The Physical Activity Loyalty Card Scheme: Development and Application of a Novel System for Incentivizing Behaviour Change

Ruth F. Hunter[1], Michael Davis[2], Mark A. Tully[1,3], and Frank Kee[1,3]

[1] Centre for Public Health, Queen's University Belfast, Northern Ireland
[2] Centre for Secure Information Technologies (CSIT), Queen's University Belfast
[3] UKCRC Centre of Excellence for Public Health, Queen's University Belfast
ruth.hunter@qub.ac.uk

Abstract. In the Public Health White Paper "Healthy Lives, Healthy People" (2010), the UK Government emphasised using incentives and "nudging" to encourage positive, healthy behaviour changes. However, there is little evidence that nudging is effective, in particular for increasing physical activity. We have created a platform to research the effectiveness of health-related behaviour change interventions and incentive schemes. The system consists of an outward-facing website, incorporating tools for incentivizing behaviour change, and a novel physical activity monitoring system. The monitoring system consists of the "Physical Activity Loyalty Card", which contains a passive RFID tag, and a contactless sensor network to detect the cards. This paper describes the application of this novel web-based system to investigate the effectiveness of non-cash incentives to "nudge" adults to undertake more physical activity.

Keywords: incentives, nudging, physical activity, behaviour change, Web 2.0, RFID tags, sensor technologies

1 Introduction

The prevalence of physical inactivity, rising obesity levels and associated health conditions in children and adults is rising [1,2,6]. A continuing trend of a more sedentary lifestyle has led to stark projections of future prevalence of obesity, morbidity and mortality [1,2,12]. Recent European figures show that only 31% of adults currently meet the physical activity recommendations [16]. This level of inactivity has directly contributed to the rising rate of obesity worldwide. In the UK, most adults are already overweight and by 2050, 60% of men and 50% of women could be clinically obese, costing an extra £45.5 billion per year in treating obesity-related disease [5].

More innovative interventions are required to halt the global increase in physical inactivity and obesity by sustaining healthy lifestyle behaviours for all ages. "Nudging" and using incentives to promote positive, long-term healthy

P. Kostkova, M. Szomszor, and D. Fowler (Eds.): eHealth 2011, LNICST 91, pp. 170–177, 2012.

behaviour changes is now the UK government's preferred strategy for promoting public health [15]. Nudging is defined as:

> *. . . any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting the fruit at eye level counts as a nudge. Banning junk food does not.* [19]

Nudging is not new and draws on behavioural economics and social psychology to explain why people may behave in ways that deviate from rationality, invoking various mechanisms of behaviour change including the changing of default options, message framing and the provision of social norm feedback. Given the vicious cycles that confound our attempts to change our behaviour [18], it is not surprising that a recent framework has underlined the value of combining approaches that can simultaneously affect our capability, opportunity and motivation to change behaviour [14].

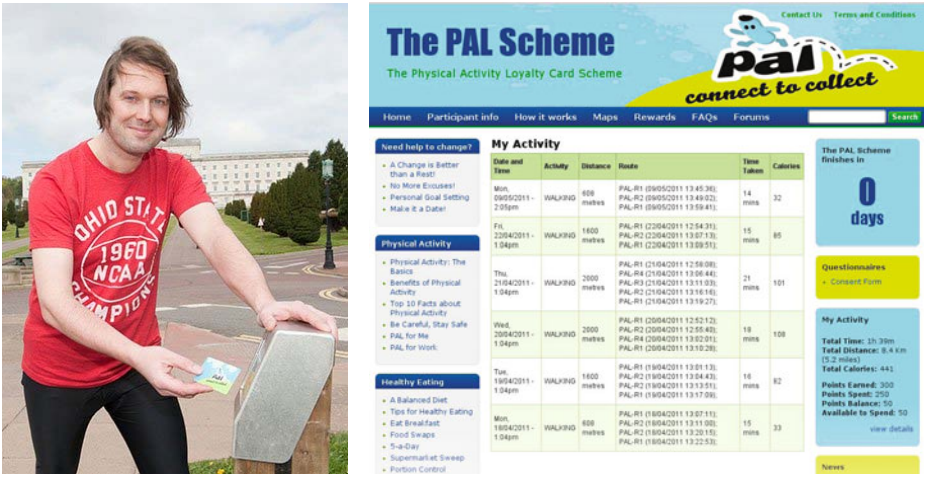
1.1 Previous Research

While there is growing evidence of effectiveness of these approaches for some behaviours, the evidence base for nudging to promote physical activity is sparse. Certainly, more behavioural economists are beginning to research the role of incentives for physical activity, and both financial [3] and non-financial [9] incentives have been shown to increase levels of physical activity, at least in the short term.

