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Exploring engagement with health apps: the emerging importance of situational involvement and individual characteristics

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Abstract

Purpose – Health apps offer a potential approach to support healthier food behaviours but a lack of sufficient engagement may limit effectiveness. This study aims to use a user engagement theoretical lens to examine the factors that influence app engagement over time and may prompt disengagement.

Design/methodology/approach – A phenomenological exploration of the lived experience was used. Women from a lower socioeconomic background (based on the occupation and employment status of the household's primary income earner) were randomly assigned to use one of two apps for a minimum of eight weeks. Multiple data collection methods, including accompanied shops, researcher observations, interviews, participant reflective accounts and questionnaires, were used at different time-points to examine engagement. Theoretical thematic analysis was conducted to explore the engagement experience and relevant social, personal and environmental influences.

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Findings – Healthy food involvement appears to drive app engagement. Changes in situational involvement may contribute to fluctuation in engagement intensity over time as the saliency of personal goals change. Negatively valenced engagement dimensions may contribute to the overall expression of engagement. A lack of congruency with personal goals or an imbalance between perceived personal investment and value was expressed as the primary reasons for disengagement.

Research limitations/implications – Situational involvement may act as a trigger of different engagement phases. There is a need to better distinguish between enduring and situational involvement in engagement research.

Practical implications – Individual characteristics may shape engagement and propensity for disengagement, which highlights the practical importance of incorporating tailored features into app design.

Originality/value – Findings broaden the current conceptualisation of engagement within the digital space and prompt a reconsideration of the role of situational involvement and negatively valenced dimensions throughout the engagement process.

Keywords Healthy eating, App, Involvement, User engagement, Food purchasing

Paper type Research paper

Introduction

Health apps are a potential tool to communicate nutrition information and support healthier food purchasing behaviour. Individuals are typically within reach of their mobile for much of the day (Dey *et al.*, 2011), which allows interaction in a natural setting at times of personal relevance to support behaviour change (Heron and Smyth, 2011). There is high use of apps across all social groups (Deloitte, 2014; eir, 2015), which positions them as a useful tool to support healthier behaviour in lower socioeconomic groups (Graham *et al.*, 2016), who are more likely to report unhealthier eating patterns (McCartney *et al.*, 2013). Apps may support healthier purchasing through information provision and healthier substitutions advice (Dunford *et al.*, 2014) or by translating nutrition recommendations into a shopping list while considering personal resources (López *et al.*, 2017). Further, apps appear to be viewed as an acceptable means for supporting healthier food behaviours, including by those from a lower socioeconomic background (Ball *et al.*, 2014; Flaherty *et al.*, 2019; Lieffers *et al.*, 2018; Schoeppe *et al.*, 2016); this illustrates their potential application as a behaviour change tool for this population group.

A key challenge faced in their use for behaviour change is ensuring that individuals engage with the app for the time necessary to experience sufficient exposure to relevant behaviour change techniques (Michie *et al.*, 2017). Insufficient engagement may result from an imbalance in the integration of appropriate theoretical content and features that sustain user interest (Hingle and Patrick, 2016; Tang *et al.*, 2015). Consumer evaluations of health apps offer insight into those features that influence continued app use. In relation to healthier food purchasing behaviour, consumers prefer apps that are perceived as useful in facilitating healthier behaviour, provide personally relevant information and are easy to use (Gilliland *et al.*, 2015; López *et al.*, 2017) with higher perceived effort a key barrier to sustained use (Ball *et al.*, 2014). Drawing on evidence from beyond the food purchasing context, consumers want personalised features that aid their individual behaviour change (Appleton *et al.*, 2019; Solbrig *et al.*, 2017), while incorporating fun and enjoyable features, including gamified elements, is also important for many (Chang *et al.*, 2012; Prapkree *et al.*, 2019). Insufficient engagement may also be influenced by personal factors (Perski *et al.*, 2017) such as previous experience (Hsu and Lin, 2016), self-efficacy (Jeon and Park, 2015) and motivation (Helander *et al.*, 2014).

