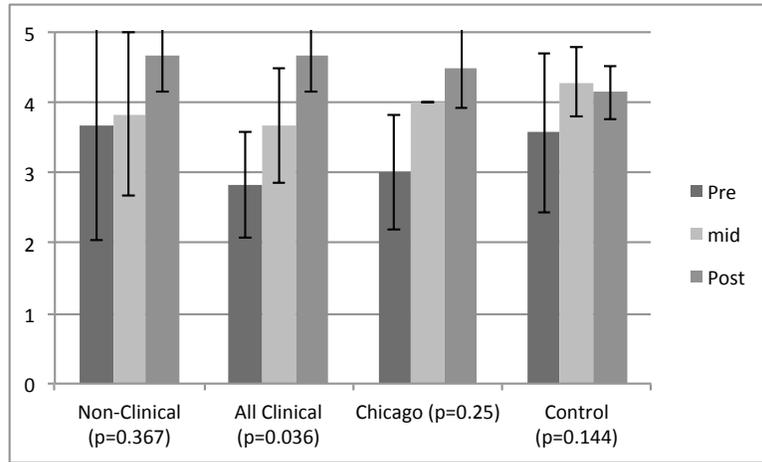


Figure 4.6: The mean values from the results of the 5-point Likert responses for *self efficacy in performing physical activity*; the error bars indicate standard deviation, and the statistical significance for repeated measure ANOVA is shown on the x-axis.

design features that contributed to these effects based on the qualitative responses showed that *getting information* from *VivoSpace* allowed one to understand their capabilities, which is shown in this qualitative response, “nice to have this information compiled and referenced on *VivoSpace*” [P16]. The Likert-scale responses into which design features contributed to increasing *Self-Efficacy* showed mild support for *Providing Information* (average Likert response 2.83) and *Self-Discovery* (average Likert response 2.91).

Goals Both distal and proximal goals were inquired through 5-point Likert questions, and the results revealed no statistically significant results for any of the groups. The only group that was trending towards significance was All Clinical for distal goals ($p=0.076$). The goals feature for *VivoSpace* was not well extensively, which likely is linked to the poor results for this determinant for health behaviour change. Participants felt that the goals that it provided were too rigid and did not represent their personal health goals.

Perceived Facilitators and Barriers The next **Appeal** determinants for health behaviour change are *Perceived Facilitators* and *Perceived Barriers*. *Perceived Facilitators* were inquired through two 5-point Likert questions. Both facilitators and individual incentives were inquired; however, neither of these showed any significant increase between the pre-, mid-, and post-questionnaire responses. Similarly, the inquiry about barriers did not significantly decrease between the questionnaires. The use of *VivoSpace* did not in anyway change the users' perceptions of facilitators and barriers. The second area of inquiry was around, which design features (and determinants for use of OSNs) linked to the *Perceived Facilitators and Barriers* determinants for health behaviour. The results around the inquiry into which determinants for use of OSN allowed one to overcome barriers revealed that *getting information* through viewing one's health information (Average 5-point Likert response was 3.0), and the *convenience* of having the information allowed one to overcome barriers and build facilitators (average 5-point Likert response was 2.64). The qualitative responses also revealed that *providing information* and the *goals* feature also increased perception of facilitators.

Subjective Norms The first **Belonging** determinant for health behaviour change is *Subjective Norms*. The pre-, mid-, and post-questionnaires inquired about *Social Norms* through 4 separate 5-point Likert scale questions: 1) social norms and influence of family; 2) social norms and influence of friends; 3) moral norms or obligation from family or friends towards eating healthy foods; and 4) moral norms or obligation from family or friends towards leading an active lifestyle. However, there were no statistically significant difference in the results. Furthermore, there was a great deal of variability in how the participants felt they were influenced by their family and friends. I would also be wary of trying to understand how *VivoSpace* influenced this determinant through the self-reported Likert scale responses, as *VivoSpace* was not building *social norms* of family and friends, but rather the participant's social connections or friends on *VivoSpace*. There was mild agreement that *Shared Identity*, *Sense of Belonging*, and *Group Norms* contributed to developing *Social Norms* with mean responses to agreement on a 5-point

Likert scale of 2.77, 2.69, and 2.85 respectively.

Self-Efficacy Vicariously Through Others The next **Belonging** determinant is *Self-Efficacy experienced vicariously through others*, which was inquired through one 5-point Likert scale questions. The results showed no statistically significant difference between the pre-, mid-, and post-questionnaires. The potential reasons for this could be evaluating self-efficacy that is achieved vicariously through others using a self-report Likert question, and that the social aspects of *VivoSpace* were not used as much as the personal health informatics features. The respondents had mild support for the following determinants for use of OSNs supported *Self-Efficacy experienced vicariously through others: Social Comparison* and *Personal Knowledge of Others* with each of these having a mean value of 2.84 on a 5-point Likert scale.

Social Facilitators and Barriers In addition to individual facilitators and barriers, *Social Facilitators* (includes both *Social Supports* and *Social Approvals*) and *Social Barriers* were also inquired through 5-point Likert scale questions. There were no statistically significant results found for this. Upon inquiry into which determinants for use of OSNs can lead to more *Social Facilitators*, there was mild agreement to *Group Norms*, *Social Interaction*, and *Social Comparison* with mean results of the 5-point Likert scale inquiry of 2.85, 2.77, and 2.83 respectively. A qualitative response also indicated “awareness” [P43], which can tie to *Self-Discovery*, but is not a social facilitator, but more likely an individual facilitator. The inquiry did not reveal any determinants or aspects of the design that can lead to a decrease in *Social Barriers*.

Environmental Cues The final **Belonging** determinant is *Environmental Cues*, or external stimulus that motivate healthy behaviour. The results from the 5-point Likert scale question for *Environmental Cues* indicated that there was no statistically significant difference between the pre-, mid-, and post-questionnaire results for each of four groups. Furthermore, there was only mild agreement that *social identity* contributed to assisting *Environmental*

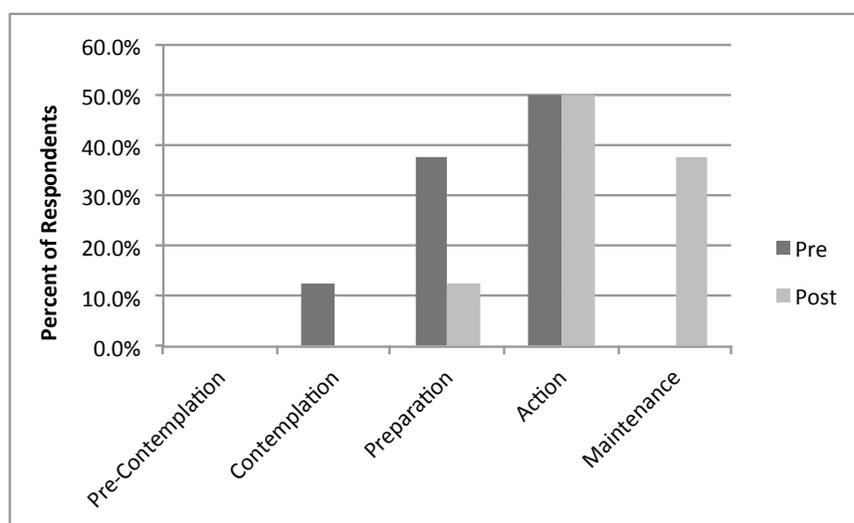


Figure 4.7: The percent of respondents from the all-clinical group (Vancouver clinic and Chicago Clinic) that were in each of the 5 stages of change from the *Transtheoretical Model* before (pre) and after (post) using *VivoSpace*.

Cues to change health behaviour with a mean 5-point Likert scale response of 2.61. The qualitative responses showed the *getting information* assisted with building *environmental cues*.

Stages of Change The *Transtheoretical Model* provides the *Stages of Change* for health behaviour within the **Commitment** dimension of the framework. Freidman's test for related samples was used to determine if there was any statistically significant difference between the pre-, mid-, and post-results for the *Stages of Change*, which revealed a significant difference for the all-clinical group ($p=0.035$), and the post-hoc analysis showed that the significant difference between pre- and post-results ($p=0.045$). Figure 4.7 shows the percent of respondents from the all-clinical group that were in each of the 5 stages of change; the figure shows that participants moved from contemplation and preparation to action and maintenance. None of the other groups had any statistically significant difference including the control group.

Summary Table 4.8 shows the summary of the statistical significance for all the determinants for health behaviour change from the **ABC Framework**; any statistically significant post hoc analysis is shown in parenthesis after the statistical significant p values. Through this evaluation, it is evident that the design of *VivoSpace* was able to change attitude and self-efficacy for the participants from the clinic, as well as assist with moving them through the stages of change. However, the design was not effective in seeing any change in the non-clinical group. Furthermore, none of the **Belonging** determinants or the *goals* determinants changed from the use of *VivoSpace*. These results are consistent with the usage of *VivoSpace* since the social and goals features were under utilized. Furthermore, the difficulties in evaluating change in the socially-based determinants for health behaviour change are due to problems with inquiring through self-reports of 5-point Likert scale questions. Generally, individuals are not actively aware of the influence of others on their health behaviour, and they are reluctant to admit the influence if they are aware of it. Future use of the **ABC Framework** should look at other methods of inquiry to better understand how to evaluate the socially-based determinants.

Change in Health Behaviour

The ultimate endpoint of this research is to see positive change in health behaviour. We enquired about health behaviour through multiple methods in the pre-, mid-, and post-questionnaires: 1) we looked at the body mass index (BMI) by asking the participants for their weight and height; 2) we asked the participants about their eating habits in the past 7 days by asking how many servings of salads, fruits, vegetables, french fries, and potato chips or similar products they consumed; 3) we asked the participants about their physical activity in the past week by asking how many times they walked for more than 30 minutes; performed cardio or aerobic exercise, and performed other physical activity such as gardening; and 4) we had each participant complete the 22-question Patient Activation Measure (PAM[®]), which is a validated and rigorous method for quantifying a patient's knowledge and

Table 4.8: Statistical significance p values (post hoc analysis shown in brackets) for all determinants for health behaviour change from the **ABC Framework** for each group.

| Determinant | Control | All Clinical | Chicago Clinic | Non Clinical |
|---|---------|---|--|---|
| Knowledge (from 10 question test) | 0.437 | 0.863 | 0.465 | 0.136 |
| Knowledge | 0.164 | 0.175 | 0.182 | 0.444 |
| Outcome expectation for healthy diet | 0.199 | 0.302 | 0.319 | 0.247 |
| Outcome expectation for physical activity | 0.128 | 0.302 | 0.465 | 0.12 |
| Perceived susceptibility to illness | 0.401 | 0.302 | 0.192 | 0.694 |
| Attitude towards healthy diet | 0.156 | 0.471 | 0.465 | 0.151 |
| Attitude towards physical activity | 0.78 | 0.044 (p=0.031 between pre and mid) | 0.056 (p=0.018 between pre and mid) | 0.44 |
| Self-Efficacy healthy diet | 0.135 | 0.044 (p=0.031 between pre and mid) | 0.056 (p=0.018 between pre and mid) | 0.054 (p=0.035 between pre and post) |
| Self-Efficacy physical activity | 0.144 | 0.036 (p=0.018 between pre and post) | 0.25 | 0.367 |
| Distal Goals | 0.422 | 0.076 | 0.31 | 0.259 |
| Proximal Goals | 0.129 | 0.59 | 1.0 | 0.79 |
| Facilitators | 0.547 | 0.145 | 0.253 | 0.792 |
| Individual Incentives | 0.215 | 0.68 | 0.465 | 0.655 |
| Barriers | 0.431 | 0.573 | 0.815 | 0.304 |
| Subjective Norms | 0.252 | 0.17 | 0.486 | 0.151 |
| Moral Norms | 0.208 | 0.147 | 0.089 (p=0.048 between mid and post) | 0.256 |
| Self-Efficacy through others | 0.448 | 0.854 | 0.92 | 0.59 |
| Social facilitators | 0.12 | 0.863 | 1.0 | 0.716 |
| Social Barriers | 0.312 | 0.431 | 0.253 | 0.454 |
| Environmental Cues | 0.522 | 0.541 | 0.483 | 0.301 |
| Stages of Change | 0.178 | 0.035 (p=0.045 between pre and post) | 0.148 | 0.097 |

confidence in managing their health.

The results of the BMI revealed no statistically significant difference between the pre-, mid-, and post-questionnaire results. This is not surprising as weight loss was not a target for this study.

The results into the eating habits also did not reveal any statistically significant results in the repeated measures ANOVA for any of the food items: salads, fruits, vegetables, french fries, and potato chips. However, upon post-hoc analysis, there was a trend found for the Chicago clinic in the number of salad consumed between the mid and post results ($p=0.098$). The mean number of salads consumed in the last week for this group went from 4.2 in the pre-questionnaire to 5.2 in the mid-questionnaire, and then dropped drastically to 4 in the post-questionnaire. Furthermore, the number of french fries and potato chips that all of the groups consumed in all the questionnaires was very low each with averages (means) of less than 1 serving per week, which makes any improvement in this category difficult.

The results for the number of times a particular physical activity such as walking and cardiovascular exercise performed in the past week revealed statistically significant results for walking for the participants associated with a clinic (experimental group). The repeated measures ANOVA showed a statistically significant result ($p=0.025$); however, the post-hoc analysis did not show reveal any statistical significance due to the small sample size. When we use Least Significant Difference (LSD) for pairwise comparison, we obtained a trend level statistical significance of 0.078 between the pre and post results. The mean number of walks in the pre-, mid-, and post-results were 3.14, 3.29, and 3.57 respectively, which shows a progressive increase in walking activity for the participants associated with a clinic, and it also shows that the progression continued even after they stopped using *VivoSpace*.

The PAM[®]-22 measure showed the most significant change in health behaviour for both the participants associated with a clinic (All Clinic experimental group) and for those associated with the Chicago clinic experimental group. The statistical significance for the all clinical experimental group is 0.026, and the statistical significance for the Chicago clinic experimental group is 0.013. There was no statistically significant results for the control

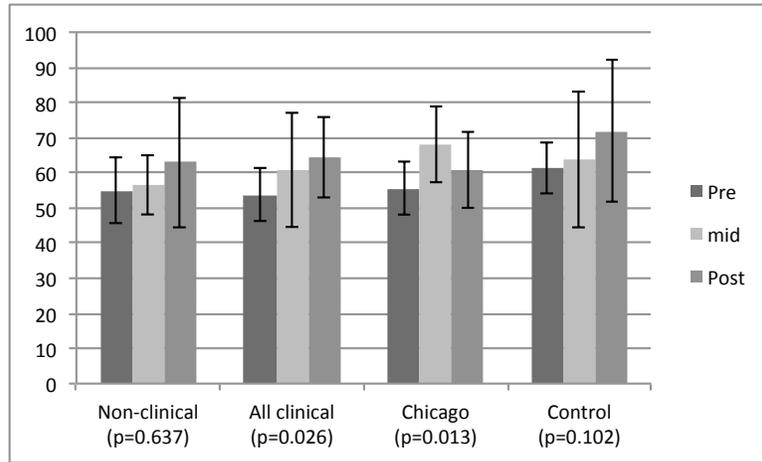


Figure 4.8: The mean values from the results of the PAM[®]-22 questionnaire; the error bars indicate standard deviation, and the statistical significance for repeated measure ANOVA is shown on the x-axis.

group or the non-clinical experimental group. Figure 4.8 shows the mean value for the PAM[®]-22 results; the measure's range is 0 to 100 with 100 indicated full activation in managing one's health. The post-hoc analysis of the two significant results show that for the all-clinical group the main effects were between the pre- and post-results ($p=0.073$), which was once again obtained using Least Significant Difference (LSD) for pairwise comparison due to the lack of power from the small sample size, and for the Chicago clinic, the main effects were between the pre- and mid- results ($p=0.013$) using the Bonferroni correction for multiple comparisons. When we look at these results with all participants associated with a clinic we see a progression in the patient activation; however, this progression does not exist when we look at the participants from the Chicago clinic. This shows that there was perhaps a reversion back to previous activation levels when the participants stopped using *VivoSpace*.

4.2.3 Discussion

The results of the evaluation of the high-fidelity prototype for *VivoSpace* shows that there is an overall benefit towards health behaviour change for those participants associated with a clinic by using *VivoSpace*. The change occurred in the determinants for health behaviour change; specifically, a change in self-efficacy for eating healthy food, self-efficacy for physical activity, and attitude towards physical activity. Furthermore, there was change observed in health behaviour; specifically, the change was observed in walking for 30 minutes every day, and in patient activation as measured using the validated PAM[®]-22 measure. Additionally, the Chicago clinic group felt that *VivoSpace* contributed to the social determinants for use more than the non-clinical group, and they were more inclined to share their health information with others from their clinic. These results show that a system such as *VivoSpace* that is designed using a theoretical foundation formed by the **ABC Framework** can change health behaviour for individuals associated with the same primary care clinic. However, there are many aspects of the design that can be improved, which can potentially further contribute to additional benefit.

*Logging meals and physical activities to reveal the nutritional value of meals and caloric expenditure of activities combined with charts showing trends of calories and nutrients consumed build **perceived self-efficacy**.* The greatest increase in self-efficacy for both healthy diet and physical activity was observed in the all clinical experimental group, which suggests that the process of logging meals and physical activity does build self-awareness. By logging health information, users become more accountable and aware of their capabilities.

*The design can be improved by also providing nutritional information for foods not eaten and having tailored messages for how to improve health behaviour to build **knowledge**.* The qualitative results show that the design can be modified to promote an increase in knowledge of nutritional value of food and energy expenditure of physical activities. The participants suggested that *VivoSpace* could assist them to make decisions about food,

so it should have the ability to obtain nutritional information for foods that were not eaten. Further, VivoSpace can be more prescriptive and provide tailored messages for how the user can make healthier choices.

*Providing reminders for **goals** and allowing for customizable **goals** will increase user engagement.* The goals feature on VivoSpace should provide reminders to the users after they are set, and goals should be more central in the design. A key change to the goals feature would be to allow users to create customized goals, as the rigidity of the goals provided on VivoSpace led to fewer people creating goals. These changes will increase *Social Enhancement* and make the system more *Entertaining*; both of which are determinants for use of OSNs.

Email notifications should be provided when comments are made to one's log entries, and a link should be provided to the log entry and the comment. VivoSpace should provide notifications when comments are made to one's posts, or when one responds to one's existing comment. This will increase dialogue between participants, which will build social supports to allow for an increase in the motivation to *Maintain Connectivity* a determinant for use of OSNs and *Perceived Facilitators* a determinant for health behaviour change.

*Design should include a mobile version and other **conveniences** such as automatic sensing to ease the time required to use it.* The time that was required to enter the data was a contributing factor for some participants to ask for easier means of entering their data. A mobile version and linking to devices such as fitbit® to automatically sense steps taken can ease the burden of data entry.

Based on the results of the field experiment, we are able to iterate the **ABC Framework**. Specifically, we use the results that inquired about which design features of VivoSpace contributed to the determinants for health behaviour change. The final **ABC Framework** is presented in the next chapter.

Chapter 5

Final ABC Framework

The results of the field experiment for the high fidelity prototype of *VivoSpace* provides us with a better understanding of the interplay between the determinants for use of OSNs and the determinants for health behaviour change. The overall revised **ABC Framework** is shown in Figure 5.1, and we will review the interplay below that is depicted on the figure by the lines with arrows. Evidence of the interplay through the field evaluation of *VivoSpace* is shown using the red (for **Appeal**) and green (for **Belonging**) solid lines with arrows. Evidence of the interplay that showed only mild agreement is shown with a dashed line. Finally the interplay that was not evaluated, but still has strong merit is shown with the black line and arrow. “Merit” was determined based on the qualitative results of the field experiment, as well as, by reducing the weight of those determinants that the design failed to meet.

We will first review the determinants in the **Appeal** dimension. *Knowledge* is a core determinant for health behaviour change, and *Providing Information* and *Getting Information* both contributed to building one’s *Knowledge* of healthy behaviour and outcomes. The evaluation provided additional insight to the original **ABC Framework** that *Getting Information* also interplayed with the health behaviour determinant of *Knowledge*. *Attitude Toward Behaviour* was only mildly influenced by *Getting Information*, which we have noted with a dashed line in Figure 5.1. We have left the interplay with *Self Discovery* for *Attitude Towards Behaviour*, as one’s attitude is likely being changed by learning more about one’s health behaviours. *Expectations About Self-Efficacy* was also affected by *Getting Information*, and we have also maintained that there is interplay with *Self*

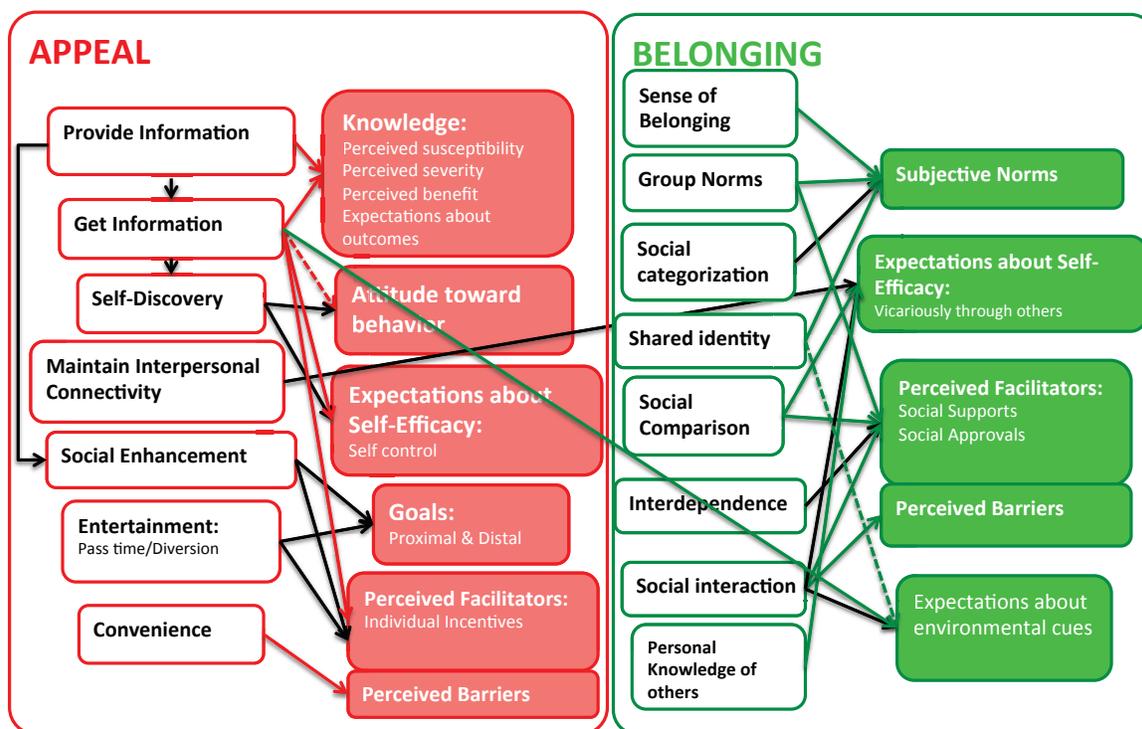


Figure 5.1: The final ABC Framework with the interplay between the determinants for use of OSN and health behaviour change shown in red for the **Appeal** dimension and in green for the **Belonging** dimension. The the interplay shown by the red and green arrows are based on evidence from the field experiments. Compare with initial framework in figure 3.1

Discovery, as one better understands one’s capability through *Self-Discovery*. The interplay of determinants for use of OSNs with the *Goals* determinant for health behaviour change could not be adequately inquired during the field experiment, as the feature was not well used; however, with more flexible goals and more gaming features that clearly indicate how many points will be earned by successfully completing a goal, *Entertainment* can play a greater role in having users create and successfully complete *Goals*. To further enhance *Goals*, *Social Enhancement* features that show what others in their social network have completed can also provide interplay between *Social*

Enhancement and *Goals*. Therefore, we have left *Entertainment* and *Social Enhancement* as providing interplay for *Goals*. For *Perceived Facilitators and Barriers*, the field experiment showed that *Getting Information* facilitated healthy behaviour, so we have added this interplay. The results of the field experiment also confirmed that the *Convenience* of having personal health information allowed users to overcome existing barriers. We have also left *Entertainment* and *Social Enhancement* as affecting *Perceived Facilitators* because social gaming features and wishing to perform for one's social network connections can also serve as a facilitator.

Next we will review the interplay in the **Belonging** dimension of the **ABC Framework**. The *Subjective Norms* determinant for health behaviour change was found to be mildly influenced by *Sense of Belonging*, *Shared Identity*, and *Group Norms*. We feel that this mild agreement is sufficient, as social determinants did not significantly change in the field experiment, so even this mild agreement shows that users of the OSN, *VivoSpace*, found some interplay for these determinants of use. We have also left the *Social Comparison* determinant as affecting *Social Norms*, as better design of social goals can allow *Social Comparisons* to develop, which may lead to the development of *Social Norms*. For *Self-Efficacy Vicariously Experienced through Others* was found to be influenced by having *Personal Knowledge of Others*, so we have added this interplay. There was agreement that *Social Comparison* effected the determinant *Self-Efficacy Vicariously Experienced through Others*. We have left *Social Interaction* and *Maintaining Interpersonal Connectivity* as influencing *Self-Efficacy Vicariously Experienced through Others* determinant, as interacting with one's social network connections will allow this determinant to develop by allowing the user to alter their own perceptions of their capability by expanding their knowledge of other's capability. Since the commenting and other social features were under utilized, this interplay could not be validated in the field experiment. For the social aspects of *Perceived Facilitators and Barriers*, an additional determinant of *Group Norms* was found to be a facilitator. The field experiment found agreement that *Social Comparisons* and *Social Interaction* provided facilitators and reduced barriers. We have left *Interdependence* as a factor that can be a

facilitator if it is positive; however, can potentially be a barrier as well if one becomes too dependent on another. For *Environmental Cues*, the field experiment showed no interplay with *Personal Knowledge of Others*, as the qualitative results showed that they would want external cues based on national standards rather than other's (peers) thoughts on health, so it has been removed; however, future iteration of the framework may show that this interplay does exist. The field experiment also showed that there was mild agreement that *Social Identity* contributed to providing *Environmental Cues* to change health behaviour, so a dotted line has been added; furthermore, *Getting Information* was also found to affect *Environmental Cues*, so this line has been added. Although the results did not show any interplay between *Social Interaction* and *Environmental Cues*, we have left this in, because communication with others may reveal *Environmental Cues* leading to health behaviour change; for example, commenting with others on specific behaviour may point the user to better understand nutritional criteria and their health benefits.

The **Commitment** dimension of the **ABC Framework** does not require iteration at this time, as the temporal factors for use of OSN, stages of change in health behaviour, and the type of attachment to the OSN that was explained in Chapter 3 represents the temporal behaviour of our field experiment; however, future iteration and inquiry can possibly show additional temporal stages and attachment categories.

Chapter 6

Design Principles

The iterated **ABC Framework** that is described in Chapter 5 provides us with the individually- and socially-based determinants for use of OSNs, the determinants for health behaviour change, and the interplay between them, and also temporal stages and attachments for use and health behaviour change. Furthermore, the field evaluation of the high-fidelity prototype of *VivoSpace* provided qualitative and quantitative results for how the design can be improved to promote more usage and health behaviour change. We use these results to provide design principles for OSNs for health behaviour change. These design principles can inform the design of the multitude of websites and mobile applications for health behaviour change that are increasingly coming to market. In this section, I will introduce the design guidelines by each determinant for use of OSNs from the **ABC Framework**, and through the description of the design principles for each determinant for use, provide details for how the guidelines contribute to the determinants for health behaviour change. An overview of the design principles is also presented in Table 6.1.

Table 6.1: Final design principles for OSNs for health behaviour change shown by each determinant for use of OSNs.

| Use of OSNs | Health Behaviour | Design Principle |
|---------------------|----------------------------------|---|
| Provide Information | Knowledge and Social Enhancement | Enter dietary information, physical activity information, and other information such as weight. |

Continued on next page

Table 6.1 – continued from previous page

| Use of OSNs | Health Behaviour | Design Principle |
|-------------------------------------|--|--|
| Get Information | Knowledge, Perceived Self-Efficacy, and Attitude Towards Behaviour | Obtain the nutritional information for meals and energy expenditure with definitions for nutrients. Provide time series charts for nutrients. Ability to obtain nutritional information for foods not eaten and physical activity not competed. Provide tailored messages about how to improve one’s diet and physical activity. |
| Self-Discovery | Attitude Towards Behaviour and Perceived Self-Efficacy | All principles for <i>Get Information</i> . Provide the user with information about which activity that they logged is “healthy”. |
| Maintain Interpersonal Connectivity | Perceived Self-Efficacy Experienced Vicariously Through Others | Provide the ability to connect with specific social connections through a friending feature, which allows visibility of friends’ shared activities. Provide a means to communicate with friends through commenting on their shared activities. Provide notifications and direct links when a friend comments on their posts. |
| Social Enhancement | Goals and Perceived Facilitators | Allow for the creation of health goals with a deadline with ability to complete the goals with their friends. Game mechanics with a points system and levelling-up when pre-set point threshold are reached and allowing visibility of the level of friends. |
| Entertainment | Goals and Perceived Facilitators | The goals feature can include the percent completion of the active goals highly visible, and show the days remaining until deadline. The points and levelling-up game features described for <i>Social Enhancement</i> can include revealing a new character or badge when a new level is reached. Additional points or bonus points should be given for the successful completion of goals with clarity on how points are earned. |

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Table 6.1 – continued from previous page

| Use of OSNs | Health Behaviour | Design Principle |
|------------------------------|---|--|
| Convenience | Perceived Barriers | Provide a store and collation of user’s personal health data. Provide the ability to automatically sense steps and scan barcodes for packaged foods. |
| Sense of Belonging | Subjective Norms | Provide a newsfeed that shows the shared meals and physical activities completed by the user’s friends. |
| Group Norms | Subjective Norms and Perceived Facilitators | Newsfeed shows when a friend has joined a goal, completed a goal, and levelled-up. All principles described for <i>Sense of Belonging</i> . |
| Social Categorization | Subjective Norms | All principles described for <i>Sense of Belonging</i> . |
| Shared Identity | Expectations about Environmental Cues | Commenting between friends on the log entries. Displaying seals when meals meet specific guidelines. |
| Social Comparison | Perceived Facilitators and Self-Efficacy Vicariously Through Others | Providing group goals. Displaying the level that friends have achieved. Newsfeed feature. |
| Interdependence | Perceived Facilitators | All principles for <i>Shared Identity</i> |
| Social Interaction | Perceived Barriers | Commenting features as described for <i>Shared Identity</i> . Organize the Newsfeed to encourage commenting. Provide notification for new comments. |
| Personal Knowledge of Others | Perceived Self-Efficacy Vicariously Through Others | Newsfeed features as described for <i>Sense of Belonging</i> and <i>Group Norms</i> ; commenting as described for <i>Shared Identity</i> ; and goals feature as in <i>Entertainment</i> and <i>Social Comparison</i> . |

6.1 Provide Information

An OSN for health behaviour change should provide a means for individuals to enter their dietary information, physical activity information, and other

relevant information such as weight. This will provide a way to diary or log their information, which will provide a means to build *Knowledge* of healthy behaviour. Once the information has been logged by the individual, the data can be further refined to include detailed information that will be explained further in Section 6.2. Since this is an OSN, the user should have the option to share the information with her/his social network connections. Allowing the user to choose what information they wish to keep private, giving her/him control over what personal health data is shared. The shared health information then promotes use through the *Social Enhancement* determinant. In other words, users will be more motivated to use the OSN and log their health data because they see other connections doing the same. The *Social Enhancement* determinant is discussed further in Section 6.5.

6.2 Get Information

OSNs should provide users with the nutritional information for meals logged and energy expenditure information for physical activities. The dietary and physical activity information that is logged can be used to calculate or obtain the specific nutritional information or energy expenditure from it. This will provide individuals with *Knowledge* about the actual nutritional value for the meals they are consuming and the energy expenditure for the activities they are taking part in. Furthermore, the users build their *Perceived Self-Efficacy* by understanding that certain behaviours (i.e. meals or physical activity) were very beneficial to their health. When the nutritional details are provided, *definitions for the nutrients should be provided with information for the beneficial or negative effects that the nutrient has on one's health,* which will allow the user to have a better understanding of how specific health behaviour can lead to poor health outcomes.

The detailed nutritional information should be graphed on time-series charts for individuals to provide a historical view of the consumption of each nutrient. By providing a historical chart of each nutrient, users can build their *Perceived Self-Efficacy*, as they can see their own capabilities through past behaviour. Furthermore, the charted information provides users with

a *Facilitator* for improved health behaviour, as they use the chart to set personal targets for consumption of specific nutrients and energy expenditure.

Getting information including detailed nutritional information from the logging of meals and energy expenditure for physical activity combined with the charting of this detailed information allows the user to formulate new *attitudes towards the behaviour*. For example, a user may like certain foods, but is unaware of their nutritional value until the information is made explicit on the OSN, which will allow them to redefine what types of food make up “healthy” foods. Similarly, as they start to log their meals and physical activity and change their health behaviour, they may realize that they enjoy eating healthy foods and being more physically active.

Allow users to obtain nutritional information for foods not eaten and energy expenditure for physical activities not completed. The OSN can support decisions about what foods to consume by allowing users to explore the nutritional value for various foods not just the foods that are consumed. This will allow the user to build *Knowledge* about nutritional value for a large variety of foods. This will build *Expectations about their Self-Efficacy*, as they become more knowledgeable about the nutritional value of the foods.

Provide tailored messages to the user for how they can improve their diet and physical activity level. By providing tailored information to the user about their health behaviour based on the information that they have logged, the user is provided with tips and hints about how to improve their health behaviour. For example, the system can inform the user that a specific meal that she/he consumed was high in saturated fats, and provide suggestions for alternative ingredients such as “turkey bacon” instead of “regular bacon”. Or it can suggest foods that are high in Vitamin C such as oranges and lemons if the user’s Vitamin C intake is low. Users should have the ability to turn-off these message or ask for suggestions, so that these prescriptive messages do not intrude on the user. This will build *Knowledge* of how to change health behaviour, contribute to changing the users’ *Attitude towards the Behaviour*, and build their *Self-Efficacy* for living in a healthier manner.

6.3 Self-Discovery

All of the features described in Section 6.2 also contribute to the motivation to use the OSN for *Self-Discovery*. As users are given detailed nutritional and energy expenditure information about their meals and physical activities, they start to discover their own health behaviours. It is through this *Self-Discovery* that the user can start to change their *Attitude* towards specific health behaviours by understanding that certain foods that they eat are beneficial to their health thus their attitude towards healthy eating improves. Similarly, users may come to understand that being physically active does not require as much effort as they originally thought through both providing their information, and the information that is obtained. In a similar manner, user's *Perceived Self-Efficacy* or understanding of their own capabilities in changing and maintaining positive health behaviour can also improve through *Getting Information* that is provided through the design features described in Section 6.2.

The system should provide an indication when a user logs a meal or physical activity that is healthy. This will provide user's with an immediate indication of when the user has eaten a healthy meal or completed physical activity where a threshold of energy is expended, which will allow the user to discover their potential to allow them to improve their *Attitude* and *Self-Efficacy* towards healthy behaviour.

6.4 Maintain Interpersonal Connectivity

OSNs for health behaviour change should provide the ability to connect with specific social connections through a friending feature, which allows for the user to view friends' shared activities. By allowing users to see what their friends are eating and their physical activities, they can improve their *Perceived Self-Efficacy Experienced Vicariously Through Others*. Users are able to formulate improved opinions about their ability by viewing their friends health behaviour, as they have visibility into the ability of their friends.

The OSN for health behaviour change should provide a means to communicate with friends through commenting on their shared activities. By designing an OSN for health behaviour change that allows for dialogue about certain meals consumed and physical activity, users are able to learn more about the activity such as the total effort required, which will allow the user to improve their *Self Efficacy Vicariously through Others*.

Notifications and direct links should be provided to users when one of their friends comments on their posts. Due to the large number of posts in an OSN for health behaviour change, the newsfeed fills very quickly even with a small social network group, notifications are required to alert the user to comments on their posts, and also link to additional comments that have been made to posts that the user has commented on. By providing notification and a direct link to comments, additional dialogue is encouraged.

6.5 Social Enhancement

An OSN for health behaviour change should allow users to create health goals with a deadline that allow the user to complete the goals with their friends. The OSN should allow the user to create *goals* that are flexible and also provide a library of existing *goals* that are static. By allowing users to create their own goals, they have the ability to customize the goals according to their needs. Conversely, users should also be able to select goals from a library of goals for ease of creation. The goals available in the library should be those goals that individuals are most likely to participate in. For example, individuals may wish to lose two pounds over one month, or walk for one hour for two weeks. Successful completion of goals is posted on the newsfeed building *Social Enhancement* because users want to make a good impression to their friends, which also encourages them to reach their goal.

Game mechanics should be provided with a points system and levelling-up when pre-set point thresholds are reached and allowing users to see the level of their friends. A unique and fun character or badge should be revealed, when the user reaches a new level. Points can be earned by successfully completing the goals, where the number of points are based on the difficulty

of the goal. Minor points or a small number of points should also be earned for logging meals and physical activity. By making the level that their friends have reached visible to the user, builds *Social Enhancement*, as users are encouraged to keep-up with their friends.

Providing Information that includes meals and physical activity and sharing this information as described in Section 6.1 also allows *Social Enhancement* to develop. Users would be inclined to eat healthier foods and be more physical active as they would want to look good to their friends and share it, which is encouraged through *Providing Information*.

All of these design principles that promote *Social Enhancement* provide a means for the individual to develop *Perceived Facilitators* by building *Individual Incentives*. These incentives include indirect incentives to health behaviour change such as the acquisition of points and levelling up that is provided in the game mechanics. More direct incentives include showing friends good health behaviour through posts on the newsfeed such as the completion of health goals and the logs of healthy foods eaten and physical activity completed.

6.6 Entertainment

The design principles that promote use through *Entertainment* are the same as those for *Social Enhancement* described in Section 6.5. More specifically, the design principle of creating goals can be augmented by *making the percent completion of the active goals visible at the top of the page through a horizontal bar that fills to 100% as the user progresses towards the target, and the number of days left to complete the goals also needs to be visible*. By viewing the progression towards the target in a goal as well as the days left to reach the target, build *Individual Incentives* to complete the proximal *Goals*.

The accumulation of points and levelling-up game mechanics can provide *Entertaining* motivation to continue to use the system. The user can be encouraged to change health behaviour as they have *Individual Incentives* to accumulate more points, and see the character (or badge) that is revealed

in the next level. Although using the system should allow the user to earn points, the largest number of points (or bonus points) should be earned through the successful completion of goals. There needs to be clear indication provided to the user when points are earned and how they earned the points, so that they can understand how to earn more points and have a more entertaining experience.

6.7 Convenience

The OSN can provide *Conveniences* by providing a store and collation of the user's personal health data, which includes the consumption of specific nutrients and energy expenditure. This is provided on the user's newsfeed with the detailed information displayed when the user clicks on the food or activity logged, and a chart of each nutrient on the dashboard showing the change in consumption or expenditure over time. All of these design principles are described in detail in Section 6.2. These design principles provide *Convenience* by reducing the *Perceived Barriers* to having to remember details of the nutritional content of foods consumed and energy expenditure for physical activity. Furthermore, the charts provide the consumption of all the nutrients and expenditure of energy over time, which conveniently shows the change in health behaviour over time.

Other *Conveniences* should also be designed to afford ease of data entry. These can include *the automatic sensing of steps*, which can be provided by linking the OSN to existing commercial hardware such as the fitbit® or Nike's FeulBand®. This can ease the effort required to enter the distance that a user walked, and also reduce the error that may be incurred due to lapses in memory and not knowing the speed or distance that the user walked. Other linkages can also be made through *barcode scanning of packaged meals found in the supermarket*. This will also reduce the effort required to enter the information and increase accuracy. Generally, this will reduce the *barriers* to using the OSN and entering one's personal health data, which is central to the system.

