REVIEW PAPER

What makes a mobile app successful in supporting health behaviour change?

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Abstract

Introduction: Health promotion apps designed to support and reinforce health behaviours or to reduce risk behaviours are the most commonly downloaded apps. Such technologies have the potential to reach and deliver health care to new populations. But the extent to which they are successful in enabling the adoption of new and desired behaviours can vary. Some apps are more effective than others; some are free to download while others require a nominal or substantial charge. Cost alone is not indicative of quality or effectiveness. This is important because the use of health apps by the public is only going to increase, as is the expectation that health care professionals understand this technology and its heuristic role in personalised health. Practitioners therefore need to be better informed regarding what makes a health app appealing to service users and successful as an intervention to facilitate behaviour change.

Objective: This paper describes and discusses how the structure and content of health care apps can facilitate or inhibit behavioural change. The aim is to support practitioners in the screening and identification of suitable apps for clinical use.

Method: Theory and literature review.

Conclusion: App content that involved clinician input at the design stage and include internal drivers such as motivation, self-efficacy and illness understanding and external drivers such as illness information, social networking and user compatibility tend to do better in facilitating behaviour change than those that do not. Of these factors motivation is considered to be the most important.

Introduction

Long term health conditions are thought, in part, to be caused, maintained and exacerbated by behavioural factors (Rosser et al., 2009; Klien, 2014). It therefore stands to reason that behaviour change is often seen by clinicians as a reasonable target for interventions (Rosser et al., 2009). Interventions to change behaviour often involve skilled health care professionals working in carefully managed clinical environments (Rosser et al., 2009). This can be expensive and pose a barrier to the adoption of new behaviours because the behaviour is learnt in isolation, in non-habitual settings and out of context to the problems experienced by the patient (Rosser et al., 2009). There is evidence to suggest that clinicians are now considering new approaches and technologies such as mobile apps for health conditions to engage service users in treatments and interventions in order to facilitate behaviour change (Chomutare et al., 2011; Buhi et al., 2013; Nundy et al., 2014; Direito et al., 2014; Yang et al., 2015).

For the purpose of this paper, mobile apps are defined as technology that can be downloaded and used on devices such as smartphones, personal digital assistants (PDAs), tablets and other wireless devices for the application of behavioural and psychological interventions (Elias et al., 2014). Behaviour change is defined as a set of interventions and strategies designed to change specified behaviour patterns (Michie et al., 2011). Behaviour change interventions are observable and replicable activities that directly bring about behaviour change (Curtis et al., 2015).

There is currently a proliferation of mobile app technology (Luxton et al., 2011; Clarke and Yarborough, 2013; Harrison and Goozee, 2014; Olf ,2015). The past 20 years have seen a significant growth in the use of technology in everyday health care settings with a corresponding increase in data security and service efficiency (Ziefle et al.,2013). Recent trends have also seen innovation in the use of technology to support treatment interventions (Ziefle et al.,2013). Health promotion apps designed to support and reinforce health behaviours or to reduce risk behaviours are among the most commonly downloaded apps (Curtis et al., 2015). Such technologies have the potential to reach and deliver health care to new populations (Mohr et al., 2013) and health professionals are increasingly using them to support their clinical work (Dennison et al.,2013; Olff, 2015). Healthcare apps have advantages over traditional treatment approaches by making the interventions readily, remotely, persistently and personally assessable to the user (Rosser and Eccleston, 2011; Direito et al., 2014). They offer a novel and effective way for clinicians to engage service users in the

promotion and adoption of new behaviours (Chomutare et al., 2011; Lyzwinski, 2014; Buhi et al., 2013; Middelweerd et al., 2014; Yang et al., 2015).

For example, the eMoods Bipolar Tracker app for iphones and Blackberry (Luxton et al., 2011) facilitates the user's tracking of their daily mood fluctuations, sleep and other symptoms commonly associated with the Bipolar disorders. The user can also email a monthly report to their key worker to support collaborative working and treatment planning. The Concussion Recognition & Response app by (PAR Inc), helps coaches and parents recognise signs and symptoms of a concussion (Walkinshaw, 2011). It helps support the decision making process of parents and coaches so as to respond quickly to a potential incident on the sporting field. It also allows the recording and tracking of pertinent information for future use with health care professionals, post injury in follow up and education sessions.

These apps have key features such as education, personalisation and networking that are considered significant for app adoption, sustain use and the facilitation of behaviour change. Other key features including quality, acceptability of use, the place of theory in informing development, the ensuring of privacy and of data protection are also considered important, and are discussed below.

