

Persuasive technology and behaviour change in parent-focused eHealth interventions supporting child health: A scoping review protocol

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ABSTRACT

eHealth interventions are widely used to support parents in managing children's health behaviours and could be beneficial in supporting physiotherapy home programmes for children with cerebral palsy. The use of technology in health crosses several disciplines, and a conceptual analysis of techniques and models used by these different disciplines could better inform eHealth intervention design. This paper describes a scoping review protocol of parent-focused eHealth interventions using a novel approach to synthesise models from both the health and psychosocial sciences (behaviour change); and computer sciences (persuasive technology behaviour design), specifically the COM-B model and Fogg Behavior Model, respectively. In addition, this paper draws on the broader literature that addresses children with special healthcare needs due to a paucity of research specific to parent-focused eHealth interventions for children with cerebral palsy. The scoping review will follow Arksey and O'Malley's (2005) five-step framework for conducting scoping reviews. This protocol details the search strategy, inclusion and exclusion criteria, data extraction, data mapping, and data synthesis. Results will be disseminated through publication and conferences supporting a rehabilitation and eHealth focus.

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INTRODUCTION

The use of eHealth to promote health behaviours in disability reportedly lags behind the tremendous growth for the use of eHealth in the general population (Jones, Morris, & DeRuyter, 2018). eHealth refers to the use of information and communication technologies for health (World Health Organisation, 2018). It has been used in rehabilitation to increase access to therapy for patients who live in geographically isolated areas, increase the intensity of home therapy programmes and improve follow-up and communication with patients (Peretti, Amenta, Tayebati, Nittari, & Mahdi, 2017). Physiotherapists are uniquely positioned to proactively promote and develop this area of health care.

For physiotherapists interested in using eHealth in paediatric rehabilitation, the promise of easy, cost-effective access to health-related interventions makes eHealth an attractive option for delivering services to children in their own homes (Cooper

et al., 2001). Parent participation in their children's home programmes is integral to traditional paediatric rehabilitation (Novak & Cusick, 2006; Paterson, Piggot, & Hocking, 2002) and considering the significant influence parents have on their children's health and development (Hall & Bierman, 2015), targeting parents with eHealth may be an effective approach.

Many parent-focused eHealth interventions are currently available, addressing a wide range of chronic health and disability issues experienced by children, from cancer and diabetes to autism and traumatic brain injuries (Greffin & Barros, 2017). In light of this, a scoping review was identified as an appropriate way to inform the design of a future parent-focused eHealth intervention intended to support standing programmes and standing activities for children with cerebral palsy at home. However, there is a paucity of literature specific to parent-focused eHealth in cerebral palsy, and therefore this scoping review addresses the broader topic of childhood chronic

health and disability, where technology is being used to support parents in managing their children's health behaviour.

The literature concerning technology in health crosses several disciplines from computer sciences to health and psychosocial sciences, with each focusing on their respective area of expertise. This has been noted to create a disconnect in assessing and researching the effective components of eHealth interventions (Kelders, Oinas-Kukkonen, Oörni, & van Gemert-Pijnen, 2016), with concepts developing in parallel. As an example, eHealth interventions with a focus on behaviour change may be referred to as digital behaviour change interventions in health sciences (Perski, Blandford, West, & Michie, 2017), and health behaviour change support systems in computer sciences (Kelders et al., 2016). To address the disconnect, this scoping review will draw together perspectives from these two main fields, referred to as "behaviour change" in health disciplines and "persuasive technology" (or more recently, "behaviour design" (Fogg, 2018)) in the discipline of computer science. This scoping review protocol will introduce the terminology and approaches of each discipline, and then describe a synthesised framework to map the fragmented research to advance our understanding of eHealth interventions targeting parents to improve the health of children with special healthcare needs.

The publication of this scoping review protocol aims to contribute to the theoretical knowledge and awareness of physiotherapists around the use of eHealth in supporting parents of children living with special healthcare needs. It also aims to solicit feedback from the physiotherapy community as to the applicability of the synthesised framework in assessing or designing eHealth for rehabilitation; and as with the publication of any protocol, is valuable in preventing duplication of research efforts and facilitating peer-review of the methodology (Moher et al., 2015; Peters et al., 2015).

Behaviour change in health and psychosocial sciences

Health behaviours are an important determinant of health outcomes in all populations (Conner, 2015). Theory driven constructs of behaviour change facilitate the design of interventions targeting health behaviours (Webb, Joseph, Yardley, & Michie, 2010). However, there are more than 80 different behaviour change theories (Davis, Campbell, Hildon, Hobbs, & Michie, 2015), presenting a challenge for determining which theory to use, when and for whom. The behaviour change technique taxonomy (BCTTv1), developed and validated by Michie, Johnston, Francis, Hardeman, and Eccles (2008), provides a means to address this challenge because it provides a systematic approach to intervention design and analysis without the need to determine which theories underpin an intervention.