Drawing on this evidence, user engagement may be an important facet of app effectiveness. Much engagement research, however, focusses on broader health behaviours rather than food purchasing (Jeon and Park, 2015; Lyzwinski *et al.*, 2018; Yardley *et al.*, 2016) or fails to examine personal factors (Ball *et al.*, 2014). Further, there is limited engagement

research focussed on lower socioeconomic groups. As engagement is context-specific (Brodie *et al.*, 2011), it is important that evidence is provided for specific population groups to best understand the phenomenon in the relevant context. The current research directly addresses these gaps by examining health app use in the context of food purchasing in individuals from a lower socioeconomic background. The findings emphasise the importance of individual user characteristics on shaping the engagement experience. Differences in personal resources, situational involvement and stage of behaviour change were all viewed as important personal factors that influenced the individual expression of engagement. Differences in certain resources, such as nutrition literacy, may be of more relevance to women from a lower socioeconomic background. Findings underline the importance of a person-centered approach to health app design (Yardley *et al.*, 2015) and the need to focus on an individual's personal resources rather than broader socio-demographic measures (König *et al.*, 2018).

Previous work undertaken by the authors (Flaherty *et al.*, 2019) examined the initial period of engagement and highlighted key components of a positive user experience in women from a lower socioeconomic background. It further highlighted, however, gaps in existing knowledge, especially in relation to engagement over time. It is necessary to understand user engagement at all stages and the factors that may influence the individual experience and mobile app acceptability (Yardley *et al.*, 2015). The present research addresses this gap by examining individual user engagement during a period of behaviour change. Findings highlight the potential importance of situational involvement as a trigger of different phases of engagement, whereby fluctuations in situational involvement may shape the intensity of the engagement expressed. Consequently, this research builds on the model of engagement proposed by Hollebeek (2011b) and much of the existing engagement literature, which views involvement primarily as an antecedent (Brodie *et al.*, 2011; Leckie *et al.*, 2016). It suggests a need to reconsider the relationship between engagement and involvement and more clearly distinguish the effects of enduring and situational involvement on the engagement process.

Gaining a better understanding of the engagement process over time in this specific population group may allow for improved health app design to ensure users are adequately supported to change behaviour. The primary research questions for the present research were, namely, what app and user-related factors influence the initiation, maintenance and intensity of user engagement over time and what app and user-related factors prompt temporary or permanent disengagement?

User engagement

It is necessary to outline the conceptualisation of user engagement used to clarify the theoretical perspective undertaken during analysis. The authors view engagement as an individual-specific, context-dependent, psychological state that emerges through two-way interaction with an object, such as an app (Brodie *et al.*, 2011; Brodie *et al.*, 2013; Hollebeek, 2011a). Engagement is expressed in behavioural, cognitive and emotional dimensions with contextual factors directing the form of engagement expressed, which may encompass one or a combination of these dimensions (Brodie *et al.*, 2013; Hollebeek, 2011a). Behavioural engagement is demonstrated through the time and effort invested, in-depth cognitive processing illustrates cognitive engagement, while an affective connection demonstrates emotional engagement (Hollebeek, 2011a). Engagement is a dynamic state of varying intensity (Brodie *et al.*, 2011; Brodie *et al.*, 2013). While engagement appears to be primarily conceptualised as positively valenced, the presence of negatively valenced expressions may be important (Bowden *et al.*, 2016; Hollebeek and Chen, 2014). These are defined as the expression of *consumers' unfavourable brand-related thoughts, feelings and behaviours during an interaction* (Hollebeek and Chen, 2014) and may contribute to the individual engagement state

and the intensity of engagement intensity demonstrated (Dolan *et al.*, 2016; Heinonen, 2018). Consequently, engagement is a complex, multi-dimensional construct, shaped by contextual influences with each component contributing to overall engagement.

Particular factors may drive engagement. Participation is the consumer's contribution to production and may be considered essential (Brodie *et al.*, 2011; Vivek *et al.*, 2012), although empirical findings are mixed (Leckie *et al.*, 2016). Flow, a psychological state of complete focus and intrinsic enjoyment, is also posited as a driver (Hollebeek, 2011b, Mollen and Wilson, 2010); however, again there is a lack of empirical support. Individual involvement has been consistently demonstrated to drive engagement (Brodie *et al.*, 2011; Dessart, 2017; Hollebeek *et al.*, 2014; Leckie *et al.*, 2016). Involvement is defined as *an individual's level of interest and personal relevance in relation to a focal object/decision in terms of (their) basic values, goals and self-concept* (Brodie *et al.*, 2011). In the context of engagement, involvement influences the extent to which an object is viewed as important or personally relevant (Brodie *et al.*, 2011; Leckie *et al.*, 2016).