The Public Health White Paper [15] highlighted a number of nudge-type initiatives, such as the Step2Get scheme, developed by Intelligent Health Ltd.[1] Based on individual incentives and innovative technology to monitor physical activity levels, students were provided with a swipe card which they touched on receivers placed on lampposts along a safe walking route to school. Each completed walk to school was converted to points and these were redeemed as rewards (*e.g.*, cinema vouchers) at the end of the week. Post-intervention results showed an 18% modal shift towards walking to school. Unfortunately, there are no follow-up results available to determine if the large extrinsic incentive (cinema vouchers) had led to a long-term intrinsic behaviour change (increased physical activity).

This paper describes the development and application of a novel web-based system for incentivizing behaviour change using innovative technology. The paper will also outline the study design and preliminary findings of a randomized controlled trial investigating the effectiveness of incentives (redeemable vouchers for retail outlets) as a nudge to encourage adults to be more physically active.

[1] `http://www.intelligenthealth.co.uk/`



(a) Swiping the PAL Card at a sensor in the park

(b) The PAL Scheme website

Fig. 1. Elements of the PAL Scheme

2 The Web-Based System

We have developed a web-based system in conjunction with The Physical Activity Loyalty Card Scheme, based on guidance from previous research [7,8,11,17,20]. The primary purpose of this system is to increase physical activity and promote a healthy lifestyle. The system incorporates a number of behaviour change tools and nudge elements, which are described in more detail in this section.

2.1 Incentives and Nudge Elements

The PAL Scheme system integrates an innovative physical activity tracking system (Intelligent Health Ltd.) with web-based monitoring and nudge elements (Fig. 1). The tracking system uses Near-Field Communication Technology (NFC) and a "Physical Activity Loyalty Card" (PAL Card) which contains a passive Radio Frequency Identification (RFID) tag. This is a contactless proximity technology: when users present their card within 10 cm of the NFC sensor, a transaction is logged. As the sensors are placed in the outdoor environment, they are housed within a wooden post. The post also contains a mobile phone, which sends the transaction (Card ID, Sensor ID, and Timestamp) via SMS to a data centre. In the back-end system, the transactions are assembled into paths (see Fig. 3a for a visualisation of the network paths). As we know the elapsed time between sensor swipes and the distance between sensors, we can calculate distance and average walking speed for each session. We also know the height and weight of each user: these can be used to estimate the number of calories burned.

The system has been set up to give users real-time feedback on various aspects of their recent bout of physical activity, including minutes completed, distance

covered and calories expended (Fig. 1b). Each user has a personal account where they can view their own physical activity data. Feedback is presented graphically to show users' daily and aggregated physical activity parameters. Personal goals can be set using this feature and shown on the graphical display. This system can be used to incorporate some nudge elements—for example, minutes of activity are converted to points and redeemed for various rewards.

We incorporated a feature that enabled automated messages to be tailored to the individual users' weekly physical activity level. For example, if a user had fallen below the recommended weekly physical activity level, a prompt was sent to encourage them to undertake more activity with links to some of the behaviour change tools featured on the website to help them.

2.2 Behaviour Change Tools

The website contains a number of interactive tools offering personal advice, support and aids for behaviour change. Two tools have been adapted to offer individually tailored advice to the participant in order to increase their physical activity levels. These include the Stages of Change Questionnaire [13] and an adapted questionnaire for identifying and overcoming barriers to becoming more physically active. In addition, the website contains tools for planning physical activity opportunities as part of their working week.