6.8 Sense of Belonging

Sense of Belonging can be designed into the system by first taking into consideration the users and the groups that will connect through it. The OSN for health behaviour change should be for small social network groups with approximately 10 people in each group based on the size of the social networks in the field experiment. The people in the groups should be connected through either close or loose ties. The most significant health behaviour change that has been observed is when an OSN is used by clinical groups, where the people within the group share the same clinic, live in the same geographic area, and come from similar socio-economic strata. By having a small number of users in each social network group and sharing the same connection such as a clinic, greater *Sense of Belonging* to the group can develop between the users because they share the same goal of living healthy. Furthermore, it is easier to see the activities of the other users since there is a limited number of users in each group.

The OSN should provide a newsfeed that shows the shared meals and physical activities completed by the user's friends. By having the ability to view the meals and physical activity of one's social network connections, the user can feel a part of a group and know that they are not alone in their wish to be healthy; in other words, they feel that they belong. This knowledge of others' eating behaviour and physical activity can allow the user to model their behaviour to that of the group, which can allow for the development of *Subjective Norms*.

6.9 Group Norms

Group Norms determinant for use of OSNs is similar to *Sense of Belonging*, and the design principles that contribute to the development of it include the newsfeed design principle described in Section 6.8. However, additional design features can also contribute to the development of *Group Norms*. *The newsfeed should display when the user's friends have joined a goal, completed a goal, and levelled-up or earned enough points to proceed to the next level.*

These design features will contribute to building awareness of what their friends are doing, which encourages the user to also participate in these activities through visibility of *group norms*.

These design features provide awareness of the health behaviour for the user's friends, which will lead to the development of *Subjective Norms*. In other words, the users will adopt the health behaviours of their friends by seeing what they are eating, their physical activity, and the goals that they are participating in and have completed. There is an overall tendency to share positive health behaviours over negative behaviours, which will allow for the sharing of good health behaviour, and lead to *subjective norms* of good behaviour over poor health behaviour. Additionally, these design features also builds *Perceived Facilitators* through the user's desire for *Social Approvals*. The user's desire to receive approvals from their friends will motivate them to share healthy choices through the newsfeed.

6.10 Social Categorization

Social Categorization is similar to *Sense of Belonging* except that it is the actual relation to a group, and the design features that contribute to *Social Categorization* is the same as the features for *Sense of Belonging*, which are described in Section 6.8. Therefore, it is no surprise that the determinants for health behaviour that are influenced by *Social Categorization* is the same, namely *Subjective Norms* are influenced by these design features.

6.11 Shared Identity

The OSN can build *Shared Identity* by allowing for dialogue between the social network connections (between the user and her/his friends). This is designed by allowing *for commenting between the users and her/his friends on the log entries*. The user is able to develop relationships and identify with others through dialogue about specific meals and physical activities. It is through this dialogue that users are able to change their *Expectations about Environmental Cues* for health behaviour. The commenting feature

will allow for dialogue about particular foods and their associated nutritional value, and physical activity and their associated energy expenditure, which will provide the user the cue to change health behaviour based on societal expectations.

Additional design features can be incorporated to show *Environmental Cues*, which were not incorporated into the high-fidelity design of *VivoSpace*, such as *displaying seals from credible organizations such the Heart and Stroke Foundation, when logged meals and physical activity meet specific guidelines*. This design guideline was incorporated into the Medium-Fidelity prototype, but could not be incorporated into the High-Fidelity prototype due to the limitations on the development of features that the prototype would allow in the time available and resources required to connect with external organizations and develop the formulas and programming required to incorporate the seal. However, the use of a “seal of approval” from particular organization would allow the user to see, which meals that she/he ate meet external approval, which would allow her/him to change her/his *Expectations of Environmental Cues*.

6.12 Social Comparison

Social Comparisons can be designed into an OSN by extending the goals feature described in Section 6.5 by *having groups goals, or goals which the user can complete with her/his friends through direct invitation*. In addition to the selection or creation goals towards a health targets with a deadline, the user should also be able to invite specific friends to complete the same goal with them. As the user progresses towards the goal target, their progress as well as the progress of their friends’ that are completing the goals with them are clearly visible through a fill bar that shows the percent complete. By allowing users to complete their goals with their friends, *Facilitators* are designed into the OSN, as *Social Supports* and *Social Approvals* for the goal are motivators to complete the goal. In other words, the user’s friends, who are completing the goal with her/him, provide both support to complete the goal as well as the desire to seek approval from her/his friend(s).

The OSN should *show the level that all of the user's friends have achieved*. This will allow the user to see how far their friends are progressing with their health, and encourage her/him to perform better because they seek *Social Approvals* from them. Generally, the visibility of the user's friends' levels build *Perceived Facilitators* towards positive health behaviour change.

Social Comparisons is also enabled through the newsfeed design feature that was described Section 6.8. Users are able to compare their health behaviour to those of their friends through this feature, which allows health behaviour change to occur as the users can change their *expectations of their self-efficacy vicariously through others*. As they see others' capabilities, they become aware of their own capabilities.

6.13 Interdependence

Interdependence is similar to *Shared Identity* except that the relationship that develops is one more of dependence than simply a sharing of identities. The design principles for *Shared Identity* are described in Section 6.11. Similarly, these design features influence the same determinants for health behaviour change, *Perceived Facilitators* with both *Social Supports* and *Social Approvals* being facilitators for health behaviour change. However, *Social Supports* are much stronger when the determinant for use is *Interdependence*, as the user relies on her/his friends to provide the support necessary to change their health behaviour.

Although *Interdependence* is a determinant for use that can ensure habitual use, we need to be careful in creating dependency on an OSN when maintained health behaviour change can be possible through use of an OSN for only a few months with design features such as those described in this chapter. There should be an ethical understanding with the design of OSNs that the end goal is health behaviour change, and not sustained use of the OSN. However, different users may have different levels of supports that are necessary for sustained healthy behaviour, and they may require *interdependence* of their social network connections to see them through times when they may revert to poor behaviour.

6.14 Social Interaction

The commenting feature on the newsfeed that is described in Section 6.11 allows for *Social Interaction*. However, the design needs to consider how to increase socialization. The high-fidelity prototype of *VivoSpace* had a limited number of comments because the newsfeed filled up very quickly, which made it difficult to see when comments had been made. Therefore, the design needs to *organize the newsfeed to encourage social interaction through the commenting feature*. This can be achieved by *displaying newsfeed items that others have commented at the top*. Similarly, *the items that have received comments from others should be displayed in the notifications menu at the top, which has a direct link to the newsfeed item*. The user should also receive email notification for the same. Finally, the newsfeed should be organized in a manner that encourages *Social Interaction* through commenting by reducing the potential clutter of the newsfeed, which can be done by *collapsing the users meals and physical activity into daily summaries, which can be expanded to view the details for the day*.

An OSN for health behaviour change that is easy to navigate and encourages *Social Interaction* can allow for dialogue that will provide the user with strategies to reduce her/his *Perceived Barriers*, which is a determinant for health behaviour change.

6.15 Personal Knowledge of Others

Personal Knowledge of Others in the OSN is provided through multiple design principles that have already been described. The newsfeed design feature that was described in Section 6.8 allows users to gain knowledge of their friends' personal nutrition and physical activity. The commenting feature that was described in Section 6.11 allows for dialogue and social interaction, which permits users to learn about each other. Finally, the group goals feature that was described in Sections 6.5 and 6.12 allows users to be exposed to what types of goals their friends participate in and how quickly their friends achieve their goals. By having *Personal Knowledge of*

Others, the users are able to change their understanding of their capabilities to change their health behaviour; in other words, they change their *Perceived Self-Efficacy Vicariously Through Others*.

6.16 Habitual Use

As for the **Commitment** dimension of the **ABC Framework**, there are several design principles that can encourage sustained use. The use of *email reminders and notifications of comments on the users log entries* can encourage sustained use. Furthermore, the use of game mechanics such as revealing a new characters when the user levels up otherwise the level is locked and the character for that level cannot be seen, as was described in Section 6.6. These game mechanics need to be continuously revised, so that if a user reached the last level, their motivation to continue to use the system does not diminish.

It should be noted, however, that sustained use of the OSN in itself does guarantee a progression towards health behaviour change. The specific design principles described in this section can lead to changes in the specific determinants for health behaviour change. Furthermore, habitual use of the OSN should not be the end goal in the design of an OSN for health behaviour change, but rather positive health behaviour change, so if maintained health behaviour change is achieved after a few months of use, we should not expect habitual use of the OSN (as explained in Section 6.13).

6.17 Consideration of the Target Users

This work showed that the design of an OSN for health behaviour change should consider the target user. The literature shows us that a large scale OSN for one's entire social network including close and distant ties such as Facebook[®] is not ideal for an OSN designed to change health behaviour. Our field experiment showed that the number of people connected on the OSN should be small, as the number of log entries can grow large very quickly. *We suggest that ideally the number of connections in the OSN designed for*

health behaviour change should be around 10 people.

Further consideration needs to be given to who would benefit from this OSN. Our field experiment revealed that loose social network connections from the same geographic and socioeconomic strata, who shared the same primary health clinic that was focused on wellness showed significant changes in the determinants for health behaviour change, as well as increased patient activation. The number of groups that were studied was limited due to the logistics in finding such groups, so there may be other social networks that may also benefit from an OSN for health behaviour change.

6.18 Summary of Design Principles

The design principles have been described by listing each determinant for use of OSNs from the **ABC Framework**. In doing so, there is significant overlap; specifically, a single design feature maps to multiple determinants for use of OSNs. Much of this occurred through the UCD process, where initially the design was much more complex, so that there was a one-to-one mapping of the design features to the determinants for use of OSNs. However, the evaluation of the paper prototype and medium fidelity prototype showed that users wanted simpler designs.

We can simplify the design features by creating a 2x2 matrix, where we have two columns, *Individual* and *Social*, and two rows for *Give* and *Obtain*. There are design principles that can be provided in each of the four quadrants. This is shown in Figure 6.1. The top left quadrant shows the individual design features where the user provides (or *Gives*) information such as their personal health information. The top right quadrant shows what information others would provide to the user such as encouragement and their own personal health information. The bottom left quadrant shows what the user obtains from the OSN such as nutritional value for the foods eaten, a historical chart of their personal health data, entertaining gaming experience, and visibility into their goals. The bottom right quadrant shows the design principles where the user obtain value through their peers on the OSN such as advice and encouragement, visibility into their health information and

| | Individual | Social |
|--------|---|---|
| Give | Personal health information such as meals eaten and physical activity completed. | Advice and encouragement to others. Sharing of one's personal health information. |
| Obtain | Nutritional value for the meals eaten and physical activity completed. Gaming experience through earning points and leveling up. Historical information through charts. Explicit and visible goal targets. | Advice and encouragement from others. Visibility into other's ability to live healthy through their shared information. Competition through visibility of gaming levels. Peers to complete goals with. |

Figure 6.1: A 2x2 Matrix showing simplified design principles for OSNs for health behaviour change.

gaming levels, and peers to complete their goals with.

The simplified 2x2 matrix allows this work to be adopted more broadly by industry without getting bogged down in definition of determinants from the **ABC Framework**. However, further research from this work should consider the **ABC Framework** when applying the design principles described in this chapter.

Chapter 7

User-Centred Design (UCD) Process

The high fidelity prototype of *VivoSpace* that was described in Chapter 4 was designed through a UCD process that is described in this chapter. The determinants that make up the **ABC Framework** form the points of inquiry throughout the UCD process. The end-point of this approach as described in Section 1.3 is to design a system that will change health behaviour.

7.1 Initial User Inquiry

We begin with the UCD process with initial user inquiry. Questionnaires and interviews are conducted to better understand motivations for using OSNs and thoughts on one's health behaviour. The initial user inquiry allows us to formulate the motivations for use of existing OSNs such as Facebook[®] and Twitter[®]. The determinants for use of OSN from the **ABC Framework** were derived from theories that were mostly applied to user participation in online communities and are rooted in social psychology, communication and organizational psychology as described in Section 3.1. For example, the Theory of Organizational Commitment [4] was developed to understand employees commitment to their employer, and it was later applied to attachment to online communities [60]. The Common Identity Theory and Common Bond Theory [95], is used to describe motivation to participate in online communities. Furthermore, the Social Identity Theory [112] describes the basis of group dynamics, and it was only later applied to online communities [27]. Since the evaluation of most of these theoretical models have not been

applied to OSNs, we conducted a questionnaire and interview evaluation of the determinants of the **ABC Framework** to determine their true validity in the motivations to use OSNs. We also evaluated the determinants for health behaviour change to better understand the validity of our synthesis; in other words, the evaluation provides a determination of whether we can extract determinants from multiple theoretical models for health behaviour change into a single framework. An initial evaluation was done through questionnaire inquiry for the key determinants of the **ABC Framework**. Additional interviews were also conducted to obtain a richer understanding of individuals' thoughts on the use of online social networks and health. The full questionnaire and interview questions can be found in the Third Appendix.

7.1.1 Questionnaires

Online and paper questionnaires were created and distributed to a diverse participant group: across gender, age (adult only) and ethnics groups. Healthy living should not be limited to young adults, who are active users of technology, nor should it be for particular ethnicities. The actual validity of the theoretical models used in the **ABC Framework** across age, gender and ethnic boundaries is unknown. Therefore, we have endeavoured to obtain adult participants in our evaluation that cross various age and ethnic groups. The evaluation also looks further at the differences within these groups, so that the design of an OSNs can focus on aspects that are similar across these groups.

Recruitment and Respondents

Participants were recruited from university listservs, the authors' personal social networks, OSNs, direct outreach to the First Nations community, and having a table at a Punjabi Diabetes forum in the Surrey BC. We obtained 104 responses to our online and paper questionnaire. 26 respondents completed a paper survey and the balance completed the questionnaires online.

Of the 104 respondents that completed the questionnaire, 52% were

women and 48% were men; 15% 19-24 years old, 29% 25-34 years old, 29% 35-49 years old, 12% 50-64 years old, 12% 65-74 years old and 3% were over 75 years old; 26% identified as Canadian, 24% as South Asian, 18% as First Nations, 14% as Chinese, 7% as European, and there were 8 other ethnic groups that represented the remaining 11%; 33% of the respondents identified as having health problems.

The respondents were users of technology and OSNs to varying degrees; 95% of the respondents used a computer at least once a day; 24% had never used Facebook[®]; and 9% had never used any OSN or online community. The respondents to this survey were high users of technology and OSNs, which was likely due to our recruitment methods. This will create a general bias towards technology; however, it will allow us to better understand the motivations to use OSNs to best evaluate the **ABC Framework's** determinants of for use of OSNs.

Results

The results from the questionnaire showed strong agreement with the **ABC Framework** and also revealed some motivational differences between age and ethnic groups. 85 of the 104 respondents answered questions inquiring about their motivation for using OSNs. Respondents were asked to rank their agreement to statements that are reflected by the **ABC Framework**. For example, respondents were asked for their degree of agreement or disagreement on a 5-point likert scale to statements such as, *I use online social networks to get information*, which reflects the *to get information* determinant in the **Appeal** dimension of the framework.

The results to the responses around individually based (**Appeal**) determinants for motivation to use OSNs revealed that the strongest agreement was *to maintain connection with people* and *convenience*. The weakest agreement was *to learn about oneself* and *social enhancement*. This is shown on Figure 7.1. The **Belonging** dimension for using OSNs was not fully incorporated into the questionnaire due to the complexity in obtaining responses around group behaviour; however, it is interesting to note that “belonging to a group”

did solicit positive and negative responses. This does suggest that evaluating social motivation requires alternate inquiry methods. This is shown on Figure 7.2. The results also revealed that the strongest **Commitment** attachment is *affective* rather than *continuance* or *normative* (attachment categories are described in Section 3.1.6).

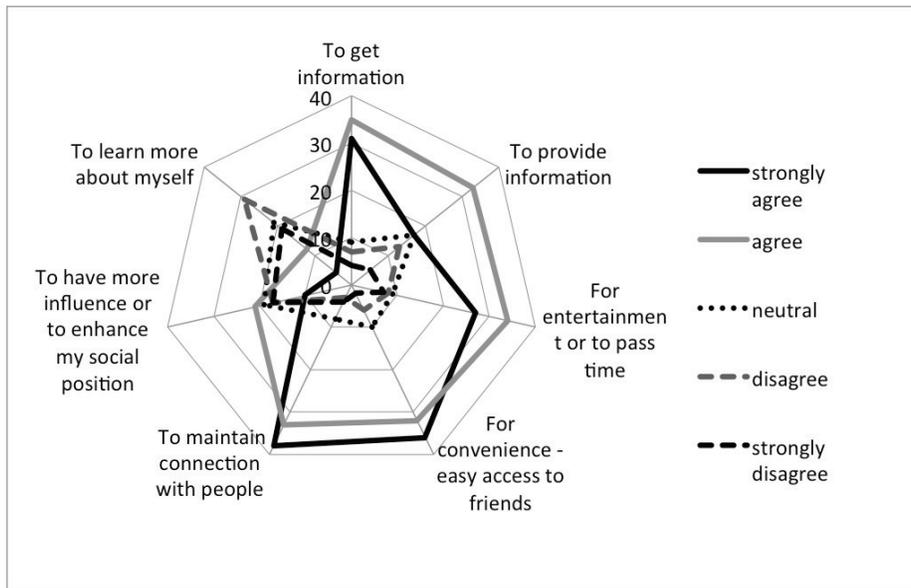


Figure 7.1: Questionnaire responses (n=85) to agreement about motivation to use online social networks for individually-based determinants.

We also looked more deeply into respondents' motivation by understanding the differences between gender, age group and ethnic group. For this reason, factorial ANOVA was run on the data to better understand any significant difference between these groups, the main effects and the interaction effects. All post hoc test was done using Tukey HSD. All mean differences are in the direction indicated in the text, so the difference between x and y will have a mean difference x-y. The factorial ANOVA revealed significant differences in the **Appeal** dimension. The motivation to use OSNs for *entertainment* ($F(4, 70)=2.89, p=0.031$) was significantly different for different age groups. The greatest difference in the *entertainment* determinant occurred between the 19-24 years old and 50-64 years old age

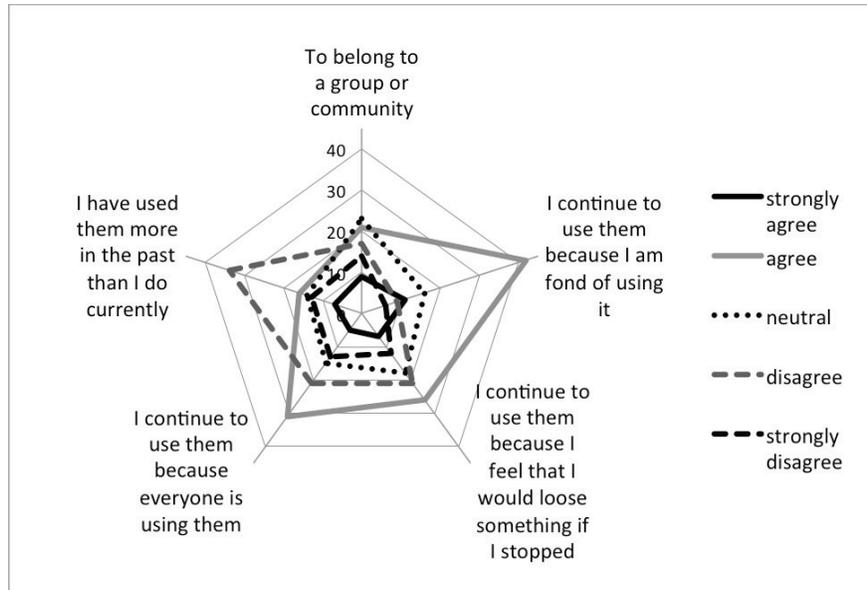


Figure 7.2: Questionnaire responses (n=85) to agreement about motivation to use online social networks for individually-based determinants.

group (mean difference=1.68, $p=0.017$). Similarly, *social enhancement* ($F(2, 66)=3.14$, $p=0.05$) was significantly different for different ethnic groups. The difference between the Canadian and Chinese/South Asian ethnic groups are statistically significant (mean difference=-1.39, $p=0.001$). The analysis also revealed a significant difference in the **Commitment** dimension, as age groups showed significant difference in continuing to use online social networks for their fondness (*affective attachment*) of them ($F(4, 55)=2.81$, $p=0.034$). The significant difference is between the 19-24 years old and 50-64 years old age group (mean difference=2.17, $p=0.024$).

Respondents were also asked about their thoughts on their health for validation of the **ABC Framework**, and the results show a strong agreement with the framework. 102 of our 104 respondents answered questions inquiring about their health. Generally, respondents seemed to have agreement with understanding how to live healthy with the greatest concern around exercise. The **Appeal** determinants for health behaviour is shown on Figure 7.3. Further, the responses to the **Belonging** and **Commitment** dimensions

show good support. Although there is somewhat mixed agreement to social influence on health behaviour, and they are mixed about commitment, since many agree that they can live healthier. This is shown on Figure 7.4. We realize that this method of inquiry and the value of responses to this inquiry are limited because asking a person if she/he understands how to live healthily does not mean she/he understands. However, the answers do reveal respondents' perceptions about their understanding of healthy living.

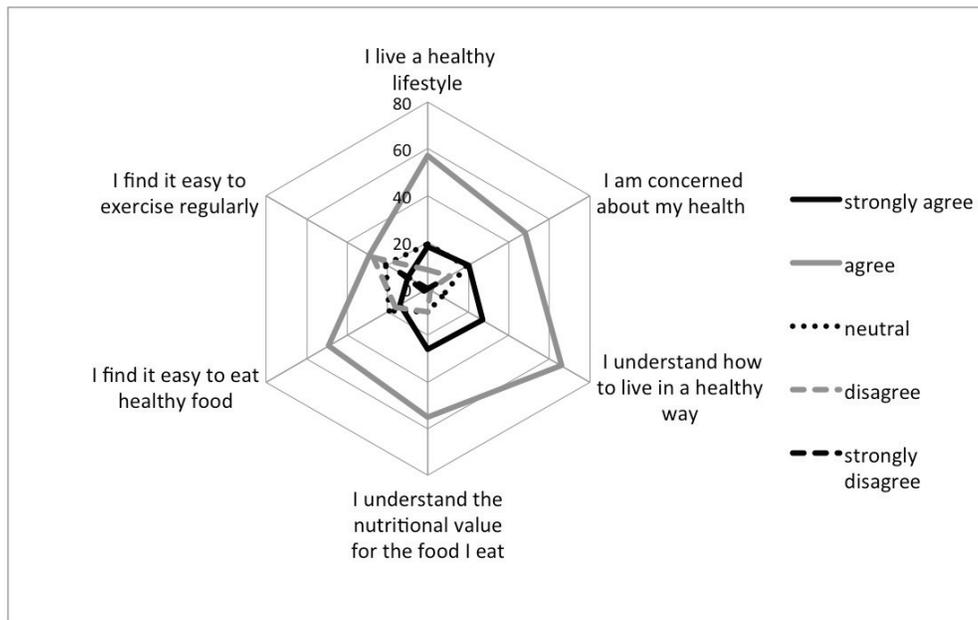


Figure 7.3: Questionnaire responses (n=85) to agreement about motivation to use online social networks for individually-based determinants.

Similar to the analysis on OSN, the data on the respondents' thoughts on health was also analyzed using factorial ANOVA to better understand the difference between gender, health status (healthy or not), age and ethnicity. The results reveal that the **Appeal** dimension does show significant differences in some of the determinants. *Knowledge* was one such determinant, as the questionnaire inquiry on “understanding the nutritional value of food” showed statistical difference. The age groups show a statistically significant difference for this determinant ($F(4, 43)=3.29, p=0.019$). This

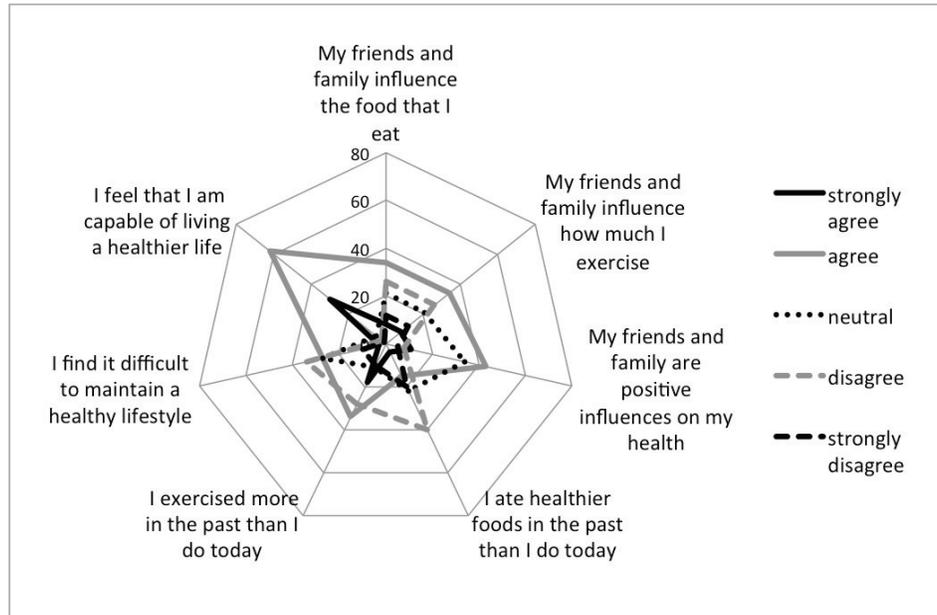


Figure 7.4: Questionnaire responses (n=85) to agreement about motivation to use online social networks for individually-based determinants.

difference is between the following age groups: 19-24 years old and 25-34 years old (mean difference=-0.59, $p=0.033$), 19-24 years old and 50-64 years old (mean difference=-0.70, $p=0.026$), 19-24 years old and 65-74 years old (mean difference=-0.97, $p=0.003$), and 35-49 years old and 50-64 years old (mean difference=-0.75, $p=0.009$). This analysis also revealed interaction between age and health status for understanding nutritional content ($F(4,43)=2.81$, $p=0.037$). Concern for one's health in the **Appeal** dimension shows a significant difference between healthy and those that have health problems ($F(1, 43)=13.81$, $p=0.001$) with a mean difference of -0.76 with the those with health problems being more concerned.

The **Belonging** dimension showed significant difference, especially when they were asked about friends and family influence on their diet. There were significant differences between age groups ($F(4,43)=2.88$, $p=0.034$), health status ($F(1,43)=6.10$, $p=0.018$), interaction between gender and age ($F(4, 43)$, $p=0.008$), interaction between age and ethnicity ($F(8, 43)=3.59$, $p=0.003$),

interaction between age and health status ($F(4, 43)=13.12, p=0.001$), and interaction between ethnicity and health status ($F(2,43)=10.42, p=0.001$).

The **Commitment** dimension showed significant differences as well in the inquiry, *I ate healthier foods in the past than I do today*. There were significant differences between gender ($F(1, 43) = 4.53, p=0.39$), where the mean difference between male and female was -0.608. Significant differences also existed between ethnic groups ($F(2, 43), p=0.043$), where the post-hoc analysis revealed differences between Canadians and First Nations (mean difference=-1.02, $p=0.007$), Canadians and Chinese/South Asians (mean difference=-0.74, $p=0.022$).

7.1.2 Interviews

In order to obtain a richer understanding of people's thoughts around using OSNs and their health behaviour, one-on-one in-person interviews were conducted with 11 people that lasted approximately one hour. Participants were recruited through university listserv and personal connections. There was no selection criteria except that all participants needed to be over 19 years old. No honorarium or other incentives were given to the participants. There were 7 men and 4 women. 4 identified as Canadians, 2 as Mexican, 1 as American, 1 as Indonesian, 1 as Korean, 1 as Persian and 1 as East Indian. Although age was not asked directly, participants were asked to select which age range they belonged to: 6 were aged 25-34 years old, 4 were aged 35-49 and one was aged 19-24. They were all users of OSNs to varying degrees: one participant checked updates every 20 minutes, and the others used it at least once a day. As for health problems, 4 said they had health problems.

The interviews were evaluated by first transcribing the interviews, grouping each comment into categories, and then further grouping each comment into themes. There were 13 categories that emerges when users were asked about their usage of OSNs, which is shown on Table 7.1. There were many components of Facebook[®], Twitter[®] and other OSNs that appealed to the participants. The most common reason to use OSNs was to connect with friends and family. The following quote shows how online social networks

allowed the participant to connect with old friends:

I found that Facebook is a very good method to keep in touch with my friends even old friends as I could find many of my old friends from university or my former colleagues from my previous company, so in this sense it is very useful. (P 6)

Table 7.1: The theme and the associated number of comments that emerged from interview inquiry of participants' use of OSNs

| | Category | # of Themes |
|--|---|-------------|
| | Frequency of use | 14 |
| | Change in frequency of use | 7 |
| | Provide information | 7 |
| To stay connected to family, friends and other connections | View friends' activities | 7 |
| | Different uses/purposes for different social networks | 7 |
| | Get information | 5 |
| | Self promotion | 2 |
| | Participate in social games | 2 |
| | Linking two OSNs together | 1 |
| | Entertain friends | 2 |
| | Not wanting to share information | 1 |

Many of the participants said that they use online social networks to get information and view the activity of their friends, such as the following example:

[I use Facebook] to see what my friends are doing, like what is interesting, what interesting things are going on around my community of friends. (P 4)

This previous quote also provides insight to the **Belonging** dimension, as participants need to view activities that their friends are doing, which builds a group and community network.

Participants also alluded to **Commitment** or lack of it in their use of OSNs. Some participants discussed how they use certain social media less

than they did in the past showing a lack of commitment, such as the following examples:

I use to use Facebook but I disabled it because it wasn't a good use of my time. (P 5)

It is funny, I actually hated [Facebook] before because of the way it spams bunch of things on to your profile. I know there is a way to control that but its like what's the point, so I actually stopped using it for awhile, a year and a half, but I decided to come back to it because I was getting disconnected to other people who I wanted to keep in touch with. (P 10)

Overall, the interview participants mentioned a number of uses and gratification or **Appeal** determinants for using OSNs, but the frequency of use and level of commitment varies based on the individual and her/his need to use it. Interestingly, the previous quote shows the commitment to Facebook[®] for this person to be more *normative* than *affective*.

A total of 18 categories emerged from a category about living healthy, which can be found in Table 7.2. The categories were mostly based around **Appeal** of living healthy. Much of the discussion was around their own practices in healthy living as it pertained to healthy eating and exercising, for example:

I do go to the gym very often and I try to exercise because its something that I need as it un-stresses me. (P 1)

The next quote touches on the **Appeal** determinant of *knowledge*, as this participant understands the importance of comprehending one's nutritional intake:

I think monitoring what you eat is one of the most important [things] and that is one of the things that you should try to do, so [I read] all of the nutritional facts about food that I purchase. (P 2)

The participants also discussed the **Belonging** components or social influences on health in great detail. The following quote show the social norms that occur through one’s friends:

If you are with thin people, your behaviours tend to match up a little better, so I think those are huge influences. (P 9)

Table 7.2: The theme and the associated number of comments that emerged from interview inquiry of participants’ thought on living healthy

| Categories | # of Themes |
|---|-------------|
| Healthy eating | 14 |
| Doing exercise | 8 |
| Importance of health | 6 |
| Need to be organized | 3 |
| Relieving stress | 2 |
| awareness of importance of healthy living | 2 |
| Motivation to live healthy is to lose weight | 2 |
| Find it is easy to be healthy | 2 |
| Reminders on food products pertaining to health | 1 |
| Living healthy improves one’s chronic health conditions | 1 |
| Need to be committed to live healthy | 1 |
| Balanced lifestyle leads to healthy lifestyle | 1 |
| Need to be motivated to live healthy | 1 |
| Will power is important | 1 |
| Need to improve health bheaviour | 1 |
| Clinical information | 1 |
| Self-initiative is more important than friends | 1 |
| Mental health | 1 |

Negative social pressures were also mentioned:

Well if you go out with friends who eat bad stuff, drink alcohol, eat at MacDonald’s everyday, eat those fried stuff, well you would eat them too. (P 8)

The difficulty in committing to healthy behaviour was discussed by many of the participants as well as possible reasons why they have not been able to commit to healthy behaviour, as shown by the following quotes:

I think that it really varies from one period or year to another period. There [is] summertime [when] there are lots of activities and I'm really a big fan of outdoor activities and I have things that I do: I go out and I go mountain climbing and stuff and I feel like I'm doing better and doing more exercise and that makes me feel healthier too. (P 4)

I think a lot of [healthy living] comes down to being better organized. You know finding time making time one of those expressions for the things you need to be doing maybe also prioritize. (P 9)

Overall, interview participants felt that they generally had the knowledge to eat healthy and they knew that they should be exercising more. However, they felt that there were barriers in motivation to maintaining a healthy lifestyle.

7.1.3 Discussion and Iteration of the Framework

As the results confirm, different population groups' behaviour is affected differently by the various determinants. For this reason, we categorize the determinants between the most and least overlap between the various population groups. These strong determinants lead to design strategies that should have the strongest impact across cultural and age groups versus ones that may need tailoring. For example, respondents across age and ethnic groups said they use online social networks to maintain connectivity with family and friends.

There is an important caveat to this iteration of our framework. The questionnaire inquired only about use of existing OSNs and personal health behaviour separately. We expect that some of these determinants will be much more important for an OSN that is designed to motivate health behaviour change. As was shown in the **ABC Framework**, there is significant interplay between the determinants from both domains when put together. Specifically, the three determinants that have a larger impact when the

domains are coupled are: 1) *self-discovery*, 2) *expectation about outcomes*, and 3) *environmental cues*. *Self-discovery* can allow one to understand one's health behaviour, which leads to designs that include personal health informatics about the user such as sodium intake over time. *Expectation about outcomes* becomes much more evident through the visibility of one's nutritional intake and exercise level. *Environmental cues* may also be designed into the OSN by displaying evidence-based 'seals of approval' when certain activity meets health and medical criteria. Thus, as seen in the next section, we exploit these determinants in proposing design strategies for an online social network promoting health behaviour change.

7.2 Paper Prototypes for VivoSpace

We now begin to design an OSN for health behaviour change called *VivoSpace*. Paper prototypes are developed based on the **ABC Framework** and the results of the initial user inquiry. However, the interviews for the initial user inquiry were conducted after these prototype were developed in order to complete the entire work proposed for this doctoral work. The interview participants were the same for the initial user inquiry as for the paper prototype evaluation. Although it would be ideal to have conducted two separate interviews for each phase of the UCD process, we feel that the results of the interviews from the initial user inquiry would not have changed the design of the prototypes significantly. Furthermore, any design consideration that would have arisen from the interview from the initial user inquiry can be adopted into the design of the medium fidelity prototypes.

7.2.1 Paper Prototype Design

The design strategy of the paper prototypes was to combine an individual's information such as organizational data (calendar and task list) with health information (such as nutritional intake and physical activity) to engage users in their health data and ensure that health fits into the user's overall digital information. The paper prototypes provide relatively high-fidelity aesthetics



Figure 7.5: Timeline page for the VivoSpace paper prototype. Timeline page is where users are able to log their daily activity and share with any portion of their social network or not share it.

to allow us to obtain feedback on both the aesthetic appeal as well as how users feel about its use. There were 14 pages in total developed using Adobe Illustrator[®]. Figures 7.5 and 7.6 show the timeline page and the dashboard page respectively; the other pages can be found in the Fourth Appendix.

The overall design of the paper prototypes include three main frames: the organization pane, the digital asset pane, and the content pane. The left pane is the organization pane and it contains items such as an overall scale to see how the user is performing in terms of their health behaviour, a calendar that allows the user to enter upcoming events such as a dinner engagement with friends and also has the ability to invite friends to events,

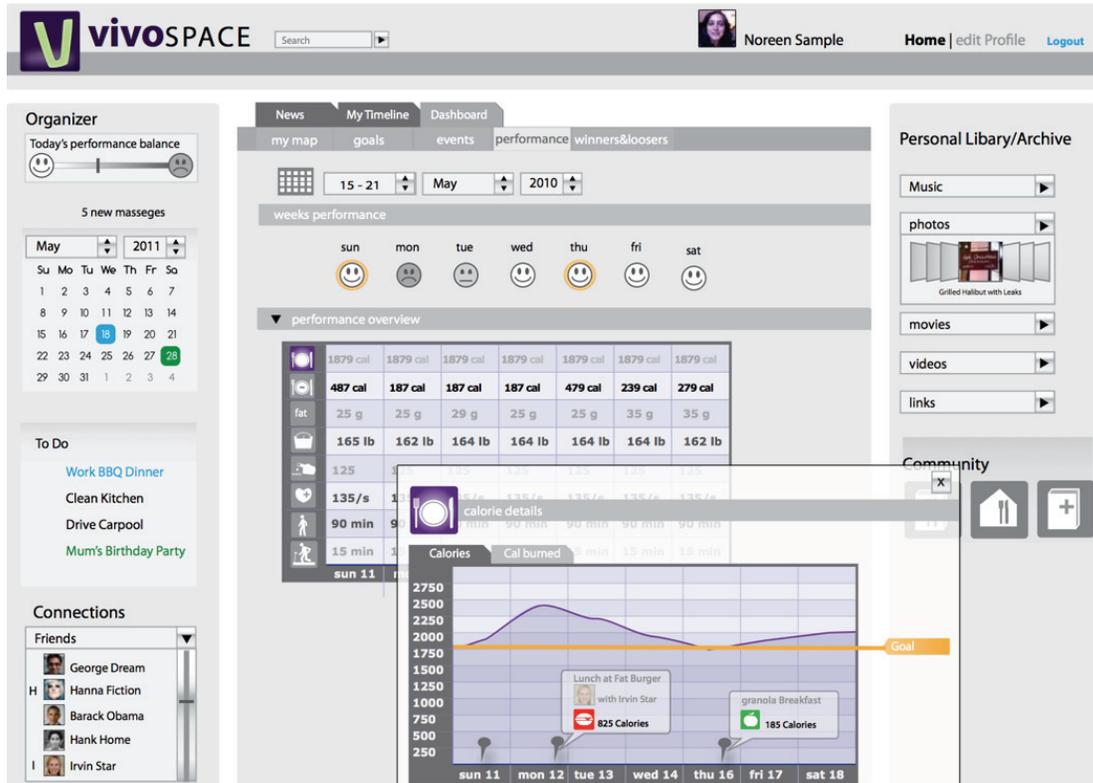


Figure 7.6: Dashboard page for the VivoSpace paper prototype. Dashboard of weekly performance with flags displayed on the graph to show what activities that were logged on that day.

a to-do list that will allow the user to manage all their action items whether they are health related or not, and finally a list of the friends or contacts on the *VivoSpace* system. The right pane is a consolidation of the users digital assets such as music, photos, movies and links that will be connected to their iTunes and/or other digital storage locations either online or on their personal computer. This pane also has connections to online communities that are part of *VivoSpace*, including a restaurant community where users can rate restaurants and suggest healthy menu items, a recipe community that allow users to share recipes, and a health community to allow discussions around specific health topics. These two panes are meant to build the **Appeal** dimension of the theoretical framework by linking to digital assets such

as music and other informational needs of the user so that health is not separated from other parts the users life. The central and most prominent pane contains all of the content, including a timeline where users enter their health related activities, a Facebook-style newsfeed and a dashboard.

The timeline page (Figure 7.5) is where users log their daily health activity. Based on this activity, *VivoSpace* provides the health information for that activity such as calories and sodium consumed or calories burned. For example, a user can add that they had a specific restaurant meal and a couple of glasses of wine; the system will look up the health related information for this activity such as total calories, amount of sodium and amount of saturated fat, and return that information. This will change the user's *knowledge* of how their behaviour affects their health, which is a central determinant for health behaviour change in the **ABC Framework**. *VivoSpace* also provides the user with the ability to link a health activity to their social activity; for example, the user in Figure 7.5 had the posted restaurant meal with two friends who are also on *VivoSpace*. This will provide the user with feedback on social influences on their health, as there may be certain friends who are good influences, while others are not. This visibility into the user's social determinants should motivate them to change their health behaviour as defined by the **ABC Framework**. Specifically, the **Belonging** dimension of the theoretical framework to motivate health behaviour change includes the subjective norm determinant. The user can also share any of the information in the timeline with all, none, or a portion of their social network. The activity for friends can be seen in the Facebook[®]- or Twitter[®]-style newsfeed page.