Involvement may be enduring where it is driven by intrinsic goals and self-concept (Houston and Rothschild, 1978) and is associated with a general interest that remains stable over time (Laurent and Kapferer, 1985; Michaelidou and Dibb, 2008). The focal object or decision is viewed as consistently pleasurable and rewarding by the individual (Kapferer and Laurent, 1985). In contrast, involvement may be situational where the individual is temporarily concerned with a particular object as directed by explicit goals or external situational factors (Houston and Rothschild, 1978; Laurent and Kapferer, 1985; Richins and Bloch, 1986). The key differentiator between enduring and situational involvement, according to Richins and Bloch (1986), is temporal duration with situational involvement subsiding as the situation passes. An additive effect is seen where situational involvement combines with existing enduring involvement to give an overall involvement response (Richins *et al.*, 1992). The involvement response is context dependent and the contribution of enduring or situational involvement at a given point is directed by individual goals and their relative importance in the given context (Michaelidou and Dibb, 2008).

The authors' conceptualisation of engagement draws upon social exchange theory, which suggests that individuals reciprocate positive thoughts, feelings and behaviours when in receipt of specific benefits (Hollebeek, 2016). Individuals constantly assess the balance between the perceived investment required and the personal value gained from engagement (Hollebeek, 2016). Personal value is perceived in terms of how engagement aids goal attainment (Calder *et al.*, 2016; Viswanathan *et al.*, 2017). A perceived imbalance between perceived value and personal investment may result in periods of dormancy, which are *temporary states of inactive, passive engagement by users who may have previously interacted* (Dolan *et al.*, 2016) or disengagement, where engagement is permanently terminated (O'Brien and Toms, 2008). Consequently, the perceived value obtained from engagement is crucial and influences the continuation of engagement (Brodie *et al.*, 2013; Viswanathan *et al.*, 2017). Thus, engagement is shaped by personal and contextual factors that influence the specific expression of engagement at different stages and the propensity for its temporary or permanent termination.

Methods

A qualitative research approach was used, which adopted phenomenological and experience-centered design perspectives (Patton, 2002; Wright and McCarthy, 2010). This approach allowed for an in-depth insight into the lived experience where personal, social and

environmental factors could be captured. Ethical approval was granted by University College Cork's Social Research Ethics Committee.

Sample

A purposive sample of 10 women aged between 30–45 years participated (Table 1). This age category are considered those most likely to use a health app (Bhuyan *et al.*, 2016; Bol *et al.*, 2018; Carroll *et al.*, 2017; Deloitte, 2014). The present research was part of a broader study where the primary aim was to explore change in food purchasing behaviour over time while using a health app (Flaherty *et al.*, 2020). There was a focus on consumers from a lower socioeconomic background as they typically report unhealthier diets and may benefit from an app-led dietary intervention (Bender *et al.*, 2014; McCartney *et al.*, 2013; Miller *et al.*, 2017; Vandelanotte *et al.*, 2016). The occupation and employment status of the household's primary income earner was used to determine socioeconomic status (Central Statistics Office, 2012). Individuals were classified as being from a lower socioeconomic background if they were in any of the following categories, namely, non-manual, manual skilled, semi-skilled and unskilled[1].

Participants were required to hold primary or equal responsibility for food purchasing. Women typically hold primary responsibility (Ball *et al.*, 2011; Checkout, 2017; Inglis *et al.*, 2005; Lake *et al.*, 2006; Vaughan *et al.*, 2017), and consequently were the population of interest. Participants were required to own a smartphone that was capable of downloading an app, had previously downloaded an app but had not previously used the study apps. Pregnant women or those with restricted diets were not eligible to participate as relevant clinical support was not available. Participants were required to be in a motivational state that is considered open to changing behaviour towards healthier eating patterns, according to the transtheoretical model of change (Prochaska *et al.*, 2008). Two participants reported being in the contemplation stage and intended on taking action in the next six months; the remaining eight participants reported being in the preparation stage, and intended to take action shortly or had recently made some changes to their healthy eating. Pseudonyms have been used to protect identity.

Recruitment

Two different methods of recruitment were used as recruitment of individuals from a lower socioeconomic background can be challenging (Bonevski *et al.*, 2014; Pescud *et al.*, 2015). In-store face-to-face recruitment was the primary method used (Ni Mhurchu *et al.*, 2009). Screening took place in two supermarkets over a four-week period in total. Supermarkets were located in two different suburban areas of Cork City, Ireland, which were designated as areas of disadvantage (CESCA, 2015). All female customers, over the age of 18, were invited to complete a screening questionnaire and were asked to provide contact details if interested in future study participation. Snowball sampling was subsequently used (Atkinson and Flint, 2001). Upon completion, participants were asked to share study information with their contacts. Interested individuals were asked to directly contact the researcher, upon which they were asked to complete a screening questionnaire.

