

It Started with a Text: An analysis of the effectiveness of mHealth interventions in changing behaviour and the impact of text messaging on behavioural outcomes.

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Abstract: New technologies are radically transforming health care. In this paper we evaluate a burgeoning method for delivering health interventions, the use of SMS text messaging via mobile telephones, or mHealth. This paper evaluates the peer-reviewed literature in this domain, examining the range of health issues that have been targeted using text messaging, their efficacy and the characteristics associated with intervention effectiveness. It introduces the Do Something Different behaviour change platform and discusses how this uses behavioural science principles to provide effective mHealth interventions.

The challenge

A pervasive challenge for governments and health-care providers is how to encourage people to adopt healthy lifestyles and manage chronic diseases. Face-to-face consultations and media can provide a limited amount of information, advice and support. However, while these traditional channels of communication raise awareness and impart knowledge, this does not always get translated into action. It has been argued that such methods are predicated on a flawed implicit assumption that understanding inevitably leads to behaviour change (Pine & Fletcher 2014). For example, in attempts to increase activity levels, 'mass media campaigns targeting broader audiences, including those who may not intend to increase their physical activity, have been successful at increasing knowledge and awareness about physical activity but are often too diffuse to successfully impact individual behavior change' (Williams et al 2008). New technologies are radically transforming health care. In this paper we consider the effectiveness of mHealth interventions in health behaviour change and identify the elements of text-based interventions that most positively impact upon behavioural outcomes.

Mobile phone usage

Recent years have seen a rapid expansion in both mobile device adoption globally and the capabilities of these devices (Bock et al. 2015). More than two thirds of the world's population now own a mobile phone. In the UK the proportion is 93% and growing (Ofcom 2015). Text messaging (short message service or SMS), is now the most ubiquitous form of mobile communication. The proportion of UK adults who said they sent or received text messages at least once a week in 2014 was 90%, an uplift from 70% in 2005. This expansion and adoption of new methods of mobile communication has created innovative opportunities for delivering health behavior change interventions (mHealth). mHealth is a component of eHealth, a term used to cover all computer-based/digital health technologies and health informatics.

The advantages of mHealth interventions

The advantages of mHealth interventions are considerable and extend far beyond the ease-of-use and low cost of texting. Namely:

- Text messaging has wide population reach and therefore offers the potential to deliver health-related interventions to individuals who would not otherwise present for in-person treatment. It provides a low-cost alternative to repeat clinic visits or counselling, while increasing convenience for users and allowing multiple daily contacts over longer periods of time.
- Many people with long-term conditions see a healthcare professional for just a few hours a year. For the rest of the time they must manage their condition themselves, managing medications, diet and activity levels. mHealth can support people during the time between appointments and help reduce the risk of them developing complications that could have serious health consequences.
- Since text messaging is a user-friendly and acceptable communication channel recipients report that they find interventions delivered in this way helpful and express high satisfaction with them, as well as reporting a greater likelihood to read text messages than emails (de Leon, Fuentes and Cohen 2015).
- Mobile health applications are particularly promising for addressing health disparities, particularly in populations who disproportionately face barriers to self-management due to limited health literacy, social support, and access to health care (Nundy et al 2013). Athena Philis-Tsimikas, M.D., corporate vice president for the Scripps Whittier Diabetes Institute. "We found that by using text messages we were able to circumvent many of the barriers these patients face, such as lack of transportation or childcare, while still being able to expand the reach of diabetes care and education."
- Mobile technology allows interventions to be delivered to people in everyday settings and in real-time. This is particularly beneficial for reaching people at high-risk times or for medication adherence.
- Texts can be individually tailored for content and timing as well as for a range of variables, including language, stage of change, baseline characteristics, age, gender etc.
- In potentially sensitive areas, such a sexual health or mental illness, mHealth can help to reduce the stigma and isolation experienced by many users. Research has demonstrated the value of text-messaging interventions for encouraging disclosure of sensitive information, such as mental health problems (Joyce & Weibelzahl, 2008).
- Text delivery provides a powerful mechanism for interrupting, and altering the course of, ingrained habitual behaviours that work against long term health. Habitual behaviours are driven by System 1 processes (Kahneman, 2014), often triggered by external cues, and carried out with little or no conscious awareness. In contrast System 2 processes are more cognitive and conscious, and may operate when the person is receiving information or guidance from a health professional. The information may be processed on an abstract and intellectual level but not translate into action in everyday life when System 1 is driving behaviour. This potential to disrupt potentially harmful behaviour and introduce a healthier alternative may be the potent ingredient behind behaviour change technologies that focus on habit disruption and behavioural strategies.

