

School for Public Health Research

1.	Project reference:	Final report date:	
	SPHR-SWP-ALC-WP1	June 2017	
2.	Project title:		
	New technologies for reducing excessive alcohol use - the development and evaluation of a theory-based smartphone application		
3.	SPHR lead investigators on project:		
	David Crane		
	Other SPHR collaborators:		
	Susan Michie, UCL Robert West, UCL Jamie Brown, UCL		
3.	Names and roles of others involved in project (e.g. include fixed term contract researchers and external collaborators / partners):		
	Claire Garnett, UCL		
4.	Project start date:	Project end date:	Duration:
	September 2013	December 2016	3 years, 3 months
5.	Project objectives originally outlined in proposal:		
	<p>The objectives for the project are to:</p> <ol style="list-style-type: none"> 1. Systematically review the evidence for, and theoretical basis of, the effectiveness of mobile phone apps in changing behaviour, including addictive behaviours; 2. Design an app to help excessive alcohol consumers reduce their consumption, drawing on PRIME Theory (West & Brown, 2013) and the Behaviour Change Wheel (Michie, van Stralen, & West, 2011); <p>Evaluate components of the app in a factorial randomised controlled trial (RCT).</p>		
6.	Briefly describe and explain the reason(s) for any changes to the project originally outlined in proposal:		
	The project met the objectives originally outlined in the proposal, though a change to the original project end date was made. A no-cost extension was granted from September 2016 to December 2016 to allow enough time to analyse, write-up and disseminate the data and findings from the factorial RCT.		
7.	Brief summary of methods, findings against objectives, and conclusions (2-4 pages max):		



The Drink Less app was developed based on theory and empirical evidence to help reduce alcohol consumption in excessive drinkers. A number of methodologies were used to identify promising modular intervention content that could be delivered by an app:

- A systematic review was conducted using the related Cochrane review of electronic interventions to reduce hazardous and harmful drinking (led by SPHR members from Newcastle and Bristol) (Kaner et al., 2015). A separate paper reported the analysis of behaviour change techniques used in these interventions and their association with effectiveness.
- A content analysis of popular alcohol reduction apps showed the most frequently used intervention components in existing apps (Crane, Garnett, Brown, West, & Michie, 2015).
- A formal consensus exercise with experts was conducted to identify the best bets for intervention content for an alcohol reduction app (Garnett, Crane, West, Brown, & Michie, 2015).

The Drink Less app content was selected based on theory and empirical evidence. The app is structured around goal-setting and includes a set of core features. It also has five intervention modules: normative feedback, cognitive bias re-training, identity change, self-monitoring and action planning. Each intervention module has two versions delivering either '*intensive*' or '*minimal*' support. Developing the app was an iterative process and involved a number of steps including choosing the most relevant design principles, usability testing and de-bugging the app. Initial development and the first version of the app was based on pragmatic considerations as to: how to deliver the intervention content; the app developers' opinions based on previous experience; previous delivery of similar intervention content; and frameworks for engagement and design. A person-based approach was taken in two usability studies. A first round of usability testing was conducted amongst people who were using the app for the first time. Twelve people interested in reducing their alcohol consumption and whose Alcohol Use Disorders Identification Test Consumption (AUDIT-C) score was greater than 5 were recruited. This sample consisted of an equal number of men and women and participants of differing ages and ethnicities. Disadvantaged users were specifically recruited to maximise the appeal across the social spectrum. Half the participants had no post-16 educational qualifications, were unemployed and/or had a routine/manual occupation. A second round of usability testing was undertaken amongst people who had the opportunity to use the app for at least two weeks. These usability studies informed further iterations and the final version of the app. The app is freely available on the iTunes app store and can be used as a stand-alone intervention as it does not require any input from a healthcare practitioner.

Methods:

A factorial RCT was used to evaluate the independent and interactive effects of the intervention modules in the Drink Less app.

Participants were recruited online and were eligible for the trial if they were: excessive drinkers (AUDIT \geq 8), aged 18 or over, from the UK, making a serious attempt to reduce their drinking, and provided their email address. Eligible users were randomised to one of 32 (2⁵) experimental conditions (intensive and minimal versions for each of: normative feedback, cognitive bias re-training, identity change, self-monitoring, and action planning) after downloading the Drink Less app.

Participants completed baseline measures on downloading the app and were contacted via e-mail and within the app after one-month with a follow-up questionnaire. The primary outcome measure was self-reported change (between follow-up and baseline) in past week consumption of alcohol (grams of ethanol consumed per week). The secondary outcome measures were change in AUDIT score, app usage data and usability ratings for the app.