Figure 7.6 shows a health dashboard based on the information that was logged. The user's health performance is shown initially in a narrow channel as happy and sad faces with higher fidelity information provided below. Users have access to a full graphical view of various health variables with annotations of activities that were logged. The "Winners and losers" tab on the dashboard show how the user is performing when compared to their friends. This tab provides a social gaming experience. The best and worst performing friends (top three and bottom three) are shown for each

day to build social motivation. The “my map” tab provides a geospatial view of one’s movements and location of activities. The prototypes also include profile presets, where users can select which health variables they wish to see. Users can also view and select evidence-based seals such as “Diabetes Safe” or “Low in Saturated Fat”.

The mapping of the design elements shown in the paper prototypes of *VivoSpace* and the determinants from the **ABC Framework** is shown in Table 7.3.

Table 7.3: Mapping of the behavioural determinants from the **ABC Framework** to the design elements in the Paper Prototype

| Determinant | Design Element |
|---|--|
| Provide Information | Allow the user to provide the diet, physical activity, and other health information on the timeline and newsfeed pages |
| Get Information, and Knowledge | Nutritional information is obtained after diet and physical activity information is entered; Information about friends’ health information is obtained |
| Maintain Connectivity to Friends and Family, Sense of belonging, Group norms, Shared identity, Social Interaction, Subjective Norms, and Personal Knowledge of others | The newsfeed allow the user to see and comment on friends status updates; the list of friends are shown on the bottom left of the page allow user to view their profile |
| Entertainment, and Goals | The MyMap page allows the user to see where they (the user and their friends) have walked or done other activity, and with which friends; and the goals page allows the user to set goals and see their ability to meet their goal through the dashboard |
| Social Enhancement, Perceived Facilitators, Social Comparison | The Winners & Losers page builds in competition between friends to see who preformed the best and the worst each week |
| Self Discovery, Knowledge, and Self-efficacy | The dashboard page builds self-discovery by allowing the user to see the change in health information combined with who they were with on certain days |
| Convenience | Narrow Channel health indicator at top left; Calendar that links to existing events as well as health deadlines; To-do list links to existing tasks as well as health tasks; a link to user’s digital assets on the right-hand bar |

7.2.2 Evaluation

The same 11 adults were interviewed that participated in the initial user inquiry, and they are described in Section 7.1.2. After the participants were asked about their thoughts on use of OSNs and health as described in Section 7.1.2, participants were asked for feedback on all 14 pages of *VivoSpace*'s paper prototypes. The participants were regular users of technology and OSNs. One participant used social media throughout the day, checking their friends status updates every few minutes. 9 used either Facebook® or Twitter® several times everyday. One respondent stopped using Facebook®, but continued to use Twitter® a few times a week. Figure 7.7 shows a photograph of all 14 pages laid out during one of the interviews. First, each participant was walked through the functionality for each page, and then they were asked questions based on the **ABC Framework**.



Figure 7.7: Photograph of all 14 pages of the paper prototype laid out during the interviews.

The interview questions about the paper prototypes of *VivoSpace* resulted in 394 comments being collected and analyzed. They were coded into 10

Table 7.4: Qualitative analysis of feedback of *VivoSpace* showing the categories, number of comments in each category and number of themes that emerged for each category.

| Category | # of Comments | # of Themes |
|---|---------------|-------------|
| Difficulties with <i>VivoSpace</i> | 91 | 20 |
| “Likes” about <i>VivoSpace</i> | 84 | 17 |
| Recommendations | 82 | 23 |
| Dislikes about <i>VivoSpace</i> | 37 | 9 |
| <i>VivoSpace</i> can influence health behaviour | 29 | 7 |
| Positive about social features | 21 | 4 |
| Design aesthetics | 16 | 8 |
| Temporal aspects | 20 | 3 |
| Negative about social features | 10 | 7 |
| Explanation of other health software | 4 | 2 |

categories and then each comment is grouped into related themes [39]. Table 2 shows these 10 categories with the number of comments for each category and the number of themes that emerged in each category.

Table 7.5 shows the themes that emerged from the category “difficulties with *VivoSpace*”. The main concern was the perceived difficulty in entering information, as it was felt that inaccurate information would make the system less effective. Privacy concerns were also raised, as it was felt that health information is personal. The second most frequently mentioned was concerns around privacy of health information. Specifically, participants voiced concern around whether they would be willing to share unhealthy behaviour, and some felt that they would not share health information at all. Many felt that access to the digital assets (personal library) did not fit the scope of *VivoSpace*, and that the prototypes had too much information.

The themes shown in Table 7.5 for what the participants did not like about the paper prototype design of *VivoSpace* can be better understood by reviewing what the participants actually said:

I would not be able to contend with the amount of data entry needed to give me good results, and that would be an issue. [P11]

Yeah, I don’t want my girlfriend to know that I had a burger,

Table 7.5: Themes emerging from “Difficulties with *VivoSpace*” category.

| | Theme | # of Comments |
|--|---|---------------|
| | Too difficult to enter information & data collection concerns | 20 |
| | Privacy: not wanting to share unhealthy habits | 13 |
| | Too much material | 10 |
| | Digital assets/personal library does not fit | 7 |
| | Lack the motivation to use the system | 4 |
| | Not wanting to join another OSN | 4 |
| | Sees difficulty in adding a recipe | 4 |
| | Privacy: willing to share the nutritional information | 3 |
| | Seals are not trustworthy | 2 |
| | Only health conscious people would find it enjoyable | 2 |
| | Concerns about how recipes are shared | 2 |
| | Needs a certain amount of people to be interesting | 2 |
| | Better to provide broad guidelines than numbers | 2 |
| | Privacy concerns: Not wanting to share the information | 2 |
| | 6 other items mentioned once each | 1 |

I want her to think that I’m having healthy food. [P1]

There must be much more simplicity for the site because people might want something quick, they want something fun. [P7]

There were many aspects of *VivoSpace* that participants liked. Table 7.6 shows the themes that emerged from this category and the number of comments for each theme. The most frequently mentioned was that logging of health information would be helpful, which is at odds the perceived difficulty in logging this information. The dashboard was the page that was most liked, as well as the recipe sharing aspect of the prototype. The participants liked certain design elements such as the personal preset icons. Encouragingly, participants did like some of the social gaming aspects such as the winners and losers and the idea of using OSNs to track life behaviour.

The themes shown in Table 7.6 for what the participants did like about the paper prototype design of *VivoSpace* can be better understood by reviewing what the participants actually said:

.. even if it helps me as a personal tools to show me how I

Table 7.6: Themes emerging from “Likes about *VivoSpace*” category.

| Theme | # of Comments |
|--|---------------|
| Personal health informatics would be helpful | 16 |
| Likes dashboard | 16 |
| Likes recipe sharing aspect | 9 |
| Like the personal preset icons | 8 |
| Likes winners and losers | 4 |
| Likes the idea of OSN to track life behaviour | 5 |
| Likes newsfeed / familiar Facebook feel | 4 |
| <i>VivoSpace</i> would help one to organize one’s life | 3 |
| Likes MyMap | 3 |
| Likes calendar | 2 |
| 6 other items mentioned once each | 1 |

am doing , I think I would keep using it and the social for me would be optional. [P5]

I like this kind of dashboard. I can see what I have done and how something like it can affect my future. [P6]

The participants shared many recommendations to improve *VivoSpace* (Table 7.7). They were very encouraged by the idea of social gaming and there were numerous suggestions to create challenges to allow groups to assist one in achieving their goals. Another recommendation was to make ones health goals more central to the design. The participants were concerned about managing another OSN, so they suggested that *VivoSpace* should integrate with existing OSNs like Facebook[®]and/or Twitter[®].

An example of how one participant suggested that the creation of group goals would be beneficial to *VivoSpace* can be found in the following quote:

...if I set a goal and people join and try to achieve the same goal then that alone even if we don’t know the person, creates a community say that person is having the same problem that I am having and trying to achieve the same goal, so that alone creates a sense of connection with that person and the progress updates. [P5]

Table 7.7: Themes emerging from “Recommendations for *VivoSpace*” category.

| | Theme | # of Comments |
|---|--|---------------|
| Creation of challenges or groups working together to achieve a goal | | 20 |
| | Goals need to be more central | 12 |
| | Better to allow for customized dashboards and trackers | 7 |
| | Need to integrate with existing OSNs and online calendars | 7 |
| | <i>VivoSpace</i> should remain focused on health information | 2 |
| | Create badges / sharing of other achievements | 2 |
| | Information of friends on Winners & Losers should include more | 2 |
| | Suggestions for dashboard | 2 |
| System needs to provide recommendations on how to live healthy | | 2 |
| | Need to be able to customize the to-do list and calendar colours | 2 |
| | 5 other items mentioned once each | 1 |

7.2.3 Discussion

The interview evaluation of the paper prototypes of *VivoSpace* reveals how the interpretation of the design elements from the **ABC Framework** resonated with the user, and how the design elements can be reworked. The design features that resonated with the users were those associated with personal health informatics aspects and the dashboard. Therefore, the determinants from the **ABC Framework** that were provided in the design were motivation to use *VivoSpace* in order to *Provide Information* and *Social Enhancement* through the ability to enter personal health information, and motivation to change health behaviour by providing a dashboard that supported the building of *Knowledge* of healthy foods and *Self-Efficacy* in one’s ability to live in a healthy manner.

There were many aspects of the **ABC Framework** that can be incorporated in a better manner. Specifically, the *Entertainment*, *Social Enhancement*, and *Social Comparison* determinants were too soft in the design, and the gaming features need to be better incorporated into the design. The suggestion to have group goals and challenges presents some better ways to make social gaming features more central. Furthermore, the design was too complex and tried to incorporate too much material, so where we felt the design was allowing for the *Convenience* of consolidating digital information,

it was actually making the system too complex. We need to remove the digital assets feature and simplifying the design by having less information on each page. Another key aspect that needs to be addressed is the motivation to *Provide Information*, the interview evaluation revealed that the current design does not provide motivation to enter information; therefore, the game design needs to reward users for providing information, which may allow for greater motivation to *Provide Information*.

There were also other aspects of the design of the paper prototype that the interviews revealed. Interview participants were fascinated by the socialization of health information and suggested the creation of challenges and group health activities as motivational features. However, the privacy issues raised still need to be resolved: the next iteration of the design needs to provide the user with a sense of control over their privacy.

7.3 Medium Fidelity Prototype for VivoSpace

The evaluation of the Paper Prototypes for *VivoSpace* through the use of the **ABC Framework** allowed us to discover how to better interpret the determinants of the framework into design elements that both promote use and health behaviour change. The changes that we described in Section 7.2.3 were incorporated into a Medium Fidelity Prototype, which provided an interactive system that was evaluated in a laboratory setting. This medium fidelity prototype was developed using HTML, CSS, Javascript and jQuery with the vision to present a realistic interactive representation of our system. In total there were 32 HTML pages, 1 css file, and 2 javascript files.

The main activity page for *VivoSpace*'s medium fidelity prototype is shown in Figure 7.8. The Medium Fidelity prototype has three main areas. The left side has the list of friends with links to their home page. There is also a link to be able to invite new friends to join *VivoSpace*. The calendar and to-do list is also available on the left side bar. All of these features remain similar to the Paper Prototype with the only minor revision of bringing the list of friends to the top to make the social aspects more prevalent. The top bar shows a picture of the user along with a summary of the gaming

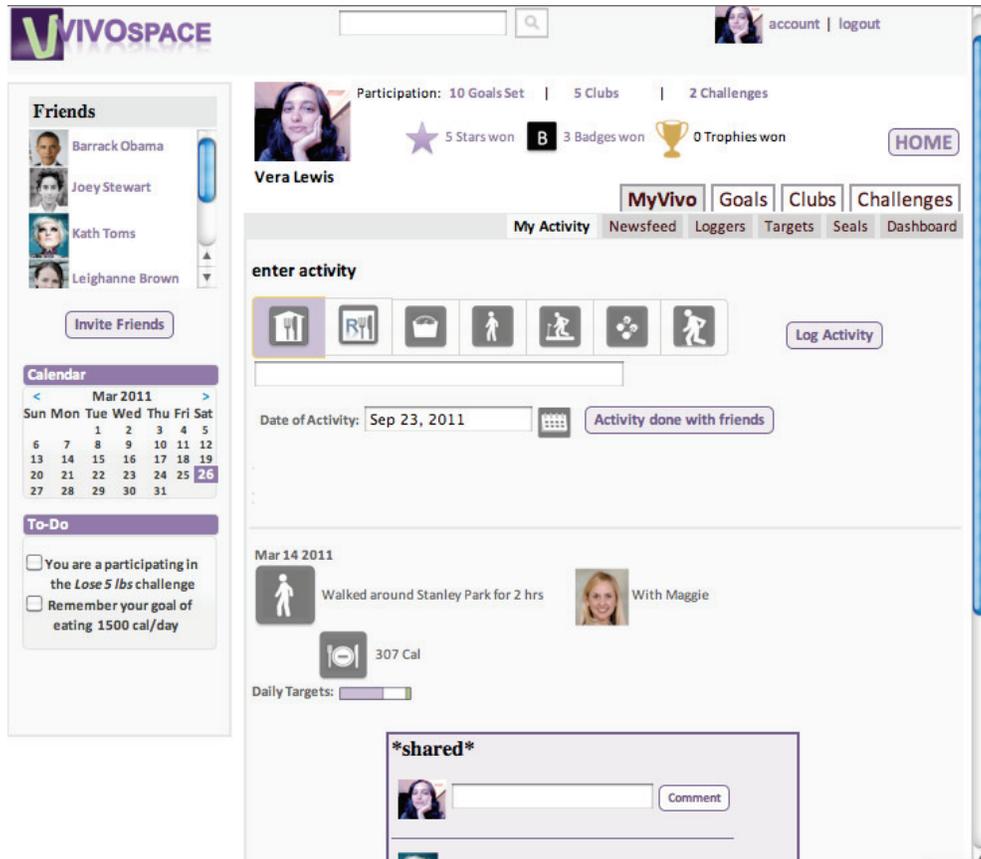


Figure 7.8: A screenshot of the Medium Fidelity Prototype for *VivoSpace* showing the main activity page.

features. There are now three main ways to engage the user through gaming: 1) through individual goals, which are personal and allow the user to earn stars when completed; 2) through clubs, which are collaborative group goals, which allow the user to earn badges; and 3) through challenges, which are competitive group goals, and allow the user to earn trophies. The main area of *VivoSpace* is shown below the goals summary. The user can enter their meals, weight or physical activity. Once entered, *VivoSpace* shows the nutritional value for the food or calories expended for physical activities, and allows the user to share the activity. Once the activity is shared, the user's social network connections (or friends as we will call them) can view it and

comment on it.

7.3.1 Key Functions of Medium Fidelity Prototype

There are 6 main functions that the medium fidelity prototype provides:

1. **Entry of meals and physical activity:** Provides a means to enter meals or activity (Figure 7.8); cumulative daily values for each of the nutrients are displayed with any evidence-based seals if it meets set criteria. The user can change the types of activities that she/he may log, the nutrients that are displayed, and the daily targets. This allows for the following determinants from the **ABC Framework**: *provide information, get information, self-discovery, convenience, entertainment, social enhancement, health outcomes, and environmental cues*.
2. **Newsfeed:** The newsfeed page shows activities and accomplishments that friends shared. Any logged activity above can be shared with the user's friends, and then it will appear on their friends newsfeed page, and they can comment on it. This allows for the following determinants from the **ABC Framework**: *get information, maintain interpersonal connectivity, entertainment, shared identity, knowledge, perceived facilitators, social comparison, social interaction, and personal knowledge of others*.
3. **Dashboard:** The dashboard page shows a summary of how the user is doing in terms of the nutritional intake based on the daily targets that are set. Time series charts are also provided along with a green checkmark for those nutrients where the target is met, and a red high or low where the target is not met. Charts are displayed for each nutrient or the user's weight when the icon is clicked on the summary table (Figure 7.9). This allows for the following determinants from the **ABC Framework**: *get information, entertainment, self-discovery, convenience, knowledge, health outcomes, perceived barriers, perceived facilitators, incentives, and self-efficacy*.
4. **Personal goals:** The goals section provides the ability to track and create new health goals, and to view rewards for successes. The current active goals are shown with the nutritional intake compared against the target goals; charts and definitions of nutrients are also provided. New goals can also be

- created from a library of goals such as lose weight and healthy heart. Stars are earned when goals are successfully completed; users can view their own stars and their friends' stars. This allows for the following determinants of use from the **ABC Framework**: *social enhancement, entertainment, goals, self-discovery, knowledge, health outcomes, self-efficacy, perceived barriers and facilitators, and attitude.*
5. **Group goals (clubs)**: Clubs are similar to goals with the exception that users friends are invited to participate in the club. When viewing current clubs users can see how other members of the club are doing. Members of the club can comment on people's progress in the club. Badges are earned when members successfully complete the requirements. Users can view and comment on their friends' badges. This allows for the following determinants of use from the **ABC Framework**: *social enhancement, entertainment, maintain connectivity, self-efficacy, get information, provide information, shared identity, goals, perceived facilitator, attitude, social interaction, social identity, sense of belonging and self-efficacy through others*
 6. **Competitive goals (challenges)**: Challenges are similar to clubs with the exception that there are competitive and there is only one winner. Challenges display a leaderboard. The winner of challenges earns a trophy. The determinants for use are the same as those listed for *group goals*.

Screen captures for all the pages of the medium fidelity prototype for *VivoSpace* can be found in the Fifth Appendix.

The medium fidelity prototype shows less information on each page, which make the design less complex than the paper prototypes. The entry of the food and physical activity and the newsfeed is easier to navigate and simplified. The goals and gaming features were the biggest change that were made to the design, as there are now more central by placing a summary at the top of the site. Furthermore, the goals now have three different levels: individual, group, and competitive allowing user to participate in the manner that suits them.

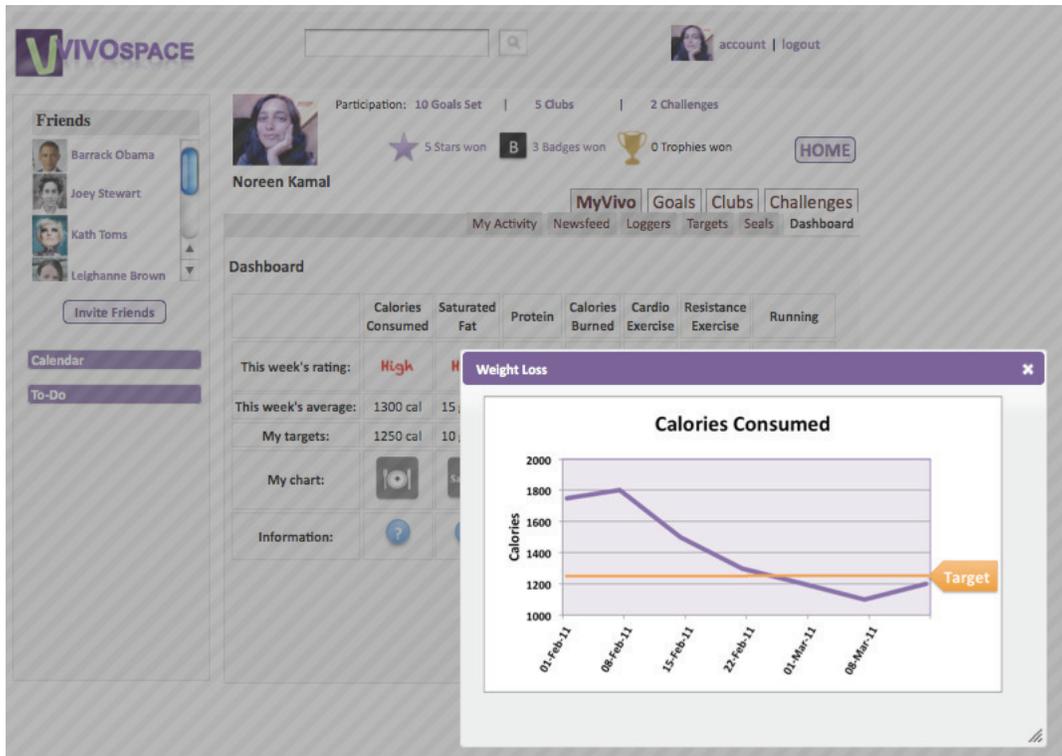


Figure 7.9: A screenshot of the Dashboard page of the medium fidelity prototype for *VivoSpace* showing the calories icon selected from the dashboard summary table, which displays the historical chart for Calories consumed.

7.3.2 Evaluation Methods

The methods to evaluate *VivoSpace* based on the determinants of the **ABC Framework** involved multiple laboratory experiments. The purpose was to determine if the design of *VivoSpace* provided the determinants for use of the OSN and motivation to change health behaviour. A total of 36 adults participated in the experiments. They were recruited through university listserves, posters located around campus, and through advertisements on Craig’s list.

The determinants of **appeal** were measured directly using self-report through questionnaire feedback after the participant completed specific tasks on the medium fidelity prototype. Some of the **belonging** determinants

were also enquired directly. However, measuring **belonging** cannot truly be measured through direct inquiry such as self-reports, as users' perception about belonging and actual sense-of-belonging are often divergent. For this reason, we turned to the field of behavioural economics and adopted the helping game experiment [103] to evaluate if *VivoSpace* evokes indirect reciprocity. The method for how this experiment was adapted for the evaluation of the medium fidelity prototype is described in the Helping Game Experiment section. Similarly, **commitment** is a temporal dimension and difficult to measure in a 1-2 hour experiment; however, the in-group experiment [29] is an indirect means to evaluate if *VivoSpace* promotes group commitment. All experiments are conducted on a MacBook Pro laptop with a magic mouse. The *VivoSpace* application is displayed using Firefox[®] web browser.

18 of the 36 participants (Participant A group) completed all three experiments. These 18 participants first complete the individual task experiment, which takes approximately 1 hour to complete. Participant B group (18 total) then individually joins each participation in the A group, and they complete the helping game and group commitment experiments together in pairs, which takes another 1 hour to complete. Each participant in the A group were remunerated \$10 and each participant in the B group were remunerated \$5. A step-by-step description of methods and questionnaires used in the laboratory experiments are provided in the Sixth Appendix.

Participants

Of the Participant A group, 10 were male and 8 were female. There were 7 aged 19-24, 5 aged 25-34, 5 aged 35-49 and 1 was aged 50-64. The ethnic identity for this group was: 10 were Canadian, 3 were West Asian, 1 was Chinese, 1 was Hispanic, 1 was First Nations, 1 was European and 1 was Australian. The majority were students: 5 were undergraduate students and another 5 were graduate students. Of the remaining participants, 4 were unemployed, 1 was a canvasser, 1 was a cleaner, 1 was a postdoctoral fellow and 1 was a physician.

In the Participant B group, 10 were male and 8 were female. There were 12 aged 25-34 and 6 aged 35-49. 8 were Canadian, 3 were West Asian, 3 were European, 1 was South Asian, 1 was Australian, 1 was Chinese and 1 was American. 6 were graduate students and 3 were software developers. The occupations of the remaining 9 were: employment assistance worker, post-doctoral fellow, professor, college teacher, researcher, software development manager, scientist, education program manager, and administrator.

The participant distribution did have diversity in gender and occupation. There was also some diversity achieved in age and ethnicity. The importance of achieving a diverse participant base is important because *VivoSpace* is being designed for use by a broad population. Therefore, we aimed to achieve a representative sample of participants.

Individual Task Experiment

The individual task experiment methodology is drawn from traditional usability tests. During this experiment, each participant is asked to complete a group of tasks on *VivoSpace*. There are six groups of tasks, which correspond to the 6 key functions that are outlined in Section 7.3.1. After each task group, the participant is given a questionnaire to complete. The questionnaire contains statements, where each statement correlates to a determinant from the **ABC Framework**. The participant can provide their level of agreement or disagreement to each statement using the 7-point Likert scale that is provided, where 1 is strongly disagree and 7 is strongly agree. Most of the determinants that were enquired are from the **Appeal** dimension, but there are also some from the **Belonging** dimension. Those **Belonging** determinants enquired through this method are chosen because they are easy to inquire directly.

The follow-up questionnaire after each group of tasks included statements such as the following, which correspond to a determinant from the **ABC Framework** (full questionnaires for each of the task groups can be found in the Sixth Appendix):

- *I would be able to gain information about myself and my capabilities by using*

- a system like this (**Appeal**: self-discovery)
- The newsfeed would allow me to stay connected with my friends and family (**Appeal**: maintain interpersonal connectivity)
 - The newsfeed would allow me to view how my friends and family are staying healthy (**Belonging**: social comparison)
 - It would be entertaining to participate in clubs (**Appeal**: entertainment)

Helping Game Experiment

The determinants in the **Belonging** dimension of the **ABC Framework** are difficult to measure through direct inquiry methods such as those described above in the individual task experiment. Therefore, indirect experimental methods are used to measure the determinants that contribute to **belonging**. Indirect reciprocity is a critical factor that facilitates sense of belonging, and other related determinants such a social categorization and group comparison. The Helping Game Experiment from experimental behavioural economics has shown to provide an understanding of indirect reciprocity and group belonging [103]. This experiment is based on the repeated helping game developed by Nowak and Sigmund [80, 81]. The helping game experiment evaluates indirect reciprocity, which is necessary for OSNs to develop social interaction and cooperation through group participation, feedback and discussion. Experimental behavioural economics is a leader in developing laboratory experiments that indirectly measure behaviours, as often individuals are not able to describe why or how they behave in particular situations. For this reason, we adopted the experiment described by Seinen et al. [103] to be applied to the evaluation of *VivoSpace* in a laboratory setting. In the Seinen et al. experiment, there was no actual activity that the randomly assigned pairs were helping each other on. They were simply being asked if they would help or not help. We adapt this experiment to be applied to providing help in completing tasks on *VivoSpace*.

We employ a mixed design to the helping game experiment in a similar manner as the Seinen et al. experiment [103]. In our experiment, after Participant A has completed the individual task experiment, she/he is

joined by Participant B. Participant A is now an expert on *VivoSpace* and understands how to use it, and Participant B is a novice. Participant A and B do not know each other. This set-up provides a good backdrop to apply the Helping Game Experiment. The following rules are provided to the participants: 1) there are 26 tasks that Participant B must complete, which are shown on a sheet of paper to both participants; participant A has already completed all of these tasks; 2) each task has a cost associated with it; there are 5 tasks that cost \$5 and there are 21 tasks that cost \$1; participant A is provided with \$50, which is provided as 50 fake \$1 bills; participant B has no money; 3) every time, Participant A helps B, she/he is given a point, so the maximum points that can be earned is 26; Participant A starts with no points; 4) in the first condition, Participant B has 17 points. In the second condition, no information is provided on Participant B's points; 5) before Participant B can start each task, Participant A must decide if she/he is going to help her/him; and 6) the object of the game is to earn points.

Therefore the mixed design experiment has 2 variables with two conditions in each variable. The first variable is the two conditions assigned to each pair: information about participant B's points is provided or no information about participant B's points is provided. The second variable is within subjects and it is the high cost tasks and low cost tasks. Therefore, the 4 conditions in this mixed design are: information provided and high cost, information provided and low cost, no information provided and high cost, and no information provided and low cost. We are looking to see if the effect of helping on *VivoSpace* will produce different results from the Seinen et al. [103] experiment, which found that having information about their partners points resulted in a statistically significant difference in the number of times help was provided. The helper (participant A) is also asked for motivations to help or not help and if any strategy was invoked during the helping game through open-ended questions.

Group Commitment Experiment

Although measuring **Commitment** to *VivoSpace* and new health behaviour is not possible in a laboratory experiment, group commitment has been measured in the laboratory by social psychologists. If *VivoSpace* can invoke group commitment, it will assist in developing commitment to the *VivoSpace* system and commitment to new health behaviours. The group commitment experiment has been adapted from Ellemers et al. experiments [29, 30]. The premise of the experiment is that group commitment can be measured by creating groups where the group boundaries are permeable. In other words, individuals have the option of staying with the group or moving to another group. The people in the group do not know each other and by imposing a situation where group status is provided and compared to other groups different conditions are created.

Again, we use a mixed design experiment. The same partners from the helping game experiment are now told that they are team, and must complete a 10-question multiple-choice test on *VivoSpace*. The test contains obscure questions that are not readily evident in the *VivoSpace* prototype. They are allowed to navigate through the system as they decide together on the response to each question. After the test is complete, the participants are separated and provided with their score and the overall average score for this test. One person is told they scored 70% and the average for the test is 50%, and the other person is told they scored 70% and the average for the test is 90%. The two conditions are counter balanced, as half the time the person that was the helper (participant A) in the previous experiment is given the below average condition and the other half is given the better than average condition. The participants are then given the option of group mobility as two separate questions with different caveats. The first caveat is that they can leave their partner but they will not be able to use *VivoSpace*, and the second caveat is that it would cost them \$50 to leave. This mixed design experiment has four conditions: above average stay with *VivoSpace*, above average stay at no cost, below average stay with *VivoSpace*, and below average stay at no cost. The reason to stay with their partner to continue to

use *VivoSpace* or leave their partner but also to lose the use of *VivoSpace* was also inquired through an open-ended question.

7.3.3 Results

The results for all three experiments are described below.

Individual Task Experiment

The results of the 7-point Likert questionnaire provide an understanding of how each of the 6 task groups promoted the **Appeal** determinants and some **Belonging** determinants of behaviour being sought through *VivoSpace*. The responses were all 7-point Likert scale, where 1 was strongly disagree and 7 was strongly agree. Each question is inquiring about a behavioural determinant from the **ABC Framework**.

Figure 7.10 shows the mean and standard deviation to the questionnaire responses for the first task group. This first group of tasks involved entering an activity, which was a meal at a local restaurant chain, and changing target values for nutrients and types of activities that can be logged. The results show that the entering activity task group most strongly endorses the following determinants: self-discovery, get information, convenience and health outcomes. The design does not favour the determinant to provide information. The remaining determinants, entertainment, social enhancement, and environmental cues, are neither strong nor weak. For this reason, we have run further statistical analysis on them. Factorial ANOVA analysis on these three determinants was performed, where the factors were gender and age group. It was found that there was a statistically significant difference between gender for finding the entertaining determinant ($F(1,12)=4.6$, $p=0.05$), where the mean difference between male and female is -1.4 with females finding it more entertaining than men.

Figure 7.11 shows the mean and standard deviation for the questionnaire responses to the second task group. This task group was based on the newsfeed page and commenting on their friends activities. The responses all show very good agreement to both the **Appeal** and **Belonging** determinants

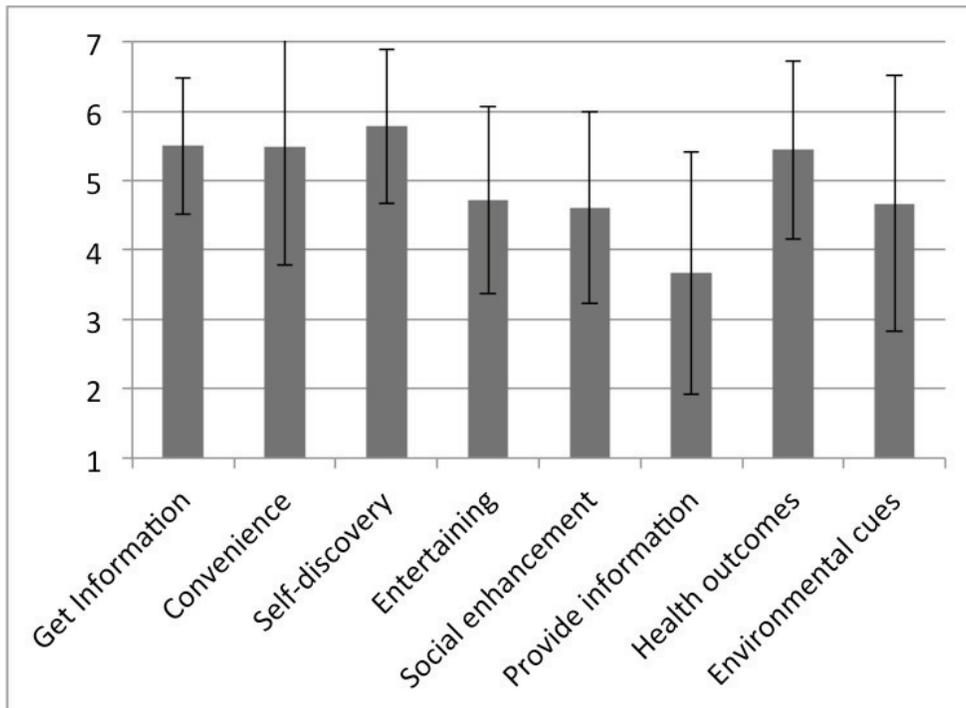


Figure 7.10: Mean 7-point Likert responses for *Entering Activity* task group showing the relevant **Appeal** determinants. The error bars represent the standard deviation.

that the design is aiming to promote. The **Appeal** determinants are *get information, connection to friends and family, entertainment, shared identity, knowledge, and perceived facilitators*. The **Belonging** determinants are *social comparison, personal knowledge of others, social interaction, personal attraction to others through similarities, and social norms*.

Figure 7.12 shows the mean and standard deviation for the responses to the third task group. This inquiry is around the *dashboard* page. There is very strong agreement for many of the **Appeal** determinants especially *get information, self-discovery, convenience and knowledge*. There is less agreement in the *dashboard* providing any value to *perceived barriers & facilitators*, and it also does not provide a very strong incentive to healthy living. Further analysis by factorial ANOVA shows no statistically significant

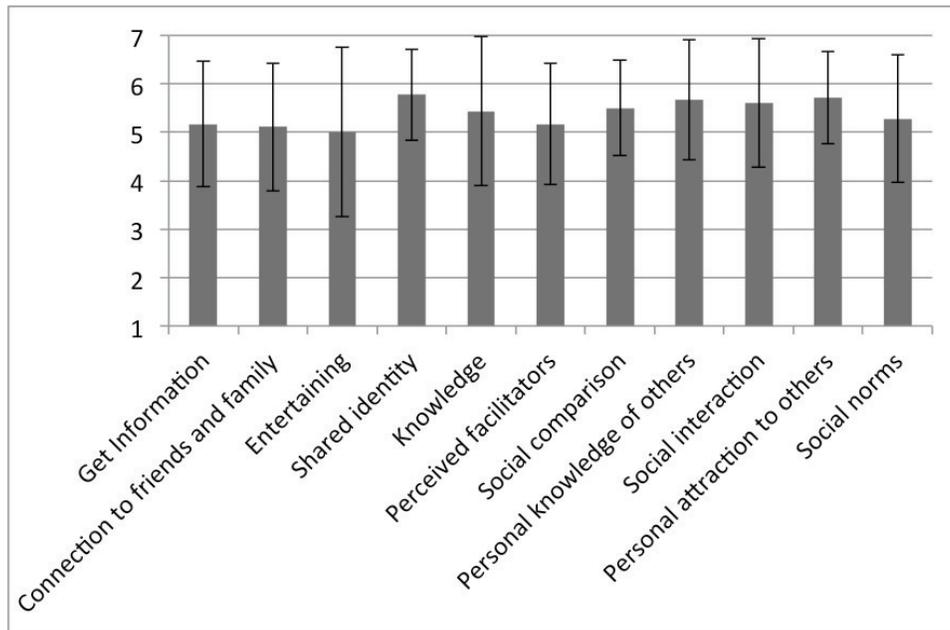


Figure 7.11: Mean 7-point Likert responses for *Newsfeed* task group showing the relevant **Appeal** and **Belonging** determinants. The error bars represent the standard deviation.

differences between gender and age for these determinants.

Figure 7.13 shows the mean and standard deviation for the responses to the fourth task group, which is based on goals and star rewards for successfully completing goals. Overall the determinants for the goals tasks were attained through the design of *VivoSpace*. However, the participants felt that receiving and sharing star rewards was not very entertaining, and they would not use it to *enhance their social position*. Further analysis of these two determinants through a factorial ANOVA show that there is no statistical difference between gender and age groups.

Figure 7.14 shows results for the fifth (clubs) and sixth (challenges) task group. There was good agreement that the design of the clubs pages with the **Appeal** and **Belonging** determinants, but the design of the challenges pages scored lower for almost all determinants. Further, the design did not support *social enhancement* especially for clubs. Further analysis factorial ANOVA

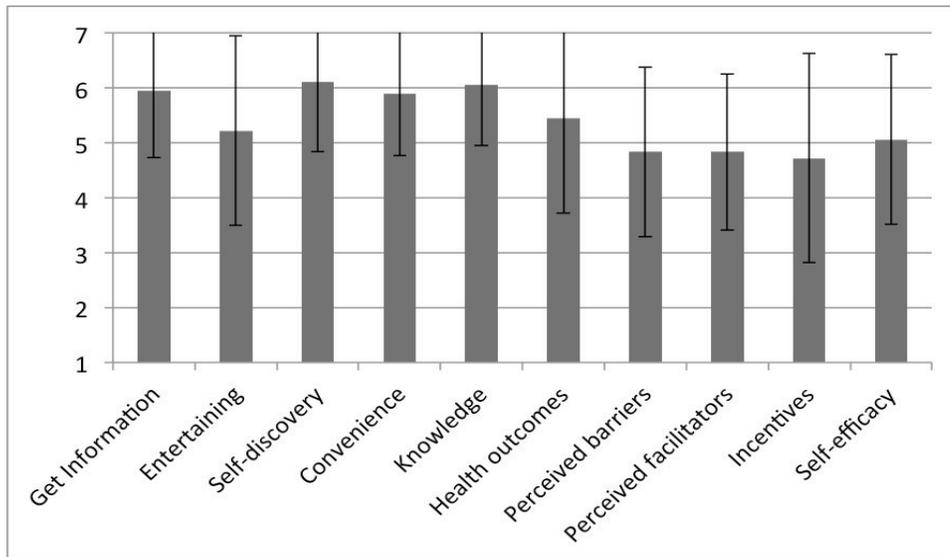


Figure 7.12: Mean 7-point Likert responses for *Dashboard* task group showing the relevant **Appeal** determinants. The error bars represent the standard deviation.

found that there is a statistically significant difference in the challenges task group between male and female in *social enhancement* ($F(1,12)=5.777$, $p=0.033$) with a mean difference between male and female of 1.8. Statistically significant difference in the interaction between gender and age groups for subjective norms ($F(2,12)=4.22$, $p=0.041$) was found showing that different genders in different age groups felt that challenges promoted *subjective norms*.

Helping Game Experiment

A mixed design factorial 2x2 ANOVA is run on the results of the Helping Game Experiment. The dependent variable is the percent of times Participant A helped Participant B. The within subject variable is the cost (cheap or expensive) for the tasks. The between subject variable is information provided or no information provided about Participant B's score. The results show that there is a significant difference between the cheap and expensive tasks ($F(1, 16)=5.54$, $p=0.032$). The mean difference between the cheap and expensive is 23.86%. This is not surprising and consistent with the Seinen et

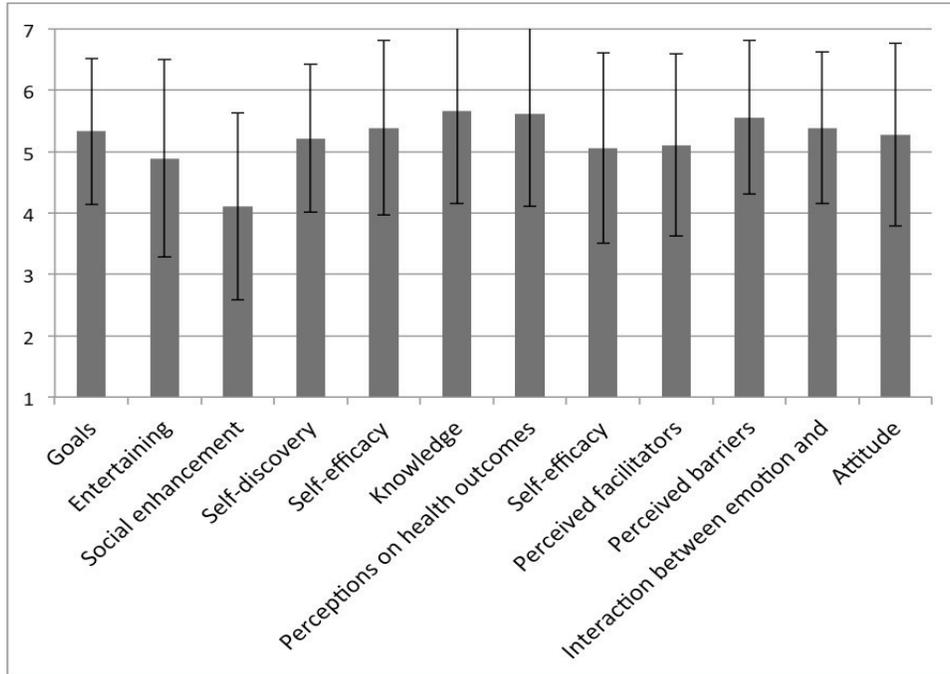


Figure 7.13: Mean 7-point Likert responses for *Goals* task group showing the relevant **Appeal** determinants. The error bars represent the standard deviation.

al. experiment [103]. This result also shows that there is validity to the use of fake money as the cost of the tasks played a role in participants decision to help or not help.