Behaviour change techniques (BCTs) are described as the smallest feature of a behaviour change theory, an active ingredient that under the right circumstances can potentially bring about a change in behaviour (BCT Taxonomy v1, 2019). The BCTTv1 is a taxonomy of 93 distinct BCTs that can be applied reliably across behaviours, disciplines and areas of interest. The BCTTv1 can be used to define the active ingredients (e.g. goal setting) that link to principles of

behavioural determinants (e.g. goals and planning) and has been used to explore or plan interventions that are intended to improve health by influencing health behaviour (BCT Taxonomy v1, 2019).

Several studies have used BCTs to categorise and understand the impact of parental support behaviour in interventions addressing child health, with improved intervention effectiveness evident when a higher number of BCTs were used, and when these were spread across behaviour change processes (Golley, Hendrie, Slater, & Corsini, 2011; Hendrie et al., 2012; Morgan, Schoonees, Faure, & Seguin, 2017; Van Der Kruk, Kortekaas, Lucas, & Jager-Wittenaar, 2013). Unsurprisingly, parental support behaviours are consistently correlated with a child's health outcomes (Gustafson & Rhods, 2006; Pyper, Harrington, & Manson, 2016; Rhodes et al., 2016). Parents play a particularly significant role in the health and function of their children living with physical disabilities such as cerebral palsy. Improvements in motor ability and other skills have been noted when interventions target parent's knowledge, skills and efficacy following a family-centred approach (Antle, Mills, Steele, Kalnins, & Rossen, 2008; Morgan, Novak, & Badawi, 2013; Saquetto et al., 2018). As with any behaviour change, parental support behaviour requires the identification of the BCTs that are effective in closing the gap between the parent's intention to improve their child's health behaviour and their action to change that behaviour.

There are an increasing number of interventions using technology to deliver BCTs (Michie, Abraham, et al., 2011; Webb et al., 2010), providing an exciting opportunity to increase the reach and effectiveness of programmes. The term "digital behaviour change interventions" has been recently used in behaviour change fields to define a product or service that "uses computer technology to promote behaviour change which can, for example, be delivered through computer programs, websites, mobile phones, smartphone applications (apps) or wearable devices" (Perski et al., 2017). The emphasis in digital behaviour change interventions is on behaviour change principles and how technology is used to support their delivery, with less concern for the more discrete design elements of the technology, such as how the platform being used conveys credibility or facilitates interaction. The impact of mode of delivery on behaviour change interventions has been recognised as significant (Michie et al., 2013), and exploring the influence of technology on behaviour from the perspective of persuasive technology is warranted.

Health behaviour change support systems and persuasive technology

Within the computer sciences, there is a growing field of research into the features and functionalities of services, applications and platforms that use internet technology to affect behaviour. This concept is encapsulated by the term "Behaviour Change Support Systems" (BCSSs), defined as "a socio-technical information system with psychological and behavioural outcomes designed to form, alter or reinforce attitudes, behaviours or an act of complying without using coercion or deception" (Kelders et al., 2016, p.3).

The emphasis is on the change occurring through building on the person's motivation or goals, and the creation of a positive user experience that motivates people to engage with the technology regularly and over an extended period of time (Oinas-Kukkonen, 2013). When the target of the behaviour change is health related, health is added as a prefix, with Health Behaviour Change Support Systems being used to encapsulate the BCSSs concept within the disciplines of health and rehabilitation (Kelders et al., 2016).

Distinct from digital behaviour change interventions, the central feature of Health Behaviour Change Support Systems is persuasive technology, a concept defined in Fogg's seminal book by the same name (Fogg, 2003). Persuasion is defined as an attempt to change attitudes or behaviours (or both), and implies voluntary change where the intention of the "persuader" is transparent. This is in contrast to deception, coercion or manipulation. With deception, people are tricked into taking certain actions without their prior consent or knowledge. Coercion occurs when change is achieved through force or threat (the direct opposite of voluntary change) (Fogg, 2003), and manipulation is defined as the act of controlling someone to your own advantage, often unfairly or dishonestly (Manipulation, 2016), which is neither transparent nor voluntary. eHealth is the transparent use of technology, used voluntarily by a person to positively influence their own behaviours, and therefore by definition, is a form of persuasive technology (Oinas-Kukkonen, Win, & Chatterjee, 2016). Persuasion occurs through technology's inherent capacity to share information, individualise interventions and create bonding relationships with the end user. These built-in qualities have been reported to be inconsistently utilised by developers of eHealth interventions, which is possibly why intended positive outcomes on health are often not realised (van Gemert-Pijnen et al., 2011).

The persuasive system design (PSD) model (Oinas-Kukkonen & Harjumaa, 2008), based on the original work by Fogg (2003), is a systematic way of designing and assessing persuasive technology. A growing number of studies are using this model in eHealth interventions to assess how persuasive technologies are being used and understand how they influence health outcomes more consistently (Kelders, Kok, Ossebaard, & van Gemert-Pijnen, 2012; Kelders et al., 2016; Lentferink et al., 2017; van Gemert-Pijnen et al., 2011; Wildeboer, Kelders, & van Gemert-Pijnen, 2016). The PSD model is specifically concerned with human-computer interaction, which refers to the inherent features of technology to influence the user's behaviour, rather than the features of technology which facilitate human-to-human interaction. The PSD model summarises the persuasive technology principles defined by Fogg (2003) into 28 elements and four design principles: primary task support, dialogue support, system credibility and social support. Similar to the BCTTv1, which links behavioural techniques to behavioural determinants, the PSD model links technology design elements (e.g. verifiability) to technology design principles (e.g. system credibility). The PSD model was recently expanded to include additional coaching elements that can be delivered via technology, namely goal setting, educational coaching, feedback and social support. To reflect these additions, "persuasive

eCoaching" was suggested as a new term to represent the additional elements (Lentferink et al., 2017). The term "persuasive eCoaching" will be used in describing the findings of the scoping review to reflect the 28 PSD elements and the additional four coaching elements.