Recruitment took place between May and October 2017. It was terminated at this point as the follow-up period would coincide with Christmas, which does not typically represent usual purchasing behaviour. Data were analysed throughout this period and saturation was deemed to have been achieved as no new themes emerged with the final participant (Bowen, 2008) and the depth and breadth of data gathered for each individual ensured data adequacy (Morrow, 2005). If saturation had not been achieved, recruitment would have recommenced following Christmas. A total of 280 women completed the screening questionnaire and 50

Table 1.
Participant characteristics ($n = 10$)

Pseudonym	Children	Nutrition literacy (baseline)[a]	Employment status	Perceived financial pressure[b]	Stage of change (self-reported)[c]	App used
Aisling	No children	Adequate	Full-time employment	Coping on present income	Preparation	A
Christine	One child	Adequate	Full-time employment (primary earner)	Coping on present income	Preparation	A
Claire	Two children	Adequate	Student	Living comfortably on present income	Preparation	B
Ellen	No children	Adequate	Full-time employment (primary earner)	Coping on present income	Preparation	B
Faye	Two children	Marginal	Full-time employment	Coping on present income	Preparation	B
Isabel	One child	Adequate	Full-time employment (primary earner)	Living comfortably on present income	Preparation	B
Julie	No children	Adequate	Full-time employment (primary earner)	Living comfortably on present income	Contemplation	A
June	Three children	Adequate	Part-time employment	Living comfortably on present income	Preparation	B
Laura	Four children	Marginal	Engaged in the home	Coping on present income	Preparation	A
Teresa	No children	Adequate	Full-time employment (primary earner)	Coping on present income	Contemplation	B

Note: [a]Nutrition literacy was assessed using the measure developed by Gibbs and Chapman-Novakofski (2013), which was adapted for an Irish population [b]Perceived financial pressure was examined using a question drawn from the European Social Survey (2016). [c]An adapted version of the Armitage (2006) single-item measure was used where individuals chose the category that best reflected their current stage in relation to healthy eating

were eligible to participate. The main reasons for ineligibility include no contact details provided ($n = 63$), inappropriate stage of change ($n = 50$), higher socioeconomic status ($n = 47$), health condition present or pregnant ($n = 37$) and not primary food shopper for the household ($n = 33$). Of the 50 eligible respondents, 19 could not be contacted and 21 were not interested in taking part. One participant was recruited via snowballing with the majority recruited in-store.

Procedure

The apps used were drawn from previous research undertaken by the authors (Flaherty *et al.*, 2018; Flaherty *et al.*, 2019). Table 2 provides further details on the study apps. Both apps were considered potentially effective at supporting healthier food purchasing behaviour as they incorporated appropriate nutrition information (Franco *et al.*, 2016; Lieffers *et al.*, 2014), were rated as being of good user quality (Stoyanov *et al.*, 2015) and integrated behaviour change techniques of relevance to supporting healthier purchasing behaviour (Michie *et al.*, 2013; van't Riet *et al.*, 2011). Both apps were free and publicly available on the iTunes and GooglePlay app stores.

Data collection

As previously outlined, the present research was part of a broader study, which aimed to explore change in food purchasing behaviour over time. Consequently, some of the methods used were chosen to primarily examine behaviour change rather than engagement with the app, such as the accompanied shop. All details are provided on the multiple methods that were used throughout the study to provide clarity for the reader. Specific details are provided, where relevant, on how data collection contributed to learning in terms of app engagement.