Quality

Health care apps are now commonly downloaded by the general public (Luxton et al., 2011; Denison et al., 2013; Sagar and Pattanayak, 2015), but the extent to which they are successful in enabling the adoption of new and desired behaviours can vary (West et al.,2012; Middelweerd et al., 2014). Some apps are more effective than others, some are free to download while others require a nominal or substantial charge. Cost alone is not indicative of quality or effectiveness. As mobile device use becomes ubiquitous, practitioners will need to be better informed regarding the design and content of mobile health apps so they can assess for themselves their value and worth for clinical practice (Lewis and Wyatt, 2014). Currently, there is limited evidence and guidance to support these decisions (Mohr et al., 2013). Authorities such as the US Food and Drug Administration and the UK Medicines and Healthcare Products Authority are now starting to regulate health apps (Marley and Farooq, 2015). Stoyanov et al. (2015) have developed a Mobile Apps Rating Scale (MARS) that rates apps according to their engagement, functionality, aesthetics, information quality and subjective quality (Baumel and Muench, 2016). Other authors have recommended the development of risk assessment frameworks to support practitioners (Lewis and

Wyatt, 2014). However, most of these endeavors are focused on product evaluation and provide little support to help the practitioner wishing to evaluate an app's effectiveness within the context of a clinical intervention (Baumel and Muench, 2016). In the absence of such support, clinicians need to be judicious when recommending health care app use to service users, not least because of safety and confidentiality concerns (Lewis and Wyatt, 2014).

Acceptability of use

Despite the proliferation and potential of mobile app technology, the uptake of such technology remains variable and dependant on key factors that relate to feasibility, acceptability and ease of use (Ziefle et al., 2013). For a health care app to be successfully adopted and regularly used by service users and staff, it has to be accepted as something that has value and relevance to their needs. The app also has to be feasible, which means it can be used by an individual as part of their daily routine or in relation to a particular activity or behaviour they wish to do or change. Acceptability and feasibility can take many different forms and mean different things to different to users and providers but authors have identified some common barriers and hurdles to uptake, sustained app use and the successful achievement of behaviour change (West et al., 2012; Abroms et al., 2011; Marley and Farooq, 2015; Sagar and Pattanayak, 2015; Lyzwinski, 2014; Middelweerd et al., 2014; Wang et al., 2014; Baumel and Muench, 2016).

Ziefle et al. (2013) found age, gender, technological upbringing, expertise, culture, usage context and the attitudes of health care professionals to be important determinants of uptake. They found patients, as experts in their condition, were more likely to accept and use heath technology than those who do not have the condition (Ziefle et al., 2013). But home usage and body proximity were negative determinants (Ziefle et al., 2013). Health care professionals however were less accepting of technology and expressed concerns regarding quality of care, technical competence of user and security issues (Ziefle et al., 2013). Health care professional therefore need to be mindful of user demographics, technology proficiency and context of use when considering and managing mobile app use. Mobile apps that have had input from medical professionals at the design stage are more likely to have considered and potentially alleviated practitioners concerns regarding use and therefore have better feasibility and acceptability by professionals (Ziefle et al., 2013).

Baumel and Muench (2016) Identified four heuristics (strategies derived from experience) to understand the therapeutic potential of electronic health interventions. They were (1). Ease of use,

(2). Compatibility within the clinical setting, (3). Content of tools that make it easier for the service user to engage in the app's therapeutic activities and (4). The possibility of therapeutic growth (Baumel and Muench, 2016). Marley and Farooq (2015) identified the challenges medical apps, psychosocial intervention apps and patient orientated self-management apps pose for the delivery of therapeutic care. They recognised poor regulation, privacy and security concerns, a lack of expert involvement at the design stage and absent evidence and theoretical base to support interventions to be key reasons for poor uptake and sustained use. Sagar and Pattanayak (2015) identified poor involvement of health care professionals at the design stage, absent government regulation, a lack of user acceptability and concerns regarding the confidentiality of the product. Shackel (2009) suggested acceptability can best be divided into the three areas of: (1) utility (the system does what it is supposed to do), (2) usability (the user can successfully work the system) and (3) likeability (the user feels the system is usable).

Closely likened and a determinant of feasibility and acceptability is ease of use. Holzinger (2016) defines ease of use as the perceived usability and the perceived usefulness of the technology by the user. These two aspects help determine the behavioural intention of the user to use the technology (Holzinger, 2016). Practitioners therefore need to ensure users understand the purpose, role and application of app content as it relates to their own condition. Practical training sessions that include education at the initial stage of uptake as well as ongoing follow up can help with this process and ensure sustain uptake.