A synthesised framework for eHealth intervention design

Both the PSD model and BCTTv1 have been used by different authors to assess technology-based interventions. Some authors have recognised their complementarity and merged them, for example, choosing several BCTs to add to the PSD model or vice versa (Geuens et al., 2016; Klaassen et al., 2018; Lehto & Oinas-Kukkonen, 2011). However, adopting aspects of one concept to condense and merge with another may not fully appreciate the functionality of each, and potentially, effective behaviour change techniques or persuasive system design elements may be missed. BCTTv1 is specifically concerned with categorising the content of behaviour change interventions, whilst the PSD model is concerned with categorising how technology is delivering the persuasive elements. Differentiating the content from the mode of delivery is important when analysing and designing behaviour change interventions (Dombrowski, O'Carroll, & Williams, 2016; Michie, Atkins, & West, 2014; Michie et al., 2013; Webb et al., 2010). Synthesising both BCTTv1 and the PSD model by including all their active ingredients may, therefore, support a more thorough consideration of an eHealth intervention than merging and condensing them.

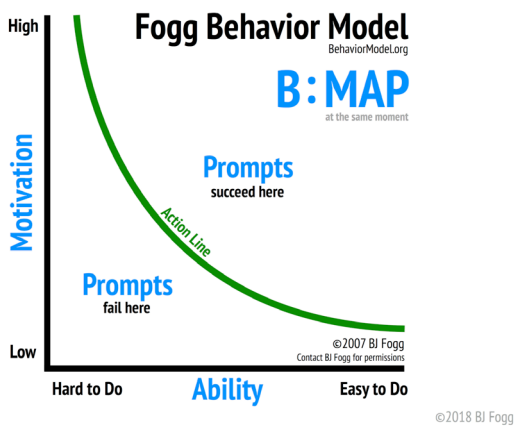
Models of behaviour change and behaviour design

The ability to identify techniques and elements is useful for categorising the active ingredients in an intervention but does not explain how behaviour can be influenced or triggered.

Fogg argues that without a systematic understanding of the technology mechanisms of influence on behaviour, designers of persuasive technology are "guessing at a solution (or imitating techniques that work without understanding why those techniques work)" (Fogg, 2009, p. 1). Technology is not only a vehicle for delivering an intervention, it has the functionality to increase a person's capabilities through simplifying, automating and streamlining processes, creating a unique (digital) experience (Fogg, 2003; Kelders et al., 2012). The Fogg Behavior Model defines how technology can trigger behaviour through the interplay of three elements: 1) The person's inherent motivation; 2) Their ability; and 3) An appropriate trigger or prompt. This relationship is represented by the formula $B=MAP$ where three elements, namely motivation (M), ability (A) and prompt (P) must converge at the same moment (above an activation threshold) in order for the desired behaviour (B) to occur (Figure 1) (Fogg, 2018). If the prompt (such as an email with direct advice) is delivered when the user has a level of motivation and ability that positions them above the activation line, it will elicit the desired behaviour (Fogg, 2009).

The COM-B model (Michie et al., 2014) is linked to BCTs and has many similarities with the Fogg Behavior model (Figure 2). It defines behaviour change (B) in relation to three synergistic components specific to the individual:

1. Capability (C): The person's psychological and physical skill set and abilities.



Notes: B:MAP, behavior, motivation, ability, trigger

Figure 1: Fogg behaviour model. From “BJ Fogg’s Behavior Model” by B. J. Fogg, 2018 (www.behaviormodel.org). Copyright 2018 by BJ Fogg.org LLC. Reprinted with permission