A sample size of 672 was required for 80% power to detect a mean difference in change of 5 units per week. The trial and analysis plan were pre-registered. A factorial between-subjects ANOVA was used



to assess the main and interactive effects of the five intervention modules. An intention-to-treat approach was used whereby those lost to follow-up were assumed to have maintained baseline drinking levels.

Results (including findings in relation to the objectives):

Of 672 participants, 27% responded to follow-up. At baseline, their mean past week alcohol consumption was 39.9 units and mean AUDIT score was 19.1, indicating that the sample was, on average, drinking at harmful levels. Their mean age was 39.2 years and the majority were women (56.1%), white (95.2%), had post-16 qualifications (72.0%), and were employed (86.5%). About a quarter were current smokers (24.6%), a higher prevalence than in the general population of the UK (which is ~20% (Brown et al., 2016)). The majority of participants had an AUDIT score of 16 or above indicating they were harmful drinkers or drinkers at-risk of alcohol dependence (66.7%).

There was an overall decline in alcohol consumption averaging 3.8 units per week. There were numerically larger, but non-significant, decreases in alcohol consumption and AUDIT score for intensive versions of normative feedback, cognitive bias re-training and self-monitoring. There were significant two-way interactions between normative feedback and cognitive bias re-training on past week alcohol consumption, and between self-monitoring and action planning on AUDIT score. These interactions were both in the direction of the largest effect occurring when participants received intensive versions of both intervention modules. The two-way interaction between normative feedback and cognitive bias re-training modules on past week alcohol consumption is supported by empirical evidence suggesting that interventions targeting both the reflective and automatic motivational systems are more likely to be effective than either one alone in achieving behaviour change (Hofmann, Friese, & Wiers, 2008; Hollands, Marteau, & Fletcher, 2016; Marteau, Hollands, & Fletcher, 2012). This finding is in line with the dual-process models of behaviour and the PRIME Theory of Motivation that proposes that behaviour is determined by motivation and its two systems (Bechara, 2005; Strack & Deutsch, 2004; West & Brown, 2013; Wiers et al., 2007). The interaction between self-monitoring and action planning on AUDIT score is consistent with previous findings from alcohol interventions (Michie et al., 2012), other behavioural domains (Michie, Abraham, Whittington, McAteer, & Gupta, 2009), and with Control theory (Carver & Scheier, 1982).

Overall, participants used the app for a mean time of 4:23 minutes each session and for an average of 11.7 times, compared with 8.5 times for the SmokeFree 28 app (Ubhi, Michie, Kotz, Wong, & West, 2015) indicating a good level of engagement with the app. Participants rated the app significantly above neutral on ease of use and satisfaction. Participants receiving the intensive version of the self-monitoring module used the app significantly more times, and rated the app more highly on 'helpfulness of the app', 'likelihood to recommend the app to a friend' and 'satisfaction with the app'.

Conclusions:

This trial established the extent to which five intervention modules offered in the Drink Less app, developed based on theory and empirical evidence, could help reduce excessive alcohol consumption. The findings suggested that a version of the Drink Less app that includes the normative feedback, cognitive bias re-training, self-monitoring and action planning intervention modules may assist with drinking reduction, and that such a version merits further evaluation in a full RCT against a minimal control with long-term outcomes.

Drink Less appears to be acceptable to, and well used by, treatment-seeking individuals who were drinking excessively and, therefore, in need of support. The trial had high ecological validity; participants were not recruited for a trial and then given an app, but sought out an app and were then recruited for a trial. Recruitment of nearly 700 eligible participants was achieved in two months. This