The analysis of variance for knowledge of Participant B's score in the 2x2 factorial ANOVA reveals divergent results from the Seinen et al. experiment [103]. Interestingly, there is no statistically significant difference between the two conditions: information and no information ($F(1, 16)=0.51$, $p=0.386$). This provides some evidence that *VivoSpace* generates indirect reciprocity because the choice to help or not help was not influenced by the points accumulated but rather some other factors. For this reason, we must assume that *VivoSpace* played a factor in the decision to help (or not help). Figure 7.15 shows the estimated marginal means and standard deviation for the percent of tasks that Participant A helped in the mixed de-

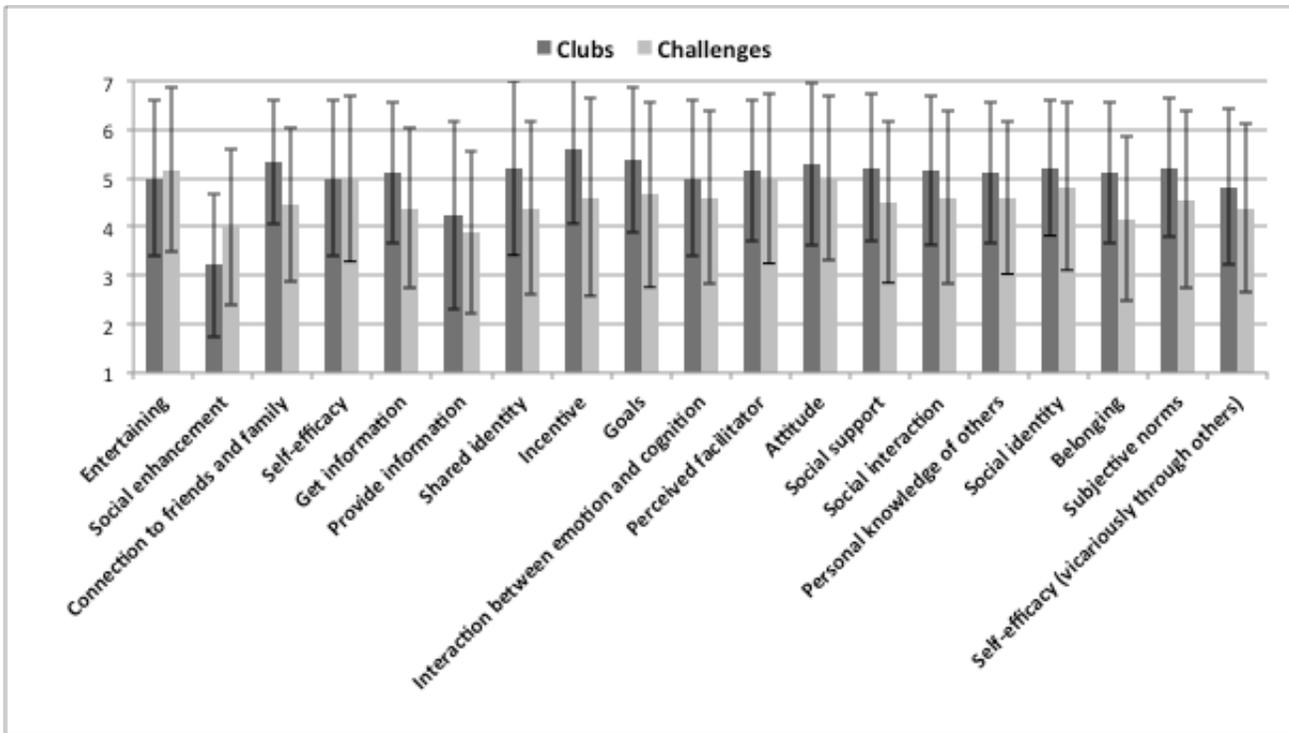


Figure 7.14: Mean 7-point Likert responses for *Clubs* and *Challenges* task group showing the relevant **Appeal** and **Belonging** determinants. The error bars represent the standard deviation.

sign helping game experiment. Further, there was no statistically significant interaction effects between the information condition and the cost condition ($F(1,16)=2.34, p=0.146$).

When the helpers (Participant A) were asked about their motivations for helping, the answers varied greatly. Some said that it was because they wanted to be helpful, others wanted to gain points, and some were pragmatic and said they helped so that they were not merely observers in the game. It was also interesting to learn about the reasons for not helping, as often it was because they felt that the tasks were easy because *VivoSpace* was simple to use. This illustrates a limitation in the application of this experiment to measure indirect reciprocity, as we are basing our prediction on the design of *VivoSpace* to invoke a desire to help. However, this qualitative data does

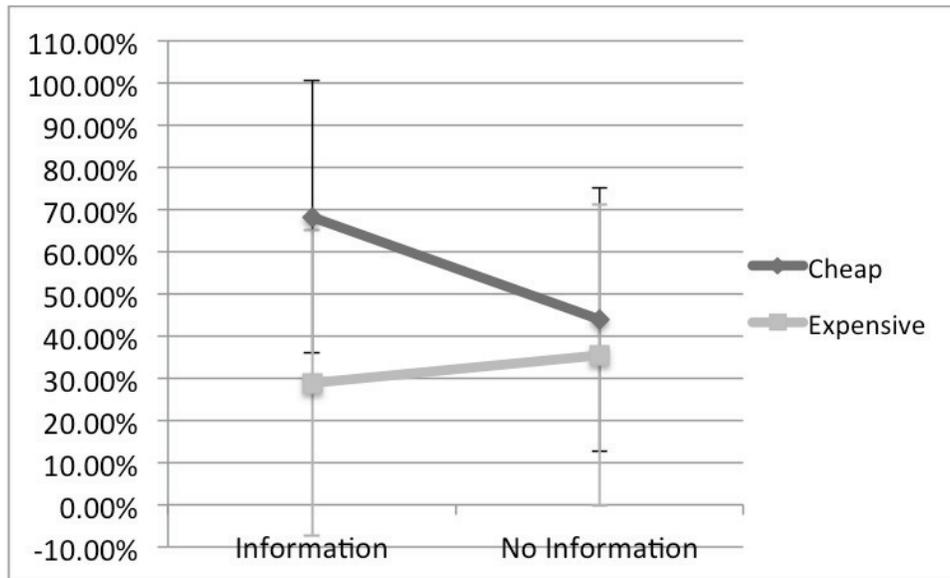


Figure 7.15: Estimated marginal mean values and standard deviation for percent of tasks helped during *helping game experiment* ($n=9$ for each condition).

reveal engagement in the *VivoSpace* system during the experiment. For those participants who did know their partners score, this seemed to play a factor in their helping strategy to varying degrees, as many participants said that they were not too concerned by their partners score.

Group Commitment Experiment

The results of the group commitment experiment reveal that participants were inclined to stay with their groups rather than leave them at some cost. The results are shown on Figure 7.16.

After pairs of participants completed their test on *VivoSpace*, each participant was told that they either performed better than the average or worse than the average. They were then asked if they would leave their partner and no longer use *VivoSpace*, and they were also asked if they would leave their partner for a cost of \$50. The results show that most participants are inclined to stay with their partner even those that were told that they performed poorly. Statistical analysis was run on this 2x2 mixed design through Chi-

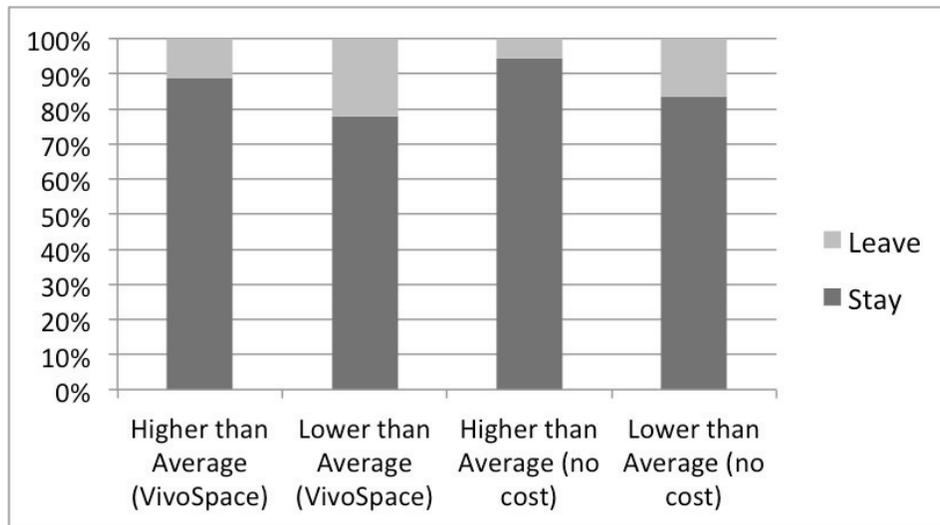


Figure 7.16: Percent willing to stay or leave in the *group commitment experiment* (n=18 for each condition).

Square test of association. The results show no statistically significant results between the test performance condition (higher and lower than average) and the choice to stay with the group for *VivoSpace* (Chi-Square(1)=1.639, $p=0.200$). Furthermore, there was no statistical difference between the test performance conditions (higher and lower than average) and the choice to stay with the group at no cost or leave for \$50 (Chi-Square(1)=1.172, $p=0.279$). This shows that *VivoSpace* did promote group commitment within the 36 adults that participated in the experiment because the use of *VivoSpace* promoted staying with the team despite poor performance.

We also analyzed the qualitative results, where reasons for staying to continue to use *VivoSpace* or leave and losing the use of *VivoSpace*. For those participants that performed better than average, their reasons were more indicative of the group dynamics, and they chose to stay because they found their partner to be helpful and knowledgeable. For most of those that did worse than the average, their reasons for staying with their partner were based more on the desire to continue to use *VivoSpace*.

7.3.4 Discussion

The **ABC Framework** provided a foundation to measure the determinants for use of an OSN designed for health behaviour change. When the determinants within the **Appeal** dimension were enquired through questionnaire responses after interacting with the system, it was found that many of the determinants were met in the design of *VivoSpace*'s medium fidelity prototype. However, there was variation in the responses between the *clubs* and *challenges* aspects of the design especially between males and females. For this reason, it would be beneficial for the design to combine *goal*, *clubs* and *challenges* into a single component that allows for participants to decide to invite friends and make it competitive or collaborative. This would allow the *goals* component to appeal to the majority of users. The individual task experiment also revealed the weakest area of the design, which is motivation to *provide information*, an integral part of the system. Without data being logged, the other components in the design become less meaningful as only partial health information may be logged. Therefore, the design of *VivoSpace* should be iterated to ensure stronger motivation to *provide information*. Some **Belonging** determinants were also inquired in this experiment, and the result show that the *newsfeed* and *clubs* components of the design provided the greatest support for these social determinants of use and health behaviour change. In summary, the *Appeal* determinants from the **ABC Framework** can be measured through a task experiment, where the determinants are inquired through questionnaire feedback with Likert-scale responses.

The *helping game experiment* provides evidence that the medium fidelity prototype for *VivoSpace* promotes indirect reciprocity and by extension **Belonging** determinants. Indirect reciprocity would promote the following belonging determinants: *subjective norms*, *shared identity* and *social interaction with others*. Since there was no statistically significant difference between having and not having information about their partners score (status), we can assume that *VivoSpace* played a part. This is because, in the Seinen et al. experiment, the knowledge of their partners score did

play a statistically significant difference than those who did not have this information [103]. Although there are many variables that could interfere with this experiment, these are encouraging results. By showing that there was no statistically significant difference, the motivation to help or not help would be based on the design of the prototype rather than their partners score. One limitation of our adaption of this experiment is that we used fake money; however, the results from the within subjects variable (expensive and cheap tasks) did show a significant difference. These results provide evidence that the limitation of fake money did not play a role in limiting the experiment. The results of the open-ended responses (for motivation to help) also supports that this experiment is a measure of indirect reciprocity, as many participants said that they helped because they enjoy helping others or it is in their nature to be helpful. When we asked about their motivation to not help, another limitation of our adaptation was revealed, as many said that it was because they found the task to be easy. Therefore, future use of the helping game experiment should consider other aspects of help beyond usability of the system. One example may be to help their partner understand the nutritional value of a meal through the *VivoSpace* system.

The group commitment experiment shows that *VivoSpace* does provide group commitment. Participants were willing to stay with their groups even those participants that performed worse than average. Furthermore, when the cost to leave the group was to block use of *VivoSpace* or a cost of \$50, there was still no statistically significant difference. Showing that *VivoSpace* does promote commitment as much as economic gain. Although the answer to the question to stay or leave question was made independently and privately, there is a risk that participants are not willing to admit their desire to leave the group. This is a limitation of this experiment.

It is difficult to assess how the **ABC Framework** can be adapted or iterated based on the results of the evaluation of the medium fidelity prototype of *VivoSpace*. Although we could use the determinants from the framework to evaluate the prototype, we could not evaluate the interactions between the determinants to use the system and the determinants for behaviour change. The primary reason for this is because we could not truly assess

health behaviour change in the short timespan of a laboratory experiment. At best, we can make some preliminary observations of how the framework might work to inform the design. The **Appeal** determinants *social enhancement, entertainment, goals, and Perceived Facilitators* can be linked to the **Belonging** determinants *group norms, social categorization, and subjective norms*, which can be provided through an engaging social gaming experience. The social gaming experience can be enhanced and also looser in its coupling to the goals features. These changes were made in the high fidelity prototype of *VivoSpace*.

Chapter 8

Conclusions

The main goal of this thesis was to clearly explicate the design of OSNs for health behaviour change from a theoretical approach. We distilled the determinants for use of OSNs and health behaviour change to develop the **ABC Framework**, which was used in a UCD process to both design and evaluate an OSN for health behaviour change. The UCD process included Initial User Inquiry through questionnaires and interviews, paper prototypes, medium fidelity prototype, and the high-fidelity prototype. The high-fidelity prototype was evaluated in a field experiment using the **ABC Framework**. This research yielded design principles for OSNs for health behaviour change. This chapter summarizes the primary contributions of this research. It also discusses the secondary contributions that came out of the research, as well as discussion of direction for future research. The lessons that were learned from this work is also described.

8.1 Primary Contribution

The primary contributions of this research are the evaluated and iterated **Appeal Belonging Commitment Framework**, the design principles for an OSN for health behaviour change, and the high-fidelity prototype of *VivoSpace* that was able to change some health behaviour.

8.1.1 Appeal Belonging Commitment Framework

Previous research in the design of technology including social technology has had limited (if any) consideration of theoretical models for health behaviour change. The **Appeal Belonging Commitment (ABC) Framework** is

a conceptual framework for the design and evaluation of OSNs designed for health behaviour change that is derived from theoretical models. This framework addresses the gap in research within the human-computer interaction community by providing a theoretically based framework that allows for the design and evaluation of OSNs for health behaviour change.

Collation of Theoretical Models to Obtain the Determinants for Use of OSNs and for Health Behaviour Change

The **ABC Framework** was derived from theoretical models for use of OSNs and for health behaviour change. We reviewed and distilled the following theories for use of OSNs: the *Uses and Gratification Theory*, *Social Influence Model*; *Social Identity Theory*; *Common Bond Theory*; *Common Identity Theory*; *Theory of Organizational Commitment*; and *Behaviour Chain for Online Participation*. The individually based and socially based determinants for use of OSNs were drawn from these theories. Temporal stages and attachment categories were also considered. Overlap between the determinants in various theories led to a collation of the determinants, and a broad perspective of all the aspects of behavioural determinants that lead to use of OSNs.

Similarly, we reviewed and distilled the following theories for health behaviour change: the *Health Belief Model*; *Social Cognitive Theory*; *Theory of Reasoned Action*; *Theory of Planned Behaviour*; *Common Sense Model*; and the *Transtheoretical Model*. The individually based and socially based determinants were drawn from these theories, as well as the stages of change. We were able to obtain a fuller picture for determinants of health behaviour change by considering the overlap between the theories as well as the determinants that were unique to only single theory. This approach contributes to existing theories by providing a theoretical framework that is more comprehensive; for example, the *Social Cognitive Theory* add *Self-Efficacy* to the *Health Belief Model*, but the *Theory of Reasoned Action* adds *Attitude towards Health Behaviour* to both the *Social Cognitive Theory* and the *Health Belief Model*, but neglects *Knowledge*, which was considered in the *Health*

Belief Model and the Social Cognitive Theory.

Interplay Between the Determinants for Use of OSNs and Determinants for Health Behaviour Change

The interplay is the relationship between the determinants, and in particular the interplay between the determinants within the two domains: use of OSNs and health behaviour change. The **ABC Framework** is then the combination of the individual and social determinants for use of OSNs and health behaviour change combined with the interplay between the determinants. The interplay between the determinants allows designers to better interpret the theoretical framework so that they can design and evaluation OSNs based on the interplay between the determinants of the two domains. The interplay between the determinants for use of OSNs and the determinants for health behaviour change were validated through the field experiment. The interplay allows the design principles to develop for an OSN designed to change health behaviour. By explicitly showing how specific determinants for use of OSNs such as *Provide Information* can contribute to health behaviour change by showing the determinants that it is suppose to influence. Therefore, the **ABC Framework** can be used to evaluate OSNs for health behaviour change, which shows how the design should be iterated to obtain more change in Health Behaviour. For example, the field experiment of our high-fidelity prototype revealed that many of the individually-based determinants such as *Self-Discovery* were met, which led to an increase in *Self-Efficacy*, but the design needs to promote the socially based determinants for use of OSNs such as *Social Categorization* to encourage *Subjective Norms* and other social determinants for health behaviour change to occur. The final **ABC Framework** is described in Chapter 5.

Using the ABC Framework

The *ABC Framework* can be used by researchers to both design social technologies for health behaviour change as well as evaluate social technologies

for health behaviour change. By having a theoretical framework that broadly collates the determinants for use and health behaviour change, researchers can design social technologies that considers all aspects. Furthermore, researchers can use the framework to evaluate existing social technologies. This can be done through pre- and post-experiments to determine if there is any change in the determinants for health behaviour, or they can use the framework determine if the determinants for use are met in the design in a manner similar to a heuristic evaluation.

8.1.2 Design Principles

We developed design principles based on the **ABC Framework** and through the results of the field experiment. The design principles that we have developed contribute to future research as well as the development of new commercial application that are designed from a theoretical foundation, which should lead to more efficacious change in health behaviour. The final **ABC Framework** showed the determinants for use of OSNs and health behaviour change change, and the interplay between them, so specific design principles were developed that link back to the theoretical framework. The **ABC Framework** informs the design of OSNs for health behaviour change, which is critical as the number of websites and mobile applications in this domain continues to grow. Through the application of the framework, the growing number of commercial applications can be designed to lead to more meaningful health behaviour change for its users. The determinants for use of OSNs from the **ABC Framework** were formalized into design principles, which had been utilized and evaluated in the design of *VivoSpace*. These design elements were matched to the determinants for use of OSNs and health behaviour change.

This research has shows that the design principles include both individual or single-user features as well as social features. Individual features include such elements as the dashboard, private logs, personal goals (when the user chooses not to invite any friends to complete a goal with them), and accumulation of points with levelling-up game features. Although an OSN

is social in its design, HCI research has shown that even a purely socially designed OSN such as Facebook[®] has personal motivations for use, such as loading photos to have a personal store of the photos and access to these photos from any location [125], which is also validated through our theoretical approach. Social OSN features such as shared log entries, commenting on logs, completing a goal with friends, and awareness of friends points and levels are also included in the design principles.

The design principles as outlined in Chapter 6 include both general and specific principles. These design principles and features can be further abstracted and viewed through various lenses to create new interaction techniques that will lead to future research in the design of OSN for health behaviour change. Furthermore, simplified design principles are provided for use by industry as described in Section 6.18.

8.1.3 The *VivoSpace* Prototype

The high fidelity prototype called *VivoSpace* of an OSN for health behaviour change was developed through a UCD process with the **ABC Framework** providing the points of inquiry for the evaluation through each stage of the UCD process. The prototype was able to positively change some of the individual determinants for health behaviour change in individuals that are associated with a primary care clinic. Specifically, *VivoSpace* was able to change *Attitude Towards Physical Activity*, *Perceived Self-Efficacy for Eating a Health Diet*, *Perceived Self-Efficacy Towards Physical Activity*, and *Stages of Change*. Furthermore, *VivoSpace* was also able positively change health behaviour. There was statistically significant results for participants associated with a primary clinic in the Patient Activation Measure (PAM[®]), which is a validated clinical measure for patient's knowledge and confidence in managing their own health. Positive changes were also seen for the patients associated with a clinic for the number of times that participants walked per week. The *VivoSpace* high fidelity prototype is described in detail in Chapter 4.

8.2 Secondary Contributions

Through the theoretically based UCD methodology that resulted in the primary contributions described in Section 8.1, there were two secondary contributions that also resulted from this research. We obtained an understanding of the target user groups that would most benefit from an OSN designed for health behaviour change. Furthermore, we were also able to obtain an understanding of the ability to maintain the acquired changes after use of the OSN has ended.

8.2.1 Target User Groups

An OSN designed for health behaviour change is most efficacious when the number of connections that a user has is relatively small (in the order of 10), as apposed to a large diffuse social network connections as we see on large social network sites such as Facebook[®]. This allows for the ability to have the most impact on the health determinants from the design principles that are provided from this research. Furthermore, the small social network user group should also be considered. Based on the results of the field experiment, we were able to compare two groups in their use of an OSN designed for health behaviour change: 1) a close-tie social network group that was not associated with the same primary medical clinic; and 2) a loose-tie social network group that was associated with the same primary medical clinic. The results showed that the loose-tie clinical group were more engaged in the social aspects of *VivoSpace*. Additionally, the clinical group showed some statistically significant change in the self-efficacy and attitude determinants for health behaviour change, and this group also showed a positive change in their Patient Activation Measure (PAM[®]).

These results show that an OSN designed for health behaviour change shows the greatest impact when applied to a group of individuals that come from the same socioeconomic strata and share the same primary medical clinic that has a focus on wellness. The potential to use OSNs with clinical patients, who would benefit the most from preventative clinical interventions

can be substantive in reducing healthcare costs through the prevention of serious and costly medical illnesses.

The current understanding of the efficacy of an OSN for health behaviour change on other groups is currently limited to the two groups included in the field experiment. Future work can be done by testing prototypes on different groups such as First Nations groups, who have epidemic prevalence of diabetes. This can potentially show how the design needs to be modified for specific cultural groups, and its ability to change the determinants for health behaviour change.

8.2.2 Maintained Health Behaviour Beyond Use

The use of ICTs for health behaviour change needs to be designed with the end-point of health behaviour change rather than habitual use of the ICT. We need to ensure that dependency on the tool is not being created through these technical solution. Instead, we are designing this OSN with the end point of building individual's ability to maintain healthy behaviour. Thus the OSN should not be a crutch to healthy living, but rather a means to achieve the ability to maintain healthy behaviour. The high fidelity design of *VivoSpace* showed that many of the changes in the determinants for health behaviour change were maintain after use of *VivoSpace* ended. Although these results were small and did not apply to all cases where changes were observed, it shows that this goal is plausible. We expect that by applying the design iterations that were outlined in Chapter 6 further sustained changes can be observed.

8.3 Relevant Publications

This work yielded several publications and presentations through conference proceedings, a book chapter, workshop organization and participation, and invited presentations.

Conference Proceedings

N. Kamal, S. Fels, and J. McGrenere (2013). Helping me helping you: designing to influence health behaviour through social connections. *INTERACT 2013*. Cape Town, South Africa. (To appear)

N. Kamal and S. Fels (2013). A user-centred methodology for designing an online social network to motivate health behaviour change. *Studies in Health Technology and Informatics, Volume 183: Enabling Health and Healthcare Through ICT*. 286-290. IOS Press. DOI: 10.3233/978-1-61499-203-5-286

N. Kamal and S. Fels (2012). Determining the determinants of health behaviour change through online social networks. In M. Bang, E. L. Ragnemalm (Eds.), *Persuasive 2012*, Lecture Notes in Computer Science 7284. Pages 1-12. Springer Berlin/Heidelberg 2012. doi: 10.1007/978-3-642-31037-9_1

N. Kamal, S. Fels, M. Blackstock, and K. Ho (2011). VivoSpace: Towards health behaviour change using social gaming. In J. C. Anacleto, S. Fels, N. Graham, B. Kapralos, S. El Nasr, and K. Stanley (Eds.), *Entertainment Computing International Conference for Entertainment Computing 2011*, Lecture Notes in Computer Science 6972. Pages 319-330. Springer Berlin/Heidelberg. doi:10.1007/978-3-642-24500-8_35

N. Kamal, S. Fels, and K. Ho (2010). Online social networks for personal health informatics to promote health behavior. In *The Second ACM SIGMM Workshop on Social Media (WSM 2010)*. Oct 25-29, 2010. Firenze, Italy. Pages 47-52. <http://doi.acm.org/10.1145/1878151.1878167>

Book Chapter

N. Kamal, S. Fels, M. Blackstock, and K. Ho (2013). The ABCs of designing social networks for health behaviour change: The VivoSpace social network. In E. Kranakis (Eds.), *Advances in Network Analysis and its*

Applications, Mathematics in Industry, Volume 18, Part 3, pages 323-348. Springer Berlin/Heidelberg. DOI: 10.1007/978-3-642-30904-5_15

Workshops

N. Kamal, S. Fels, M. Fergusson, J. Preece, D. Cosley, and S. Munson (2013). Designing social media for change. *CHI '13 Extended Abstracts on Human Factors in Computing Systems*, 3183-3186.

N. Kamal, and S. Fels (2013). Increasing sociability of online social networks for personal health informatics. *ACM CHI 2013 Workshop Designing Social Media for Change*. <http://socialmedia4change.org/kamal/>

N. Kamal, S. Fels, K. Ho, L. Cheng, and M. Blackstock (2012). Patient-clinician partnership through a personal online health social network system. *ACM CHI 2012 Workshop Bridging Clinical and Non-Clinical Health Practices: Opportunities and Challenges*
<http://www.ics.uci.edu/yunanc/chi2012health/Participants.html>

N. Kamal, S. Fels, and M. Blackstock (2011). Personal health informatics: What is the role for online social networks? *ACM CHI 2011 Workshop Personal Informatics and HCI: Design, Theory, and Social Implications*. <http://personalinformatics.org/chi2011/kamal>

Peer Reviewed Presentations

N. Kamal (2012). Designing VivoSpace: An online social network to motivate health behaviour change. For Panel Let's Play: Motivate Healthy Behaviour Using Games (M. Fergusson and N. Kamal). *SXSW Interaction 2012*, March 2012, Austin, TX. http://schedule.sxsw.com/2012/events/event_IAP11179

N. Kamal (2011). Appeal, Belonging, Commitment (ABC) Conceptual

Framework and a User Centered Design Process: An online social network for positive health behavior change. SoCS (Social Computational Systems) Workshop. NSF funded. Minneapolis, MN. June 9 - 11, 2011. (Doctoral Symposium with poster presentation)

N. Kamal, S. Fels, K. Ho. (2010). Framework for personal health management using social networks. *MITACS Workshop on Social Networks* (Aug 9-13, 2010) Vancouver, BC.

8.4 Limitations

There are several limitations to this research, which we will describe in this section. Many of these limitations are addressed in the next section (Section 8.5 Directions for Future Research). The first limitation is on the reliance on self-report data, which has the possibility of bias and it threatens the construct validity of the experiments. This was somewhat addressed with the use of control groups, as the control group was also exposed to the same self-report questions; however, true behaviour change and changes in overall health through clinical measures such as weight and percent fat would more accurately measure changes in health behaviour. It should be noted that self-reports are used in clinical encounters, as well as health and HCI research. The second limitation is evaluation of the **ABC Framework**, as the evaluation was conducted with only with a small group of participants from a narrow geographic and socioeconomic strata, so the framework was not validate but rather there was evidence to support the final **ABC Framework**. The framework's validation and iteration has only begun, and should be evaluated further with more groups. Along a similar vein, the *VivoSpace* prototype was only tested against a control group. Further comparisons can be done with lower level interventions such as food diaries and use of commercial applications such as FitBit®.

8.5 Directions for Future Research

This research answers the call for a more theoretical foundation to the design and evaluation of technology for behaviour change [47]. However, this work is only the beginning for HCI research in the design and evaluation of social technology for health behaviour change using a theoretical foundation. There are many possibilities for future research in this area.

1. The role of the clinician in this OSN needs to be considered. Since the changes that were seen in the field experiment were for the clinical group, we need to consider how the clinician fits into the OSN. We need to be able to design for communication between individual and the clinician, and the ability to share information with the clinician differently than sharing information with the individual's peer group. Further research can also be done to consider how this type of technology can augment clinical group visits, so that there is a face-to-face component to peer contact.
2. The **ABC Framework** should be used to evaluate exiting commercial applications for health behaviour change. The theoretically based **ABC Framework** should be used to evaluate existing commercial applications to see which design features are contributing to the determinants for health behaviour change, and which design elements are not contributing. Furthermore, the evaluation can also reveal where specific commercial applications are failing, which can lead to the development of commercial application that lead to more efficacious health behaviour change.
3. The **ABC Framework** was initially evaluated in the field experiment and should be further validated and iterated. Future research can further evaluate the **ABC Framework** through field evaluation of social technologies for health behaviour change to iterate the theoretical conceptual framework. Further iterations of the **ABC Framework** will allow for the design of future OSNs that can lead to greater changes in health behaviour.

4. Future research should be done to better understand how to design for different groups. The initial UCD process showed that there are differences between gender, age groups, and ethnic groups in the determinants for use of OSNs and health behaviour change. Furthermore, health behaviour change was not observed for the younger non-clinical group. Larger field studies can reveal more insight into how different gender, age, and ethnic groups relate to determinants of the **ABC Framework**, and how new design principles can be tailored for specific groups. Therefore, future research can be done to design for different groups, and to iterate the **ABC Framework** for different genders, age groups, and ethnic groups. Conversely, additional field experiments with small groups of different age groups and ethnic groups can also be done to better understand each group's relation to the determinants from the **ABC Framework**, so that tailored design principles can be developed for specific groups. Specifically, future research can look at how to design social technology for younger closely-tied groups.
5. Future field studies can also compare the *VivoSpace* prototype with lower level interventions such as food diaries and technologies such as FitBit® to see if designing using the **ABC Framework** provides more change over conventional interventions.

8.6 Lessons Learned

We have learned a great deal from this research. Primarily the lessons learned relate to the accuracy of applying the **ABC Framework** to the low- and medium-fidelity prototypes. Although inquiring through self-reports and indirect inquiry methods based on the **ABC Framework** provides some understanding of the design's ability to meet the requirements of the framework, the value of the framework is limited. The evaluation of the low- and medium- fidelity prototype should be rapid and focus on user preferences, usability, and affect. For example, our low-fidelity prototype and our medium

fidelity prototype both revealed that the users would not *Provide Information*; however, in the field experiment with the high-fidelity prototype, the users said that *Providing Information* was the main motivator to use *VivoSpace*. This shows that individual's perceptions of their behavioural determinants for use are different in a laboratory than in the field.

The UCD process should continue through multiple field experiments with larger number of participants in each iteration. Our field experiment revealed some usability issues with the social features. The participants wanted to have email notification to encourage their use of the comments and group goals feature, so through a small pilot field experiment, we can find these usability issue that can only be identified in the field, iterate the design, and then run a larger field experiment with a prototype that more accurately reflects the determinants that we are trying to achieve such as *Social Interaction* in the example described.

8.7 Concluding Comments

Designing technologies for health behaviour change is a growing field of study in HCI research and in industry. Many of these technologies have social aspects to their design. Furthermore, health research shows the importance of social connections to one's health. For these reasons, we use OSNs as the basis for the designing a technology for positive health behaviour change. This work contributes to providing a theoretically based conceptual framework, the **ABC Framework**, for designing and evaluating and OSN for health behaviour change. The final design principles are developed through the de-abstraction of the determinants for use of OSNs from the **ABC Framework**, which then influence the determinants for health behaviour change.

By applying OSNs designed for health behaviour change as informed by this research to small loosely-tied social network groups associated with primary medical clinics focused on wellness, we can begin to see health behaviour change.

Bibliography

- [1] ADOLPH, M. 2011. Trends in video games and gaming. ITU-T Technology Watch Report, International Telecommunication Union. September.
- [2] AJZEN, I. 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes* 50, 179–211.
- [3] AJZEN, I. AND FISHBEIN, M. 1977. Attitude-behavior relations: a theoretical analysis and review of empirical research. *Psychological Bulletin* 84, 5, 888–918.
- [4] ALLEN, N. J. AND MEYER, J. P. 1990. The measurement and antecedents of affective, continuance and normative commitment to the organization. *Journal of Occupational Psychology* 63, 1–18.
- [5] ANDERSON, I., MAITLAND, J., SHERWOOD, S., BARKHUUS, L., CHALMERS, M., HALL, M., BROWN, B., AND MULLER, H. 2007. Shakra: Tracking and sharing daily activity levels with unaugmented mobile phones. *Mobile Networks and Applications* 12, 185–199. 10.1007/s11036-007-0011-7.
- [6] ANDERSON, J. J., PALOMBO, R. D., AND EARL, R. 1998. Position of the american diabetic association: the role of nutrition in health promotion and disease prevention programs. *Journal of the American Diabetic Association* 98, 2, 205–208.
- [7] ARDITO, C., BUONO, P., COSTABILE, M. F., AND LANZILOTTI, R. 2006. Two different interfaces to visualize patient histories on a pda. In *MobileHCI '06: Proceedings of the 8th conference on Human-computer interaction with mobile devices and services*. Number Helsinki, Finland. ACM, New York, NY, USA, 37–40.

BIBLIOGRAPHY

- [8] AYOGO GAMES INC. Personal communication. May 15 2012.
- [9] BANDURA, A. 1977. *Social Learning Theory*. Prentice Hall, Englewood Cliff, NJ.
- [10] BANDURA, A. 2004. Health promotion by social cognitive means. *Health Education & Behavior* 31, 2, 143–164.
- [11] BAUMER, E. P., KATZ, S. J., FREEMAN, J. E., ADAMS, P., GONZALES, A. L., POLLAK, J., RETELNY, D., NIEDERDEPPE, J., OLSON, C. M., AND GAY, G. K. 2012. Prescriptive persuasion and open-ended social awareness: expanding the design space of mobile health. In *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work. CSCW '12*. ACM, New York, NY, USA, 475–484.
- [12] BERKMAN, L. F. 1995. The role of social relations in health promotion. *Psychosomatic Medicine* 57, 245–254.
- [13] BERNSTEIN, M., VAN KLEEK, M., KARGER, D., AND SCHRAEFEL, M. C. 2008. Information scraps: How and why information eludes our personal information management tools. *ACM Transactions on Information Systems* 26, 4, Article 24.
- [14] BLAIR, S. N. AND MORRIS, J. N. 2009. Healthy hearts and the universal benefits of being physically active: Physical activity and health. *Annals of Epidemiology* 9, 4, 253–256.
- [15] BODENHEIMER, T., LORIG, K., HOLMAN, H., AND GRUMBACH, K. 2002. Patient self-management of chronic disease in primary care. *Journal of the American Medical Association* 288, 19, 2469–2475.
- [16] CALORIE COUNT. Accessed on March 15 2013. <http://caloriecount.about.com/>.
- [17] CIVAN-HARTZLER, A., McDONALD, D. W., POWELL, C., SKEELS, M. M., MUKAI, M., AND PRATT, W. 2010. Bringing the field into focus: user-centered design of a patient expertise locator. In *Proceedings of the*

BIBLIOGRAPHY

- 28th international conference on human factors in computing systems, CHI '10*. Number Atlanta, GA, USA. ACM, New York, NY, USA, 1675–1684.
- [18] COHEN, S. 2004. Social relationships and health. *American Psychologist*, 676–684.
- [19] COMSCORE. 2011. It's a social world: top 10 need-to-knows about social networking and where its heading. Tech. rep., ComScore, Inc. December.
- [20] CONSOLVO, S., EVERITT, K., SMITH, I., AND LANDAY, J. A. 2006. Design requirements for technologies that encourage physical activity. In *Proceedings of the SIGCHI conference on Human Factors in computing systems*. CHI '06. ACM, New York, NY, USA, 457–466.
- [21] CONSOLVO, S., KLASNJA, P., McDONALD, D. W., AND LANDAY, J. A. 2009a. Goal-setting considerations for persuasive technologies that encourage physical activity. In *Proceedings of the 4th International Conference on Persuasive Technology*. Persuasive '09. ACM, New York, NY, USA, 8:1–8:8.
- [22] CONSOLVO, S., McDONALD, D. W., AND LANDAY, J. A. 2009b. Theory-driven design strategies for technologies that support behavior change in everyday life. In *Proceedings of the 27th international conference on Human factors in computing systems*. CHI '09. ACM, New York, NY, USA, 405–414.
- [23] DAI, L., LUTTERS, W. G., AND BOWER, C. 2005. Why use memo for all? restructuring mobile applications to support informal note taking. In *Proceedings of the 23th international conference on human factors in computing systems, CHI '05*. Number Portland, OR, USA. ACM, New York, NY, USA, 1320–1323.
- [24] DAILYBURN. DailyBurn. Accessed on March 15 2013. <http://dailyburn.com/>.
- [25] DAILYMILE. Dailymile. Accessed on March 15 2013. <http://www.dailymile.com/about>.

BIBLIOGRAPHY

- [26] DETERDING, S., DIXON, D., KHALED, R., AND NACKE, L. 2011. From game design elements to gamefulness: Defining gamification. In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*. MindTrek'11. ACM, New York, NY, USA, 9–15.
- [27] DHOLAKIA, U. M., BAGOZZI, R. P., AND PEARO, L. K. 2004. A social influence model of consumer participation in network- and small-group-based virtual communities. *International Journal of Research in Marketing* 21, 241–263.
- [28] DUBBERLY, H., MEHTA, R., EVENSON, S., AND PANGARO, P. 2010. Reframing health to embrace design of our own well-being. *interactions* 17, 56–63.
- [29] ELLEMERS, N., SPEARS, R., AND DOOSJE, B. 1997. Sticking together or falling apart: In-group identification as a psychological determinant of group commitment versus individual mobility. *Journal of Personality and Social Psychology* 72, 3, 617–626.
- [30] ELLEMERS, N., WILKE, H., AND KNIPPENBERG, A. V. 1993. Effects of the legitimacy of low group and individual status on individual and collective identity enhancement strategies. *Journal of Personality and Social Psychology* 64, 5, 766–778.
- [31] FESTINGER, L. 1957. *A theory of cognitive dissonance*. Vol. 2. Stanford University Press.
- [32] FISHER, E. B., BROWNSON, C. A., O'TOOLE, M. L., SHETTY, G., ANWAURI, V. V., AND GLASGOW, G. E. 2005. Ecological approaches to self-management: The case of diabetes. *Journal of Public Health* 95, 9, 1523 – 1535.
- [33] FITBIT. 2013. Fitbit. Accessed on March 15 2013. <http://www.fitbit.com/company>.