Baseline data collection. Participants completed an accompanied shop, incorporating the use of "think-aloud" protocol and researcher observations, to explore typical purchasing behaviour and in-store mobile use (Saarela *et al.*, 2013). Participants were asked to verbalise their thoughts during their shop to provide an insight into cognitive processes underlying decision-making (Ericsson and Simon, 1998). The primary objective of the accompanied shops was to explore the typical food shopping experience and identify cues directing purchasing behaviour. It was also an opportunity to explore the use of mobile phones or apps during the food shopping process. The researcher noted if a mobile phone or app was used during shopping or if a reference was made to their use in the broader purchasing process, and this was discussed further in the subsequent interview. Accompanied shops, at baseline, took an average of 26 min. A semi-structured interview was conducted upon completion during which participants discussed food purchasing behaviour, existing app use, self-efficacy in relation to apps and mobile technology and the perceived role of apps in supporting healthier behaviour. The average interview time was 58 min. Participants then self-completed a questionnaire that examined their experience of using mobile technology (Lowe *et al.*, 2015; Meuter *et al.*, 2005) and nutrition literacy (Gibbs and Chapman-Novakofski, 2013). Such information provided additional context for each participant. The questionnaire took, on average, 13 min to complete.

Initiation of app use. Participants were randomly assigned, using an online randomisation programme, to use one of two apps for a minimum of eight weeks. Each participant was sent a text with a link to download the app, and additional support was provided if necessary.

Interim data collection. At the midway point, participants were asked to record a reflective account discussing their experience of using the app. A reminder text suggested some reflective prompts, including typical app use, preferred or disliked features, change in

App A	*App description* The primary goal is weight loss with users able to choose their own goal. Users can choose different weekly meal plans (calorie-controlled), which are aligned with their weight loss goal. A daily menu, including pictures and a weekly shopping list, are provided, which can be tailored, including taste preferences and shopping frequency. Recipes are provided for most meals. Users are prompted to monitor their weight-loss goals on a weekly basis. Advice is provided on foods that should be consumed as part of a healthy diet and unhealthier foods that should be avoided or consumed in reduced amounts. Healthier meal options are offered for eating out occasions. Users can access a community forum that is facilitated by a nutritionist where they can share advice with other users or obtain advice from the facilitator. Reminders, via push notifications, are sent to the user relating to meal times and goals and can be tailored by the user. Examples of prompts include: "you are doing great! Time for your morning snack" and "today was a great day! Keep it up" *Integrated behaviour change techniques* Goal setting (outcome), such as weight change Self-monitoring of outcome(s) of behaviour, such as weight change Behaviour substitution, such as advice on alternative healthier food options Conserving mental resources, such as an automatically generated shopping list that can be tailored to individual needs Prompts/cues, such as in-app reminders to make a healthy shop list Social support (unspecified), such as encouraging the user to seek support to enable performance of the desired behaviour *User quality* This app was rated as good in terms of user quality but was of slightly lower quality than App B. It was aesthetically appealing with a clear flow between features that improved ease of use. It was considered less interactive than App B as minimal feedback on user progression was provided and reduced prompting of user interaction
App B	*App description* The primary goal is weight loss with users able to choose their own goal. Users can choose additional goals from a range of suggested healthy eating and physical activity goals or can input a specific goal of personal relevance. Users can set a daily calorie goal and monitor food consumption and physical activity to align with this calorie goal. Goal reminders are sent via push notifications at a time and frequency chosen by the user. Users can add personal photos to act as a goal reminder or to monitor progress over time. Advice is provided on different aspects of healthy eating, including healthy food purchasing behaviour. The user is able to choose particular health tips or add personally relevant health tips, which can be set as reminders for a relevant time and frequency. Examples include: "it is not what you eat, it is what is eating you" or "remember you are not depriving yourself, this is your choice". Users can choose daily health-behaviour challenges, such as create a healthy shopping list, which give point rewards upon completion. These points build up over time to procure clothes for the user's virtual avatar. Challenges can be chosen from a range of suggestions or users can input their own personally relevant challenges. Advice is provided on how to use different app features *Integrated behaviour change techniques* Goal setting (outcome), such as weight change Self-monitoring of outcome(s) of behaviour, such as weight change Comparative imagining of future outcomes, such as encouraging the user to imagine the benefits of changing their food behaviour Information about antecedents, such as advising the user to examine actions that occur prior to the purchasing of unhealthier foods Behaviour substitution, such as advice on alternative healthier food options

(*continued*)

Table 2.
Overview of the study mobile apps

	Prompts/cues, such as in-app reminders to make a healthy shop list Distraction, such as encouraging the user to identify cues, which trigger undesirable food behaviours and focus on alternatives activities at this time Restructuring the physical environment, such as planning navigation of the supermarket to support healthier purchasing behaviour Restructuring the social environment, such as encouraging family and important individuals to support healthier food behaviours Avoidance/reducing exposure to behaviour cues, such as avoiding certain supermarket aisles to reduce exposure to unhealthier food products Social support (unspecified), such as encouraging the user to seek support to enable performance of desired behaviour Information about others' approval, such as telling the user that healthier food behaviour is viewed positively by others Non-specific reward, such as encouraging the user to reward oneself if healthier behaviour performed Non-specific incentive, such as in-app gamification where points received for performing healthier food behaviours
	User quality This app had higher user quality than App A. It was aesthetically appealing with an easy to use interface. It was considered interactive and entertaining with many features that could be tailored to individual user needs. It was considered a credible app with sufficient quantity of relevant information