Role of theory in informing development and use

Apps that include behaviour change theory and apply a range of behaviour change strategies such as CBT, goal setting and real time feedback have been found to be the most effective in securing behaviour change in its users (Abroms et al., 2011; Rosser and Eccleston, 2011; Direito et al., 2014; Klein et al., 2014; Lyzwinski, 2014; Middelweerd et al., 2014; Wang et al., 2014). Webb et al.'s (2010) systematic review of the use of theory in the promotion of behaviour change by internet based interventions found those that incorporated more behaviour change techniques did better than those that had fewer techniques. Many apps designed for the purpose of affecting behaviour change however do not possess the theory and evidence based content required to do so (Pagoto et al., 2013; Direito et al., 2014; Shantanu et al., 2014) often because they have been developed without significant input from health professionals or academics (Dennison et al., 2013, Lewis and Wyatt, 2014; Sagar and Pattanayak, 2015). This can result in limited user and operational use,

inflexible and irrelevant content and poor customisation capacity (Luxton et al., 2011; Marley and Farooq, 2015). Collectively these issues can inhibit uptake due to a reduced customer experience and failure of product to achieve personalisation and individualisation of content to need (Luxton, 2011; Marley & Farooq, 2015).

The use of behaviour change theory alone is not sufficient and practitioners need to also consider how the app is used to engage the user and to facilitate change. West et al. (2012) used the Precede-Proceed Model (PPM), (Green and Kreuter, 1991) to categorise the behaviour change content of paid health and fitness apps. The PPM has it is roots in public health and health promotion and *is used to* assess health needs and to plan health interventions *(*Mirtz et al. 2005). West et al. (2012) identified (1) predisposing factors - the dissemination of generic health information; (2) enabling factors - the collecting of personal data and health behaviour information, and (3) reinforcing factors - the facilitation, development and maintenance of social networks as key behaviour change content areas that promote and facilitation behaviour change. Other authors have found apps focused on personal enabling factors such as recording behaviour and tailoring feedback to be the most successful in effecting behaviour change because they create an authentic, individual and live experience (Chomutare et al., 2011; West, 2012; Middelweerd et al., 2014; Wang et al., 2014). Apps focusing solely or wholly on predisposing factors are the least successful (Rosser and Eccleston, 2011; Wang et al., 2014). Few apps currently include reinforcing factors such as social networking, but these were considered important for long-term uptake of behaviour change (Abroms et al., 2011; Chomutare et al., 2011; West et al., 2012; Wang et al., 2014). Apps with a higher purchasing price are more likely to be perceived by users as credible and trustworthy and these apps also tend to be more sophisticated in their design and to include a theoretical basis, but are less likely to be uploaded because of cost (Abroms et al., 2011, Middelweerd et al., 2014).

The Health Belief Model (Hochbaum et al.'s, 1952) hypothesises that in order to change one's behaviour there needs to be present three simultaneous factors: sufficient motivation for change, the belief that one is susceptible to a particular health problem or threat, and the belief that this threat can be mitigated by following a particular health recommendation (Janz and Becker, 1984). App content therefore needs to include content that promotes a personal connection between the user, the health issue and the intervention so as to facilitate motivation to engage in the behaviour change activities.

Heider's (1958) Attribution Theory (a theory of social perception) explains behaviour change in terms of how the individual understands the causes of the behaviours and events they experience (Crandall et al., 2007). Attributions are made via internal acknowledgments of one's own person attitude, character and personality and the identification of external influences such as other people, the environment and society (Crandall et al., 2007). According to this theory, for a health care app to facilitate change it needs to connect with the user and create within them recognition that the problems they experience or needs they have are related and caused by certain events, behaviours and activities. Change therefore takes place through the adoption or inhibition of these events, behaviours or activities. Once new behaviours have been adopted social networking features within the app can becomes important reinforces and maintainers of the new behaviour.

Social Cognitive Theory also known as the Social Learning Theory (Bandura, 1977) introduced the concept of self-efficacy. Self-efficacy describes the confidence one has to act with positive outcomes and is a significant predictor of behaviour (Holloway and Watson, 2002; Klien et al., 2014). Behaviour is not only learned via direct experience but also via modelling, the vicarious observation of self and others (Bandura, 1977). Self-efficacy and task performance have been found to increase when modelling is included in a treatment regime (Bandura, 1977) and the stronger an individual's self-efficacy, the greater their motivation and effort there is to engage in an activity or treatment (Holloway and Watson, 2002). The inclusion of app contents that measures and compares task performance with the user's baseline and aspirational goals and with the wider population and or comparative social group is important for motivating and maintaining engagement.