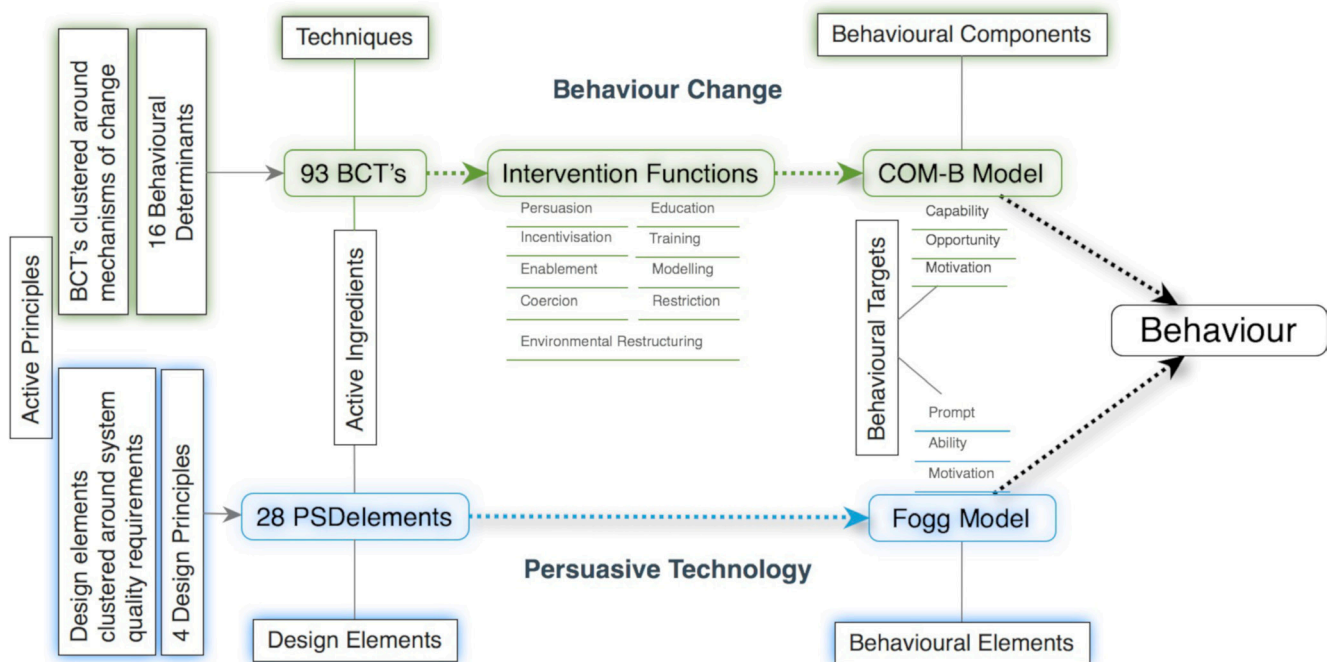
2. Opportunity (O): The environmental and social factors external but related to the individual that facilitate or inhibit a behaviour.
3. Motivation (M): The person’s state of readiness to change, related to both reflective processes (e.g. planning/goal setting) and automatic processes (e.g. habits/emotion).

These components can be targeted by intervention functions that are known to change behaviour (e.g. incentivisation,

education and environmental restructuring). Nine intervention functions have been identified from a systematic review of behavioural change interventions (Michie, Van Stralen, & West, 2011), and each of these have been linked to appropriate BCTs by a consensus of experts in behavioural change (Michie et al., 2014). Behavioural targets (i.e. motivation, capability or opportunity) can therefore be linked to BCTs through these intervention functions (Figure 3). Assessing or designing a behavioural intervention based on these intervention functions and their behaviour targets assists in recognising the different components that can impact the success or failure of an intervention.

Within the COM-B model (Michie et al., 2014), the interactive relationship between the behaviour components is recognised, but the emphasis is on how each of these components can be influenced by intervention functions using a combination of BCTs. The Fogg Behavior Model (Fogg, 2018) differs from COM-B in two ways. Firstly, although COM-B recognises the interactive relationship between components, it does not emphasise the reciprocal relationship between ability and motivation in eliciting a target behaviour. Secondly, COM-B is not concerned with how the components converge to elicit a behaviour. This relationship between the timing of the prompt to the person’s level of motivation and ability is an essential behaviour design aspect addressed by the Fogg Behavior Model and provides a systematic approach to understanding why a behaviour occurred (or did not) at a moment in time.

We have synthesised these frameworks and models as illustrated in Figure 3. The synthesised framework enables a



Notes: BCT, behavior change technique; COM, capability, opportunity, motivation; PSD, persuasive system design

Figure 2: The COM-B system - A framework for understanding behaviour. From “The behaviour change wheel: A new method for characterising and designing behaviour change interventions,” by S. Michie, M.M. Van Stralen, and R. West, 2011, *Implementation Science*, 6, p. 42. Copyright 2011 by BioMed Central Ltd. Reprinted with permission

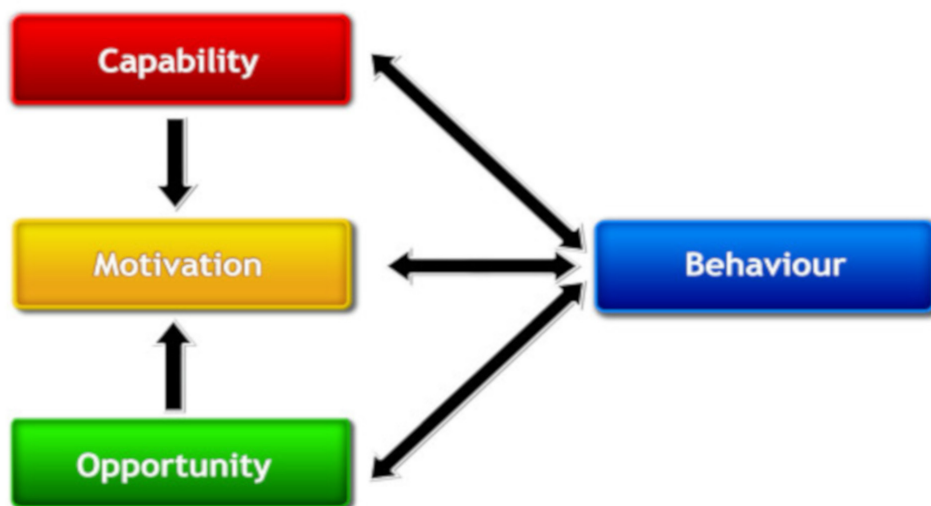


Figure 3: A synthesised framework for behaviour change and persuasive system design