BIBLIOGRAPHY

- [34] FLEGAL, K. M., CARROLL, M. D., KUCZMARSKI, R. J., AND JOHNSON, C. L. 1998. Overweight and obesity in the united states: prevalence and trends, 1060-1994. *International Journal of Obesity and Related Metabolic Disorders* 22, 1, 39–47.
- [35] FOGG, B. J. 2003. *Persuasive Technology: Using Computers to Change What We Think and Do*. Morgan Kaufmann Publishers, San Francisco, CA, USA.
- [36] FOGG, B. J. AND ECKLES, D. 2007. The behavior chain for online participation: how successful web services structure persuasion. In *Proceedings of the 2nd international conference on Persuasive technology*. PERSUASIVE'07. Springer-Verlag, Berlin, Heidelberg, 199–209.
- [37] FROST, J. H. AND MASSAGLI, M. P. 2008. Social uses of personal health information within patientslikeme, and online patient community: what can happen when patients have access to one another's data. *JMIR* 10, 3, e15.
- [38] GASSER, R., BRODBECK, D., DEGEN, M., LUTHIGER, J., WYSS, R., AND REICHLIN, S. 2006. Persuasiveness of a mobile lifestyle coaching application using social facilitation. In *Persuasive Technology*, W. IJsselsteijn, Y. de Kort, C. Midden, B. Eggen, and E. van den Hoven, Eds. Lecture Notes in Computer Science Series, vol. 3962. Springer Berlin / Heidelberg, 27–38.
- [39] GLASER, B. G. AND STAUSS, A. 1967. *Discovery of Grounded Theory: Strategies for Qualitative Research*. Sociology Press.
- [40] GOÅMAN, E. 1959. The presentation of self in everyday life.
- [41] GOLDSTEIN, L. B., ADAMS, R., AND ET AL. 2001. Prevention of ischemic stroke: A statement for healthcare professionals from the stroke council of the american heart association. *Circulation* 103, 163–182.
- [42] GRIMES, A., BEDNAR, M., BOLTER, J. D., AND GRINTER, R. E. 2008. Eatwell: sharing nutrition-related memories in a low-income commu-

BIBLIOGRAPHY

- nity. In *Proceedings of the 2008 ACM conference on Computer supported cooperative work*. CSCW '08. ACM, New York, NY, USA, 87–96.
- [43] GRIMES, A. AND GRINTER, R. E. 2007. Designing persuasion: health technology for low-income african american communities. In *Proceedings of the 2nd international conference on Persuasive technology*. PERSUASIVE'07. Springer-Verlag, Berlin, Heidelberg, 24–35.
- [44] GRIMES, A., KANTROO, V., AND GRINTER, R. E. 2010. Let's play!: mobile health games for adults. In *Proceedings of the 12th ACM international conference on Ubiquitous computing*. UbiComp '10. ACM, New York, NY, USA, 241–250.
- [45] GUSTAFSON, D. H., HAWKINDS, R. R., BOBERG, E. W., BRICKER, R., PINGREE, S., AND CHAN, C. 1994. The use and impact of a computer-based support system for people living with aids and hiv infection. In *Proceedings of the American Medical Informatics Association, JAMIA Symposium Supplement*. Hanley and Belfus, Inc., Philadelphia, PA, 604–608.
- [46] HE, H. A., GREENBERG, S., AND HUANG, E. M. 2010. One size does not fit all: applying the transtheoretical model to energy feedback technology design. In *Proceedings of the 28th international conference on human factors in computing systems, CHI '10*. Number Atlanta, GA, USA. ACM, New York, NY, USA, 927–936.
- [47] HEKLER, E. B., KLASNJA, P., FROEHLICH, J. E., AND BUMAN, M. P. 2013. Mind the theoretical gap: interpreting, using, and developing behavioral theory in HCI research. In *Proceedings of the 2013 ACM annual conference on Human factors in computing systems*. CHI '13. ACM, New York, NY, USA, 3307–3316.
- [48] HIBBARD, J. H., MAHONEY, E. R., STOCKARD, J., AND TUSLER, M. 2005. Development and testing of a short form of the patient activation measure. *Health Services Research* 40, 6p1, 1918–1930.

BIBLIOGRAPHY

- [49] HIBBARD, J. H., STOCKARD, J., MAHONEY, E. R., AND TUSLER, M. 2004. Development of the patient activation measure (PAM): Conceptualizing and measuring activation in patients and consumers. *Health Services Research* 39, 4p1, 1005–1026.
- [50] JANZ, N. K. AND BECKER, M. H. 1984. The health belief model: A decade later. *Health Education & Behavior* 11, 1, 1–47.
- [51] JENKINS, H., CAMPER, B., CHISHOLM, A., GRIGSBY, N., KLOPPER, E., OSTERWEIL, S., PERRY, J., TAN, P., WEISE, M., AND GUAN, T. C. 2009. From serious games to serious gaming. In *Serious Games: Mechanisms and Effects*, U. Ritterfeld, M. Cody, and P. Vorderer, Eds. Taylor & Francis, New York, NY, 448–468.
- [52] JOINSON, A. N. 2008. Looking at, looking up or keeping up with people?: motives and use of facebook. In *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems*. CHI '08. ACM, New York, NY, USA, 1027–1036.
- [53] KAMAL, N. AND FELS, S. 2012. Determining the determinants of health behaviour change through an online social network. In *Persuasive Technology. Design for Health and Safety*, M. Bang and E. Ragnemalm, Eds. Lecture Notes in Computer Science Series, vol. 7284. Springer Berlin / Heidelberg, 1–12.
- [54] KAMAL, N. AND FELS, S. 2013. A user-centred methodology for designing an online social network to motivate health behaviour change. In *Proceeding of Information Technology and Communication for Health 2013*. ISO.
- [55] KAMAL, N., FELS, S., BLACKSTOCK, M., AND HO, K. 2013a. The abcs of designing social networks for health behaviour change: The vivospace social network. In *Advances in Network Analysis and its Applications*, E. Kranakis, Ed. Mathematics in Industry Series, vol. 18. Springer Berlin Heidelberg, 323–348.

BIBLIOGRAPHY

- [56] KAMAL, N., FELLS, S., AND HO, K. 2010. Online social networks for personal informatics to promote positive health behavior. In *Proceedings of second ACM SIGMM workshop on Social media*. WSM '10. ACM, New York, NY, USA, 47–52.
- [57] KAMAL, N., FELLS, S., MCGRENERE, J., AND NANCE, K. 2013b. Helping me helping you: Designing to influence health behaviour change through social connections. In *INTERACT 2013*. Springer, 18 pages.
- [58] KLASNJA, P., CIVAN-HARTZLER, A., UNRUH, K. T., AND PRATT, W. 2010. Blowing in the wind: unanchored patient information work during cancer care. In *Proceedings of the 28th international conference on human factors in computing systems, CHI '10*. Number Atlanta, GA, USA. ACM, New York, NY, USA, 193–202.
- [59] KLASNJA, P., CONSOLVO, S., AND PRATT, W. 2011. How to evaluate technologies for health behavior change in hci research. In *Proceedings of the 2011 annual conference on Human factors in computing systems*. CHI '11. ACM, New York, NY, USA, 3063–3072.
- [60] LAMPE, C., WASH, R., VELASQUEZ, A., AND OZKAYA, E. 2010. Motivations to participate in online communities. In *CHI '10: Proceedings of the 28th international conference on Human factors in computing systems*. Number Atlanta, Georgia, USA. ACM, New York, NY, USA, 1927–1936.
- [61] LEVENTHAL, H., DIEFENBACH, M., AND LEVENTHAL, E. A. 1992. Illness cognition: Using common sense to understand treatment adherence and affect cognition interactions. *Cognitive Therapy and Research* 16, 143–163. 10.1007/BF01173486.
- [62] LI, I., DEY, A., AND FORLIZZI, J. 2010. A stage-based model of personal informatics systems. In *Proceedings of the 28th international conference on human factors in computing systems, CHI '10*. Number Atlanta, GA, USA. ACM, New York, NY, USA, 557–565.

BIBLIOGRAPHY

- [63] LI, I., DEY, A. K., AND FORLIZZI, J. 2012. Using context to reveal factors that affect physical activity. *ACM Trans. Comput.-Hum. Interact.* 19, 1, 7:1–7:21.
- [64] LIN, J. J., MAMYKINA, L., LINDTNER, S., DELAJOUX, G., AND STRUB, H. B. 2006. Fish'n'steps: encouraging physical activity with an interactive computer game. In *Proceedings of the 8th international conference on Ubiquitous Computing*. UbiComp'06. Springer-Verlag, Berlin, Heidelberg, 261–278.
- [65] LLOYD-JONES, D., ADAMS, R. J., AND ET AL. 2010. Heart disease and stroke statistics-2010 update. *Circulation* 121, e46–e215.
- [66] LOCKE, E. A. AND LATHAM, G. P. 2002. Building a practically building a practically useful theory of goal setting and task motivation: a 35-year odyssey. *American Psychologist* 57, 9, 705–717.
- [67] LOSE IT. Lose It! Accessed March 15 2013. <http://www.loseit.com/what-is-lose-it/>.
- [68] MADAN, A., MOTURU, S. T., LAZER, D., AND PENTLAND, A. S. 2010. Social sensing: obesity, unhealthy eating and exercise in face-to-face networks. In *Proc. Wireless Health '10*. 104–110.
- [69] MAITLAND, J. AND CHALMERS, M. 2011. Designing for peer involvement in weight management. In *Proc. CHI 2011*. ACM Press, 315–324.
- [70] MALONEY-KRICHMAR, D. AND PREECE, J. 2005. A multilevel analysis of sociability, usability, and community dynamics in an online health community. *ACM Trans. on Comput.-Hum. Interaction* 12, 2, 201–232.
- [71] MAMYKINA, L., MILLER, A. D., MYNATT, E. D., AND GREENBLATT, D. 2010. Constructing identities through storytelling in diabetes management. In *Proceedings of the 28th international conference on human factors in computing systems, CHI '10*. Number Atlanta, GA, USA. ACM, New York, NY, USA, 1203–1212.

BIBLIOGRAPHY

- [72] MAMYKINA, L. AND MYNATT, E. D. 2007. Investigating and supporting health management practices of individuals with diabetes. In *Proceedings of the 1st ACM SIGMOBILE international workshop on Systems and networking support for healthcare and assisted living environments, HealthNet '07*. Number San Juan, Puerto Rico, USA. ACM, New York, NY, USA, 49–54.
- [73] MAMYKINA, L., MYNATT, E. D., DAVIDSON, P. R., AND GREENBLATT, D. 2008. Mahi: Investigation of social scaffolding for reflective thinking in diabetes management. In *Proceedings of the 26th international conference on human factors in computing systems, CHI '08*. ACM, New York, NY, USA, 477–486.
- [74] MCCULLUM, S. 2012. Gamification and serious games for personalized health. In *pHealth 2012*, B. Blobel, Ed. IOS Press, 85–96.
- [75] MCQUAIL, D. 1994. *Mass Communication Theory: An Introduction*. Sage Publications, Chapter The Rise of Media of Mass Communication, 1–29.
- [76] MYFITNESSPAL. MyFitnessPal. Accessed on March 15 2013. <http://www.myfitnesspal.com/>.
- [77] NATIONAL INSTITUTES OF HEALTH. Calculate Your Body Mass Index. Accessed on July 15 2013. <http://www.nhlbi.nih.gov/guidelines/obesity/BMI/bmicalc.htm>.
- [78] NEWMAN, M. W., LAUTERBACH, D., MUNSON, S. A., RESNICK, P., AND MORRIS, M. E. 2011. It's not that i don't have problems, i'm just not putting them on facebook: challenges and opportunities in using online social networks for health. In *Proceedings of the ACM 2011 conference on Computer supported cooperative work. CSCW '11*. ACM, New York, NY, USA, 341–350.
- [79] NIKE. 2013. Nike plus FuelBand. Accessed on March 15 2013. http://www.nike.com/us/en_us/c/nikeplus-fuelband.

BIBLIOGRAPHY

- [80] NOWAK, M. A. AND SIGMUND, K. 1998a. The dynamics of indirect reciprocity. *Journal of Theoretical Biology* 194, 4, 561 – 574.
- [81] NOWAK, M. A. AND SIGMUND, K. 1998b. Evolution of indirect reciprocity by image scoring. *Nature* 393, 11, 573–577.
- [82] OINAS-KUKKONEN, H. AND HARJUMAA, M. 2009. Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems* 24, 28, 485–500.
- [83] ORJI, R., MANDRYK, R. L., VASSILEVA, J., AND GERLING, K. M. 2013. Tailoring persuasive health games to gamer type. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '13. ACM, New York, NY, USA, 2467–2476.
- [84] PAPACHARISSI, Z. AND RUBIN, A. M. 2000. Predictors of internet use. *Journal of Broadcasting & Electronic Media* 44, 2, 175–196.
- [85] PARKER, A., KANTROO, V., LEE, H. R., OSORNIO, M., SHARMA, M., AND GRINTER, R. 2012. Health promotion as activism: building community capacity to effect social change. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '12. ACM, New York, NY, USA, 99–108.
- [86] PATE, R. R., PRATT, M., BLAIR, S. N., AND ET AL. 1995. Physical activity and public health: A recommendation from the centers for disease control and prevention and the american college of sports medicine. *The Journal of the American Medical Association* 273, 5, 402–407.
- [87] PLAISANT, C., MILASH, B., ROSE, A., WIDOFF, S., AND SHNEIDERMAN, B. 1996. Lifelines: visualizing personal histories. In *Proceedings of the 14th international conference on human factors in computing systems, CHI '96*. Number Vancouver, British Columbia, Canada. ACM, New York, NY, USA, 221–227.
- [88] POOLE, E. S., MILLER, A. D., XU, Y., EIRIKSDOTTIR, E., CATRAMBONE, R., AND MYNATT, E. D. 2011. The place for ubiquitous computing

BIBLIOGRAPHY

- in schools: lessons learned from a school-based intervention for youth physical activity. In *Proceedings of the 13th international conference on Ubiquitous computing*. UbiComp '11. ACM, New York, NY, USA, 395–404.
- [89] PRATT, W., UNRUH, K. T., CIVAN, A., AND SKEELS, M. M. 2006. Personal health information management. *Communications of the ACM* 49, 1, 51–55.
- [90] PROCHASKA, J. O. AND VELICER, W. F. 1997. The transtheoretical model of health behavior change. *American Journal of Health Promotion* 12, 1, 38–48.
- [91] PURPURA, S., SCHWANDA, V., WILLIAMS, K., STUBLER, W., AND SENEGERS, P. 2011. Fit4life: the design of a persuasive technology promoting healthy behavior and ideal weight. In *Proceedings of the 2011 annual conference on Human factors in computing systems*. CHI '11. ACM, New York, NY, USA, 423–432.
- [92] RAMIREZ, E. The state of self-tracking. Accessed on March 20 2013. <http://quantifiedself.com/2013/03/the-state-of-self-tracking/>.
- [93] RASCH, G. 1960. *Probabilistic Models for Some Intelligent and Attainment Tests*. Danmarks Paedagogiske Institut, Copenhagen, Denmark.
- [94] REDDING, C. A., ROSSI, J. S., ROSSI, S. R., VELICER, W. F., AND PROCHASKA, J. O. 2000. Health behavior models. In *Handbook of Health Assessment Tools*. 83–100.
- [95] REN, Y., KRAUT, R., AND KIESLER, S. 2007. Applying common identity and bond theory to design of online communities. *Organizational Studies* 28, 3, 377–408.
- [96] RESNICK, P. J., JANNEY, A. W., BUIS, L. R., AND RICHARDSON, C. R. 2010. Adding an online community to an internet-mediated walking program. part 2: Strategies for encouraging community participation. *Journal of Medical Internet Research* 12, 4, e72.

BIBLIOGRAPHY

- [97] RICHARDSON, C. R., BUIS, L. R., JANNEY, A. W., GOODRICH, D. E., SEN, A., HESS, M. L., MEHARI, K. S., FORTLAGE, L. A., RESNICK, P. J., STRECHER, B. J. Z.-F. V. J., AND PIETTE, J. D. 2010. An online community improves adherence in an internet-mediated walking program. part 1: Results of a randomized controlled trial. *Journal of Medical Internet Research* 12, 4, e71.
- [98] ROGERS, E. M. 1983. *Diffusion of Innovation* 3rd Edition Ed. The Free Press, a division of Simon & Schuster Inc., New York, NY.
- [99] ROSENSTOCK, I. M. 1974. Historical origins of the health belief model. *Health Education Monographs* 15, 175–183.
- [100] ROSENSTOCK, I. M., VICTOR, J. S., AND BRECKER, M. H. 1988. Social learning theory and the health belief model. *Health Education & Behavior* 15, 175, 175–183.
- [101] RUGGIERO, T. E. 2000. Uses and gratification theory in the 21st century. *Mass Communication and Society* 3, 1, 3–37.
- [102] RUNKEEPER. RunKeeper. Accessed on March 15 2013. <http://runkeeper.com/>.
- [103] SEINEN, I. AND SCHRAM, A. 2006. Social status and group norms: Indirect reciprocity in a repeated helping experiment. *European Economic Review* 50, 3, 581 – 602.
- [104] SERLACHIUS, A. AND SUTTON, S. 2009. *Chronic Physical Illness: Self-Management and Behavioural Interventions*. Number 3. McGraw Hill: Open University Press, New York, NY, USA, Chapter Self-management and behaviour change: theoretical models, 47–63.
- [105] SHARP, H., ROGERS, Y., AND PREECE, J. 2007. *Interaction design : beyond human-computer interaction*. Wiley.
- [106] SHEPPARD, B. H., HARTWICK, J., AND WARSHAW, P. R. 1988. The theory of reasoned action: a meta-analysis of past research with

BIBLIOGRAPHY

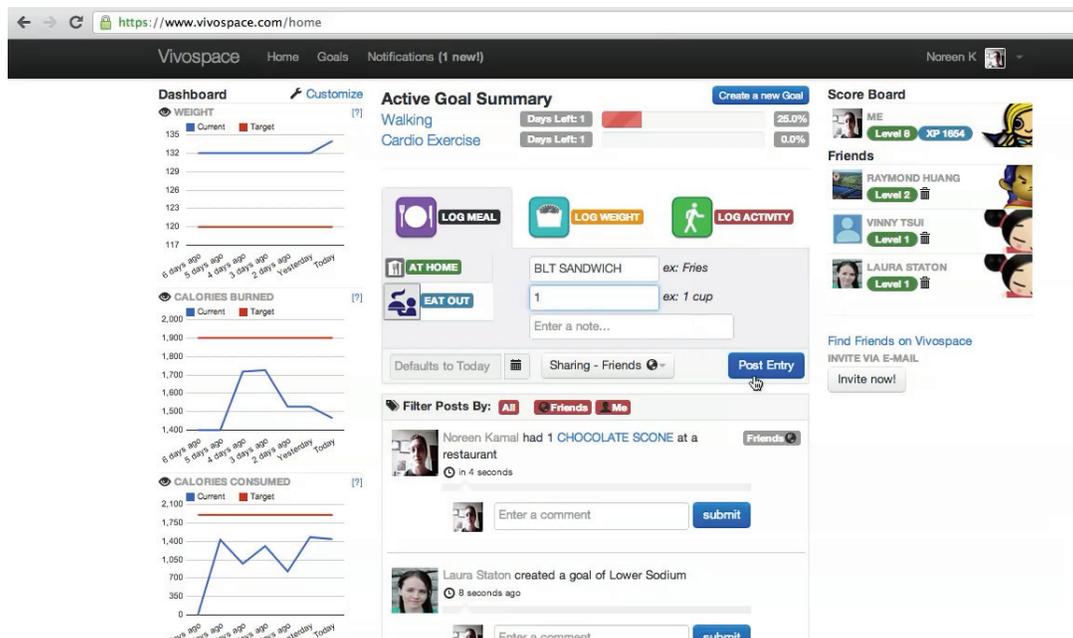
- recommendations for modifications and future research. *The Journal of Consumer Research* 15, 3, 325–343.
- [107] SILLENCE, E., BRIGGS, P., HARRIS, P. R., AND FISHWICK, L. 2007. How do patients evaluate and make use of online health information? *Social Science & Medicine* 64, 9, 1853–1862.
- [108] SILVERGLADE, B. AND HELLER, I. R. 2009. Food labeling chaos: the case for reform. Tech. rep., Center for Science in the Public Interest.
- [109] SKEELS, M. M., UNRUH, K. T., POWELL, C., AND PRATT, W. 2010. Catalyzing social support for breast cancer patients. In *Proceedings of the 28th international conference on human factors in computing systems, CHI '10*. ACM, New York, NY, USA, 173–182.
- [110] SPARKPEOPLE. SparkPeople. Accessed on March 15 2013. <http://www.sparkpeople.com/>.
- [111] SPILIOTOPOULOS, T. AND OAKLEY, I. 2013. Understanding motivations for facebook use: usage metrics, network structure, and privacy. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI '13*. ACM, New York, NY, USA, 3287–3296.
- [112] TAJFEL, H. 1974. Social identity and intergroup behaviour. *Social Science Information* 13, 2, 65–93.
- [113] TAP AND TRACK. Tap and Track. Accessed on March 15 2013. <http://www.tapandtrack.com/home/index>.
- [114] TOSCOS, T., FABER, A., AN, S., AND GANDHI, M. P. 2006. Chick clique: persuasive technology to motivate teenage girls to exercise. In *CHI '06 extended abstracts on Human factors in computing systems. CHI EA '06*. ACM, New York, NY, USA, 1873–1878.
- [115] TWITTER. Bootstrap. Accessed on March 31 2013. <http://twitter.github.com/bootstrap/index.html>.

- [116] VALENTE, T. W. 1996. Social network thresholds in the diffusion of innovation. *Social Networks* 18, 69–89.
- [117] WAGNER, E. H. AND GROVES, T. 2002. Care for chronic diseases. *British Medical Journal* 325, 7370, 913 – 914.
- [118] WEBB, T. L., JOSEPH, J., YARDLEY, L., AND MICHIE, S. 2010. Using the internet to promote health behavior change: A systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of Medical Internet Research* 12, 1, e4.
- [119] WITHINGS. 2013. Withings Activity Tracker. Accessed on March 14 2013. <http://www.withings.com/en/activitytracker/keepmeinformed>.
- [120] WOLFRAM—ALPHA. Wolfram—Alpha API. Accessed on April 3 2013. <http://products.wolframalpha.com/api/>.
- [121] WORLD HEALTH ORGANIZATION. The determinants of health. Accessed March 14 2013. <http://www.who.int/hia/evidence/doh/en/>.
- [122] WRIGHT, B. D. AND MASTERS, G. 1982. *Rating Scale Analysis*. Mesa Press, Chicago.
- [123] YETIM, F. 2013. Critical perspective on persuasive technology reconsidered. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '13. ACM, New York, NY, USA, 3327–3330.
- [124] YOUNG, K. T., READING, J., ELIAS, B., AND O'NEIL, J. D. 2000. Type 2 diabetes mellitus in Canada's first nations: status of an epidemic in progress. *Canadian Medical Association Journal* 163, 5, 561–566.
- [125] ZHAO, X., SALEHI, N., NARANJIT, S., ALWAALAN, S., VOIDA, S., AND COSLEY, D. 2013. The many faces of facebook: experiencing social media as performance, exhibition, and personal archive. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '13. ACM, New York, NY, USA, 1–10.

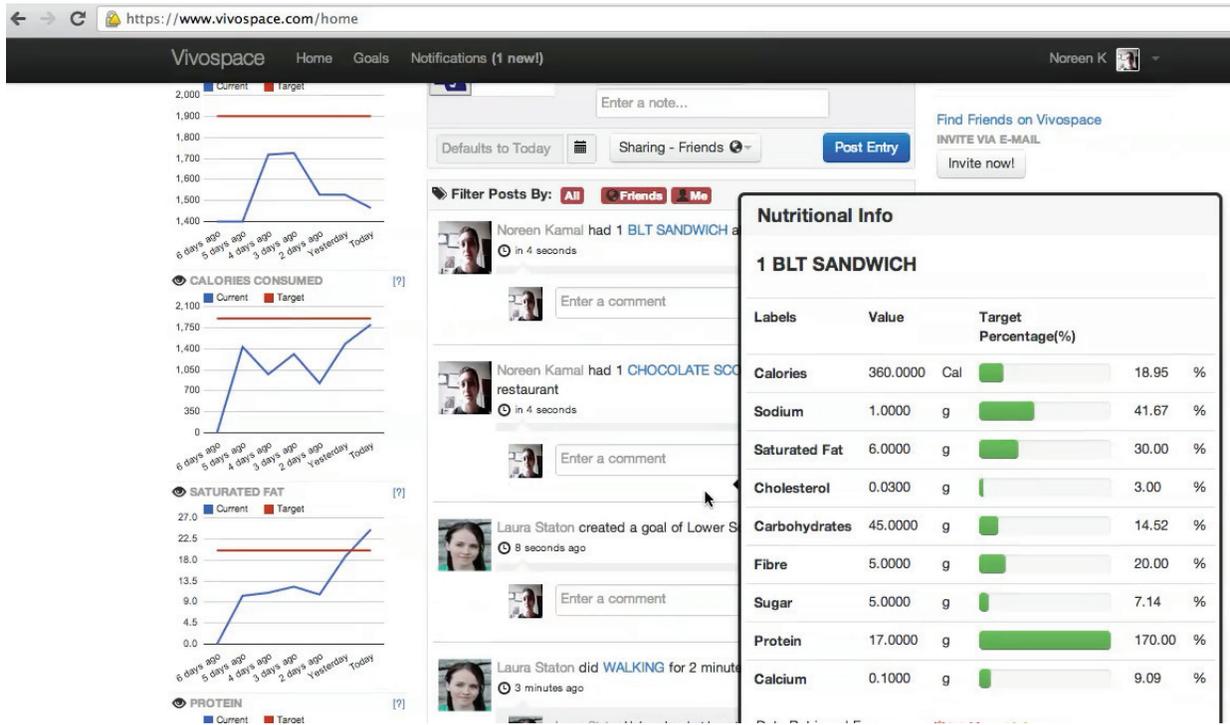
First Appendix: Screen Captures of High-Fidelity Prototype

This appendix shows screen captures for all the relevant pages and pop-up windows for the high-fidelity prototype of *VivoSpace*. The design of this prototype is described in Chapter 4.

Main Home Page



Main Home Page when food item is clicked

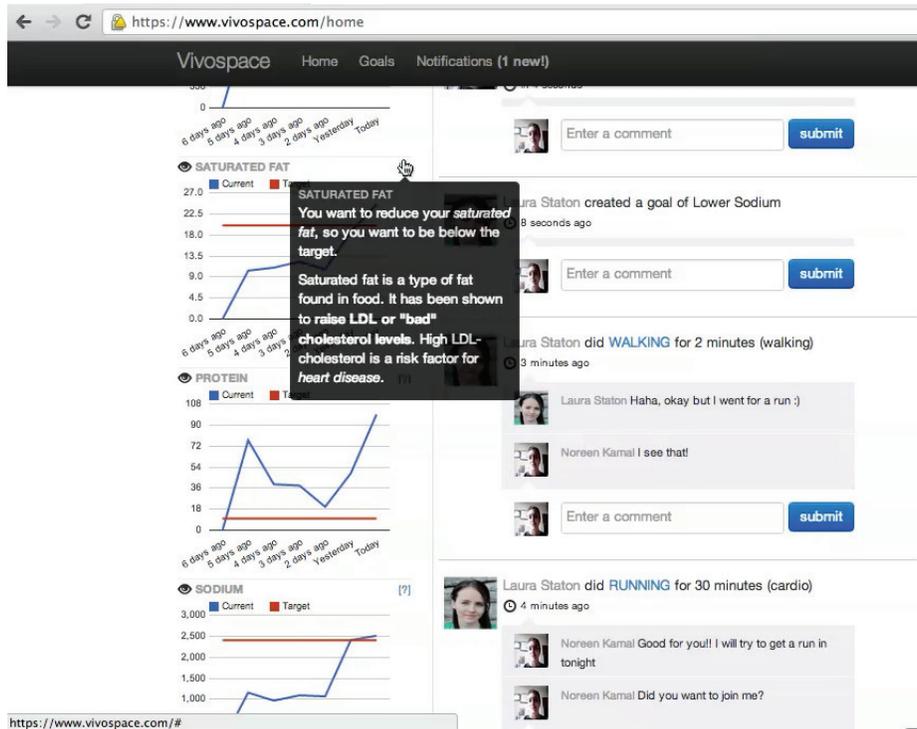


Newsfeed showing friends' log entries

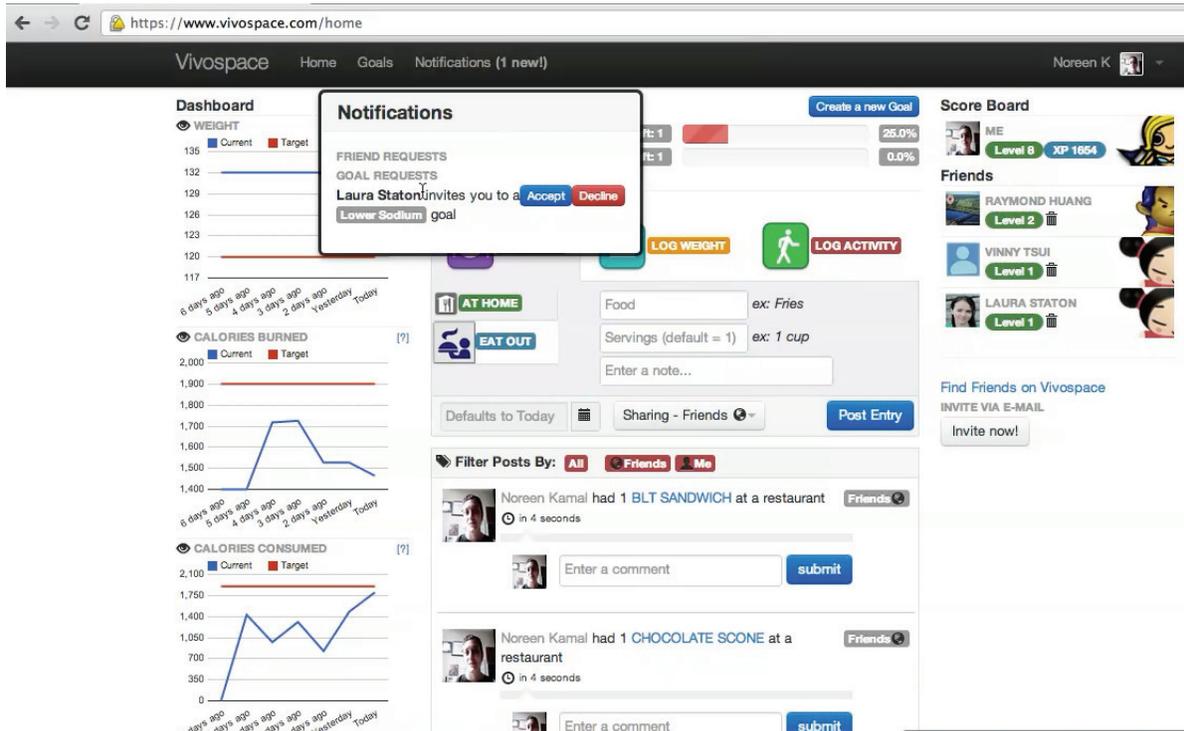
The screenshot shows a web browser at <https://www.vivospace.com/home>. The page features a navigation bar with 'Vivospace', 'Home', 'Goals', and 'Notifications (1 new!)'. The main content is divided into two columns. The left column contains three line charts for 'PROTEIN', 'SODIUM', and 'TRANS-FAT', each comparing 'Current' (blue line) and 'Target' (red line) values over a 6-day period. The right column displays a newsfeed of activity logs:

- Laura Staton did WALKING for 2 minutes (walking)** (3 minutes ago)
 - Comment: Laura Staton Haha, okay but I went for a run :)
 - Comment: Noreen Kamal I see that!
 - Input: Enter a comment [submit]
- Laura Staton did RUNNING for 30 minutes (cardio)** (4 minutes ago)
 - Comment: Noreen Kamal Good for you! I will try to get a run in tonight
 - Input: Did you | [submit]
- Laura Staton created a goal of Cardio Exercise** (4 minutes ago)
 - Input: Enter a comment [submit]
- Noreen Kamal did WALKING for 15 minutes (walking)** (4 minutes ago) [Friends]

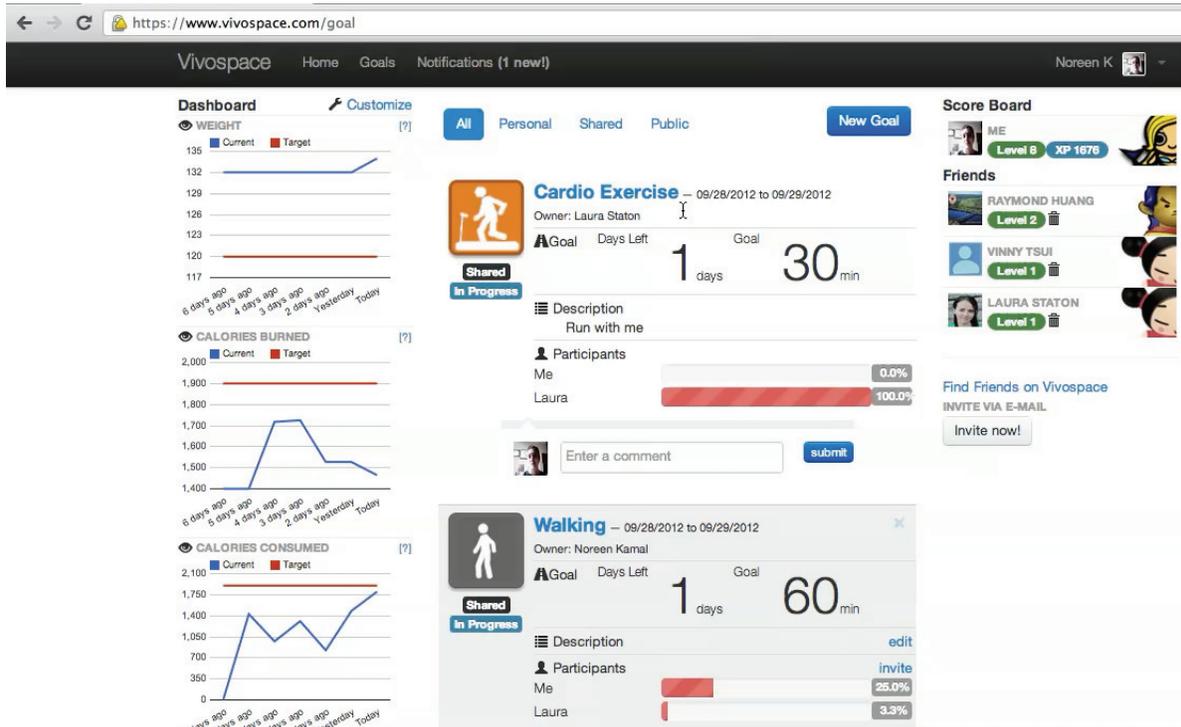
Dashboard when a help question mark is clicked



Notifications is clicked



Goals Page



Customize page accessed by clicking Customize on Dashboard or going to profile

The screenshot shows the Vivospace settings page for a dashboard. The page is titled "Dashboard" and has a "Customize" button. The dashboard displays three line graphs: "WEIGHT", "CALORIES BURNED", and "CALORIES CONSUMED". Each graph shows "Current" (blue line) and "Target" (red line) values over a 7-day period. The "Target Graphs" section on the right allows users to enable and customize various targets.

| Enable | Target | Value | Default/Unit |
|-------------------------------------|-----------------------|-------------|----------------|
| <input checked="" type="checkbox"/> | Weight [?] | 120 | none (lbs) |
| <input checked="" type="checkbox"/> | Calories Burned [?] | 1900.000000 | 1900 (cal/day) |
| <input checked="" type="checkbox"/> | Calories Consumed [?] | 1900.000000 | 1900 (cal/day) |
| <input checked="" type="checkbox"/> | Saturated Fat [?] | 20.000000 | 20 (g/day) |
| <input checked="" type="checkbox"/> | Protein [?] | 10.000000 | 10 (g/day) |
| <input checked="" type="checkbox"/> | Sodium [?] | 2400.000000 | 2400 mg/day |
| <input checked="" type="checkbox"/> | Trans-Fat [?] | 0.000000 | none (g/day) |
| <input checked="" type="checkbox"/> | Cholesterol [?] | 1.000000 | 1 (g/day) |

Customize page when a help question mark is clicked

The screenshot shows the Vivospace settings page for a user named Noreen K. The page is titled "Target Graphs" and features a table of customizable targets. On the left, there are three line graphs for "CALORIES BURNED", "CALORIES CONSUMED", and "SATURATED FAT", each comparing "Current" (blue) and "Target" (red) values over a 7-day period. A help tooltip is visible over the "Protein" target, providing information about protein's benefits and sources.

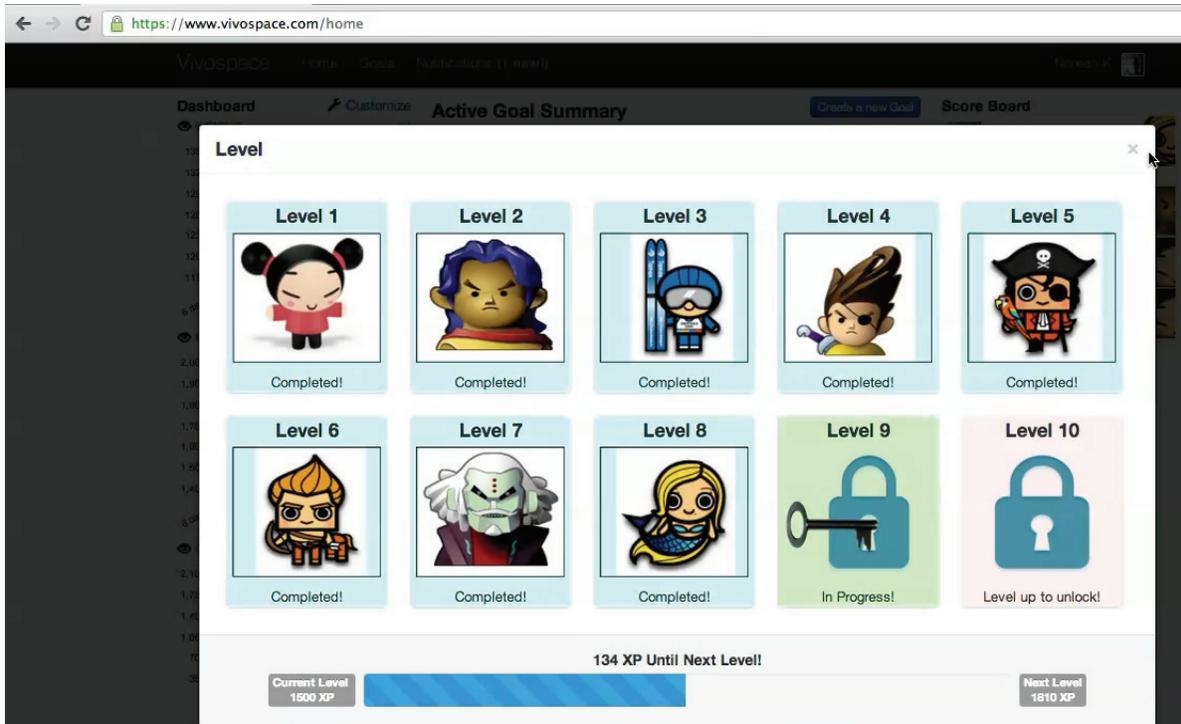
Target Graphs

Target graphs are shown in the left dashboard, tracking your last 7-days progress. It is customizable so you can set choose targets and see at a glance how close you are to reaching them.

| Enable | Target | Value | Default/Unit |
|-------------------------------------|-----------------------|-------------|----------------|
| <input checked="" type="checkbox"/> | Weight [?] | 120 | none (lbs) |
| <input checked="" type="checkbox"/> | Calories Burned [?] | 1900.000000 | 1900 (cal/day) |
| <input checked="" type="checkbox"/> | Calories Consumed [?] | 1900.000000 | 1900 (cal/day) |
| <input checked="" type="checkbox"/> | Saturated Fat [?] | 20.000000 | 20 (g/day) |
| <input checked="" type="checkbox"/> | Protein [?] | 10.000000 | 10 (g/day) |
| <input checked="" type="checkbox"/> | Sodium [?] | 2400.000000 | 2400 mg/day |
| <input checked="" type="checkbox"/> | Trans-Fat [?] | | none (g/day) |
| <input checked="" type="checkbox"/> | Cholesterol [?] | 1.000000 | 1 (g/day) |
| <input checked="" type="checkbox"/> | Carbohydrates [?] | 310.000000 | 310 (g/day) |
| <input checked="" type="checkbox"/> | Fibre [?] | 25.000000 | 25 (g/day) |

PROTEIN
You want to increase your protein, so you want to be above the target.
Protein is an important nutrient for your health, as it helps build and repair body tissue. Protein is a source of energy.
Protein can be found in dairy products, eggs, legumes, fish, meat, nuts and seeds.