The literature reveals that a wide variety of different health behaviors have been targeted using text messaging including breast self-examination, asthma, hypertension, weight management, mental health, cardiovascular health, diabetes management, physical activity, smoking cessation, methamphetamine use, sexual health, mammography adherence, and sun protection.

The type of message used in interventions

Studies of mHealth interventions reveal a wide variation in the content of text messages delivered and do not always identify the characteristics associated with intervention effectiveness. The message types include (see Eysenbach for a full analysis):

- Appointment reminders
- Medication reminders
- Health education messages
- Encouragement
- Motivational messages
- Instructional messages
- Prompts for self-management
- Prompts for intention formation
- Trivia messages
- Prompts for barrier identification
- Help with cravings
- Lifestyle modifications
- Suggestions and strategies
- Updates on progress
- Tips from other users
- Rewards
- Challenges
- Information

Behavioural outcomes of mHealth interventions

In a meta-analysis of the effectiveness of messaging interventions (text and email) based on 55 research articles, De Leon, Fuentes and Cohen (2015) found significant behavioural outcomes in 76% of the studies.

In a review of behavior change interventions delivered purely by mobile telephone and including pre- and post-intervention measurement, Fjeldsoe, Marshall and Miller (2009) reported positive behavior change outcomes in 13 of the 14 reviewed studies.

In a meta-analysis of random controlled trials of text messaging interventions published in 2015, involving data from 19,641 participants worldwide, Orr and King found that 'SMS messages had a small, positive, significant effect ($g = 0.291$) on a broad range of healthy behaviours'. They found this effect to be robust, irrespective of population characteristics or target behaviour.

An earlier systematic review of healthcare via mobile phones carried out by Krishna, Boren and Balas (2009) noted significant improvements in compliance with medicine-taking, asthma symptoms, HbA1C, stress levels, smoking quit rates, and self-efficacy. The studies reviewed involved 38,060 participants. Other improvements reported included lower failed appointments, quicker diagnosis and treatment, and improved teaching and training.

Williams et al (2008) in a review of interventions to increase walking behavior, found brief telephone prompts to be as effective as lengthy telephone counselling and concluded that non-face-to-face delivery methods may be optimal for walking promotion interventions.

In a systematic review of mobile phone smoking cessation interventions Whittaker et al found these interventions to be effective at helping people quit smoking in the short term. Two large-scale Cochrane reviews evaluated the short-term and longer-term efficacy of text messaging-based smoking cessation interventions (see Bock et al., 2013, 2015) and concluded that, although there is heterogeneity among

study results, overall there is a benefit of mobile phone-based smoking cessation interventions and these also result in lower levels of nicotine withdrawal symptoms.

Cole-Lewis and Kershaw's (2010) review of text-messaging interventions for disease prevention and management found evidence of the short-term positive effect of these interventions. Text messaging interventions were also reported to exhibit good acceptance and short-term efficacy in Wei et al's review on text messaging for clinical and health behavior intervention. Due to the limited number of studies with long-term follow-up, a common view is that more evidence is needed regarding long-term outcomes.

Broom et al (2015) reported that supportive text messages were an effective way of supporting low-income mothers of racial and ethnic minority backgrounds with postpartum depression and an effective way of making contact with a group that had an extreme need at relatively low-cost.

Nundy et al (2013) found a message-based program for diabetes reduced denial of diabetes and reinforced the importance of self-management. Participants perceived the automated program as a "friend" and "support group" that monitored and supported their self-management behaviors.

Text characteristics associated with intervention effectiveness

As a methodology, the use of text messaging in health interventions is far from homogenous; in fact there is wide variation in the content and timing of texts delivered. Therefore it is important to ascertain which combination of elements are most likely to be associated with intervention effectiveness in order to gain full understanding of text message features that contribute to positive outcomes.

In a review of text-messaging interventions, Fjeldsoe, Marshall and Miller (2009) found intervention initiation (researcher or participant), text dialogue initiation, tailoring of text content and interactivity to be important features of interventions.