comprehensive approach to defining an eHealth intervention: capturing mechanisms of action, behavioural targets, content and mode of delivery. To summarise, the Fogg Behavior Model (Fogg, 2018) specifies how the technology is eliciting a target behaviour at a moment in time, connecting the trigger with the user's level of motivation and ability; the COM-B model (Michie et al., 2014) defines the behavioural targets (motivation, capability and opportunity) of the intervention, linking them to the active ingredients or BCTs through appropriate intervention functions. The BCTTv1 categorises the content of the intervention, and the PSD elements define how the system is delivering the intervention. Table 1 provides an example of mapping part of an eHealth intervention using this framework.

The framework is not specific to the platform or device that will be used to deliver the intervention. Technology is constantly evolving, and there is growing recognition that focusing on underlying active principles of an eHealth intervention allows the core functionality of an intervention to be researched or transferred to new or emerging platforms as they arise (Hall & Bierman, 2015; Jones, 2014; Michie, Yardley, West, Patrick, & Greaves, 2017). This synthesised framework is a novel approach to assessing and designing eHealth interventions that incorporates the active principles of both persuasive technology and behaviour change, and may provide a comprehensive, evidence-based structure for advancing research within a rapidly changing technology landscape.

Our intention is to use this synthesised framework in a scoping review to map the currently fragmented research on persuasive design and behaviour change in eHealth. We will focus on interventions where the user of the technology is the parent and the purpose of the technology is to facilitate positive health behaviours in children with special healthcare needs, with particular attention to applicability for parents of children with cerebral palsy.

Study design

Scoping reviews are recommended as a way of searching, selecting and synthesising knowledge for a defined area of interest. They are intended to provide a broad map of

existing research and to synthesise current understanding in an emerging field, and they are often used to inform future research (Colquhoun et al., 2014). Scoping reviews have been found to be particularly useful in emerging areas like eHealth and are ideally suited for rehabilitation research where the paucity of randomised control trials may make systematic reviews difficult in many areas (Levac, Colquhoun, & O'Brien, 2010). They can be used to review knowledge from both quantitative and qualitative data within diverse methodologies and disciplines, and typically address fragmented or broad areas of research (Colquhoun et al., 2017). A scoping review was therefore identified as an appropriate method for synthesising the fragmented research on parent-focused eHealth interventions in children with special healthcare needs.

Aims and questions

The main objective of the scoping review is to inform a parent-focused eHealth intervention supporting home programmes for children with cerebral palsy. The secondary objective is to explore the utility of the synthesised framework in capturing and defining the active principles of an intervention where both the content and mode of delivery can have significant influences on behaviour.

Although a few digital health interventions that provide home programmes for children with cerebral palsy have been reported (Boyd et al., 2013; Lorentzen et al., 2015; Sandlund, Dock, Häger, & Waterworth, 2012), these either target the children and are not directed at supporting parents, or target parents with infants at risk of cerebral palsy (Basu, Pearse, Baggaley, Watson, & Rapley, 2017; Basu et al., 2018). Given the absence of literature on parent-focused eHealth interventions for children with cerebral palsy, the target population of the scoping review was broadened to include parents of children with special healthcare needs. Children with special healthcare needs is defined as children with "chronic physical, developmental, behavioural, or emotional conditions who also require health and related services of a type or amount beyond that required of children generally" (McPherson et al., 1998). In addition, as increasing standing time and decreasing sedentary time

Table 1: Charting the data with the synthesised framework for behaviour change eHealth interventions