Current Level and Revealed Character pop-up when Level is click on Home Page



Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

This appendix provides all the questionnaires for the field experiment that was conducted to evaluate the high-fidelity prototype of *VivoSpace*. It included the pre-questionnaire for all groups. This questionnaire was also the mid- and post-questionnaire for the control group. After the pre-questionnaire, this appendix also has the questionnaire that was used for the mid- and post-questionnaire for the experimental group. The measures and the results of the field experiment are described in detail in Chapter 4.

Pre-study questionnaire for All Participants, and mid- and post-questionnaire for control group

1) Please provide your PARTICIPANT NUMBER that you were given by the researcher. If you can't remember your number, please email Noreen Kamal at noreenk@ece.ubc.ca

I. Demographic Information

2) Please specify your gender

- a) Female
- b) Male

3) What is your age?

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

4) What is your profession? (Please indicate that you are "unemployed" if you are currently seeking employment. If you look after the home and/or children, please indicate "homemaker")

5) What is the highest level of education you have received?

- a) High school graduate or less
- b) Trade school or some university/college
- c) University/college graduate or more

6) What is your household income?

- a) Less than \$20,000
- b) \$20,000 to \$29,999
- c) \$30,000 to \$39,999
- d) \$40,000 to \$49,999
- e) \$50,000 to \$64,999
- f) \$65,000 to \$79,000
- g) \$80,000 or more

7) Please indicate how frequently (if ever) you use the following online social networks

Never, I have tried it out (1 to 3 times), Monthly (or a few times/month), Weekly (or a few times/week), Daily (or a few times/day)

Facebook

Twitter

Google Plus

Other (specify below)

II. Your Health Status

8) Please indicate if you are a current or past patient at one of our partner clinics

- a) I am a current weight management patient at Dr. Kara Nances clinic

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

- b) I am a past weight management patient at Dr. Kara Nances clinic
 - c) I am a current regular medical patient at Dr. Kara Nances clinic
 - d) I am a current patient at Connect Health
 - e) none of the above
 - f) I am a past patient at Connect Health
 - g) I am a medical group visit patient at Connect Health
- 9) Please describe if you have participated in any other wellness, weight loss, or health programs
- 10) Do you have any health problems?
- a) Yes
 - b) No
- 11) Please specify the health problem(s)
- 12) What is your current weight? lbs
- 13) What is your current height?
- Feet
- Inches
- 14) How many servings do you consume on average every week for the following foods?
- Salads
- Fruits
- Vegetables
- French Fries
- Potato Chips (or similar)
- 15) How often do you do on average every week for the following activities?
- Walking (30 minutes or more)
- Cardio or Aerobic Exercise like jogging (20 min or more)

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

Active sports

Other activities like Gardening

Resistance exercise (like weight lifting)

16) How healthy do you think you are? (6-point Likert Scale: 1 (very unhealthy) - 6 (very healthy))

17) Please select which statement best describes your current stage in living healthy

- a) I am not considering changing my lifestyle to live healthier
- b) I am thinking about changing my lifestyle to live healthier
- c) I am starting to prepare to change my lifestyle to live healthier
- d) I am changing my lifestyle and I am living in a healthy way
- e) I am now maintaining the lifestyle changes that I have made to continue to live healthy

18) Were you in a different stage 4 months ago?

- a) Yes
- b) No

19) Which stage were you in 4 months ago?

- a) I was not considering changing my lifestyle to live healthier
- b) I was thinking about changing my lifestyle to live healthier
- c) I was starting to prepare to change my lifestyle to live healthier
- d) I was changing my lifestyle and I am living in a healthy way
- e) I was maintaining the lifestyle changes that I have made to continue to live healthy

20) Please provide any additional comments about your current or past stage in living healthy

Nutrition and Health Multiple Choice test

Please answer the questions based on your current knowledge. Do not ask

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

for help. Do not use the internet to find the answers.

21) How many calories (approximately) does the average person ideally consume daily?

- a) 500 calories
- b) 1,000 calories
- c) 2,000 calories
- d) 3,000 calories

22) All fats are unhealthy

- a) True
- b) False

23) What foods have high fiber content (select the most accurate item below)

- a) Whole wheat bread, beans and vegetables
- b) Any breads and cereals grains (such as oat, barley, rice and quinoa)
- c) Whole wheat bread and meats
- d) All of the above

24) Even walking at a slow pace will burn calories

- a) True
- b) False

25) What is iron?

- a) Iron is a mineral that helps produce red blood cells and helps transport oxygen throughout the body
- b) Iron is a nutrient that helps build and repair body tissue
- c) Iron is a nutrient that helps the digestive system
- d) Iron is a nutrient that helps keep skin healthy

26) Select the most correct response about sugar

- a) Sugar is necessary in small amounts
- b) Sugar is not necessary for good health in any amount

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

- c) Sugar is not found naturally in breads
 - d) All carbohydrates are sugars
- 27) Select the most correct response about salt
- a) Any amount of salt is unhealthy
 - b) Sodium is found in salt
 - c) Eating high amounts of salt leads to diabetes
 - d) Eating too much salt leads to low blood pressure
- 28) How does a person lose weight?
- a) With the help of certain drugs and special diet
 - b) By eating more white meat and vegetables
 - c) By eating less food (fewer calories) and exercising more
 - d) Only by exercising more
- 29) What is Vitamin C good for?
- a) It will make my bones strong
 - b) It helps heal wounds
 - c) It helps me to recover from a cold or flu
 - d) It helps with night vision
- 30) Protein is found in what foods?
- a) Potatoes
 - b) Breads
 - c) Tomatoes
 - d) Milk

Thoughts on Your Health

- 31) Please select how strongly you agree or disagree with the following statements.
- 5-point Likert Scale: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

- a) I feel that there are many barriers to healthy living such as lack of time
- b) I have many strategies to assist me in living healthy such as reminders
- c) I understand that how events are connected such as eating better leads to becoming healthy and avoiding illness
- d) The food I eat does have an effect on my overall health
- e) My activity level including walking and/or exercising has an effect on my overall health
- f) I have a good understanding of nutritional value of foods
- g) I am capable of eating highly nutritious foods and resisting unhealthy foods
- h) I am capable of increasing my activity level by walking or exercising every day
- i) I am motivated to live in a healthy manner because of rewards such as losing weight (or other rewards)
- j) I have health goals that I try to meet in the long term (over one month)
- k) I have health goals that I try to meet in the short term (over one day or week)
- l) Eating healthy foods and leading an active lifestyle will help me to avoid illness
- m) Eating healthy foods and leading an active lifestyle will help me to live longer
- n) I enjoy eating healthy foods and avoiding unhealthy foods
- o) I enjoy leading an active lifestyle and exercising regularly
- p) I have similar eating and exercising habits as my family
- q) I have similar eating and exercising habits as my friends
- r) I often feel obligated to eat healthy foods because of my family and friends
- s) I often feel obligated to lead an active life and exercise because of my family and friends
- t) I often feel obligated to eat healthy foods because of society's expectations
- u) I often feel obligated to lead an active life and exercise because of society's expectations
- v) I learn that I am capable of living healthier by seeing what my friends and family are doing
- w) Some of my friends and family (or other systems and technologies) help

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

me to live healthier

x) Some of my friends and family (or other things such as work) prevent me from living healthier

y) I think eating healthy foods and leading an active lifestyle will help me to avoid illness because of what others have told me

z) I am motivated to live healthier based on what society and experts have told me

32) Please feel free to provide any additional comments about your thoughts on your personal health.

Evaluation of your engagement as a patient

33) Please select if you how strongly you agree or disagree with the following statements.

4-point Likert Scale: Strongly Disagree, Disagree, Agree, Strongly Agree

a) When all is said and done, I am the person who is responsible for managing my health condition

b) Taking an active role in my own health care is the most important factor in determining my health and ability to function

c) I know what each of my prescribed medications do

d) I am confident I can tell my health care provider concerns I have even when he or she does not ask

e) I am confident that I can tell when I need to go get medical care and when I can handle a health problem myself

f) I know the lifestyle changes like diet and exercise that are recommended for my health condition

g) I am confident that I can follow through on medical treatments I need to do at home

h) I am confident that I can take actions that will help prevent or minimize some symptoms or problems associated with i) my health condition(s)

j) I am confident that I can find trustworthy sources of information about my health condition and my health choices

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

- k) I am confident that I can follow through on medical recommendations my health care provider makes, such as changing my diet or doing regular exercise
- l) I understand the nature and causes of my health condition(s)
- m) I know the different medical treatment options available to my health condition
- n) I have been able to maintain the lifestyle changes for my health that I have made
- o) I know how to prevent further problems with my health condition(s)
- p) I know about the self-treatments for my health condition(s)
- q) I have made the changes in my lifestyle like diet and exercise that are recommended for my health condition
- r) I am confident I can figure out solutions when new situations or problems arise with my health condition
- s) I am able to handle symptoms of my health condition on my own at home
- t) I am confident that I can maintain lifestyle changes like diet and exercise even during times of stress
- u) I am able to handle problems of my health condition on my own at home
- v) I am confident I can keep my health problems from interfering with the things I want to do
- w) Maintaining the lifestyle changes that are recommended for my health condition is NOT too hard to do on a daily basis

Mid- and Post-Questionnaire for Experimental Group

1) Please provide your PARTICIPANT NUMBER that you were given by the researcher. If you can't remember your number, please email Noreen Kamal at noreenk@ece.ubc.ca

2) Please select which statement best describes your current stage in living healthy

- a) I am not considering changing my lifestyle to live healthier
- b) I am thinking about changing my lifestyle to live healthier
- c) I am starting to prepare to change my lifestyle to live healthier
- d) I am changing my lifestyle and I am living in a healthy way
- e) I am now maintaining the lifestyle changes that I have made to continue to live healthy

3) Please provide any additional comments about your current or past stage in living healthy

4) What is your current weight? lbs

5) What is your current height?

Feet

Inches

6) How many servings do you consume on average every week for the following foods?

Salads

Fruits

Vegetables

French Fries

Potato Chips (or similar)

7) How often do you do on average every week for the following activities?

Walking (30 minutes or more)

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

Cardio or Aerobic Exercise like jogging (20 min or more)

Active sports

Other activities like Gardening

Resistance exercise (like weight lifting)

8) How healthy do you think you are? (6-point Likert Scale: 1 (very unhealthy) - 6 (very healthy))

Nutrition and Health Multiple Choice test

Please answer the questions based on your current knowledge. Do not ask for help. Do not use the internet to find the answers.

9) How many calories (approximately) does the average person ideally consume daily?

- a) 500 calories
- b) 1,000 calories
- c) 2,000 calories
- d) 3,000 calories

10) All fats are unhealthy

- a) True
- b) False

12) What foods have high fiber content (select the most accurate item below)

- a) Whole wheat bread, beans and vegetables
- b) Any breads and cereals grains (such as oat, barley, rice and quinoa)
- c) Whole wheat bread and meats
- d) All of the above

13) Even walking at a slow pace will burn calories

- a) True
- b) False

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

14) What is iron?

- a) Iron is a mineral that helps produce red blood cells and helps transport oxygen throughout the body
- b) Iron is a nutrient that helps build and repair body tissue
- c) Iron is a nutrient that helps the digestive system
- d) Iron is a nutrient that helps keep skin healthy

15) Select the most correct response about sugar

- a) Sugar is necessary in small amounts
- b) Sugar is not necessary for good health in any amount
- c) Sugar is not found naturally in breads
- d) All carbohydrates are sugars

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- a) Any amount of salt is unhealthy
- b) Sodium is found in salt
- c) Eating high amounts of salt leads to diabetes
- d) Eating too much salt leads to low blood pressure

17) How does a person lose weight?

- a) With the help of certain drugs and special diet
- b) By eating more white meat and vegetables
- c) By eating less food (fewer calories) and exercising more
- d) Only by exercising more

18) What is Vitamin C good for?

- a) It will make my bones strong
- b) It helps heal wounds
- c) It helps me to recover from a cold or flu
- d) It helps with night vision

19) Protein is found in what foods?

- a) Potatoes

- b) Breads
- c) Tomatoes
- d) Milk

Thoughts on VivoSpace

- 19) What feature(s) of VivoSpace did you like the most?
- 20) What feature(s) of VivoSpace did you like the least?
- 21) Do you have any suggestions on how to improve VivoSpace?
- 22) What were some of the reasons that you stopped using VivoSpace?
- 23) What features would have motivated you to continue to use VivoSpace?
- 24) Do you have any other thoughts about VivoSpace that you would like to share?

Please select how strongly you agree or disagree with the following statements.

- 25) I used VivoSpace to get information (such as nutritional information)
a) strongly disagree b) disagree c) neutral d) agree e) strongly agree
- 26) Please provide additional information about your thoughts on getting information from VivoSpace
- 27) I used VivoSpace to provide information (such as my meals and physical activity)
a) strongly disagree b) disagree c) neutral d) agree e) strongly agree
- 28) Please provide additional information about your thoughts on providing information on VivoSpace
- 29) I used VivoSpace to connect with other people

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

a) strongly disagree b) disagree c) neutral d) agree e) strongly agree
30) Please provide additional information about your thoughts on connecting with other people on VivoSpace

31) I used VivoSpace to learn more about myself (e.g. my eating habits)
a) strongly disagree b) disagree c) neutral d) agree e) strongly agree
32) Please provide additional information about your thoughts on learning more about yourself from VivoSpace

33) I used VivoSpace to look good to others on VivoSpace (e.g. show others that you are eating nutritious foods)
a) strongly disagree b) disagree c) neutral d) agree e) strongly agree
34) Please provide additional information about your thoughts on using VivoSpace to look good to others

35) I used VivoSpace because it was entertaining (e.g. achieving new levels or successfully completing goals)
a) strongly disagree b) disagree c) neutral d) agree e) strongly agree
36) Please provide additional information about your thoughts on VivoSpace being entertaining

37) I used VivoSpace to relate to people who are similar to myself
a) strongly disagree b) disagree c) neutral d) agree e) strongly agree
38) Please provide additional information about your thoughts on using VivoSpace to relate to similar people

39) I used VivoSpace because it was a convenient way to obtain health information (or other conveniences)
a) strongly disagree b) disagree c) neutral d) agree e) strongly agree
40) Please provide additional information about your thoughts on VivoSpace being convenient

Your thoughts on your health and use of VivoSpace

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

41) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

- a) I feel that there are many barriers to healthy living such as lack of time
- b) I better understood barriers by viewing my health information on VivoSpace
- c) I better understood barriers by connecting with others on VivoSpace
- d) The convenience of VivoSpace helped me to overcome barriers
- e) I was better able to overcome barriers because I wanted to look good to others on VivoSpace (e.g. your friends on VivoSpace)

42) Were there any other aspects of VivoSpace that helped you to overcome barriers to living in a healthy way?

43) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

- a) have many strategies to assist me in living healthy such as reminders
- b) I was able to have new ways to assist me in living healthier by viewing my information on VivoSpace
- c) I was able to have new ways to assist me in living healthier by connecting with others on VivoSpace
- d) The convenience of VivoSpace helped me to assist me in living healthier
- e) I was able to have new ways to assist me in living healthier because I wanted to look good to others on VivoSpace

44) Were there any other aspects of VivoSpace that assisted you to live in a healthy way?

45) Please select how strongly you agree or disagree with the following statements.

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

a) I understand how events are connected such as eating better leads to becoming healthy and avoiding illness

b) I was able to understand how events are connected for my personal health from the information that I received on VivoSpace such as nutritional information

c) I was able to understand how events are connected for my personal health because I wanted to promote myself to others on VivoSpace

d) I was able to understand how events are connected for my personal health through exchanging comments with other people on VivoSpace

46) Were there any other aspects of VivoSpace that helped you to understand how events are connected to your personal health

47) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

a) The food I eat does have an effect on my overall health

b) My activity level including walking and/or exercising has an effect on my overall health

c) I have a better appreciation that the food I eat and/or exercising affects my health through the information that I received on VivoSpace such as nutritional information

d) I have a better appreciation that the food I eat and/or exercising affects my health through the gaming features on VivoSpace like the completion of goals

48) Were there any other features on VivoSpace that changed how you believed that the food you eat and/or exercising affects your overall health

49) Please select how strongly you agree or disagree with the following state-

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

ments. 5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

- a) I have a good understanding of nutritional value of foods
- b) I obtained a good understanding of nutritional value for foods from the information that I received from VivoSpace

50) What other aspects of VivoSpace provided you the opportunity to learn about the nutritional value of foods and other healthy behaviors?

51) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

- a) I am capable of eating highly nutritious foods and resisting unhealthy foods
- b) I am capable of increasing my activity level by walking or exercising every day
- c) VivoSpace allowed me to discover more about myself that showed me my capabilities for eating healthy and exercising
- d) I was able to learn about my capabilities by logging my eating/activity information on VivoSpace

52) What other aspects of VivoSpace showed you what you are capable of?

53) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

- a) I am motivated to live in a healthy manner because of rewards such as losing weight (or other rewards)
- b) The gaming features in VivoSpace motivated me to live in a healthy manner

54) Were there any other rewards or incentives that VivoSpace provided that

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

motivated you to be healthier?

55) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

a) I have health goals that I try to meet in the long term (over one month)

b) I have health goals that I try to meet in the short term (over one day or week)

c) The goals feature on VivoSpace helped me to meet my goals

56) Were there any other aspects of VivoSpace that helped you to meet your goals?

57) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

a) Eating healthy foods and leading an active lifestyle will help me to avoid illness

b) Eating healthy foods and leading an active lifestyle will help me to live longer

c) I have a better understanding of how eating healthy and exercising more will help me to avoid illness through the information that I obtained in VivoSpace

58) Were there any other aspects of VivoSpace that helped you to understand how healthy eating and exercising can help avoid illness?

59) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

- a) I enjoy eating healthy foods and avoiding unhealthy foods
- b) I enjoy leading an active lifestyle and exercising regularly
- c) The gaming features of VivoSpace helped me to enjoy healthy eating and exercising more

60) Were there any other features of VivoSpace that helped you to enjoy healthy eating and exercising more?

61) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

- a) I have similar eating and exercising habits as my family
- b) I have similar eating and exercising habits as my friends
- c) I have similar eating and exercising habits as my friends on VivoSpace
- d) VivoSpace allowed me to be a part of a group that helped me to have similar eating and exercise habits as my VivoSpace Friends
- e) VivoSpace allowed me to feel that I belonged to a group that helped me to have similar eating and exercise habits as my VivoSpace Friends
- f) VivoSpace allowed me to see what my VivoSpace friends are doing that helped me to have similar eating and exercise habits as my VivoSpace friends
- g) VivoSpace allowed me to be dependent on others in VivoSpace, which helped me to have similar eating and exercise habits as my VivoSpace friends
- h) VivoSpace allowed for the development of groups (such as group goals) that helped me to have similar eating and exercise habits as my VivoSpace friends

62) What other aspects of VivoSpace helped you to have similar eating and exercise habits as your VivoSpace friends? Why?

63) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

Agree

- a) I often feel obligated to eat healthy foods because of my family and friends
- b) I often feel obligated to lead an active life and exercise because of my family and friends
- c) I often feel obligated to eat healthy foods because of societys expectations
- d) I often feel obligated to lead an active life and exercise because of societys expectations
- e) VivoSpace allowed me to be a part of a group that made me feel obligated to be healthier
- f) VivoSpace allowed me to feel that I belonged to a group that made me feel obligated to be healthier
- g) VivoSpace allowed me to see what my VivoSpace friends are doing that made me feel obligated to be healthier

64) Were there any other aspects to VivoSpace that made you feel obligated to be healthier by eating healthier foods and/or exercising more?

65) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

- a) I learned that I am capable of living healthier by seeing what my friends and family are doing
- b) VivoSpace allowed me to compare my health habits to others, which showed me that I am capable of living healthier
- c) VivoSpace allowed me to have personal knowledge of others, which showed me that I am capable of living healthier
- d) VivoSpace allowed for the development of groups (such as group goals), which showed me that I am capable of living healthier

66) Were there any other aspects of VivoSpace that showed you that you are capable of living healthier?

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

67) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

a) Some of my friends and family (or other systems and technologies) help me to live healthier

b) VivoSpace allowed me to be a part of a group that helped me to live healthier

c) VivoSpace allowed me to interact with others that helped me to live healthier

d) VivoSpace allowed me to be dependent on others in VivoSpace, which helped me to live healthier

e) VivoSpace allowed to compare my health habits with others, which helped me to live healthier

68) Were there any other aspects of VivoSpace that helped you to live healthier?

69) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

a) Some of my friends and family (or other things such as work) prevent me from living healthier

b) VivoSpace allowed me to interact with others that helped me to overcome barriers to living healthier

c) VivoSpace allowed me to compare my health habits with others, which helped me to overcome barriers to living healthier

70) Where there any other aspects of VivoSpace that helped you to overcome social barriers to living healthier?

71) Please select how strongly you agree or disagree with the following state-

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

ments.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

- a) I think eating healthy foods and leading an active lifestyle will help me to avoid illness because of what others have told me
- b) VivoSpace allowed me to see what my VivoSpace friends are doing that allowed me to see that living healthy will help me to avoid illness
- c) VivoSpace allowed me to interact with others on VivoSpace that allowed me to learn that living healthy will help me to avoid illness
- d) VivoSpace allowed me to have personal knowledge of others that allowed me to see that living healthy will help me to avoid illness

72) Were there any other aspects of VivoSpace that allowed you to see that living healthy will help you to avoid illness?

73) Please select how strongly you agree or disagree with the following statements.

5-point Likert scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

- a) I am motivated to live healthier based on what society and experts have told me
- b) VivoSpace allowed me to be a part of a group that motivated me to live healthier based on what society and experts have told me
- c) VivoSpace allowed me to develop a sense of belonging that motivated me to live healthier based on what society and experts have told me
- d) Some of the people on VivoSpace motivated me to live healthier based on what society and experts have told me
- e) VivoSpace allowed me to interact with others on VivoSpace that motivated me to live healthier based on what society and experts have told me

74) Were there any other aspects of VivoSpace that motivated you to live healthier based on what society and experts have told you?

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

75) How do you feel a system such as VivoSpace can help you change or maintain good health behavior?

76) Do you feel that your health behavior has changed (e.g. are you eating healthier foods)?

77) Do you have any additional thoughts on your health?

Evaluation of your engagement as a patient

33) Please select if you how strongly you agree or disagree with the following statements.

4-point Likert Scale: Strongly Disagree, Disagree, Agree, Strongly Agree

a) When all is said and done, I am the person who is responsible for managing my health condition

b) Taking an active role in my own health care is the most important factor in determining my health and ability to function

c) I know what each of my prescribed medications do

d) I am confident I can tell my health care provider concerns I have even when he or she does not ask

e) I am confident that I can tell when I need to go get medical care and when I can handle a health problem myself

f) I know the lifestyle changes like diet and exercise that are recommended for my health condition

g) I am confident that I can follow through on medical treatments I need to do at home

h) I am confident that I can take actions that will help prevent or minimize some symptoms or problems associated with i) my health condition(s)

j) I am confident that I can find trustworthy sources of information about my health condition and my health choices

k) I am confident that I can follow through on medical recommendations my health care provider makes, such as changing my diet or doing regular exercise

Second Appendix: Questionnaires for Field Experiment of High-Fidelity Prototype

- l) I understand the nature and causes of my health condition(s)
- m) I know the different medical treatment options available to my health condition
- n) I have been able to maintain the lifestyle changes for my health that I have made
- o) I know how to prevent further problems with my health condition(s)
- p) I know about the self-treatments for my health condition(s)
- q) I have made the changes in my lifestyle like diet and exercise that are recommended for my health condition
- r) I am confident I can figure out solutions when new situations or problems arise with my health condition
- s) I am able to handle symptoms of my health condition on my own at home
- t) I am confident that I can maintain lifestyle changes like diet and exercise even during times of stress
- u) I am able to handle problems of my health condition on my own at home
- v) I am confident I can keep my health problems from interfering with the things I want to do
- w) Maintaining the lifestyle changes that are recommended for my health condition is NOT too hard to do on a daily basis

Third Appendix: Initial User Inquiry Questionnaire and Interview Questions

This appendix contains the initial user inquiry questionnaire that was used at the beginning of the UCD process. Following the questionnaire, the interview questions are also shown. The initial user inquiry is described in detail in Chapter 7 Section 7.1.

Initial User Inquiry Questionnaire

I. Demographic information

1. Please specify your gender.
 - a. Female
 - b. Male

2. Which age group do you belong to? (select one)
 - a. 19-24 years old
 - b. 25-34 years old
 - c. 35-49 years old
 - d. 50-64 years old
 - e. 65-74 years old
 - f. 75 years old and older

3. Do you identify as a First Nations or Aboriginal person (North American Indian, Metis, or Inuit)? If you answer yes to this question, please go to

Third Appendix: Initial User Inquiry Questionnaire and Interview Questions

Question 7.

- a. Yes
- b. No

4. If you answered No to question 3, do you primarily identify as being Canadian?

- a. Yes
- b. No

5. If you answered No to question 4, which ethnic group do you primarily identify belonging to, please specify

- a. Chinese
- b. East Asian (including Japanese, Korean)
- c. South East Asian (Including Filipino, Malaysian, Thai, Indonesian, Vietnamese, Cambodian)
- d. South Asian (including Punjabi, Indian, Pakistani, Bangladeshi, Sri Lankan)
- e. Arab
- f. West Asian (including Iranian, Afghani)
- g. Hispanic (including Mexican, Cuban, South & Central American)
- h. Other:

6. Do you identify with a secondary ethnic group?

- a. Yes. please specify
- b. No

II. Computer and Mobile Phone Usage

7. Do you own a computer?

- a. Yes
- b. No

8. Do you own a mobile phone?

Third Appendix: Initial User Inquiry Questionnaire and Interview Questions

- a. Yes
- b. No

9. If yes, please specify the brand of mobile phone?

- a. iPhone
- b. Blackberry
- c. Android (includes: HTC Magic, Google Nexus One, LG Eve, Motorola Quench, Motorola droid, Motorola CLIQ XT, Motorola Backflip, Samsung I7500, Sony Experia, Acer Liquid)
- d. Windows Mobile (includes: HTC Typhoon, HTC Breeze, HTC Oxygen, HP IPAC)
- e. Symbian (includes: Nokia, Sony P800 & P900)
- f. Other. Please Specify

10. Please specify how often you use the following technology (Throughout the day, at least once a day, at least once a week, a few times a day, a few times a month, once a month or less, or never):

- a. Use a computer
- b. Use email
- c. Use a mobile phone
- d. Use the internet on a computer
- e. Use the internet on a mobile phone

III. Use of Social Networks

11. Please specify how often you have used the followings online social networks over the past 2 months (Throughout the day, at least once a day, at least once a week, a few times a day, a few times a month, once a month or less, or never):

- a. Facebook
- b. LinkedIn
- c. MySpace
- d. Twitter

Third Appendix: Initial User Inquiry Questionnaire and Interview Questions

e. Orkut

f. Other. Please Specify:

12. Do you use online communities such as special interest online forums or discussion groups?

a. Yes

b. No

13. If yes, please specify the online community (or communities) that you have participated in.

14. If you answered yes to question 12, how often do you use the online community? (If you participate in more than one online community, please specify for the online community that you use most often)

a. Throughout the day

b. At least once a day

c. At least once a week

d. A few times a month

e. Once a month or less

15. If you use or have used online social networks or online communities, please select how strongly you agree or disagree with the following statements on *the reasons that you use online social networks and/or online communities* (Strongly disagree, disagree, neutral, agree, strongly agree):

a. I use online social networks and/or online communities to get information

b. I use online social networks and/or online communities to provide information

c. I use online social networks and/or online communities for entertainment or to pass time

d. I use online social networks and/or online communities for convenience such as easy access to friends

e. I use online social networks and/or online communities to maintain connection with people

Third Appendix: Initial User Inquiry Questionnaire and Interview Questions

- f. I use online social networks and/or online communities to have more influence with people I know or to enhance my social position
- g. I use online social networks and/or online communities to learn more about myself
- h. I use online social networks and/or online communities to belong to a group or community
- i. I use online social networks and/or online communities to connect with similar people
- j. I *continue* to use social networks and/or online communities because I am fond of using it
- k. I *continue* to use social networks because I feel that I would lose something if I stopped using it
- l. I *continue* to use social networks because everyone is using them
- j. I have used online social networks or online communities more in the past than I do currently

16. Please provide any additional information about your use of online social networks and/or online communities.

IV. Informational Needs

17. Please select how you store the information type below (Computer or mobile phone, paper, both paper and computer/mobile phone, do not store this type of information):

- a. Phone numbers for family and friends
- b. Addresses for family and friends
- c. Information about upcoming social events
- d. Information about appointments
- e. Personal to-do lists
- f. Doctors (or other health person) office information (e.g. address and phone number)
- g. Prescription information
- h. Nutritional information (e.g. food that you have eaten)
- i. Information about exercise

Third Appendix: Initial User Inquiry Questionnaire and Interview Questions

j. Information about how to live healthy

18. Please specify any other type of information that is not listed above and comment about your method of storing this information.

19. Does anyone else in your home assist you with managing your personal information?

- a. Yes. Please specify types of personal information
- b. No

20. If yes, please specify who in your household assists you with the management of your personal information. (Select all that apply)

- a. Wife or female partner
- b. Husband or male partner
- c. Mother
- d. Father
- e. Sister
- f. Brother
- g. Daughter
- h. Son
- i. Other. Please Specify

21. Does anyone else in your home assist you with managing your health information?

- a. Yes. Please specify type of health information
- b. No

22. If yes, please specify who in your household assists you with the management of your health information. (Select all that apply)

- a. Wife or female partner
- b. Husband or male partner
- c. Mother
- d. Father

Third Appendix: Initial User Inquiry Questionnaire and Interview Questions

- e. Sister
- f. Brother
- g. Daughter
- h. Son
- i. Other. Please Specify

23. Do you assist anyone in your household with the management of their personal information?

- a. Yes. Please specify type of personal information
- b. No

24. If yes, please specify who in your household you assist with the management of their personal information. (Select all that apply)

- a. Wife or female partner
- b. Husband or male partner
- c. Mother
- d. Father
- e. Sister
- f. Brother
- g. Daughter
- h. Son
- i. Other. Please Specify

25. Do you assist anyone in your household with the management of their health information?

- a. Yes. Please specify type of health information
- b. No

26. If yes, please specify who in your household you assist with the management of their health information. (select all that apply)

- a. Wife or female partner
- b. Husband or male partner
- c. Mother

- d. Father
- e. Sister
- f. Brother
- g. Daughter
- h. Son
- i. Other. Please Specify

27. Please feel free to make any additional comments about the storage and management of personal information and health information.

V. Your health status and thoughts about your health

28. Do you have any health problems?

- a. Yes
- b. No

29. If yes, please specify the health problem(s)

30. Does anyone in your household have any health problems?

- c. Yes
- d. No

31. If yes, please specify the health problems(s)

32. Please select if you how strongly you agree or disagree with the following statements (Strong disagree, disagree, neutral, agree, strongly agree):

- a. I live a healthy lifestyle
- b. I eat healthy food
- c. I exercise regularly
- d. I am concerned about my health
- e. I understand how to live in a healthy way
- f. I understand the nutritional value for the food I eat
- g. My friends and family influence the food that I eat
- h. My friends and family influence how much I exercise

Third Appendix: Initial User Inquiry Questionnaire and Interview Questions

- i. My friends and family are positive influences on my health
- j. I find it easy to eat healthy food
- k. I find it easy to exercise regularly
- l. I ate healthier foods in the past than I do today
- m. I exercised more in the past than I do today
- n. I find it difficult to maintain a healthy lifestyle
- o. I feel that I am capable of living a healthier life

33. Please feel free to provide any additional comments about your thoughts on your personal health.

Interview Questions

I. Demographic information

1. Please specify your gender.
 - a. Female
 - b. Male

2. Which age group do you belong to?
 - a. 19-24 years old
 - b. 25-34 years old
 - c. 35-49 years old
 - d. 50-64 years old
 - e. 65-74 years old
 - f. 75 years old and older

3. Do you identify as a First Nations or Aboriginal person (North American Indian, Metis, or Inuit)?

4. Do you primarily identify as being Canadian?

5. If you answered No to question 4, which ethnic group do you primarily identify belonging to?

6. Do you identify with a secondary ethnic group? Which one?

II. Computer and Mobile Phone Usage

7. Do you own a computer? How often do you use it? What do you primarily use it for?

8. Do you own a mobile phone? How often do you use it? What do you primarily use it for? If yes, please specify the brand of mobile phone?

9. Do you use the internet? How often to you use it? What do you primarily use it for?

III. Use of Online Social Networks

10. Do you use online social networks (e.g. facebook, myspace, linkedin, Friendster, Orkut)? How often do you use it? What do you primarily use it for?

11. Do you use online communities such as special interest online forums or discussion groups? How often do you use it? What do you primarily use it for?

IV. Your health status and thoughts about your health

12. Do you have any health problems? Explain.

13. What are your thoughts about living a healthy lifestyle? What does it take? Do you feel that you do live healthy?

14. Do your friends and family influence your health behaviour?

V. Feedback on prototypes (show prototypes and explain them briefly)

15. What are your initial thoughts on these prototypes?

16. Would this type of system be fun and enjoyable to use? Why or why not?

17. What benefits would this type of communication provide to you?

18. Would this type of system allow you to belong to a social group or

Third Appendix: Initial User Inquiry Questionnaire and Interview Questions

community? Why or why not?

19. Would you want to continue to use this system over a long period of time? Why or why not?

20. Would this type of system influence your health behaviour? Why or why not?

21. Would this type of system allow you to see the key influences of health behaviour? Why or why not?

22. Would this type of system allow you to be influenced by your social group? Why or why not? How can we design this so that the influence is positive?

23. Would this system allow you to see change in health behaviour over time? Why or why not?

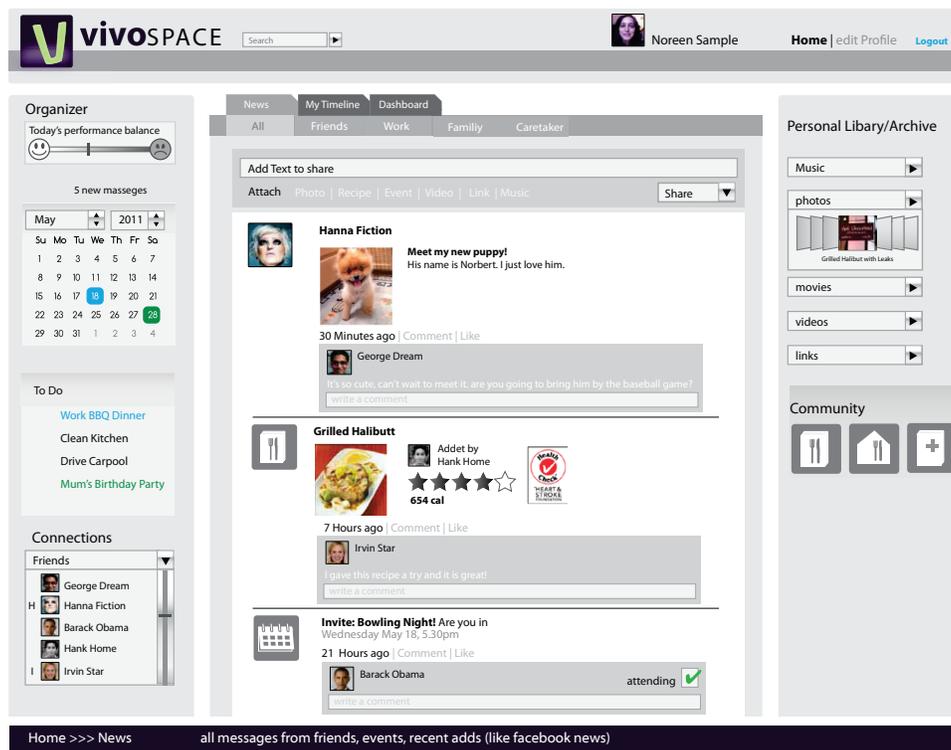
24. What changes would you like to see in the design of this system?

Fourth Appendix: Paper Prototypes

Prototypes

This chapter shows each page of the paper prototypes that were developed using Adobe Illustrator. The design and evaluation of the paper prototypes are described in detail in Section 7.2.

Newsfeed



My Timeline

The screenshot displays the Vivospace user interface for 'My Timeline'. At the top, the user is identified as 'Noreen Sample' with a profile picture and navigation links for 'Home', 'edit Profile', and 'Logout'. The main content area is titled 'My Timeline' and shows a calendar for May 2010. The timeline entries include:

- Today Tuesday, 19th May 9:00am** (Shared with [Caretakers](#)):
 - Walking 15 mins
 - Breakfast Cerials 185 cal
 - Vitamin C Sublement 85 mg
 - Some personal information about what I did that day. (edit)
- Wednesday, 18 May 8:00pm** (Shared with [Family, Friends, Caretakers](#)):
 - Dinner at Earls with Irvin and Cloe
 - at Earls
 - Gourmet Burger & Calpirinna (1010:cal, 25g, 312:cal, 62min)
 - I walked there and it was a beautiful spring day. The girls and had a really nice time, but ate to much. (edit)
- Wednesday, 18 May 4:00pm** (Shared with [not shared](#)):
 - Double Double from TH
 - at Tim Hortons (150:cal)
 - 16 oz Coffee, 2 sugar, 2 cream

On the left side, there is an 'Organizer' section with a 'Today's performance balance' slider, '5 new messages', a calendar for May 2011, a 'To Do' list (Work BBQ Dinner, Clean Kitchen, Drive Carpool, Mum's Birthday Party), and a 'Connections' list of friends (George Dream, Hanna Fiction, Barack Obama, Hank Home, Irvin Star). On the right side, there is a 'Personal Library/Archive' section with categories like Music, photos, movies, videos, links, and a 'Community' section with icons for a fork and knife, a house, and a plus sign.