In a larger and more recent meta-analysis De Leon and colleagues (2015) et al identified the most important characteristics to be:

- Strategies rather than educational content
- Tailoring of messages
- Feedback and support
- High frequency rather than low frequency

These characteristics are explored in further detail below.

- Strategies not education
Most interventions reported delivering educational content, reminders or both. However this type of content was not closely associated with effectiveness in the absence of strategies for behaviour change. In fact "interventions including feedback and prompts that included strategies were more likely to report significantly positive outcomes" (De Leon et al). The over-preponderance of educational health messages may be due to health professionals rather than behaviour change experts providing the content for the text intervention, although some interventions involved the end-user in the development of the text content. Of the 13 studies that reported non-significant results 4 provided health education only, whereas of the 42 that reported significant results only 5 provided education only.

- Tailoring of messages
In the meta-analysis conducted by De Leon et al tailoring featured in 34 of the 55 studies. This ranged from using the participant's name to tailoring by stage of change (as per the transtheoretical model) or by patient's baseline activity.

Participants reported a preference for tailored messages, seeing them as more meaningful and/or helpful. User feedback on an mHealth intervention to prevent cardiovascular events highlighted the importance of relevant messaging, for example not sending messages about meat to vegetarians, and the need for text messages suitable for diverse cultures and in different languages. (Redfern et al 2014). A text messaging support system for young people with diabetes, 'Sweet Talk', included messages based on patient profiles and diabetes self-management goals. The authors conclude that, "*Such personalisation appears fundamental to behavioural support interventions*" (Franklin et al, 2008) while Bock et al argue for a participatory framework, involving the end-user in creation of the messages.

'To have an impact on health and health behaviors, interventions must be perceived by individual users as both useful and desirable. These applications must be something that an individual would want to use.' (Bock et al 2015).

- Feedback and support
Feedback was also identified as a factor contributing to the success of interventions. Studies with significant results tended to provide participants with feedback regarding progress in making a given health behavior change. Interventions with prompts delivered less frequently, e.g. on a monthly basis, did better if they included feedback. The form of feedback varied considerably across studies, from a message to request a follow-up phone call (Matthew et al 2015), to medically-related questions (Franklin et al, 2008), to elicit support for cravings (Bock et al 2015) or social support (Uhrig et al, 2012). Bock et al's participants also indicated that social networking functions and the ability to connect with others on the programme were important for them.
- High frequency
In the 55 studies included in the De Leon et al review, message frequency included multiple prompts per day, daily, several times a week, weekly, monthly, bi-monthly, and even yearly. Some interventions varied the frequency depending on progress through the intervention, particularly in smoking cessation interventions where frequency of messages tended to be higher around the quit date. Participants in the Bock et al (2015) intervention expressed a preference for varying the time of messages. Orr and King's (2015) meta-analysis of random controlled trials of message interventions found that text frequency mediated intervention effectiveness, with multiple messages per day showing a significantly greater effect ($g = 0.395$) than that of lower doses ($g = 0.244$).

Theoretical models informing mHealth interventions

While some mHealth intervention studies are atheoretical, others draw on a range of theoretical models for behavior change to inform the content of prompts and/or to tailor prompts for individuals. The transtheoretical model (TTM), was the most popular foundation for the interventions identified in De Leon's review. Other theoretical models employed include social cognitive theory (SCT), the theory of planned behavior (TPB), the health belief model (HBM), self-determination theory (SDT), precaution adoption model (PAM), goal setting theories, the elaboration likelihood model, and behavioral self-regulation. Some studies chose several different models and/or theories to draw upon. For example, de Vries developed the I-change model, which integrates TPB, SCT, HBM, TTM, PAM, and goal-setting.

Attrition

De Leon et al note that typical attrition for the interventions reviewed was difficult to assess due to the automated nature of many of the prompts. Participants who had not formally withdrawn from studies may have stopped acknowledging the messages sent. Eysenbach (2005) notes that in any eHealth trial a substantial proportion of users drop out before completion or stop using the application. In contrast to drug trials, he argues, high dropout rates may be a natural and typical feature of many eHealth trials but not necessarily indicate that the intervention was unsuccessful. What distinguishes eHealth studies from other clinical or drug trials is that two different processes occur. One is the phenomenon of losing participants to follow-up (e.g., participants do not fill in follow-up questionnaires), referred to as *dropout attrition*, and the other concerns nonusage, or *nonusage attrition*. Although they may be closely related, high loss-to-follow-up rates do not necessarily indicate that participants have lost interest in the application and stopped using it. It may also be possible to have a low loss-to-follow-up rate, and still have participants not using (or infrequently using) the intervention. Researchers conducting studies using mHealth to deliver interventions should, therefore, pay close attention to dropout rates and make efforts to distinguish between these processes.