Behaviour Target	"Eat breakfast daily; do activity and outside play; limit sweetened beverage consumption; television (TV) viewing; and computer time" (Van Grieken et al., 2017)					
Intervention Description	Opportunity / Trigger		Motivation		Capability / Ability	
"After reading the tailored advice, parents could make an implementation-intention plan in which they could specify actions (e.g. what, when, and where to improve child health-related behaviour). The tailored advice and implementation plan was sent by email to the parent" (Van Grieken et al., 2017)	BCT	PSD	BCT	PSD	BCT	PSD
	<i>Prompts / cues</i> Email to prompt implementation of plan	<i>Dialogue support: Suggestion</i> Tailored advice and implementation plan sent via email (not a reminder as doesn't prompt immediate action, but suggests future action and builds intrinsic motivation)	<i>Action Planning</i> Parents could make an implementation-intention plan	<i>Dialogue Support: Suggestion</i> Tailored advice and implementation plan based on parent's choice of actions builds on intrinsic motivation	<i>Instruction on how to perform the behaviour</i> Tailored advice to instruct parents on what, when, and where to improve child's health-related behaviour	<i>Primary task support: Reduction; Tailoring</i> The plan is tailored to parent's needs and preferences. Suggestions for the plan were tailored, reducing the need to choose from a large number of options. The plan is automatically generated and emailed, reducing need for parents to remember and write out the plan for themselves
Behavioural Targets	Physical	Motivation	Reflective	Hope/Fear	Psychological	Time/Brain Cycles/ Physical Effort
Intervention Function	Environmental Restructuring		Enablement			
B=MAT	The trigger is not timed to the target behaviour but encourages implementation of the target behaviour by increasing motivation - higher motivation (parents are more motivated to implement a tailored plan that they have just made) with reduced effort (the plan is emailed to them for easy recall). The intervention does not provide a direct prompt to trigger the behaviour at any point in time.					
Technology used	Online interactive web platform + email					

Note: BCT, behavior change technique; B=MAT, behavior, motivation, trigger; PSD, persuasive system design; 'Behaviour Target' and 'Intervention Description' are direct quotes from Van Grieken et al. (2017); BCT, behaviour change technique; PSD, persuasive system design

are currently recommended for promoting or maintaining musculoskeletal, gastrointestinal and cardiovascular health in children with cerebral palsy (Glickman, Geigle, & Paleg, 2010; Paleg, Smith, & Glickman, 2013; Verschuren, Peterson, Balemans, & Hurvitz, 2016), the more general literature concerning health behaviours is also included. Health behaviour is described by the World Health Organisation as "any activity undertaken by an individual, regardless of actual or perceived health status, for the purpose of promoting, protecting or maintaining health" (Nutbeam 1998, p.355).

The scoping review will therefore focus on eHealth interventions in the broader population that target parents of children with special healthcare needs. The term "parent" is used in this publication to describe the child's primary caregiver (including parent, legal guardian, matua or matua whāngai¹).

The specific research questions that will be addressed in the scoping review are:

1. What are the active principles commonly found in parent-focused eHealth interventions for children with special healthcare needs?
2. What are key concepts or common themes in the literature on parent-focused eHealth interventions for children with special healthcare needs?
3. Is a synthesised framework of behaviour change and persuasive technology principles useful for analysing eHealth interventions?
4. How do these principles overlap and interact in parent-focused eHealth interventions for children with special healthcare needs described in the literature?

METHODS

Eligibility criteria

In order to inform a parent-focused eHealth intervention supporting a child with special healthcare needs, we will only include articles on eHealth interventions where the target of the intervention is the parent and the outcome of interest is a change in activity or behaviour of their child.

The PSD model is specifically concerned with human-computer interaction, and therefore, automated responses to active parent engagement with the technology must be a fundamental component of the eHealth programme.

This scoping review excludes interventions that principally require the child to interact with the technology, are predominantly a replacement for face-face interventions or coaching (i.e. computer mediated synchronous communication) and that are not interactive (e.g. static text such as a digital version of an information pamphlet). A detailed table of inclusion and exclusion criteria can be found in Appendix 1.

¹ "Matua" or "matua whāngai" are Māori words translated into English as "parent" or "foster parent", and are included in this text in recognition of the status of the Māori language in New Zealand.

Information sources

We will limit our search to articles published after 2008, the year that both BCTTv1 and the PSD model were first published (Michie et al., 2008; Oinas-Kukkonen & Harjumaa, 2008). The benefits of including earlier digital interventions that would not have had access to today's prevailing technologies are unlikely to add additional value to our objective of informing a future eHealth intervention (Hall & Bierman, 2015; Jones, 2014; Lentferink et al., 2017).

Search

Key words "MESH" and "EMTREE" have been defined by a preliminary search of the literature using SCOPUS, testing key words and major headings, and then extrapolating them to match criteria of the remaining databases in consultation with a medical librarian (Appendix 2). We will use these keywords to conduct an electronic search of Medline (Ovid), EMBASE (Ovid), PsycINFO (Ovid), Scopus, Web of Science, CINAHL (EbscoHost), and ERIC (Ovid) to identify relevant studies to import into EndNote X7.

Selection of sources of evidence

Two review authors will independently screen the titles and abstracts of each potential study and categorise them as either "retrieve" (eligible or potentially eligible/unclear) or "do not retrieve" using Endnote X7 software. For the former, we will retrieve the full-text study reports/publications, and two review authors will independently screen the full text and identify studies for inclusion, identifying and recording reasons for exclusion of the ineligible studies. We will resolve any disagreement through discussion or, if required, consultation with a third member of the team. Finally, reference list mining will be used to identify any further eligible studies. The selection process will be illustrated using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses – Extension for Scoping reviews (PRISMA-ScR) flow diagram (Tricco et al., 2018).