At the bottom of the interface, a dark bar contains the text: 'Home >>> Timeline track of all personal notes, automatically added or personal written (handwriting parts)'

Dashboard

vivospace

Noreen Sample [Home](#) | [edit Profile](#) | [Logout](#)

Organizer

Today's performance balance

5 new messages

May 2011

| Su | Mo | Tu | We | Th | Fr | Sa |
|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | 1 | 2 | 3 | 4 |

To Do

- [Work BBQ Dinner](#)
- [Clean Kitchen](#)
- [Drive Carpool](#)
- [Mum's Birthday Party](#)

Connections

Friends

- George Dream
- Hanna Fiction
- Barack Obama
- Hank Home
- Irvin Star

News
My Timeline
Dashboard

my map
goals
events
performance
winners&loosers

15 - 21 | May | 2010

weeks performance

sun
mon
tue
wed
thu
fri
sat

▼ performance details

| | | | | | | | |
|---|----------|----------|----------|----------|----------|----------|----------|
| + | 1879 cal |
| 🔥 | 487 cal | 187 cal | 187 cal | 187 cal | 479 cal | 239 cal | 279 cal |
| 🥩 | 25 g | 25 g | 29 g | 25 g | 25 g | 35 g | 35 g |
| 🍗 | 165 lb | 162 lb | 164 lb | 164 lb | 164 lb | 164 lb | 162 lb |
| 👤 | 125 | 125 | 125 | 125 | 125 | 125 | 125 |
| 🏃 | 135/s |
| 🕒 | 90 min |
| 🏃 | 15 min |
| | sun 11 | mon 12 | tue 13 | wed 14 | thu 16 | fri 17 | sat 18 |

Personal Library/Archive

Music

photos

Grilled Halibut with Leeks

movies

videos

links

Community

[Home >>> Dashboard](#) Performance: weekly calories, nutrition, activity overview

Dashboard when an icon is clicked

The screenshot shows the Vivospace dashboard interface. At the top, there is a search bar and user information for Noreen Sample. The main navigation includes 'News', 'My Timeline', and 'Dashboard'. The 'Dashboard' tab is active, showing a 'performance overview' table and a 'calorie details' popup.

performance overview

| | sun | mon | tue | wed | thu | fri | sat |
|----------|----------|----------|----------|----------|----------|----------|----------|
| Calories | 1879 cal |
| fat | 487 cal | 187 cal | 187 cal | 187 cal | 479 cal | 239 cal | 279 cal |
| fat | 25 g | 25 g | 29 g | 25 g | 25 g | 35 g | 35 g |
| fat | 165 lb | 162 lb | 164 lb | 164 lb | 164 lb | 164 lb | 162 lb |
| fat | 125 | 125 | 125 | 125 | 125 | 125 | 125 |
| fat | 135/s |
| fat | 90 min |
| fat | 15 min |
| fat | sun 11 | | | | | | |

calorie details

Calories Cal burned

2750
2500
2250
2000
1750
1500
1250
1000
750
500
250

Goal

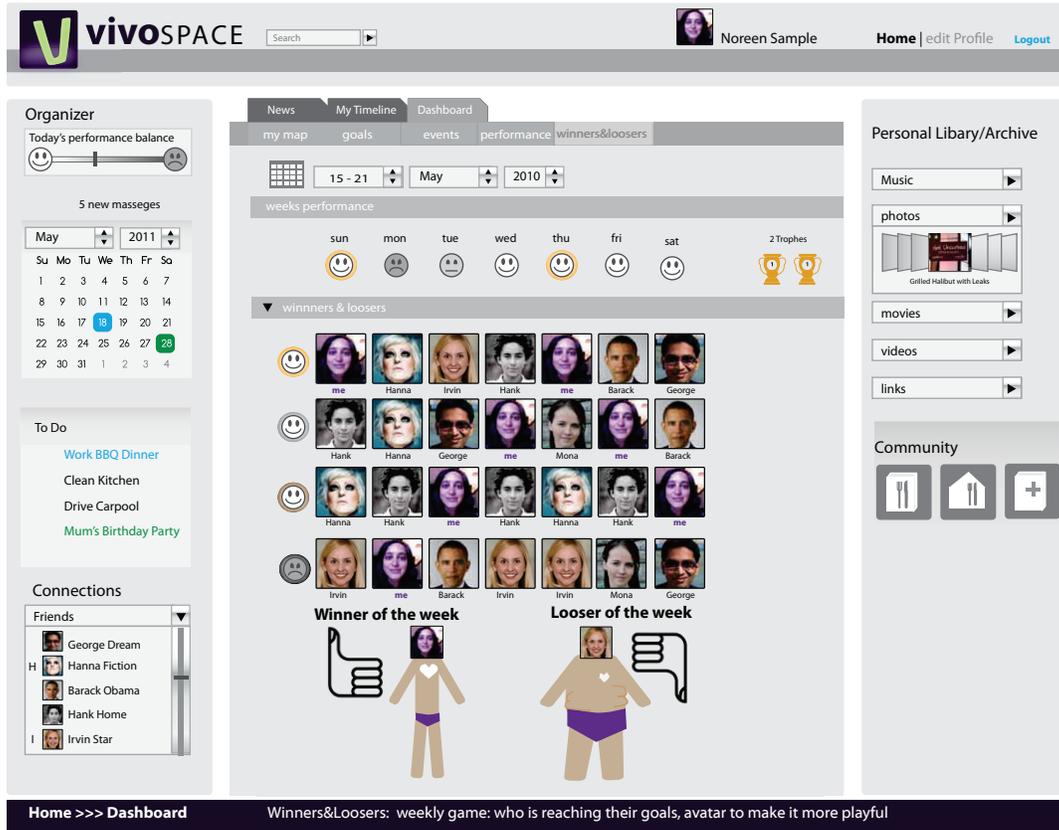
Lunch at Fat Burger with Irvin Star 825 Calories

granola Breakfast 185 Calories

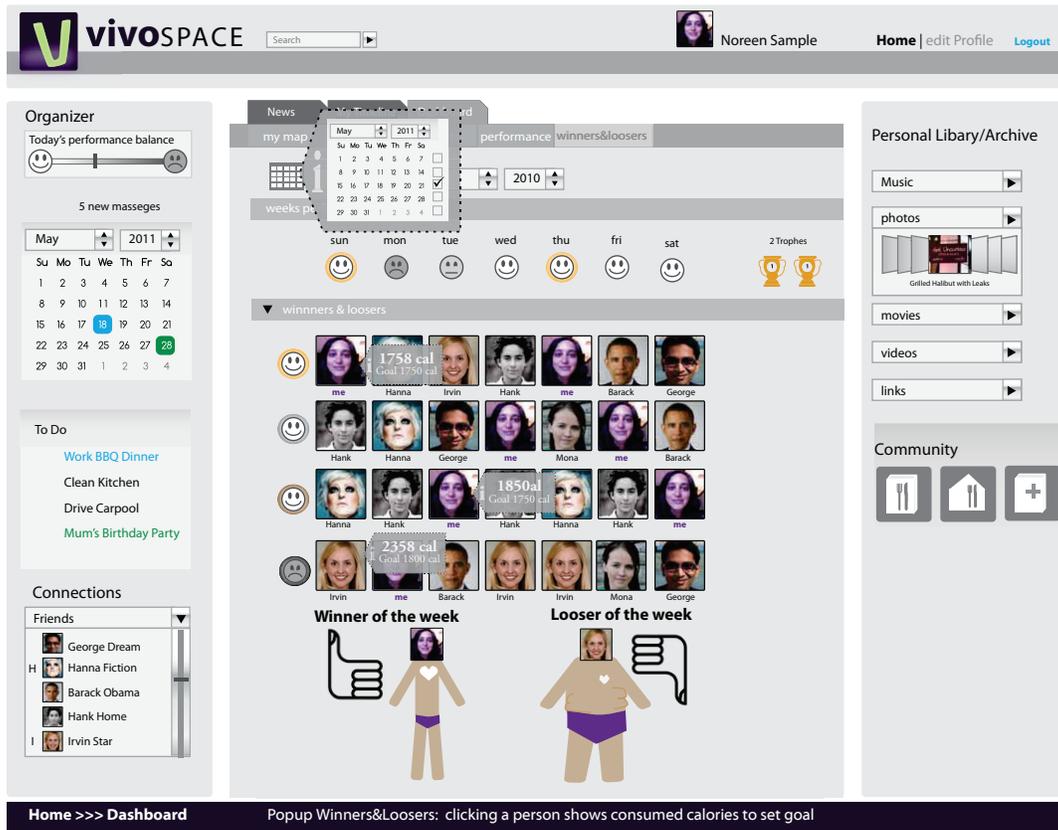
sun 11 mon 12 tue 13 wed 14 thu 16 fri 17 sat 18

Home >>> Dashboard Popup by clicking icons for details

Winners and Losers



Winners and Losers when elements are clicked



My Map

The screenshot displays the Vivospace user interface. At the top, the logo 'VIVOSPACE' is on the left, a search bar in the center, and the user's name 'Noreen Sample' with a profile picture on the right. Navigation links for 'Home', 'edit Profile', and 'Logout' are also present.

The main content area is divided into several sections:

- Organizer:** Features a 'Today's performance balance' slider, a notification for '5 new messages', a calendar for May 2011, a 'To Do' list (including 'Work BBQ Dinner', 'Clean Kitchen', 'Drive Carpool', and 'Mum's Birthday Party'), and a 'Connections' list of friends (George Dream, Hanna Fiction, Barack Obama, Hank Home, Irvin Star).
- Navigation:** Tabs for 'News', 'My Timeline', and 'Dashboard' are at the top. Below them are sub-tabs for 'my map', 'goals', 'events', 'performance winners&loosers', and 'Personal Library/Archive'.
- Map:** A map of Vancouver shows a route for 'Wednesday May 18' starting at 8:30 pm with a 2-hour duration. The event is 'Dinner at Earls' (Gourmet Burger & Caipirinha, 1010 Calories) with '+ 2 other friends'. Below the map, walking options are shown: 'walking 60 minutes calories burned 280' and 'public transport 15 km'.
- Personal Library/Archive:** Lists categories like Music, photos (with a photo of 'Grilled Halibut with Leaks'), movies, videos, and links.
- Community:** Includes icons for a restaurant, a house, and a plus sign.

At the bottom, a dark bar contains the text 'Home >>> Dashboard' and 'My map: just to show the option of having a personal map, ...'

Fourth Appendix: Paper Prototypes

Recipes

vivospace Search [] Noreen Sample Home | edit Profile Logout

Organizer
Today's performance balance []
5 new messages
May 2011
Su Mo Tu We Th Fr Sa
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30 31 1 2 3 4
To Do
Work BBQ Dinner
Clean Kitchen
Drive Carpool
Mum's Birthday Party
Connections
Friends
George Dream
Hanna Fiction
Barack Obama
Hank Home
Irvin Star

Recipe
Recipe Favorites Add recipe
Cajun Chicken and Sausage Gumbo by Samuel Reh Add to Favorites Create a Variation
"This is a Cajun-style gumbo made with a seasoned roux, a classic from the bayous of south Louisiana. I revised the recipe after many, many trials. Serve it hot over cooked rice or with potato salad."
**Ingredients**
1 cup vegetable oil
1 cup all purpose flour
1 large onion, chopped
1 large green bell pepper, chopped
2 celery stalks, chopped
1 pound andouille or smoked sausage, sliced 1/4 inch thick
4 cloves garlic, minced
salt and pepper to taste
Creole seasoning to taste
6 cups chicken broth
1 bay leaf
1 rotisserie chicken, boned and shredded
1. Make the roux
Heat the oil in a Dutch oven over medium heat. When hot, whisk in flour. Continue whisking until the roux has cooked to the color of chocolate milk, 8 to 10 minutes. Be careful not to burn the roux. If you see black specks in the mixture, start over.
2. Fry ingredients
Stir onion, bell pepper, celery, and sausage into the roux; cook 5 minutes. Stir in the garlic and cook another 5 minutes. Season with salt, pepper, and Creole seasoning; blend thoroughly.
3. Boil and Simmer
Pour in the chicken broth and add the bay leaf. Bring to a boil over high heat, then reduce heat to medium-low, and simmer, uncovered, for 1 hour, stirring occasionally. Stir in the chicken, and simmer 1 hour more. Skim off any foam that floats to the top during the last hour.
Nutritional Info
Cajun Chicken and Sausage Gumbo
Serving Per Recipe: 18
Amount Per Serving
Calories: 460
Total Fat: 70.5g
Cholesterol: 30mg
Sodium: 1300mg
Total Carbs: 24.5g
Dietary Fiber: 1.5g
Protein: 16.5g
Log to Recently Tried
Write a Review
Add to Recipe Box
Create a Variation
Activity
Andrew Smith reviewed: "The first time I made this I was too impatient and didn't brown the roux long enough. The second time I took the time and made sure it was browner. I'd definitely take the time to let it brown. Also, I am from Maryland so I added 1 lb of shrimp with Old Bay seasoning sprinkled on it, not authentic gumbo, but we like it!"
Natasha Adams rated: []
Caroline Chang reviewed: "The roux was not difficult to make as long as you take your time, keep it on lower heat and stir constantly. It was fantastic!"
Write Review

Personal Library/Archive
Music []
photos []
Grilled Halibut with Leeks
movies []
videos []
links []
Community
[] [] []

Community >>> Recipe: just a screenshot, community recipe with options to create own version, add to favourites, reviews, ...

Recipes overview page

vivospace Search []

Noreen Sample Home | edit Profile Logout

Organizer

Today's performance balance

5 new messages

May 2011

| Su | Mo | Tu | We | Th | Fr | Sa |
|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | 1 | 2 | 3 | 4 |

To Do

- Work BBQ Dinner
- Clean Kitchen
- Drive Carpool
- Mum's Birthday Party

Connections

Friends

- George Dream
- Hanna Fiction
- Barack Obama
- Hank Home
- Irvin Star

Recipe

Recipe Favorites Add recipe

My Recipe Box

Original Reviews Favorites

- All Cuisines**
- American
- Asian
- Cajun/Creole
- Chinese
- English/Scottish
- German
- Indian
- Irish
- Jewish
- Mexican
- Southwestern
- Spanish/Portuguese
- Vietnamese
- All Meal / Course**
- First Course
- Breakfast Foods
- Lunch
- Dinner
- Dessert
- Meat
- Poultry
- Salad
- Sandwich
- Soups, Stews and Stocks
- Vegan
- Vegetarian

| | | |
|--|---------------------------------|-------|
| | Holiday Chicken Salad | ★★★★☆ |
| | Angela's Awesome Enchiladas II | ★★★★☆ |
| | Mulligatawny Soup I | ★★★★★ |
| | Fruity Curry Chicken Salad | ★★★★☆ |
| | Fast Chicken Soup Base | ★★★★☆ |
| | Curried Chicken Tea Sandwiches | ★★★★☆ |
| | Cobb Salad | ★★★★☆ |
| | Cajun Chicken and Sausage Gumbo | ★★★★☆ |
| | Easy Chicken Fajita Soup | ★★★★★ |

Personal Library/Archive

Music []

photos []

movies []

videos []

links []

Community

[] [] []

Community >>> Recipe Favourites: my personal section with favourite recipes

Create Recipe Page

vivospace Search [] Noreen Sample Home | edit Profile Logout

Organizer

Today's performance balance []

5 new messages

May 2011

| Su | Mo | Tu | We | Th | Fr | Sa |
|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | 1 | 2 | 3 | 4 |

To Do

- Work BBQ Dinner
- Clean Kitchen
- Drive Carpool
- Mum's Birthday Party

Connections

Friends

- George Dream
- Hanna Fiction
- Barack Obama
- Hank Home
- Irvin Star

Recipe

Recipe Favorites Add recipe

Enter a creative and informative title, try to be original.

Description

Ingredients

k ~ ã È n | ~ ã ã ã ounces

+ Add Another Ingredient

Steps

1 p | È ã q ã ã a È ã ã ã ã ã

+ Add Another Step

Course

- Appetizer First Course Beverage Breakfast Foods Lunch Dinner Cocktail
- Dessert Fish and Seafood Main Course Meat Pasta Poultry Rice and Grains
- Salad Sandwich Soups, Stews and Stocks Sauces and Condiments Side Vegan
- Vegetarian

Cuisine

- Fusion Dutch American Asian Cajun/Creole Central/South American Chinese
- Eastern European/Russian English/Scottish French German Greek Indian Irish
- Italian Japanese Jewish Mediterranean Mexican Middle Eastern Moroccan

Personal Library/Archive

Music []

photos []

Grilled Halibut with Leeks

movies []

videos []

links []

Community

[] [] []

Community >>> Recipe: just a screenshot, how to add personal recipe

Personal Profile Page

Vivospace Search [] Noreen Sample Home | [edit Profile](#) | [Logout](#)

Organizer
Today's performance balance []
5 new messages
May 2011
Su Mo Tu We Th Fr Sa
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30 31 1 2 3 4
To Do
[Work BBQ Dinner](#)
[Clean Kitchen](#)
[Drive Carpool](#)
[Mum's Birthday Party](#)
Connections
Friends
George Dream
Hanna Fiction
Barack Obama
Hank Home
Irvin Star

Profile Picture
Shared with [all](#)
First Name: Noreen
Middle Name:
Second Name: Sample [edit](#)
Shared with [Family, Friends, Caretakers](#)
Address: [edit](#)
Shared with [Family, Friends, Caretakers](#)
Nationality: Canadian [edit](#)
Shared with [all](#)
Website: infosample.org [edit](#)
Shared with [Family, Friends, Caretakers](#)
Date of Birth: 17 April 1976 [edit](#)
Shared with [Caretakers](#)
Height: 168 cm
Weight: 135 lb
BMI: 35 [edit](#)
Shared with [Family, Friends, Caretakers](#)
Bio: linkedIn [edit](#)
Shared with [Family, Friends](#)
Relationship: married [edit](#)
Shared with [Family, Friends](#)
Interests: running, reading, movies [edit](#)

Personal Library/Archive
Music []
photos []
movies []
videos []
links []
Community
[] [] []

[Edit profile >>> Info](#) Personal Information with groups to create, options of sharing, ...

Approval Seals

V **vivospace**

 Noreen Sample
 [Home](#) | [edit Profile](#) | [Logout](#)

Organizer

Today's performance balance

5 new messages

May 2011

| Su | Mo | Tu | We | Th | Fr | Sa |
|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | 1 | 2 | 3 | 4 |

To Do

- [Work BBQ Dinner](#)
- [Clean Kitchen](#)
- [Drive Carpool](#)
- [Mum's Birthday Party](#)

Connections

Friends

- George Dream
- Hanna Fiction
- Barack Obama
- Hank Home
- Irvin Star

Info
Seals
Health

Health Check

is one important way the Heart and Stroke Foundation helps Canadians eat well.

Healthy eating is one of the most important things you can do to improve your overall health. Whether you are cooking at home or eating out, you can make healthy choices that will help you feel and look better and at the same time lower your risk of heart disease and stroke and other diseases.

<http://www.healthcheck.org>

Diabetes Society

Do you want a better quality of life and better health in your middle and older years? There is now a solid body of medical research showing that patients who have one or more chronic diseases like high blood pressure, high cholesterol, heart disease or diabetes can live longer lives, have fewer heart attacks, strokes, kidney failure and other complications if they succeed in reaching specific goals for their conditions.

<http://www.primedphysicians.com/health/chronic.html>

Vegetarian Society

The Vegetarian Society of the United Kingdom is the oldest vegetarian organisation in the world. It is an educational charity promoting understanding and respect for vegetarian lifestyles

<http://www.vegsoc.org/>

Personal Library/Archive

-
-
-
-
-

Community

Edit profile >>> Seals
Track of seals used to classify food, nutrition or health

Personal Presets

vivospace Search [] Noreen Sample Home | [edit Profile](#) | [Logout](#)

Organizer
Today's performance balance []
5 new messages
May 2011
Su Mo Tu We Th Fr Sa
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30 31 1 2 3 4
To Do
Work BBQ Dinner
Clean Kitchen
Drive Carpool
Mum's Birthday Party
Connections
Friends
George Dream
Hanna Fiction
Barack Obama
Hank Home
Irvin Star

Personal Preset
Info | Seals | Personal Preset
Calories Shared with Family, Friends, Caretakers
calories eaten calories burned [] [] [] edit
Nutrition Shared with Friends, Caretakers
Salt Sodium Vitamin C Iron Protein Calcium Sugar [] [] [] [] [] [] [] [] [] edit
Saturated Fat Trans Fat [] [] [] [] edit
Activity Shared with all
walking cardio strength exercise [] [] [] [] [] [] [] [] [] [] edit
Medical Shared with Caretakers
weight bloodsugar heartrate [] [] [] [] [] [] [] [] [] [] edit
Daily Target Shared with Family, Friends, Caretakers
Walking 15 mins [] edit
Breakfast Cereals 185 cal
Vitamin C Supplement 85 mg
[]

Personal Library/Archive
Music []
photos []
Grilled Halibut with Leeks
movies []
videos []
links []
Community
[] [] []

Edit profile >>> Personal Preset Set up daily does (shown in timeline), choose icons you want to use for your tracking

Personal Presets when elements are clicked

The screenshot displays the Vivospace website interface. At the top, the logo 'VIVOSPACE' is on the left, a search bar in the center, and a user profile 'Noreen Sample' on the right with links for 'Home', 'edit Profile', and 'Logout'. The main content area is titled 'Personal Preset' and is divided into several sections:

- Calories:** A section for tracking 'calories eaten' and 'calories burned' with corresponding icons and checkboxes.
- Nutrition:** A section for tracking various nutrients: Salt, Sodium, Vitamin, Iron, Protein, Calcium, and Sugar. A tooltip for 'Trans Fat' is visible, explaining that it is the common name for unsaturated fat with trans-isomer fatty acid(s) and providing a Wikipedia link.
- Activity:** A section for tracking activities: walking, cardio, strength, and exercise, each with an icon and a checkbox.
- Medical:** A section for tracking health metrics: weight, bloodsugar, and heartrate, each with an icon and a checkbox.
- Dayly Does:** A section for tracking daily tasks: Walking 15 mins, Breakfast Cerials 185 cal, and Vitamin C Sublement 85 mg. A tooltip for 'Daily Does' explains that these are things done everyday and automatically tracked in the user's timeline.

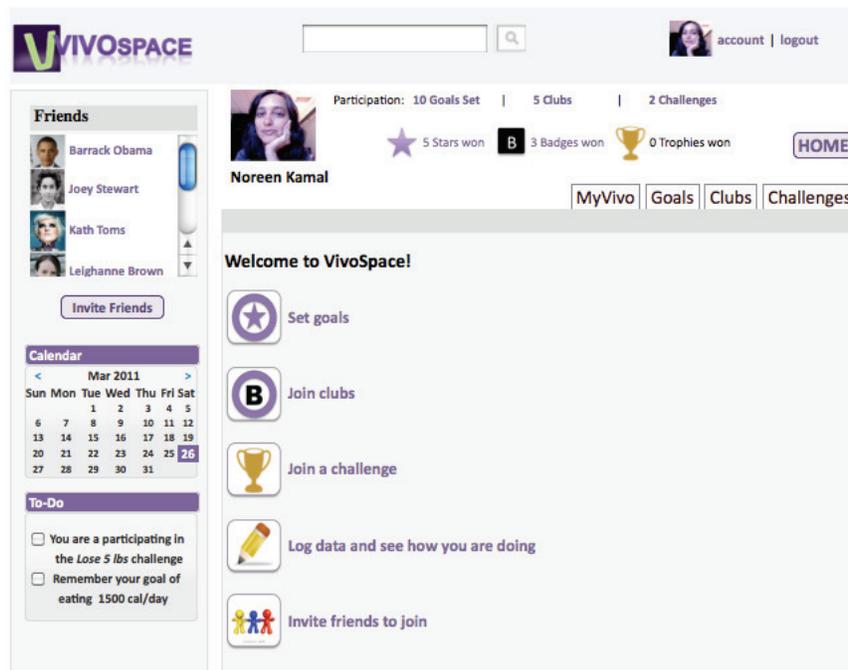
On the left side, there is an 'Organizer' section with a performance balance slider, a calendar for May 2011, and a 'To Do' list including 'Work BBQ Dinner', 'Clean Kitchen', 'Drive Carpool', and 'Mum's Birthday Party'. Below that is a 'Connections' section listing friends like George Dream, Hanna Fiction, Barack Obama, Hank Home, and Irvin Star.

On the right side, there is a 'Personal Library/Archive' section with dropdown menus for Music, photos (showing a photo of 'Grilled Halibut with Leeks'), movies, videos, and links. Below that is a 'Community' section with icons for a fork and knife, a house, and a plus sign.

At the bottom, a dark bar contains the text 'Edit profile >>> Personal Preset' and 'Popups: show information by hovering or clicking'.

Fifth Appendix: Screen Captures of Medium Fidelity Prototypes

Initial Landing Page



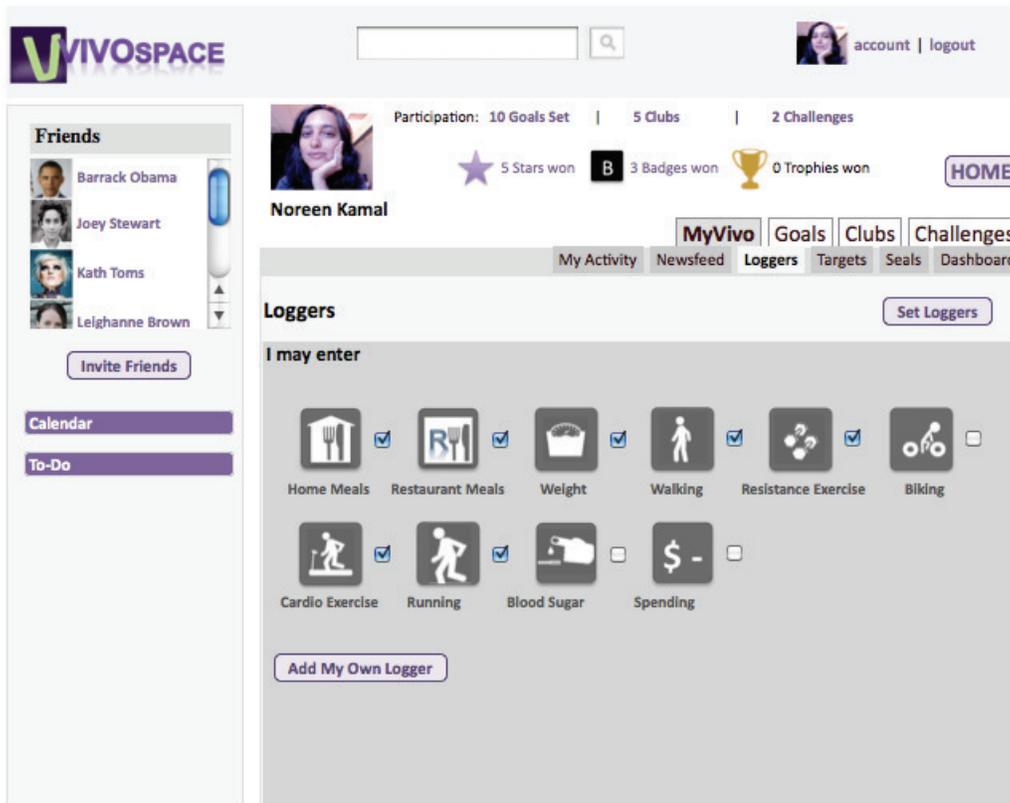
Newsfeed

The screenshot displays the Vivospace web application interface. At the top left is the Vivospace logo. A search bar and user account information (account | logout) are at the top right. The main content area features a user profile for Noreen Kamal, showing statistics: Participation: 10 Goals Set, 5 Clubs, 2 Challenges, 5 Stars won, 3 Badges won, and 0 Trophies won. A 'HOME' button is present. Below the profile is a navigation menu with 'MyVivo' selected, and other options: Goals, Clubs, Challenges, My Activity, Newsfeed, Loggers, Targets, Seals, and Dashboard. An 'enter activity' section contains icons for various activities and a 'Log Activity' button. The newsfeed shows a post from March 15, 2011, where William won a challenge to eat the most vegetables and fruits every day for 1 month. Below the post, 'Daily Averages' are listed: Calcium 1.1 gram/day, Fibre 40 grams/day, Vit. A 92% DV/day, and Vit. C 99% DV/day. A comment box is visible with a 'Comment' button. Below the comment box, two comments are shown: one from Joey stating 'Those targets values are so impressive. I was close but couldn't match your calcium targets' and one from William stating 'The best are Kale, Spinach and Brocccholl. All vegetables that I have grown to like; not love... yet!'.

My Activities (User Activities)

The screenshot displays the Vivospace user interface. At the top left is the Vivospace logo. A search bar and a user profile picture with 'account | logout' are on the top right. The main header for the user 'Vera Lewis' shows statistics: 'Participation: 10 Goals Set | 5 Clubs | 2 Challenges', '5 Stars won', '3 Badges won', and '0 Trophies won'. A 'HOME' button is also present. Below the header is a navigation menu with 'MyVivo', 'Goals', 'Clubs', and 'Challenges'. The 'My Activity' tab is selected, showing sub-tabs for 'Newsfeed', 'Loggers', 'Targets', 'Seals', and 'Dashboard'. The 'enter activity' section contains icons for various activities (golf, basketball, shopping, walking, running, etc.) and a 'Log Activity' button. Below this is a form for 'Date of Activity' set to 'Mar 29, 2013' and a checkbox for 'Activity done with friends'. The main content area shows a past activity from 'Mar 14 2011': 'Walked around Stanley Park for 2 hrs' with a photo of 'Maggie' and '307 Cal'. A 'Daily Targets' progress bar is shown below. A '*shared*' section contains a comment input field with a 'Comment' button and a shared post from 'Kath' saying 'What a beautiful day to be at Stanley Park!'.

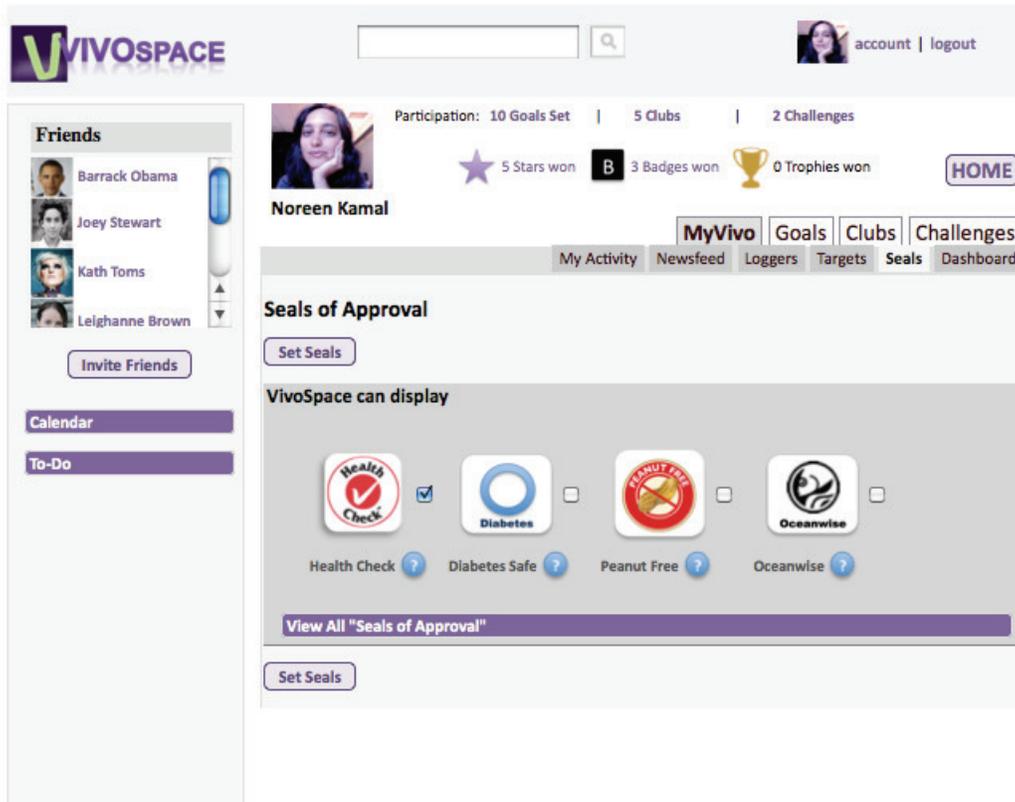
Set Loggers Page



Set Targets Page

The screenshot shows the Vivospace user interface for Noreen Kamal. At the top, the Vivospace logo is on the left, a search bar in the center, and a user profile picture with 'account | logout' on the right. Below the logo is a 'Friends' sidebar with profiles of Barack Obama, Joey Stewart, Kath Toms, and Leighanne Brown, along with an 'Invite Friends' button and 'Calendar' and 'To-Do' sections. The main header for Noreen Kamal displays 'Participation: 10 Goals Set | 5 Clubs | 2 Challenges', '5 Stars won', '3 Badges won', and '0 Trophies won', with a 'HOME' button. A navigation bar includes 'MyVivo', 'Goals', 'Clubs', 'Challenges', 'My Activity', 'Newsfeed', 'Loggers', 'Targets', 'Seals', and 'Dashboard'. The 'Targets' section is active, showing a 'Set Targets' button. Under 'VivoSpace can display', there are two widget sections: 'Eating' and 'Exercise'. The 'Eating' widget includes 'Calories Consumed' (checked), 'Sodium' (unchecked), 'Sat. Fat' (checked), and 'Trans Fat' (unchecked). Below these are input fields for targets: 1500 Cal/day, 2500 mg, 20 g, and 0 g. The 'Exercise' widget includes 'Calories Burned' (checked), 'Weight' (unchecked), 'Walking' (unchecked), and 'Biking' (unchecked). Below these are input fields for targets: 1500 Cal/day, 120 lbs, 15 min/day, and 0 min/day. Both sections have 'View All' buttons and 'Add Widget' buttons. A 'Set Targets' button is at the bottom of the page.

Set Seals Page



Dashboard Page

VIVOSPACE account | logout

Participation: 10 Goals Set | 5 Clubs | 2 Challenges

★ 5 Stars won | **B** 3 Badges won | 🏆 0 Trophies won [HOME](#)

Noreen Kamal

MyVivo | Goals | Clubs | Challenges

My Activity | Newsfeed | Loggers | Targets | Seals | **Dashboard**

Dashboard

| | Calories Consumed | Saturated Fat | Protein | Calories Burned | Cardio Exercise | Resistance Exercise | Running |
|----------------------|-------------------|---------------|----------|-----------------|-----------------|---------------------|-------------|
| This week's rating: | High | High | ✓ | Low | ✓ | ✓ | Low |
| This week's average: | 1300 cal | 15 grams | 70 grams | 1700 cal | 41 min | 40 min | 5 km/week |
| My targets: | 1250 cal | 10 grams | 50 grams | 1800 cal | 40 min | 30 min | 4.1 km/week |
| My chart: | | | | | | | |
| Information: | | | | | | | |

Friends

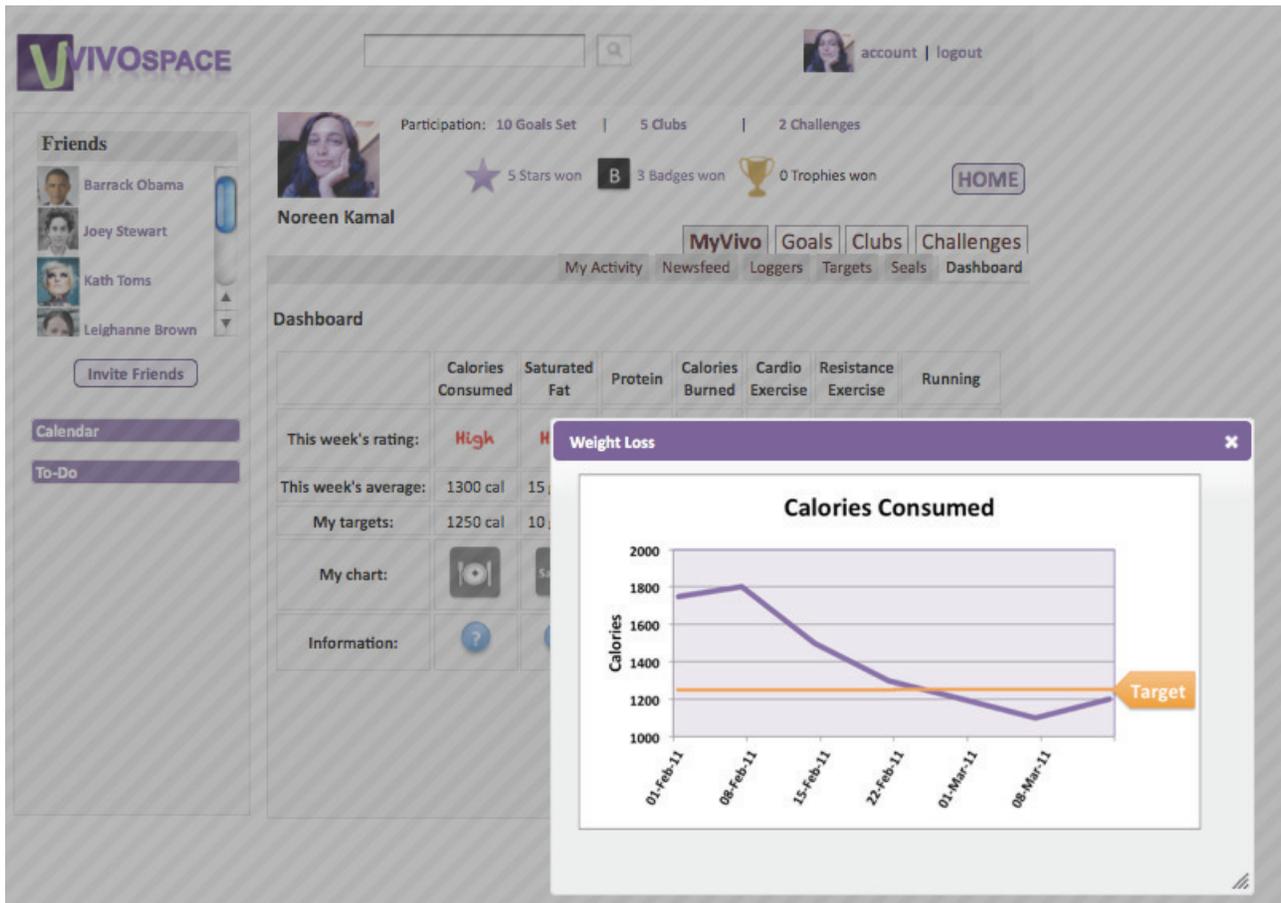
- Barrack Obama
- Joey Stewart
- Kath Toms
- Leighanne Brown

[Invite Friends](#)

Calendar

To-Do

Dashboard Page when Icon is Clicked



Main Goals Page

The screenshot shows the Vivospace web application interface. At the top left is the Vivospace logo. A search bar and user account information (account | logout) are at the top right. A navigation bar includes links for MyVivo, Goals, Clubs, and Challenges, with sub-links for My Goals, Create, My Stars, and Friends. The user's profile, Noreen Kamal, is shown with statistics: Participation: 10 Goals Set, 5 Clubs, 2 Challenges; 5 Stars won, 3 Badges won, 0 Trophies won. A 'HOME' button is also present.

Friends

- Barrack Obama
- Joey Stewart
- Kath Toms
- Leighanne Brown

[Invite Friends](#)

Calendar

To-Do

My Goals

Lose 10 lbs

- 7 lbs I have a goal to lose 10 lbs. [Log Meals and Exercise](#)

Start Date: April 1 2011 End Date: August 31 2011

Enter Current Weight: 125 lbs [enter](#)

My Current Status:

-3 lbs (currently)

1300 calories (ave) 15 grams (ave) 1700 calories (ave) 41 minutes (ave)

My Targets:

1250 Calories 10 grams 1800 Calories 40 minutes

[CREATE A CLUB: Meet this goal with your friends](#)

Create Goals Page (Step 1)

The screenshot displays the Vivospace user interface for creating goals. At the top left is the Vivospace logo. A search bar and user account information (account | logout) are at the top right. The user profile for Noreen Kamal is shown, including participation statistics: 10 Goals Set, 5 Clubs, and 2 Challenges. Achievement icons for 5 Stars won, 3 Badges won, and 0 Trophies won are also present, along with a HOME button. A navigation menu includes MyVivo, Goals, Clubs, and Challenges, with sub-options for My Goals, Create, My Stars, and Friends. The main content area is titled 'Step 1: SELECT GOAL CATEGORY' and features a 'Library' section. The 'Lose Weight Goal' is expanded, showing a list of criteria: Eating foods that are low in calories, Eating foods that are low in saturated fats, Eating foods that are low in trans fats, and Exercising more (increasing the your calories burned). A 'Choose' button is located below the list. Other goal categories visible are 'Healthy Heart Goal', 'Strong Bones Goal', and 'Lower Cholesterol Goal'.

VIVOSPACE  account | logout

Participation: 10 Goals Set | 5 Clubs | 2 Challenges

★ 5 Stars won | **B** 3 Badges won | 🏆 0 Trophies won

Noreen Kamal

MyVivo **Goals** Clubs Challenges
My Goals **Create** My Stars Friends

Step 1: SELECT GOAL CATEGORY

Library

▼  **Lose Weight Goal**

This goal is met by:

- Eating foods that are low in calories
- Eating foods that are low in saturated fats
- Eating foods that are low in trans fats
- Exercising more (increasing the your calories burned)

▶  **Healthy Heart Goal**

▶  **Strong Bones Goal**

▶  **Lower Cholesterol Goal**

Create Goals Page (Step 2)

The screenshot shows the Vivospace interface. At the top left is the VIVOSPACE logo. To its right is a search bar and a user profile picture with the text "account | logout". Below the logo is a "Friends" sidebar with a list of names: Barack Obama, Joey Stewart, Kath Toms, and Leighanne Brown, along with an "Invite Friends" button. Below the sidebar are "Calendar" and "To-Do" buttons. The main content area features a user profile for Noreen Kamal with statistics: Participation: 10 Goals Set, 5 Clubs, 2 Challenges; 5 Stars won, 3 Badges won, 0 Trophies won. A "HOME" button is next to these stats. Below the profile are tabs for "MyVivo", "Goals", "Clubs", and "Challenges", with "Goals" selected. Under "Goals" are sub-tabs: "My Goals", "Create", "My Stars", and "Friends". The main heading is "Step 2: ENTER GOAL DETAILS". The form includes a goal title "Lose Weight Goal" (My title), a target weight of "10 lbs", and a current weight of "125 lbs". A section titled "Here is what I will need to do:" lists four metrics: "Reduce Calories Consumed" (1300 Cal/day), "Reduce Saturated Fat" (10 g/day), "Increase Calories Burned" (1800 Cal/day), and "Increase Cardio Exercise" (30 min/day). At the bottom are "Start Date:" and "End Date:" input fields, and a "Create Goal" button.