How Do Something Different meets the challenge of mHealth

Do Something Different is a digital behaviour change platform that delivers mHealth interventions, while meeting the criteria for effectiveness identified by the scientific literature. Designed in the UK by psychologists, Professor Ben (C) Fletcher and Professor Karen Pine of the University of Hertfordshire, the system has global reach and now operates in 63 countries. A Do Something Different programme starts by profiling individuals online. It then generates a bespoke programme to change the person's behaviour, delivered mainly by SMS text but also by email if desired.

Do Something Different is based on the scientific principle that most people's everyday behaviours are automatic, driven by habit and context, rather than by rational decisions, and that behaviour is easier to change when habits are disrupted. In attempting to understand and resolve the barriers that prevent people changing, Do Something Different takes account of the limitations of the human mind revealed by behavioural science. This has given rise to a methodology that can influence people's automatic choices and break habits to produce a range of beneficial outcomes, both for the individual and for society in general. Do Something Different programmes address a wide a range of topics, including stress, diabetes management, happiness, smoking cessation, weight management and work life balance.

Do Something Different has incorporated the characteristics associated with mHealth effectiveness in the following ways:

Tailoring of messages

Every participant is profiled before starting a Do Something Different programme. The system then sends them intermittent behavioural prompts specifically designed to address their own health goal and lifestyle habits.

Strategies rather than educational content

Each prompt, or Do, is activity-based. It focuses on the person 'doing' rather than 'knowing', the aim being to bring about actual behaviour change rather than simply offering information. These are positive actions, small steps towards a bigger goal and designed to be fun and motivating.

High frequency rather than low frequency

Prompts are sent regularly, usually several times per week over a number of weeks. A typical programme lasts for 6 weeks during which time the individual receives around 3 – 4 Do's per week.

Feedback and support

Participants on a Do Something Different programme gain access the Do Zone: an online community where they can see their programme, share what they are doing, get inspiration and support.

In addition Do Something Different programmes are:

Measurable

All participants are measured at baseline and a sub-sample are remeasured after a Do Something Different programme. This provides benchmarking as well as quantitative indicators of change and improvement. The online Do Zone community also yields qualitative data through the visible records of the changes people are sharing.

Applying Behavioural Sciences to mHealth

The EAST publication from the UK Behavioural Insights Team has specified a number of recommendations (below) for behaviour change. There are now many initiatives that apply some of these principles, and Do Something Different is a digital platform and a methodology that incorporates all of them.

1.Reduce the ‘hassle factor’ of taking up a service.

Do Something Different: Sign up via mobile device

2.Simplify messages.

Do Something Different: Texts are no longer than 153 characters.

3. Attract attention.

Do Something Different: Text alerts deliver engaging behavioural prompts

4. Show that most people perform the desired behaviour/ Use the power of networks.

Do Something Different: The Do Zone community features others also doing things differently

5.Harness the power of defaults

Do Something Different: Default settings e.g. receive text and email, public sharing

6.Encourage people to make a commitment to others.

Do Something Different: Default setting in Do Zone is ‘public sharing’

7.Prompt people when they are likely to be most receptive.

Do Something Different: Texts arrive at different times and disrupt habits

8.Help people plan their response to events.

Do Something Different: Texts give strategies for different responses

This award-winning system (recipient of a Royal Society for Public Health Award in 2015 and a Google Award for technology in 2013) has been adopted by a number of Public Health authorities and Clinical Commissioning Groups across the UK. It yields smoking cessation rates in excess of those achieved by the NHS, without the need for any face-to-face consultation. As well as targeted changes (e.g. weight loss, smoking cessation, increased happiness) the data demonstrate a cross-programme significant impact on the anxiety and depression levels of people engaging in a Do Something Different programme.

The challenge now is to continue to rigorously evaluate the elements of mHealth that create positive behavioural outcomes in order to provide low-cost health solutions to people everywhere.

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