Table 2.

use over time and rationale underlying these points. Participants could also include further points of personal relevance. In total, 6 of the 10 participants provided reflective accounts. Four participants shared audio-recorded accounts and two participants shared written accounts. These reflections allowed for insight into the initial individual experience of using the health app. They were discussed during the participant's final interview and drawn upon during analysis.

Follow-up data collection. Follow-up data collection was conducted at 8 to 11 weeks after baseline depending on the participant's availability to meet. All 10 participants attended the follow-up meeting. An accompanied shop was conducted following the same protocol as baseline. The primary objective was exploring differences in the food shopping experience from baseline. It was also an opportunity to examine app use during in-store purchasing or reference to its use in alternative stages of the food purchasing process. Accompanied shops, at follow-up, took an average of 22 min. A subsequent semi-structured interview explored their experience of using the app and, where relevant, its use in the food purchasing process. All data for the participant were reviewed in advance of this final meeting to ensure that the final interview was tailored appropriately for the individual to allow for discussion of relevant factors. The average interview time at follow-up was 55 min. Participants were then asked to self-complete a questionnaire that examined nutrition literacy (Gibbs and Chapman-Novakofski, 2013), highest level of education, perceived financial pressure (European Social Survey, 2016) and nationality. The questionnaire took, on average, 13 min to complete. Participants were subsequently given a €75 voucher to acknowledge their participation of which they were informed during recruitment.

Analysis

In total, approximately 2½ to 4 h of data were available per participant. All interviews, think-aloud verbalisations and reflective accounts were transcribed verbatim either by the

research team or an external transcription professional. All transcribed material was checked for accuracy. Questionnaire data, relating to nutrition literacy and technology experience, were inputted into statistical package for the social sciences (Version 24). Theoretical thematic analysis, through the lens of engagement theory, was undertaken by drawing on the guidelines provided by Braun and Clarke (2006). Familiarisation comprised of multiple readings of the transcripts and note-taking to build a narrative of each participant's experience. Questionnaire data were drawn upon to provide participant context. Initial coding and theme development was undertaken by the primary author. Initial codes were defined and applied to the data and newer codes, identified upon subsequent readings, were then applied. Data from two participants were coded by a second researcher using the initial coding structure. The aim was to ensure that coding had been applied consistently and suggest new codes if gaps were apparent. Disagreements and suggestions were discussed with the second coder upon completion. The coding and theme structure were reviewed and updated to reflect this discussion while ensuring they continued to accurately reflect data. Initial themes and relationships were discussed with co-authors. A review of relevant literature was undertaken to inform theme refinement. Themes and relationships were further refined through continuous discussion with co-authors until a final agreement was reached. Analysis was conducted using NVivo 11.

Results

Exploration of the user experience allowed valuable insight into the engagement process over time and three main themes were identified. Firstly, the important role of healthy food involvement throughout the engagement process. Secondly, the impact of negatively valenced engagement dimensions on overall engagement and, thirdly, a lack of congruency or a perceived imbalance between personal investment and value were primary reasons for disengagement.

Role of healthy food involvement

Sufficient healthy food involvement appeared necessary for engagement to occur. In the current context, healthy food involvement relates to the user's interest in healthy food or its perceived personal relevance. For the reader to best understand the role of healthy food involvement, it is necessary to initially describe the broader goal systems that were in place for participants. While all participants held healthy food goals, such goals were connected to different higher-order goals that related to either a desired body image or a sense of health and well-being. This difference is discussed in greater detail in another paper (Flaherty *et al.*, 2020) that drew on the same data to explore change in food purchasing behaviour over time. A brief overview is presented here to provide sufficient context for the reader. Individuals driven by higher-order health and well-being goals appeared to take a more holistic approach to health, and healthy food goals were more likely to focus on improving overall health and achieving a balanced lifestyle. In contrast, those motivated by higher-order body image goals expressed a desire to achieve a particular body weight or shape, which arose in response to sociocultural ideals. Healthy food goals in this context were more likely to relate primarily to weight-loss and be expressed as explicit, shorter-term goals. This difference in higher-order goals appeared to influence the type of healthy food involvement expressed, either enduring or situational, which subsequently shaped the engagement process.