2.3 Other Features

The website contains health promotion material for leading a healthy lifestyle, including advice on physical activity, diet and smoking. We used Facebook and Twitter to disseminate health promotion messages and regular encouragements to keep participants engaged with the scheme. Additionally, the website incorporated a number of Web 2.0 features (e.g. forums, user comments) to receive feedback on the system. Participants were also able to use the social networking features to provide social support—for example, planning walks with other users.

Finally, the web-based system also acts as a comprehensive research tool, incorporating features to support each stage from recruitment to data analysis. This includes electronic data collection, processing and aggregation.

3 Application of the System

3.1 Trial Design

We have built upon the non-randomized scheme highlighted in Sect. 1.1 and designed an intervention with several nudge components (including modest incentives for physical activity participation). We also draw upon evidence-based approaches from the behavioural science literature, including self-monitoring, the provision of personal feedback and goal-setting resources. The aim of the intervention is to provide an extrinsic incentive to nudge individuals to develop a

long-term intrinsic behaviour change. The system has been piloted in a 12-week intervention with civil servants who work at Stormont Estate, Belfast, Northern Ireland. Based on a sample size calculation, we recruited 406 employees aged 18–65 years old, who work on the Estate at least four days a week (minimum of 6 hours per day) to participate in a randomized controlled trial investigating the effectiveness of incentives for encouraging physical activity in adults. Participants were recruited via email, posters and flyers distributed around the workplace. Participants were randomly allocated to one of two groups:

1. Participants received incentives for being physically active. Participants collected points for each minute of physical activity that they completed by swiping their "loyalty card" across sensors placed around the Estate. Points could be earned by walking/running around the Estate, and by attending the gym/exercise classes. Points were reimbursed for rewards at the end of week 6 and week 12. Participants could earn a maximum of 30 points per day, five days per week (equivalent to the physical activity recommendations). The rewards were various redeemable vouchers from a number of local businesses. Participants received feedback regarding minutes of activity, points earned, distance covered and calories burned.
2. Participants did not receive incentives for being physically active. Participants used their "loyalty card" to monitor their physical activity levels and received feedback regarding time, distance, and calories. They were not able to collect points or earn rewards.

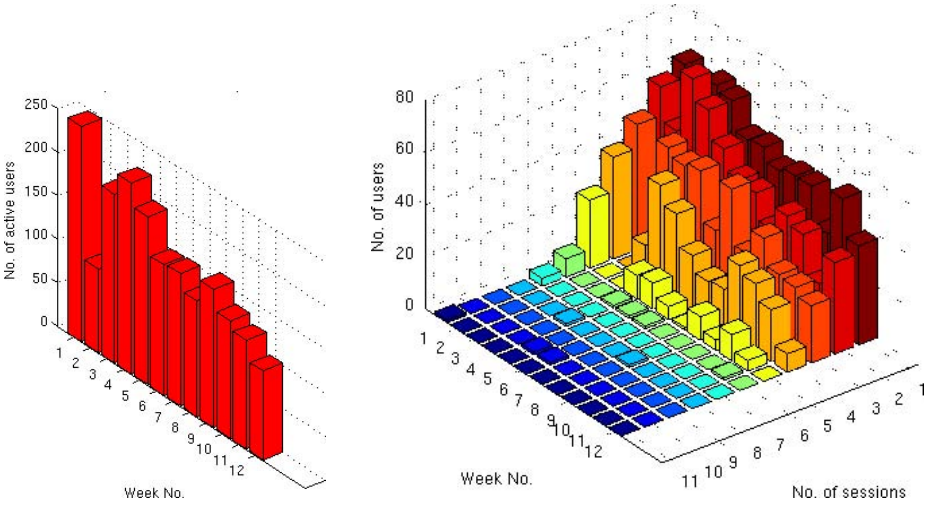
3.2 Preliminary Results

There were 406 participants in the trial: 67% were female and the mean age was 43.2 years. Fig. 2a shows the number of unique PAL Card users during the 12-week intervention. There were 250 users in the first week. This gradually declined from week 4, with approximately 100 users during the final week.

Fig. 2b shows the number of times each participant used their PAL Card per week. Most users undertook activity (used their PAL Card) between 1 and 5 times per week. This data will be further analysed to investigate the effectiveness of incentives for increasing physical activity and the predictors of card usage.