My Stars (Successfully Completed Goals)

The screenshot displays the VIVOSPACE user interface. At the top left is the VIVOSPACE logo. A search bar and user account information (account | logout) are at the top right. The user's profile, Noreen Kamal, is shown with statistics: Participation: 10 Goals Set, 5 Clubs, 2 Challenges, 5 Stars won, 3 Badges won, and 0 Trophies won. A 'HOME' button is present. Navigation tabs include MyVivo, Goals, Clubs, Challenges, My Goals, Create, My Stars, and Friends. The 'My Stars' section is titled 'My Stars' and states 'Stars are earned when goals are successfully completed'. It shows 5 stars. Two goal entries are listed: 'Lower salt for 2 weeks' (Start Date: April 1 2011, End Date: April 14 2011, Achievement: Sodium 1800 mg/day Average) and 'High fibre diet for 1 month' (Start Date: March 1 2011, End Date: March 31 2011, Achievement: Fibre 30 g/day Average). A 'Share' button is next to the first goal. A 'view' button is next to the achievement for the second goal. A 'shared' comment box is visible at the bottom, with a 'Comment' button and a partial comment from 'Joey: Good Job!'. A 'Text' button is at the bottom right.

My Friends' Stars (Successfully Completed Goals by Friends)

The screenshot displays the MyVivoSpace user interface. At the top left is the VIVOSPACE logo. A search bar and user account information (account | logout) are at the top right. The main profile area for Noreen Kamal shows her name, a profile picture, and statistics: Participation: 10 Goals Set, 5 Clubs, 2 Challenges, 5 Stars won, 3 Badges won, and 0 Trophies won. A HOME button is present. Below the profile are tabs for MyVivo, Goals, Clubs, and Challenges, with sub-tabs for My Goals, Create, My Stars, and Friends. The 'My Friends' Stars' section lists two items: 'Healthy Heart Diet for 4 months' with a heart icon and a comment from Joey, and 'Iron Pumper for 2 months' with a circular arrow icon. A left sidebar contains a 'Friends' list with names like Barack Obama, Joey Stewart, Kath Toms, and Leighanne Brown, along with 'Invite Friends', 'Calendar', and 'To-Do' buttons.

Main Clubs Page

The screenshot displays the Vivospace interface. At the top left is the Vivospace logo. A search bar and user account information (account | logout) are at the top right. The main content area features a user profile for Noreen Kamal with statistics: Participation: 10 Goals Set, 5 Clubs, 2 Challenges, 5 Stars won, 3 Badges won, and 0 Trophies won. A 'HOME' button is present. Below the profile is a navigation menu with 'MyVivo', 'Goals', 'Clubs', and 'Challenges'. Under 'Clubs', there are sub-links for 'My Clubs', 'Join', 'Create', 'My Badges', and 'Friends'. The 'My Clubs' section shows a club created by Joey: 'Walk 5km every week for 3 months Club'. The club goal is 5 km/week, with a start date of April 1 2011 and an end date of June 30 2011. A 'Members:' list shows: Barrack's status: 5.5 km/week, Leighanne's status: 4.1 km/week, My status: 3.7 km/week (with a 'Log Meals and Exercise' button), and Joey's status: 3.1 km/week. A 'Calendar' and 'To-Do' section are visible in the left sidebar. A 'Comment' box is at the bottom.

Join Clubs Page

The screenshot shows the Vivospace user interface. At the top left is the Vivospace logo. A search bar and user account information (account | logout) are at the top right. The user's profile, Noreen Kamal, is displayed with statistics: Participation: 10 Goals Set, 5 Clubs, 2 Challenges, 5 Stars won, 3 Badges won, and 0 Trophies won. A 'HOME' button is next to her name. Navigation tabs include MyVivo, Goals, Clubs, and Challenges. Below these are sub-tabs: My Clubs, Join, Create, My Badges, and Friends. The main content area is titled 'Clubs Available to Join' and lists two clubs:

- Kath's Build Muscle Club**: Start Date: June 1 2011, End Date: August 31 2011. Status: This Club is Closed You have been ***INVITED***. Current Members: 3. A 'Join' button is present.
- Ashton's Healthy Heart Club**: Start Date: June 1 2011, End Date: August 31 2011. Status: This Club is Open to all.

At the bottom left, the browser address bar shows: 127.0.0.1:8000/VivoSpace/home.html

Create Clubs Page (Step 1)

The screenshot displays the VIVOSPACE user interface. At the top left is the VIVOSPACE logo. A search bar and a user profile picture with 'account | logout' are at the top right. The user profile for Noreen Kamal is shown, including statistics: Participation: 10 Goals Set, 5 Clubs, 2 Challenges, 5 Stars won, 3 Badges won, and 0 Trophies won. A 'HOME' button is present. Navigation tabs include MyVivo, Goals, Clubs, and Challenges, with sub-tabs My Clubs, Join, Create, My Badges, and Friends. The main content area is titled 'Step 1: SELECT CLUB CATEGORY' and 'Library'. It features a list of club categories: Lose Weight Club (expanded to show details), Healthy Heart Club, Strong Bones Club, and Lower Cholesterol Club. The 'Lose Weight Club' details include a list of activities: Eating foods that are low in calories, Eating foods that are low in saturated fats, Eating foods that are low in trans fats, and Exercising more (increasing the your calories burned). A 'Choose' button is located below the details.

VIVOSPACE account | logout

Participation: 10 Goals Set | 5 Clubs | 2 Challenges

5 Stars won | 3 Badges won | 0 Trophies won

Noreen Kamal HOME

MyVivo Goals Clubs Challenges
My Clubs Join Create My Badges Friends

Step 1: SELECT CLUB CATEGORY

Library

Lose Weight Club

This Club involves:

- Eating foods that are low in calories
- Eating foods that are low in saturated fats
- Eating foods that are low in trans fats
- Exercising more (increasing the your calories burned)

Choose

Healthy Heart Club

Strong Bones Club

Lower Cholesterol Club

Create Goals Page (Step 2)

The screenshot displays the 'VIVOSPACE' user interface. At the top, there is a search bar and a user profile for 'Noreen Kamal' with 'account | logout' options. The user's profile shows 'Participation: 10 Goals Set | 5 Clubs | 2 Challenges', '5 Stars won', '3 Badges won', and '0 Trophies won'. A 'HOME' button is visible.

The main content area is titled 'Step 2: ENTER CLUB DETAILS'. It features a 'Lose Weight Club' entry with a trash icon. Below this, there are input fields for 'I want to lose' (10 lbs) and 'My current weight' (125 lbs). A section titled 'Here is what I will need to do:' lists four goals with input fields and help icons:

- Reduce Calories Consumed: 1300 Cal/day
- Reduce Saturated Fat: 10 g/day
- Increase Calories Burned: 1800 Cal/day
- Increase Cardio Exercise: 30 min/day

At the bottom, there are 'Start Date' and 'End Date' input fields, radio buttons for 'Open (anyone can join this club)' and 'Closed (by invitation only)', and buttons for 'Invite Friends to Join this Club' and 'Create Club'.

A calendar for 'March 2013' is overlaid on the right side of the page, showing dates from Sunday to Sunday. The date '29' is highlighted in yellow, and a 'Today' button is located below the calendar.

My Badges (Successfully Completed Clubs)

The screenshot shows the Vivospace user interface. At the top left is the Vivospace logo. A search bar and user account information (account | logout) are at the top right. A left sidebar contains a 'Friends' list with names like Barack Obama, Joey Stewart, Kath Toms, and Lelghanne Brown, along with 'Calendar' and 'To-Do' buttons. The main content area features a user profile for Noreen Kamal with statistics: Participation: 10 Goals Set, 5 Clubs, 2 Challenges; 5 Stars won, 3 Badges won, 0 Trophies won. A 'HOME' button is present. Below the profile is a navigation menu with 'MyVivo', 'Goals', 'Clubs', and 'Challenges', and sub-links 'My Clubs', 'Join', 'Create', 'My Badges', and 'Friends'. The 'My Badges' section is active, displaying the text 'Badges are earned when goals are successfully completed' and '3 Badges'. A specific badge titled 'Stronger Bones' is highlighted, showing a start date of November 1 2010 and an end date of January 31 2011. Under 'Achievements', there are two items: 'Calcium 110 % Daily Value/day average' and '35 min/day average', each with a 'view' button. Below the badge details, it shows 'Created By:' with a user profile and 'Members:' with three user profiles. A comment box with a 'Comment' button is at the bottom.

My Friends' Badges (Successfully Completed Badges by Friends)

The screenshot displays a user profile for Noreen Kamal on the Vivospace platform. The profile header includes the Vivospace logo, a search bar, and a user account menu with 'account' and 'logout' options. The user's statistics are shown as: Participation: 10 Goals Set, 5 Clubs, 2 Challenges, 5 Stars won, 3 Badges won, and 0 Trophies won. A 'HOME' button is present. Navigation tabs for 'MyVivo', 'Goals', 'Clubs', and 'Challenges' are visible, with sub-tabs for 'My Clubs', 'Join', 'Create', 'My Badges', and 'Friends'. The main section is titled 'My Friends' Shared Badges' and lists two shared achievements:

- Maggie** shared the badge: **Run 1/2 Marathon (21 km) in 2 hours**. The description reads: 'Best Achievement 21km in 1 hour 51 minutes'. A comment from Kath says: 'Wow! You did it!'.
- William** shared the badge: **Lose 10 lbs in 6 months**. The description reads: 'Lost 12 lbs in 6 months'.

The left sidebar contains a 'Friends' list with profile pictures and names: Barrack Obama, Joey Stewart, Kath Toms, and Leighanne Brown. Below the list is an 'Invite Friends' button. Further down are buttons for 'Calendar' and 'To-Do'.

Main Challenges Page

VIVOSPACE account | logout

Participation: 10 Goals Set | 5 Clubs | 2 Challenges

★ 5 Stars won | **B** 3 Badges won | 🏆 0 Trophies won [HOME](#)

Noreen Kamal

[MyVivo](#) [Goals](#) [Clubs](#) [Challenges](#)

[My Challenges](#) [Join](#) [Create](#) [My Trophies](#) [Friends](#)

My Challenges

Leighanne created the **Run a 1/2 Marathon (21.1km) by August Challenge**

21.1 km Continuous

Start Date: April 1 2011 End Date: August 31 2011

Leader Board: [View Performance](#)

| | | |
|----|---------------------|---|
| 1. | Alex's status: | 14 km |
| 2. | Leighanne's status: | 8 km |
| 3. | My status: | 7 km Log Meals and Exercise |
| 4. | Joey's status: | 5 km |
| 5. | Barrack's status: | 4 km |

Friends

- Barrack Obama
- Joey Stewart
- Kath Toms
- Leighanne Brown

[Invite Friends](#)

[Calendar](#)

[To-Do](#)

Join Challenges Page

The screenshot displays the Vivospace user interface. At the top left is the Vivospace logo. A search bar and a user profile picture with 'account | logout' are on the top right. A navigation bar below the header includes 'MyVivo', 'Goals', 'Clubs', and 'Challenges', with 'Challenges' being the active tab. Below this is a sub-navigation bar with 'My Challenges', 'Join', 'Create', 'My Trophies', and 'Friends'. The main content area is titled 'Challenges Available to Join' and features two challenge cards. The first card is for 'Joey's Build Muscle Challenge', which is closed and has a 'View Details' button. The second card is for 'Ali's Healthy Heart Challenge', which is open to all and also has a 'View Details' button. A left sidebar contains a 'Friends' list with names like Barack Obama, Joey Stewart, Kath Toms, and Leighanne Brown, along with buttons for 'Invite Friends', 'Calendar', and 'To-Do'. A top status bar for the user shows 'Participation: 10 Goals Set | 5 Clubs | 2 Challenges' and '5 Stars won | 3 Badges won | 0 Trophies won'.

VIVOSPACE account | logout

Participation: 10 Goals Set | 5 Clubs | 2 Challenges
5 Stars won | 3 Badges won | 0 Trophies won

Noreen Kamal HOME

MyVivo | Goals | Clubs | **Challenges**
My Challenges | Join | Create | My Trophies | Friends

Challenges Available to Join

Joey's Build Muscle Challenge
View Details

Start Date: June 1 2011 End Date: August 31 2011
This Challenge is Closed You have been ***INVITED***

Current participants:

Join

Ali's Healthy Heart Challenge
View Details

Start Date: June 1 2011 End Date: August 31 2011
This Challenge is Open to all

Friends: Barack Obama, Joey Stewart, Kath Toms, Leighanne Brown
Invite Friends
Calendar
To-Do

Create Challenge Page (Step 1)

VIVOSPACE account | logout

Participation: 10 Goals Set | 5 Clubs | 2 Challenges

★ 5 Stars won | **B** 3 Badges won | 🏆 0 Trophies won

Noreen Kamal

MyVivo Goals Clubs **Challenges**

My Challenges Join **Create** My Trophies Friends

Step 1: SELECT CHALLENGE CATEGORY

Library

▼ **Lose Weight Challenge**

This Challenge involves:

- Eating foods that are low in calories
- Eating foods that are low in saturated fats
- Eating foods that are low in trans fats
- Exercising more (Increasing the your calories burned)

▶ **Healthy Heart Challenge**

▶ **Strong Bones Challenge**

▶ **Lower Cholesterol Challenge**

Create Challenge Page (Step 2)

VIVOSPACE

Participation: 10 Goals Set | 5 Clubs | 2 Challenges

5 Stars won | 3 Badges won | 0 Trophies won

Noreen Kamal

MyVivo | Goals | Clubs | **Challenges**

My Challenges | Join | **Create** | My Trophies | Friends

Step 2: ENTER CHALLENGE DETAILS

Lose Weight Challenge -> (My title)

I want to lose lbs

My current weight lbs

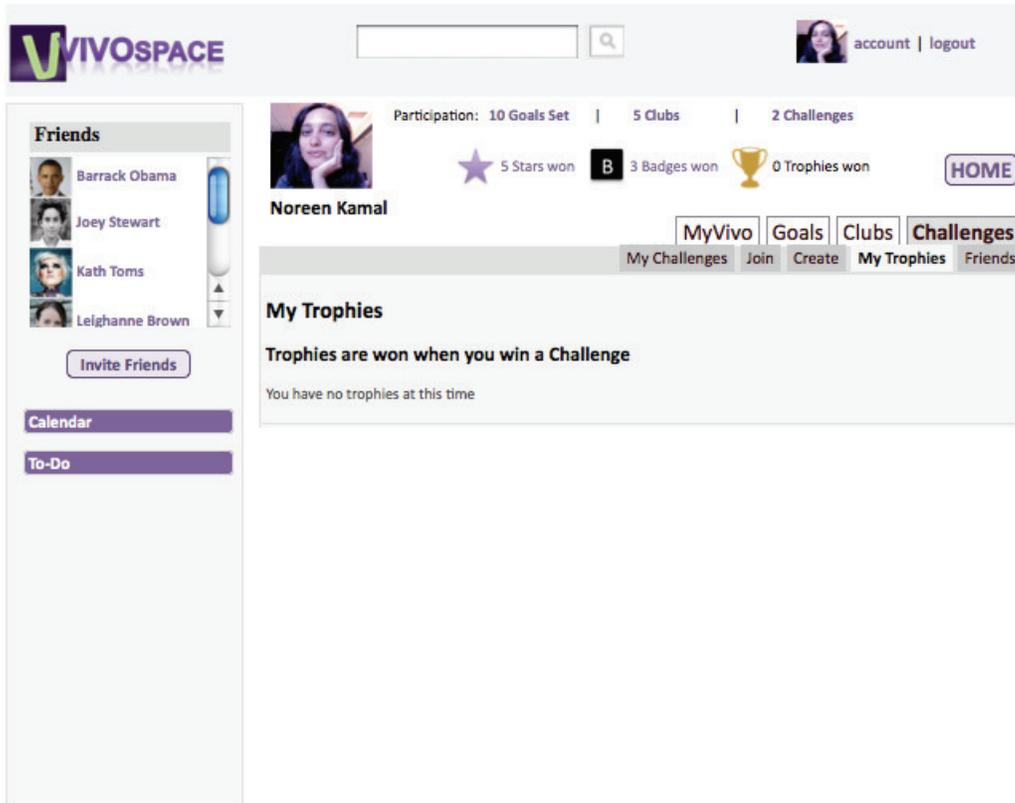
Here is what I will need to do:

| | | | |
|--------------------------|-----------------------------------|---------|---------------------------------------|
| Reduce Calories Consumed | <input type="text" value="1300"/> | Cal/day | <input "="" type="button" value="?"/> |
| Reduce Saturated Fat | <input type="text" value="10"/> | g/day | <input "="" type="button" value="?"/> |
| Increase Calories Burned | <input type="text" value="1800"/> | Cal/day | <input "="" type="button" value="?"/> |
| Increase Cardio Exercise | <input type="text" value="30"/> | min/day | |

Start Date: End Date:

Open (anyone can join this challenge) Closed (by invitation only)

My Trophies (Successfully Completed Challenges)



My Friends' Trophies (Successfully Completed Challenges by Friends)

The screenshot displays the Vivospace web application interface. At the top left is the Vivospace logo. A search bar and a user profile picture with 'account | logout' are on the top right. The main profile area for Noreen Kamal shows statistics: 'Participation: 10 Goals Set | 5 Clubs | 2 Challenges', '5 Stars won', '3 Badges won', and '0 Trophies won'. A 'HOME' button is present. Below this are navigation tabs: 'MyVivo', 'Goals', 'Clubs', and 'Challenges'. A secondary row of tabs includes 'My Clubs', 'Join', 'Create', 'My Badges', and 'Friends'. The main content area is titled 'My Friends' Shared Badges' and lists two items:

- Maggie**
B Run 1/2 Marathon (21 km) in 2 hours
Best Achievement 21km in 1 hour 51 minutes
A comment from Kath says: 'Wow! You did it!'
- William**
B Lose 10 lbs in 6 months
Lost 12 lbs in 6 months

On the left side, there is a 'Friends' list with names: Barrack Obama, Joey Stewart, Kath Toms, and Leighanne Brown. Below the list are buttons for 'Invite Friends', 'Calendar', and 'To-Do'.

Sixth Appendix: Laboratory Evaluation of Medium-Fidelity Prototype

This appendix shows the questionnaire and steps that were taken by the experimenter for the entire laboratory experiment that evaluated the medium fidelity prototype of *VivoSpace*. The first questionnaire was completed by all the participants. This is followed by the individual task experiment that was done by half of the participants to evaluate **Appeal** determinants of the **ABC Framework**. The steps followed by the experimenter and the questions asked of the participants for the helping game is described next. The final section shows the Test given and the steps followed by the experimenter for the group commitment experiment. The experiment and the results are described in detail in Section 7.3.

Questionnaire for All Participants

All participants will be asked basic demographic questions to understand the diversity of participants that completed the study. These questions are the following:

1. Please specify your gender
 - a. Female
 - b. Male

2. Which age group do you belong to? (select one)
 - a. 19-24 years old

- b. 25-34 years old
- c. 35-49 years old
- d. 50-64 years old
- e. 65-74 years old
- f. 75 years old and older

3. Do you identify as a First Nations or Aboriginal person (North American Indian, Metis, or Inuit)?

If you answer yes to this question, please go to Question 6.

- a. Yes
- b. No

4. If you answered No to question 3, do you primarily identify as being Canadian?

- a. Yes
- b. No

5. If you answered No to question 4, which ethnic group do you primarily identify belonging to, please specify

- a. Chinese
- b. East Asian (including Japanese, Korean)
- c. South East Asian (Including Filipino, Malaysian, Thai, Indonesian, Vietnamese, Cambodian)
- d. South Asian (including Punjabi, Indian, Pakistani, Bangladeshi, Sri Lankan)
- e. Arab
- f. West Asian (including Iranian, Afghani)
- g. Hispanic (including Mexican, Cuban, South & Central American)
- h. Other:

6. If you are you a student, please specify the following

- a. Undergraduate
- b. Graduate

- c. Post-graduate
 - d. Other:
7. If you are not a student, please specify your occupation

I. Appeal:

Script and tasks to measure the Appeal of the system

You will be asked to complete the following tasks. Data will be collected by asking specific questions on the tasks and the results of completing the task to determine how well the system is designed for users like you. Audio recording and a recording of the screen as you move through the tasks will be made to collect data about the usability of the tasks.

A. You have recently joined VivoSpace and you decide to log your food to see how your nutritional intake is.

1. Enter the following activity that you did recently with a friend, who is also your friend on Vivospace:
 - a. You want to log that you ate at Whit Spot Restaurant. Type the following in the enter activity area: White Spot Chargrilled Burger
 - b. You did this activity with Barrack Obama, so select Barrack as the friend that you did this activity with.
 - c. Now Log the activity

2. Answer the following questions:
 - a. How many calories are in this meal?
 - b. What do the target mean to you?

3. In the walking activity that you have already completed and logged on VivoSpace, add a comment in response to your friends Kath's comment
 - a. Please write: I wish you could have joined us.

4. Go to the Targets page
 - a. Select Sodium as a nutrient that you want to track and change the amount to 700mg
 - b. Select Fibre as a nutrient that you want to track and change the value to 50 g
 - c. You are interested in the iron nutrient, but you are unsure of what this is.
 - i. Can you find out more about iron?
 - ii. If so, what can you find?

5. Go to the Loggers page
 - a. You no longer want to track resistance exercise but you do want to track biking.
 - i. Please select or unselect as appropriate

6. Go to the Seals page
 - a. You are interested in the Oceanwise seal and want to learn more.
 - i. What can you find out?
 - ii. You want to select this seal, so please select it.

7. Feedback (feel free to play with the website while answering the question).
 - a. Likert-Scale responses (1-7)
 - i. I found the information that the system provided useful when I entered what I ate useful
 - ii. I found the nutritional information (calories, saturated fat and protein) that I received useful
 - iii. I would find it easy to enter my health information
 - iv. I would be able to gain information about myself and my capabilities by using a system like this
 - v. I found the targets on the my activity page easy to understand
 - vi. I found the targets page easy to understand in terms of the nutrition and values
 - vii. I would find this system entertaining to use
 - viii. I could learn more about myself and my health through using VivoSpace

- ix. By sharing my activities, I could build my social position or have more influence on my friends
- x. I would use a system like this to provide information on my activities to my friends
- xi. I would use a system like this because I can share my experiences and identity with friends who are similar
- xii. I would use this system to learn the health outcomes of my activities
- xiii. The health check logo provided me with information about the healthiness of activity based on society and/or an external source
- xiv. Please tell the experimenter your thoughts on this prototype

B. Newsfeed page

- 1. Go to the Newsfeed page
 - a. What do you first see when you go to this page?
 - b. What is this page showing you?
 - c. How do these activities show up on your newsfeed page?
 - d. Please enter a comment on Williams activity, such as good job

- 2. Feedback (please feel free to play with the system as you answer these questions):
 - a. Likert Responses:
 - i. A newsfeed such as this would provide me with information about my friends that I would find useful
 - ii. This would allow me to stay connected with my friends
 - iii. I would find it entertaining to view my friends activities
 - iv. I would be able to discover shared or similar experiences and identities through the newsfeed
 - v. I would be able to learn about health (e.g. what activities and foods are good for me) through the newsfeed
 - vi. I would be able to view how my friends are staying healthy
 - vii. I would be able to see how my friends are overcoming barriers to staying healthy

- viii. I would be able to learn what types of activities are healthier
- ix. I would be able to know what my friends are doing
- x. I would be able to interact with my friends
- xi. I would be able to see friends that I have similarities with
- xii. I would model my activities to match healthy activities completed by friends.
- xiii. Please tell the experimenter your thoughts on this prototype

C. Dashboard Page

1. Go to the Dashboard Page
 - a. This week, how are you doing with respect to the amount of calories that you are consuming?
 - b. What is the definition of calories?
 - c. View the chart for Calories.
 - i. Were you better at the beginning of the week? Why?
 - ii. How do you think you will be do next week based on the information on the chart?
 - d. What areas did you perform well at this week? Why?
2. Feedback (please feel free to play with the system as you answer these questions):
 - a. Likert Responses:
 - i. The dashboard provides useful information
 - ii. It is entertaining to be able to use this dashboard over time
 - iii. I would be able to learn about myself through the dashboard
 - iv. It is convenient to see the information that the dashboard provides
 - v. I would be able to gain health knowledge about myself
 - vi. I would be able to learn health outcomes based on my activities
 - vii. I would be able to learn about barriers to healthier living
 - viii. I would be able to learn about facilitators (what helps) to healthier living
 - ix. The dashboard provides an incentive (a reason) to live healthier
 - x. The dashboard allows me to understand my capabilities in term of healthy

living

xi. Please tell the experimenter your thoughts on this prototype

D. Goals

1. You are interested in created some health goals.
 - a. View your existing goals
 - b. What is the name of one of your current goals
 - c. In the lose weight goal, how much weight have you lost?
 - d. Based on your current averages, what targets are you doing well in?
 - e. Based on your current averages, what targets do you need to improve in?
 - f. What is the definition of Saturated fats?
 - g. Go to the page to create a goal
 - h. Browse the library of goals that you can create
 - i. Recently, one of your family friends has had a heart attack, so you decide to create a healthy heart goal
 - j. Give this goal a name that is different than the default
 - k. You also decide to select a lower trans fat goal, so enter 3 g/day for trans fat
 - l. Select a start date of today
 - m. Select an end date of next of the end of next month
 - n. Then create this goal
 - o. By meeting a goal in the specified timeframe, you have earned some stars. How many stars have you earned?
 - p. Find the page that lists all of your stars
 - q. How many of your stars have you shared with your friends?
 - r. View the chart for the sodium star? What does the chart tell you about your sodium consumption?
 - s. Go to the page that shows the stars that your friends have earned.
 - t. What star has your friend Barrack Obama earned?
 - u. Comment on his star achievement

2. Feedback (please feel free to play with the system as you answer these questions):

a. Likert Responses:

- i. By setting goals with a start date and end date, I will try to meet the goal.
- ii. The types of goals shown in the library are adequate
- iii. The ability to create goals and earn stars is entertaining
- iv. I can earn respect from my friends or enhance my social position by earning stars
- v. I can learn about myself through the ability to participate in goals and earn stars
- vi. I can be motivated to overcome barriers to healthier living by using VivoSpace to achieve my goals and earn stars
- vii. I can understand about my capabilities to live health through the goals functionality
- viii. I can be able to gain health knowledge about myself
- ix. I can be able to learn health outcomes based on my activities
- x. I would be able to learn about barriers to healthier living
- xi. I would be able to learn about facilitators (what helps) to healthier living
- xii. I would create goals to overcome my feeling about certain activities that I know are healthy
- xiii. I would participate in clubs to allow me to live healthier and have a better attitude towards it
- xiv. Please tell the experimenter your thoughts on this prototype

E. Clubs

1. You are interested in the clubs
 - a. First you want to see the clubs that you are a part of, go to your clubs
 - b. What clubs are you a part of?
 - c. Who else is part of this club?
 - d. How are you doing over time (are you getting better or worse)?
 - e. Now, you want to join a club. Go to the page to join clubs
 - f. You Ashtons club, what is the name of it?
 - g. What does his club involve?

- h. Join Ashtons club
 - i. You decide to create a club of your own, so that you can allow others to join it. Go to the create clubs page
 - j. Choose the lose weight club from the library.
 - k. Call it “lose 10 lbs club”
 - l. Change the daily value for saturated to 7g/day
 - m. Enter tomorrow as the start date
 - n. Enter the end of October for the end date
 - o. Make this club closed on to those people that you invite
 - p. Invite the following friends: William, Joey and Maggie
 - q. Create the club
 - r. You now want to view the badges that you have earned from clubs that you completed successfully, go to your badges page
 - s. How many badges have you earned?
 - t. Out of the badges that you earned, which one was from a club that you created?
 - u. What did you have to do to earn this badge?
 - v. View the badges that your friends have earned
 - w. What did your friend Maggie do to earn her badge?
 - x. Comment on her badge by saying “very impressive Maggie!”
2. Feedback (please feel free to play with the system as you answer these questions):
- a. Likert Responses:
 - i. It would be entertaining to participate in clubs
 - ii. I would participate in clubs to have more status than my friends or to enhance my social position
 - iii. I would participate in clubs to be connected with my friends
 - iv. I would participate in clubs to learn more about myself and what I am capable of
 - v. I would participate in clubs to obtain information about myself and/or my friends
 - vi. I would participate in clubs to provide information about myself
 - vii. I would participate in clubs to build a common or shared identity with

my friends

- viii. I would participate in clubs to have an incentive to live healthier
- ix. I would participate in clubs to have health related goals
- x. I would participate in clubs to overcome any negative feelings I may have about certain activities that I know are healthy
- xi. I would participate in clubs to have my friends motivate me to live healthier
- xii. I would participate in clubs to allow me to live healthier have a better attitude towards it
- xiii. I would participate in clubs to support from my friends
- xiv. I would participate in clubs to interact with my friends
- xv. I would participate in clubs to get to know other people better
- xvi. I would participate in clubs to learn who I am similar to
- xvii. I would participate in clubs to belong to a group
- xviii. I would participate in clubs to gain positive influence from my friends and other members
- xix. I would participate in clubs to learn about my own capability by seeing what others are capable of
- xx. I would participate in clubs to act as a way to have my friends help me to live healthier
- xxi. Please tell the experimenter your thoughts on this prototype

F. Challenges

1. You are interested in the Challenges
 - a. First you want to see the challenges that you are participating in, go to your challenges
 - b. What challenges are you participating in?
 - c. Who else is participating in this challenge?
 - d. Who is winning the challenge?
 - e. How are you performing?
 - f. Now, you want to join a challenge. Go to the page to join challenges
 - g. For Joeys challenge, what is the name of it?
 - h. What does his challenge involve?

- i. Join Joeys challenge
 - j. Now you want to create a challenge, go to the create challenges page
 - k. Choose the lose weight challenge from the library
 - l. Give the challenge the following name Lose the most weight before the fall
 - m. Set the main target as 15 lbs
 - n. Set the start date for next week and the end date for the beginning of October
 - o. Open this challenge for everyone
 - p. Invite all your friends to participate
 - q. Create the Challenge
 - r. Now you want to see how many trophies you have won in the challenges that you have participated in. Go to your trophies page
 - s. How many trophies have you won
 - t. View the trophies that your friends have won.
 - u. Which of your friends have won the a trophy
2. Feedback (please feel free to play with the system as you answer these questions):
- b. Likert Responses:
 - i. It would be entertaining to participate in challenges
 - ii. I would participate in challenges to have more status than my friends or to enhance my social position
 - iii. I would participate in challenges to be connected with my friends
 - iv. I would participate in challenges to learn more about myself and what I am capable of
 - v. I would participate in challenges to obtain information about myself and/or my friends
 - vi. I would participate in challenges to provide information about myself
 - vii. I would participate in challenges to build a common or shared identity with my friends
 - viii. I would participate in challenges to have an incentive to live healthier
 - ix. I would participate in challenges to have health related goals
 - x. I would participate in challenges to overcome any negative feelings I may have about certain activities that I know are healthy

- xi. I would participate in challenges to motivate me to live healthier
- xii. I would participate in challenges to allow me to live healthier have a better attitude towards healthy activities
- xiii. I would participate in challenges to be part of a group
- xiv. I would participate in challenges to interact with my friends
- xv. I would participate in challenges to get to know other people better
- xvi. I would participate in challenges to learn who I am similar to
- xvii. I would participate in challenges to compare myself with others
- xviii. I would participate in challenges to belong to a group
- xix. I would participate in challenges to gain positive influence from my friends and other members
- xx. I would participate in challenges to learn about my own capability by seeing what others are capable of
- xxi. I would participate in challenges to act as a way to have my friends help me to live healthier
- xxii. Please tell the experimenter your thoughts on this prototype

II. BELONGING

Repeated Helping Game Experiment: A second participant (B) joins the first participant (A). Care will be taken to ensure that two do not know each other. They are randomized into two conditions.

Instructions for Condition 1

1. Participant A is given 50 fake \$1 bills (they are 3"x2" size printed copies of Canadas old 1 dollar bill), and Participant A is told that the Participant B has just gone through a similar study with another person and earned 18 points by helping another person. A single point is earned every time Participant A decides to help Participant B. However, Participant B has never seen VivoSpace before.

2. Participant B will be asked to complete tasks on VivoSpace and the Participant A can help participant B, but it will cost her/him \$1 dollar for most tasks and \$5 dollars for other tasks
 - a. Participant A will earn a point every time she/he chooses to help Participant B for any task
 - b. Participant B will earn twice the amount that it cost participant A every time participant A helps Participant B
 - c. The points that Participant A and B are displayed on a whiteboard in front of each participant

3. You can choose to end this experiment at anytime if you feel uncomfortable and you can choose to have your data removed from this study permanently.

Instructions for Condition 2

1. Participant A is given 50 fake \$1 bills (they are 3"x2" size printed copies of Canadas old 1 dollar bill), and Participant A is told that the Participant B has just gone through a similar study with another person and earned some points by helping another person. A single point is earned every time Participant A decides to help Participant B. However, Participant B has never seen VivoSpace before.

2. Participant B will be asked to complete tasks on VivoSpace and the Participant A can help participant B, but it will cost her/him \$1 dollar for most tasks and \$5 dollars for other tasks
 - a. Participant A will earn a point every time she/he chooses to help Participant B for any task
 - b. Participant B will earn twice the amount that it cost participant A every time participant A helps Participant B
 - c. The points that Participant A (but NOT B) are displayed on a whiteboard in front of the participants

3. You can choose to end this experiment at anytime if you feel uncomfortable and you can choose to have your data removed from this study permanently.

Here are the tasks that participant B is asked to complete and the cost to help is presented beside each task. Before participant B starts the task participant A can choose to help otherwise A cannot help B until the next task.

- 1) You want to log that you ate at White Spot Restaurant. Type the following in the enter activity area: White Spot Chargrilled Burger; you did this activity with Barrack Obama, so select Barrack as the friend that you did this activity with. Now Log the activity (\$5)
- 2) In the walking activity that you have already completed and logged on VivoSpace, add a comment in response to your friends Kath's comment. Please write: I wish you could have joined us. (\$1)
- 3) Go to the Loggers page. You no longer want to track resistance exercise but you do want to track biking. Please select or unselect as appropriate (\$1)
- 4) Go to the Seals page. You are interested in the Oceanwise seal. You want to select this seal, so please select it. (\$1)
- 5) Go to the Newsfeed page. Please enter a comment on Williams activity, such as good job. (\$5)
- 6) Go to the Dashboard Page. This week, how are you doing with respect to the amount of calories that you are consuming? What is the definition of calories? (\$1)
- 7) View the chart for Calories. (\$1)
- 8) View your existing goals. What is the name of one of your current goals? (\$1)
- 9) Go to the page to create a goal. Browse the library of goals that you can create. You decide to create a healthy heart goal. Give this goal a name that is different than the default. You also decide to select a lower trans fat goal, so enter 3 g/day for trans fat. Select a start date of today. Select an end date of next of the end of next month. Then create this goal. (\$5)
- 10) By meeting a goal in the specified timeframe, you have earned some stars. How many stars have you earned? Find the page that lists all of your stars (\$1)

- 11) How many of your stars have you shared with your friends? (\$1)
- 12) View the chart for the sodium star? (\$1)
- 13) Go to the page that shows the stars that your friends have earned. (\$1)
- 14) What star has your friend Barrack Obama earned? (\$1)
- 15) First you want to see the clubs that you are a part of, go to your clubs. What clubs are you a part of? (\$1)
- 16) Now, you want to join a club. Go to the page to join clubs. You see Ashtons club. Join Ashtons club (\$1)
- 17) You decide to create a club of your own, so that you can allow others to join it. Go to the create clubs page. Choose the lose weight club from the library. Call it lose 10 lbs club. Change the daily value for saturated to 7g/day. Enter tomorrow as the start date. Enter the end of October for the end date. Make this club closed on to those people that you invite. Invite the following friends: William, Joey and Maggie. Create the club (\$5)
- 18) You now want to view the badges that you have earned from clubs that you completed successfully, go to your badges page. How many badges have you earned? (\$1)
- 19) Out of the badges that you earned, which one was from a club that you created? (\$1)
- 20) View the badges that your friends have earned. Notice Maggies badge. Comment on her badge by saying very impressive Maggie! (\$1)
- 21) You want to see the challenges that you are participating in, go to your challenges. What challenges are you participating in? (\$1)
- 22) Who is winning this challenge? (\$1)
- 23) Now, you want to join a challenge. Go to the page to join challenges. Notice Joeys challenge. Join Joeys challenge (\$1)
- 24) Now you want to create a challenge, go to the create challenges page. Choose the lose weight challenge from the library. Give the challenge the following name Lose the most weight before the fall. Set the main target as 15 lbs. Set the start date for next week and the end date for the beginning of October. Open this challenge for everyone. Invite all your friends to participate. Create the Challenge (\$5)
- 25) Now you want to see how many trophies you have won in the challenges

that you have participated in. Go to your trophies page. How many trophies have you won? (\$1)

26) View the trophies that your friends have won. Which of your friends have won a trophy? (\$1)

Both Participants are given paper questionnaires to complete and taken to a private setting to be able to complete them without any fear that their partner will see what they are writing.

1. Questions for participant A:

- a. What were your reasons & motivations for helping B?
- b. What were your reasons & motivations for not helping B?
- c. Did you develop a strategy when playing this game?

2. Questions for participant B (feel free to play with VivoSpace as you answer these questions):

- a. Please provide your general thoughts on VivoSpace and make any suggestions for improvements

III. COMMITMENT

In-group experiment: Both Participant A and B are given the following questions to answer about VivoSpace. They need to develop answers together as a team, and they can play with VivoSpace when trying to find the answer:

1. You can only view your friends activities in the newsfeed if the activity has been shared by your friend even if you were with your friend when you did the activity

- a. True
- b. False

2. Please select the correct way to earn stars

- a. By successfully completing a goal that you have set
- b. By successfully completing a goal that either you have set or a friend has

set

- c. By successfully completing a goal by the deadline
 - d. You earn a star when the deadline for a goal is reached
3. What happens to goals where the targets are not reached
- a. You have the option of creating a new deadline
 - b. They are no longer visible
 - c. They are shown in your goals page
 - d. It is not clear in the prototype
4. Evidence-based seal appear automatically when an activity is entered
- a. True
 - b. False
5. Clubs are competitive
- a. True
 - b. False
6. Only the following number of people can earn a badge in any club
- a. It depends on the club
 - b. All members can earn a badge
 - c. Only one member can earn a badge
 - d. It is not clear in the prototype
7. Badges are earned when the following occurs
- a. When the targets are met
 - b. When the first person meets the targets
 - c. Simply by joining the club
 - d. After the end date
8. Challenges are competitive
- a. True
 - b. False

9. Only the following number of people can earn a trophy in any challenge
 - a. It depends on the challenge
 - b. All participants in the challenge
 - c. Only one participant can earn a trophy
 - d. It is not clear in the prototype

10. When a friend earns a badge or trophy it is automatically visible to you
 - a. No, they need to share it first
 - b. Yes, this is true

Alternately, each participant is told the following in private:

1. You scored 70% and the average is 90%.
 - a. Would you keep working with this group, if it was the only way to continue using VivoSpace?
 - a. Yes, I would stay with this group rather than go to another group to use VivoSpace.
 - b. No, I would go to another group and stop using VivoSpace
 - b. Why?
 - c. Would you keep working with this group, if it cost you \$50 (of the funds used for the helping game) to leave the group?
 - a. Yes, I would stay with this group at no cost
 - b. No, I would pay \$50 to work with another group

2. You scored 70% and the average is 50%.
 - a. Would you keep working with this group, if it was the only way to continue using VivoSpace?
 - a. Yes, I would stay with this group rather than go to another group
 - b. No, I would go to another group and stop using VivoSpace
 - b. Why?
 - c. Would you keep working with this group, if it cost you \$50 (of the funds used for the helping game) to leave the group?

Sixth Appendix: Laboratory Evaluation of Medium-Fidelity Prototype

- a. Yes, I would stay with this group at no cost
- b. No, I would pay \$50 to work with another group

Full disclosure statement is provided to each participant and read to each participant that explains the deceptions in both the Belonging and Commitment experiments and the reasons for it.