The Transtheoretical Model (TM), (Prochaska and DiClemente, 1984), views behaviour change as a dynamic process involving five stages or process of change: (1) precontemplation - not intending to make any changes; (2) contemplation - considering a change; (3) preparation - making small changes; (4) action - actively engaging in a new behaviour and (5) maintenance - sustaining change over time (Prochaska et al., 1992; Klein et al., 2014). An awareness of how and why an individual considers and adopts change is therefore important. App content that assumes a user's level of change may therefore fail to engage them in the desired behaviour or intervention because they may not be ready for that level of therapeutic activity.

Privacy and data protection

The collection of data, the personalisation of data and the use of that data in social networking to reinforce desired behaviours are key characteristics of successful health app. Security issues relating to the content, holding and distribution of that data however remain a prime concern of users and health care professionals (Marley and Farooq, 2015; Malle et al., 2016). Data protection regulations also known as 'The right to be forgotten' means customers can have their data deleted on request (Malle et al., 2016). Such a request could significantly reduce the feasibility and usefulness of a health app as an intervention; rendering its content useless as a social and personally meaningful tool for change. Mental health app data infrastructure must therefore be constructed in such a way so as to reduce the risk of data becoming identifiable with the user and or necessitating a user request for deletion (Malle et al., 2016). The aim is to reduce the identifiable content of a data piece from the specific to the general (Malle et al., 2016). Personal identifiers (e.g. age, name, address), sensitive identifiers (e.g. condition, income, drug use) and quasi identifiers (e.g. post code, gender, date of birth) should be anonymised and generalised whenever possible. For example using only the first half of a post code e.g. SE 15 instead of SE 15 9 QS.

Professional involvement

The growth of technology use in health care has predominantly involved large data sets without requiring human involvement (Hozinger, 2016). However, when considering health interventions, data sets are often small, involving rare events for which there are little or no training samples and therefore require some form of human involvement, expertise or problem solving (Hozinger, 2016). Many apps also include the involvement of therapists either as live or delayed participants, ranging from distance monitoring to personal face to face or telephone contact, but the more sophisticated technologies include a combination of automated self-help and direct therapist involvement (Rosser et al., 2009). Aguilera and Muench (2012) identified text messaging, passive sensing, diaries, videos, voice activation and feedforward modelling as an increasingly common feature of health care apps. There has been some resistance to this level of therapist involvement, but in general authors have found users and therapists who have worked with such content to have had a positive experience (Postel de Haan and De Jong, 2008). It is therefore possible that that any future developments in health care apps will include some form of therapist input. This is important because social networking content has been found to be a significant motivator for behaviour change (Abroms et al., 2011; Chomutare et al., 2011; West et al., 2012; Wang et al., 2014).

Conclusion

Factors that influence health behaviour change can therefore be broadly divided into two main drivers: internal drivers such as motivation, self-efficacy, illness understanding and attributions about self and the world, and external drivers such as available illness information, the beliefs of peers, family, friends and the role of social support networks. The inclusion of these drivers in the operational content of mental health apps is recommended by authors and designers and apps that have such drivers tend to do better in facilitating behaviour change than those that do not (Abroms et al., 2011; Chomutare et al., 2011; West et al., 2012; Klein et al., 2014; Middelweerd et al., 2014; Wang et al., 2014; Direito et al., 2014; Lyzwinski, 2014; Middelweerd et al., 2014).

Not all health apps are the same. A strong determinant to the acquisition of a health care app is cost (Abroms et al., 2011, Middelweerd, 2014), but cost alone is not a sufficient indicator of quality or clinical suitability. The design, content, evidence base and relevance to user need is also important. Of the behaviour change drivers identified and discussed above, motivation is suggested by authors to be the most important target for any intervention (Rosser et al., 2009). But all of these factors overlap and relate to each other. User compatibility and acceptability of an app is only possible if the app has had significant service user and professional input, especially at the design stage. Without the inclusion of a strong evidence base and behaviour change theory an app will struggle to facilitate user engagement and therefore be unable to promote therapeutic progress. Without ease of use, accessible and relevant functions and clear security features a user will not pick up and download an app and a provider won't promote it within their clinical work. How an app is designed and how it engages the user in the activity or identified need are important considerations when considering the use of a mental health app in a clinical setting.

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