	<p>was not a constant rate of recruitment but increased as the app got more users (through promotional activity through the help of a number of organisations). Drink Less is now self-sustaining with about 40 new downloads a day and generally appears in the top two results on the iTunes app store for 'alcohol'. This makes Drink Less a useful research tool as there is an existing user base available who have consented to have their anonymous data used in academic studies.</p>
<p>8.</p>	<p>Plain English Summary (400 words max) Please provide a summary of the project, including background, findings and conclusions:</p> <p>Alcohol consumption is responsible for approximately 3.3 million deaths worldwide each year. Over 10 million people in the UK regularly drink in excess of Government guidelines. Tackling excessive alcohol consumption is a public health priority. Web interventions to help people reduce their alcohol consumption appear to be effective, but there is little evidence about apps and a lack of understanding about what techniques an app should contain to make it effective.</p> <p>SPHR researchers examined the literature for behaviour change theory and techniques that may inform interventions to help people to reduce their alcohol consumption. Alcohol and behaviour change experts were consulted for their views about which techniques an app should contain. This led to a scientifically-informed app which was professionally designed and subsequently improved in response to user feedback. The main feature of the app was that it allowed each user to set their own goal to which they would like to reduce their alcohol consumption. There were five additional features that were based on behaviour change techniques to help participants reduce their drinking. These features were called normative feedback, cognitive bias re-training, identity change, self-monitoring, and action planning.</p> <p>Almost 700 drinkers took part in a study to evaluate the effectiveness of the app. Groups of users were randomly given 'intensive' or 'minimal' versions of different techniques and the effectiveness of each was measured by comparing levels of drinking before and after using the app. On average, people logged-in 12 times during a one-month period and drank four fewer units of alcohol at the end of using the app compared with the start. People who received a more intensive version of a technique did not reduce their alcohol consumption significantly more than people who got a less intensive version of the same technique.</p> <p>The combinations of normative feedback and cognitive bias re-training, and of self-monitoring and action-planning led to improved alcohol outcomes. These findings suggest that these techniques may assist with reducing drinking and are worth keeping in the next version of the app for further development and evaluation.</p>
<p>9.</p>	<p>Keywords Please provide up to 8 keywords that relate to the research undertaken in this study:</p> <p>Alcohol; drinking; app; behaviour change; intervention; digital</p>
<p>10.</p>	<p>Dissemination – please detail planned or published articles in peer-reviewed journals (including web links):</p> <p>Crane, D., Garnett, C., Brown, J., West, R., & Michie, S. (2015). Behavior change techniques in popular alcohol reduction apps: content analysis. Journal of medical Internet research, 17(5). http://www.jmir.org/2015/5/e118/</p>

Garnett, C., Crane, D., West, R., Brown, J., & Michie, S. (2015). Identification of behavior change techniques and engagement strategies to design a smartphone app to reduce alcohol consumption using a formal consensus method. *JMIR mHealth and uHealth*, 3(2).
<http://mhealth.jmir.org/2015/2/e73/>

Garnett, C., Crane, D., West, R., Michie, S., Brown, J., & Winstock, A. (2015). Normative misperceptions about alcohol use in the general population of drinkers: A cross-sectional survey. *Addictive behaviors*, 42, 203-206.
<http://www.sciencedirect.com/science/article/pii/S0306460314003827>

Kaner EF, Beyer FR, Brown J, Crane D, Garnett C, Hickman M, Muirhead C, Redmore J, Michie S, de Vocht F. (2015) Personalised digital interventions for reducing hazardous and harmful alcohol consumption in community-dwelling populations (Protocol). *Cochrane Database of Systematic Reviews*. <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD011479/full>

Crane D, Garnett C, Brown J, West R, Michie S. (2016). Evaluating the effectiveness of a smartphone app to reduce excessive alcohol consumption: Protocol for a randomised control trial. *BMC Public Health*, 16(1),536. <https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-3140-8>

Crane D, Garnett C, Brown J, West R, Michie S. (2017) Factors influencing usability of a smartphone app to reduce excessive alcohol consumption: think-aloud and interview studies. *Frontiers in Public Health*, 5 (39). <http://journal.frontiersin.org/article/10.3389/fpubh.2017.00039/full>

Garnett, C. V., Crane, D., Brown, J., Kaner, E. F., Beyer, F. R., Muirhead, C. R., ... & Michie, S. (2018). Behavior Change Techniques Used in Digital Behavior Change Interventions to Reduce Excessive Alcohol Consumption: A Meta-regression. *Annals of Behavioral Medicine*, 52(6), 530-543.
<https://www.ncbi.nlm.nih.gov/pubmed/29788261>

Garnett, C., Crane, D., West, R., Brown, J., & Michie, S. (2018). The development of Drink Less: an alcohol reduction smartphone app for excessive drinkers. *Translational behavioral medicine*.
<https://www.ncbi.nlm.nih.gov/pubmed/29733406>

David Crane, Dr Jamie Brown, and Prof Susan Michie have also given a number of presentations on the alcohol app:

Oral presentation: David Crane "The Art of Engagement" eHealth unit technology knowledge sharing seminar: Enhancing engagement with digital interventions, 15-Apr-15

Oral presentation: David Crane "Behaviour change techniques in popular alcohol-reduction apps" British Psychological Society, Division of Health Psychology, Annual Conference 2015, 18-Sep-15

Oral presentation: Susan Michie. "The development and evaluation of a theory-based smartphone application". The School for Public Health Research: Alcohol Programme, Meeting with DH, PHE & HMRC Alcohol Policy, 17-Sep-15

Oral presentation: David Crane "Behaviour change techniques used in digital interventions to reduce excessive alcohol consumption" UK Society of Behavioural Medicine Annual Scientific Meeting 2015, 09-Dec-15