In those individuals driven by health and well-being goals, enduring healthy food involvement was typically expressed at a level sufficient to prompt engagement where it was driven by an inherent interest and viewed as central to one's self-concept. For example, Claire saw herself as a health-conscious "foodie": *I am constantly googling things [. . .] I*

obsess about food [. . .] it is part of my personality [. . .] it is something I have an interest in beyond the obsession with weight-loss. Healthy food goals were set as a means of fulfilling this health-conscious perception of herself, which led to a general interest in building nutrition knowledge and a continual search for tools to help meet higher-order health and well-being goals. The app was viewed as one such tool, which prompted her engagement. A similar enduring involvement in healthy food was expressed by Aisling, who works as a care assistant. She admits that when she was younger she focussed on the *need to lose weight [. . .] to look better*, but since a serious injury a few years previous, she now *care*(s) *about what is in my food [. . .] about the quality of it*. This prompted a greater general interest in healthy food where she now regularly *tend*(s) *to read the back of labels [. . .] to check out [. . .] they can be full of sugar [. . .] and I would check that against [. . .] some of the other ones that look healthier* and seeks out healthier recipes to try at home. She likes to improve her nutrition knowledge whenever she can and this enduring involvement prompted engagement with the app. She hoped that it would further increase relevant knowledge and skills and contribute to a healthier and balanced lifestyle.

For others, engagement was prompted by situational healthy food involvement, which arose because of the setting of explicit goals. Increased situational involvement increased the overall involvement response to a level that prompted engagement with the app. This was more common in those motivated by body image goals as they were more likely to set shorter-term healthy food goals in an attempt to lose weight in advance of a special event. Isabel, who works full-time in administration, was soon to be a bridesmaid at her friend's wedding and wanted to lose weight to fulfil perceptions of the ideal body size for such occasions. She viewed eating healthier as a means of losing weight and set healthy food goals to achieve the desired body image. This prompted a temporary increased interest in healthy food and a search for relevant tools. She viewed the app as relevant during this time to aid attainment of healthy food goals and desired body image: *it could not come at a better time [. . .] the wedding coming up [. . .] I needed to cop on (sort myself out) basically to fit into the dress*. June, a mother of three children, also demonstrated situational healthy food involvement, which prompted engagement with the app. Her interest in healthy eating centered around the setting of short-term healthy food goals to aid weight loss in advance of different events:

> "I probably need a [. . .] wedding coming up or something [. . .] we had a wedding over the summer and [. . .] I would have been way better and then I suppose the wedding is over, I don't have to fit into that dress again now until next May for the Communion [. . .] we'll start again in January".

While involvement is typically viewed as an antecedent in the literature, the influence of situational involvement appeared to contribute to fluctuations in engagement intensity over time. The setting of an explicit healthy food goal resulted in an increase in situational healthy food involvement, which prompted engagement. However, a reduction in goal saliency meant that healthy food was seen as less personally relevant, which decreased situational involvement and resulted in lower engagement intensity. Isabel achieved her desired body image goal in advance of the wedding, which reduced the saliency of healthy food goals. This reduced her situational involvement as she acknowledged that she *could not have cared less at that stage*. Consequently, her engagement with the app reduced and *the app got pushed aside [. . .] probably for about two weeks, it went totally out the window* as it was no longer viewed as highly relevant. However, the setting of a new body image-related goal, as she thought *of all the other clothes that we have to fit into*, again increased situational involvement and prompted an increase in engagement. A change in a user's context may

also alter the involvement response. Changing levels of situational involvement, driven by changing goals, appeared to influence engagement intensity and contribute to fluctuations in engagement over time. Ellen works as a shop assistant and recently increased her working hours. This led to a deprioritisation of healthy food goals as goals related to work and her relationship took precedence over health goals. This decrease in goal saliency reduced situational involvement and prompted a reduction in engagement intensity:

> "I really used it for about four or five weeks [. . .] the last couple of weeks I really didn't [. . .] it's just busy at work, I work crazy hours at the moment [. . .] that wasn't really my priority".