Fig. 3 represents the PAL Card transactions as network graphs. In Fig. 3a, the vertices represent RFID sensors and edges represent patterns of mobility. Sensors R1–R5 were placed along paths in the outdoor environment; there were two additional sensors on the door to the Gym and the Fitness Studio. Edge weights are proportional to the frequency that each path segment is traversed. This allows us to analyse the mobility patterns of the participants in the study.

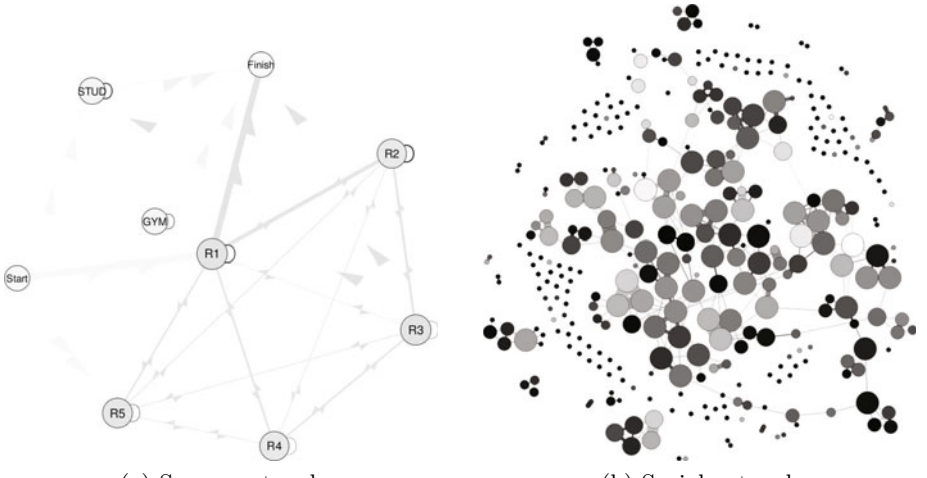
Fig. 3b shows the social connections between participants in the study. We used a method similar to [10] to infer social connections based on users who presented their cards at the same sensor within a few seconds of each other. If two users present their cards in the same place at the same time, this suggests a possible social connection. If this happens frequently for a given pair of users, a connection is almost certainly present. The graph shows that certain users



(a) Unique active PAL Card users per week

(b) Number of PAL Card activity sessions per participant per week

Fig. 2. PAL Card activity during the 12-week intervention



(a) Sensor network

(b) Social network

Fig. 3. PAL Card transactions represented as network graphs

formed clear clusters, whereas others preferred to exercise on their own. The size of each node indicates the degree of connectedness; the shade represents the level of physical activity (darker shades indicate less activity and lighter shades indicate more activity). We propose to use this kind of graph to investigate whether physical activity behaviour changes percolate through social networks. Beyond visual analytics, we intend to investigate the formal properties of the graph representations using graph-mining techniques such as [4].

4 Future Applications

There is scope for this web-based system to be used to investigate the effectiveness of nudge interventions including the influence of social norms, competition, and other lessons learnt from the behavioural economics literature. This innovative technology can be applied to future schemes and research trials investigating the use of incentives and nudges to encourage positive lifestyle behaviour changes in terms of, for example, smoking and diet, and in various settings—for example, school and workplace.

5 Conclusions

In this paper, we have described a sophisticated system which has been used to investigate the effectiveness of incentives for encouraging adults to be more physically active. Preliminary results indicate that this is a useful tool for this purpose. The data will be further analysed to investigate the effectiveness of incentives, the predictors of users of the system and the influence of peer relationships in increasing physical activity in adults. We plan to develop a set of software tools for the development and deployment of future nudge and behaviour change interventions that can be used by other researchers and public health practitioners.

Acknowledgements. We would like to acknowledge funding from the National Prevention Research Initiative (NPRI) and their funding partners (Alzheimer's Research Trust; Alzheimer's Society; Biotechnology and Biological Sciences Research Council; British Heart Foundation; Cancer Research UK; Chief Scientist Office, Scottish Government Health Directorate; Department of Health; Diabetes UK; Economic and Social Research Council; Engineering and Physical Sciences Research Council; Health and Social Care Research and Development Division of the Public Health Agency (HSC R&D Division); Medical Research Council; The Stroke Association; Welsh Assembly Government; and World Cancer Research Fund (`http://www.npri.org.uk`). We also wish to acknowledge funding from the Department for Employment and Learning, Northern Ireland and the support of Intelligent Health Ltd., London.