Following recommendations by Arksey and O'Malley (2005), we will undertake data extraction as an iterative process, whereby we will revise our approach to data extraction after we have completed study selection and as we become more familiar with the relevant literature. The unit of analysis for our data will be the eHealth intervention. Therefore, replication of the same intervention in a different country or population, which to our knowledge contains the same content and delivery and is an identical programme, will be collapsed into a single unit of analysis, as will publications reporting on different aspects of one intervention. We will combine data from these publications to extract the most comprehensive details of the eHealth intervention.

Data charting process

To begin with, one researcher will extract data using a pre-specified data extraction form, reviewed by a second researcher. The following information will be captured:

1. Study characteristics, including methodology used, year of publication, country or origin, cohort details, intervention and placebo (if relevant), outcome measures, and key findings.

2. Technology characteristics, including type of technology or devices used, types of computer mediated interactions employed (e.g. blended coaching, social networking, mHealth strategies such as text messaging).

Updates to the extraction form will occur following discussions with the research team. In line with recommendations for collating, summarising and reporting results of scoping reviews (Levac et al., 2010), two reviewers will code the qualitative data jointly using Nvivo 11 and a shared coding book to identify key concepts and themes across the included publications using a content analysis approach. We will undertake a directed approach to content analysis (Hsieh & Shannon, 2005) using the BCTTv1 and PSD as predetermined codes, and extract data from the full text as well as any tables, figures and appendices. As the unit of analysis is the eHealth intervention and the purpose of the scoping review is to inform a future intervention, we will adopt a pragmatic approach that acknowledges the rapidly changing landscape of technology. We will therefore analyse the most updated version of the eHealth intervention available, including analysing the updated web version when available or updated version of the intervention in subsequent publications. Data will be tabulated and mapped using the synthesised framework incorporating BCTTv1 and COM-B within the PSD model and Fogg Behavior Model as illustrated in Table 1. The expectation is that this table and the associated coding book will be updated by the research team as part of the purpose and process inherent in a scoping review.

Data that do not fit the predetermined codes will be explored to determine if they represent a new category or a subcategory of an existing code. Findings will be collated and analysed in line with our secondary objective of exploring the utility of the synthesised framework in capturing and defining active principles of an eHealth intervention.

Data will be analysed descriptively to identify patterns of elements commonly used in eHealth interventions, such as how BCTs are being delivered using PSD elements and how human-computer interactions are combined with computer facilitated human-human interaction. Key themes that arise from this analysis will be determined by the two reviewers in consultation with the whole research team.

Ethics and data reporting

Ethics will not be required. We will report findings of the scoping review in a rehabilitation journal using both a descriptive summary and data maps (Arksey & O'Malley, 2005) to conceptualise these broad fields, identify gaps and provide a useful data extraction form for analysing eHealth interventions, with the intention of informing future eHealth research. Submission for presentation of results at relevant conferences in eHealth and rehabilitation will be initiated on completion of the scoping review.

CONCLUSION

We propose a novel approach aimed at capturing technology elements and behavioural change techniques alongside their mechanism of action through a synthesised framework of persuasive technology and behaviour change. This scoping review protocol outlines how this framework will be applied

to mapping eHealth interventions supporting parents with managing the health of their children with special healthcare needs at home. The intention is to advance an evidence-based approach that can be used to develop and evaluate eHealth interventions that support paediatric physiotherapy home programmes.

KEY POINTS

1. In eHealth interventions, both the technology and the techniques can influence behaviour.
2. The active principles of influence can be identified as persuasive system design elements and behaviour change techniques respectively.
3. Theoretical models from persuasive design and behaviour change fields can be used to understand how these active principles influence behaviour.

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PERMISSIONS

Written permission for reproduction of figures in the New Zealand Journal of Physiotherapy was obtained from BJ Fogg.org LLC (Figure 1, Fogg Behavior Model) and Professor Susan Michie, University College London, United Kingdom (Figure 2, COM-B Model). Professor B.J. Fogg provided permission for including an acknowledgement of his contribution.

DISCLOSURES

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Appendix 1

INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria	Exclusion criteria
1 The intervention included human-computer interaction delivered using the internet or mobile technology, i.e. automated responses to active human engagement with the technology.	The intervention was only one-way communication without any interaction from the user (e.g. only involved text messaging and reminders) or was a replacement for face-to-face interventions or coaching (i.e. only used synchronous communication) or the intervention was not interactive (e.g. only static text, such as a digital version of an information pamphlet) or only used computer mediated communication (e.g. social media, without any automated elements).
2 The intervention was aimed at parents to address health-related issues that are likely to last longer than six months in their children. Example of health-related issues might be obesity, disordered sleep, diabetes or disability related conditions, such as cerebral palsy and autism.	The intervention was intended for a single event of medical care or to address a health-related issue of less than six months (e.g. preparation for surgery, vaccinations or short-term health conditions, such as post-operative management following tonsillectomy in typically developing children).
3 The intervention was aimed at the child's parents to support behaviour change in their child at home, school or in their community. Teachers, other caregivers and children may also be included in the intervention, but parents must be the primary target of the intervention or at least equally targeted.	The intervention was targeted at the child. Parent's participation was only as an adjunct to the intervention (e.g. virtual reality game where the child played the game and the parent helped set it up and kept a diary of how it was used). Interventions targeting parents with health issues (e.g. parental cancer, parental mental health).
4 Outcomes of interest included the child's health-related or behaviour issues (e.g. child's mental health, behaviour, fitness, diet, sleep and biomarkers); or parent behaviours that directly address the child's health issues (e.g. parents giving children healthier meal options, regular bed times, physical activity opportunities and less screen time).	The outcome was primarily concerned with the parent's health-related issues or well-being or behaviours that indirectly improve children's health (e.g. decreased parental stress or parents engaging better with health services, such as not missing medical appointments or attending a parent education class).
5 The intervention group included parents of children between two to 12 years.	The intervention was only aimed at infants or babies under two years of age, or teenagers.
6 The intervention was intended to be used over more than one week.	The intervention was only intended to be accessed once or twice (e.g. reading information or watching a video to prepare children for a one-off surgical event).
7 All studies where the eHealth intervention is described included qualitative and quantitative research.	The eHealth intervention was not adequately described.