Oral presentation: David Crane. "Usability of a smartphone app to reduce excessive alcohol consumption" 2nd Behaviour Change Conference: Digital Health and Wellbeing, 24-Feb-16

Oral presentation: Jamie Brown. "Behaviour change techniques used in digital interventions to reduce excessive alcohol consumption: A meta-regression" Digital Health and Wellbeing, 24-Feb-16

Poster presentation: David Crane. "User views of a smartphone app to reduce excessive alcohol consumption". NIHR School for Public Health Research Annual Scientific Meeting, 10-Mar-16

Oral presentation: Susan Michie. "The development and evaluation of a theory-based smartphone application". NIHR School for Public Health Research Annual Scientific Meeting, 10-Mar-16

Keynote presentation: Susan Michie. An evidence-based alcohol-reduction smartphone app. 2nd International Conference on e-Coaching for Health and Wellbeing, Amsterdam, Netherlands, 26-Jan-17

Oral presentation: Claire Garnett. Estimating effectiveness of components of a smartphone app ('Drink Less') to reduce excessive alcohol consumption: a factorial randomised control trial. 3rd UCL Centre for Behaviour Change Digital Health Conference 2017: Harnessing digital technology for behaviour change, 22nd February 2017.

11. Impact – please use this space to capture information (e.g. data, case studies, quotes, 'thank you' emails etc.) that can be used now and in the future to effectively and concisely demonstrate the impact of your project:

	Used during project	Used after project	Would have liked to use but didn't
Academic Journals (e.g. BMJ)	✓	<input type="checkbox"/>	<input type="checkbox"/>
Full Report (paper)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Full report (web access)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Summary report (paper)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Summary report (web access)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Academic conference - talks	✓	<input type="checkbox"/>	<input type="checkbox"/>
Academic conference – posters	✓	<input type="checkbox"/>	<input type="checkbox"/>
Academic seminars	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Academic workshops	✓	<input type="checkbox"/>	<input type="checkbox"/>
Other (please give details)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please provide further details – e.g. full publication reference / conference or workshop title etc:

Details of the academic journals and conference talks/posters are listed above.

Academic workshop: "Behaviour change techniques in apps: their selection, implementation & evaluation". CBC Digital Health Pre-conference Workshop. London. February 2017.

Presentation at Think, Drink, Do; a conference for web developers interested in health-related behaviour change.

A Twitter account has been created for the UCL Health Psychology department and regular Tweets have been posted. Whilst some of the 300+ Tweets posted are not alcohol-related, the majority are



and the close to 200 followers secured so far provides a ready audience for future dissemination of work.

Regular posts relating to alcohol reduction, behaviour change and published papers continue to be made to the Twitter account (1,200 in total), which now has 900 followers.

Drink Less consistently appears in the top two results for 'alcohol' searches in the iTunes app store and has about 40 new downloads each day without any active promotional activity.

Drink Less has been selected as one of three apps for inclusion in a project by the Health Innovation Network – the Academic Health Science Network for South London (<http://www.hin-southlondon.org/>). This project involves the prescription of alcohol apps to the patients/customers of a couple of primary care practices and pharmacies.

12. Public and practitioner involvement and engagement - please summarise your progress to date in implementing your plan for PPIE. Please provide comment on your experiences, any changes made and lessons drawn:

The involvement of the public during the iterative testing provided valuable insight into the factors influencing the usability, which in turn led to substantial refinements of the app. These findings and experiences are formally detailed in a publication: Factors influencing usability of a smartphone app to reduce excessive alcohol consumption: think-aloud and interview studies. *Frontiers in Public Health*, 5 (39). We found the criterion to have at least half the sample from more disadvantaged backgrounds indicated by occupational status or education provided a greater diversity of opinion.

The team authored a public health evidence briefing about the app and its initial evaluation disseminated by SPHR and hosted a SPHR alcohol event together with the UCL Centre for Behaviour Change attended by practitioners, public and policymakers (total attendance of over 75 people).

13. Any other information:

References:

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<https://doi.org/10.1038/nn1584>

Brown, J., West, R., Angus, C., Beard, E., Brennan, A., Drummond, C., ... Michie, S. (2016). Comparison of brief interventions in primary care on smoking and excessive alcohol consumption: a population survey in England. *The British Journal of General Practice*, 66(642), e1-9. <https://doi.org/10.3399/bjgp16X683149>

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Garnett, C., Crane, D., West, R., Brown, J., & Michie, S. (2015). Identification of Behavior Change Techniques and Engagement Strategies to Design a Smartphone App to Reduce Alcohol Consumption Using a Formal Consensus Method. *JMIR mHealth and uHealth*, 3(2), e73. <https://doi.org/10.2196/mhealth.3895>



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Department of Health and Social Care Disclaimer:

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