References

1. White house task force report on childhood obesity: Report to the president. solving the problem of childhood obesity within a generation (May 2010), `http://www.letsmove.gov/white-house-task-force-childhood-obesity-report-president`
2. Branca, F., Nikogosian, H., Lobstein, T.: The challenge of obesity in the WHO European region and the strategies for response. Technical report, WHO Regional Office for Europe (2007)
3. Charness, G., Gneezy, U.: Incentives to exercise. Econometrica 77(3), 909–931 (2009)

4. Davis, M., Liu, W., Miller, P., Redpath, G.: Detecting anomalies in graphs with numeric labels. In: 20th ACM Conference on Information and Knowledge Management (CIKM 2011), Glasgow (October 2011)
5. DHSSPS. A fitter future for all: An obesity prevention framework for Northern Ireland 2011–2021 (draft), http://www.dhsspsni.gov.uk/obesity-prevention-framework-2011-2021.pdf (accessed September 13, 2011)
6. Farhat, T., Iannotti, R.J., Simons-Morton, B.G.: Overweight, obesity, youth, and health-risk behaviors. American Journal of Preventive Medicine 38(3), 258–267 (2010)
7. Ferney, S.L., Marshall, A.L.: Website physical activity interventions: preferences of potential users. Health Education Research 21(4), 560–566 (2006)
8. Ferney, S.L., Marshall, A.L., Eakin, E.G., Owen, N.: Randomized trial of a neighborhood environment-focused physical activity website intervention. Preventive Medicine 48(2), 144–150 (2009)
9. Johannesson, M., Östling, R., Ranehill, E.: The effect of competition on physical activity: A randomized trial. The B.E. Journal of Economic Analysis & Policy 10(1), 91 (2010)
10. Lauw, H.W., Lim, E.-P., Pang, H., Tan, T.-T.: Social network discovery by mining spatio-temporal events. Comput. Math. Organ. Theory 11, 97–118 (2005)
11. Leslie, E., Marshall, A.L., Owen, N., Bauman, A.: Engagement and retention of participants in a physical activity website. Preventive Medicine 40(1), 54–59 (2005)
12. Lieberman, D.A., Chamberlin, B., Medina, E., Franklin, B.A., Sanner, B.M., Vafiadis, D.K.: The power of play. In: Innovations in Getting Active Summit 2011, vol. 123, pp. 2507–2516 (2011)
13. Marcus, B.H., Selby, V.C., Niaura, R.S., Rossi, J.S.: Self-efficacy and the stages of exercise behavior change. Research Quarterly for Exercise and Sport 63(1), 60–66 (1992)
14. Michie, S., van Stralen, M., West, R.: The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implementation Science 6(42) (April 2011)
15. Department of Health. Healthy lives, healthy people: our strategy for public health in England (2010), http://dera.ioe.ac.uk/1974/1/dh_122347.pdf
16. World Health Organization. 10 key facts on physical activity in the WHO European region, http://tinyurl.com/10factsPA-EU (accessed September 13, 2011)
17. Pressler, A., Knebel, U., Esch, S., Kölbl, D., Esefeld, K., Scherr, J., Haller, B., Schmidt-Trucksäss, A., Krcmar, H., Halle, M., Leimeister, J.M.M.: An internet-delivered exercise intervention for workplace health promotion in overweight sedentary employees: a randomized trial. Preventive Medicine 51(3-4), 234–239 (2010)
18. Swinburn, B., Egger, G.: The runaway weight gain train: too many accelerators, not enough brakes. BMJ 329(7468), 736–739 (2004)
19. Thaler, R.H., Sunstein, C.R.: Nudge: Improving decisions about health, wealth and happiness. Penguin, London (2008)
20. Vandelanotte, C., Spathonis, K.M., Eakin, E.G., Owen, N.: Website-delivered physical activity interventions. American Journal of Preventive Medicine 33(1), 54–64 (2007)