Appendix 2

SEARCH STRATEGY

The initial keywords were developed in Medline (Ovid) and then expanded for Embase, PsycINFO, ERIC, Web of Science, CINAHL, and SCOPUS. Below is the Medline final search strategy:

- 1 Mobile applications/ (5462)
- 2 Internet/ (89369)
- 3 Caregivers/ (43431)
- 4 Child development/ (55288)
- 5 Paediatrics/ (63780)
- 6 Health behaviour/ (63322)
- 7 Patient compliance/ (70552)
- 8 Tertiary prevention/ (208)
- 9 Cerebral palsy/ (23713)
- 10 Social media/ (8236)
- 11 Practice guideline/ (32752)
- 12 Child behaviour/ (22239)
- 13 Telerehabilitation/ (271)
- 14 Family/ (88900)
- 15 Parent/ or father/ or mother/ or single parent/ (131881)
- 16 Muscle stretching exercises/ or / exercise therapy/ (50664)
- 17 Exercise/ (128426)
- 18 Health education/ or consumer health information/ or patient education as topic/ (171095)
- 19 Child health/ or physical fitness/ or health communication/ or health promotion/ or healthy people programmes/ or weight reduction programmes/ (129623)
- 20 Child care/ (6351)
- 21 Rehabilitation/ or "activities of daily living"/ or exercise therapy/ or neurological rehabilitation/ or occupational therapy/ or "rehabilitation of speech and language disorders"/ (156493)
- 22 Child/ or disabled children/ (1991803)
- 23 Parent-child relations/ or father-child relations/ or mother-child relations/ or parenting/ (77923)
- 24 Child rearing/ (6443)
- 25 Child health services/ or "early intervention (education)"/ (27504)
- 26 Telemedicine/ (25775)
- 27 Computers, handheld/ or smartphone/ (7757)
- 28 Patient care/ (11578)
- 29 Posture/ or patient positioning/ (85926)
- 30 Occupational therapy/ or "rehabilitation of speech and language disorders"/ (16401)
- 31 1 or 2 or 10 or 13 or 26 or 27 (126866)
- 32 3 or 14 or 15 or 23 or 24 (298391)
- 33 6 or 7 or 8 or 11 or 16 or 17 or 18 or 19 or 21 or 25 or 28 or 29 or 30 (781188)

- 34 4 or 5 or 9 or 12 or 20 or 22 (2058446)
- 35 31 and 32 and 33 and 34 (401)
- 36 ("Persuasive system*" or "behav* change support system*" or captology or "human computer interface" or human-computer interface).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (321)
- 37 ("Information technolog*" or "smart phone*" or app or apps or computer* or e-health or ehealth or internet* or ipad* or iphone* or i-phone* or i-pad* or m-health or mhealth or mobile or online* or persuasive or smart-phone or smartphone* or "tablet computer" or technolog* or telecare or telehealth or telemedic* or telemonitoring or telerehabilitation or "web based" or "web-based" or website*).m_titl. (254205)
- 38 (caregiver* or parent* or mother* or mom* or mum* or father* or dad* or famil*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (2505828)
- 39 (child* or pediatric* or paediatric* or "cerebral pals*" or "child* adj4 disab*").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (2936976)
- 40 (resource* or "problem solv" or "problem-solv*" or "goal set*" or "goal-set" or help* or improv* or reduc* or develop* or increas* or impact* or adher* or compliance or comply or complies or care* or caring or portal* or platform* or home* or persuasive or train* or educat* or change or promot* or rehab* or treat* or serv* or support* or motivat* or coach or inform* or health or manag* or behav* or interven* or prevent* or program* or physical or sedentary or exercis* or therap* or physiotherap* or lifestyle or life-style* or tutor*).m_titl. (7418723)
- 41 ("parent focused" or parent-focused or "parent* of children" or "parent* of a child").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (21076)
- 42 Limit 41 to abstracts (20487)
- 43 36 or 37 (254378)
- 44 40 or 42 (7429620)
- 45 38 and 39 and 43 and 44 (2891)
- 46 35 or 45 (3109)
- 47 Remove duplicates from 46 (2055)
- 48 Limit 47 to yr="2009 - current" (1462)