While it appears that involvement influenced engagement, the reverse relationship was also demonstrated. If the app was viewed as valuable it led to increased levels of healthy food involvement in some users. Christine, a mother of one son, viewed the app as valuable as it increased her nutrition knowledge: *I thought some things were healthy [. . .] I was proved wrong*. Engagement with the app facilitated this building of personal resources and illustrated that *there is always room for improvement*. This appeared to increase her healthy food involvement and prompted her to consider new foods during shopping to maintain a healthy diet: *I would be open to trying out different (foods) [. . .] look into them a bit [. . .] to vary diets*. Consequently, if engagement was viewed as personally valuable it appeared to increase involvement illustrating a potential two-way interaction.

Negatively valenced dimensions of engagement

Negatively valenced expressions of engagement refer to unfavourable expressions of engagement dimensions. In this sample, they were primarily demonstrated in relation to emotional engagement where app interaction evoked a negative affective response. A visual representation of the user before and after weight-loss evoked an undesirable emotional response in Teresa who explains:

> "they have the plump avatar [. . .] you're meant to aspire to the slimmer avatar [. . .] it puts your weight under the plumpy one [. . .] it's too much of a visual reminder [. . .] if you only have a few pounds to lose [. . .] it would give you a little push but if you've got too far to go it would push you the other way".

This visualisation provided a stark reflection of the transformation desired and its enormity evoked feelings of disappointment and frustration.

It is less clear what influence this had on Teresa's overall engagement process. She reported continued app use and appeared to demonstrate both behavioural and cognitive engagement. However, by the end of the study, she was attending a weight-management programme where she gains individual advice on healthy food goals. There is also peer support where she can discuss perceived challenges with others that are changing their behaviour. It is possible that experiencing negatively valenced emotional engagement prompted Teresa to partially disengage from the app and seek alternative options. She acknowledged that the app was valuable in terms of knowledge building and facilitating self-regulation but that it lacked the type of personal feedback that she desired. In contrast, this desired personal approach was available from the weight-management programme: *listening to the other girls [. . .] how they approach things like parties [. . .] really good to have that group feedback [. . .] having people around you is great*. It may be that the negative emotions experienced influenced the type of engagement demonstrated and subsequently overall levels of engagement intensity.

It is important to note that experiencing negatively valenced emotional engagement did not automatically reduce overall engagement intensity for all participants. The apps

typically highlighted if a user was failing to achieve desired goals through in-app text prompts or a visual representation of non-achievement. For many users, this led to feelings of shame and guilt as it emphasised their lack of progression. However, this was viewed positively by Claire, a mother of two who has adequate nutrition literacy. She discussed how she *would like to be able to shame myself more on the app [. . .] it works for me*. Claire perceived that a negative emotional response may prompt greater app use thereby strengthening engagement intensity. While this alternative experience was only expressed by one participant, it is important to acknowledge. It is possible that the influence of negatively valenced expressions of engagement may differ depending on the individual. This illustrates the potential importance of personal characteristics and the need to consider such in future research and development.

Disengagement from the app

At the end of the study, it was evident that a number of users had permanently terminated their app use. A key reason for disengagement was a lack of congruency with personal goals, which was demonstrated by Julie, who works full-time and has adequate nutrition literacy. Julie's higher-order goal related to health and well-being and she wanted to achieve a balanced approach to healthy food that allowed attainment of social and relationship goals. She disliked that the app focussed on food restriction and monitoring intake as this was not perceived as balanced. Instead, Julie wanted to build her capacity to self-regulate behaviour, such as meal planning and healthy substitutions, which allowed for a balance between healthy food and hedonic goals. She describes how *it was not really working with what I was [. . .] wanting to do myself with dinners [. . .] you are not really batch cooking [. . .] it did not work [. . .] for my own eating patterns*. Furthermore, Julie's construction of healthy food did not mean an elimination of unhealthier foods but rather a change towards their occasional consumption as part of social participation. Having dessert after a family meal was viewed as part of a balanced, healthy diet and its restriction was unnecessary: *if I go up to (my husband's) parents I am not going to [. . .] start saying [. . .] I am not having apple tart and cream*. Julie did not think that the app adequately facilitated a balance between healthy food and hedonic goals; this incongruency with her personal goals prompted disengagement by the end of the study.

Disengagement also occurred due to an imbalance between the perceived investment required, both in terms of time and effort and the perceived value gained in relation to personal goals. Users were continually evaluating their user experience and assessing if perceived value warranted the investment required. Faye, a mother with marginal nutrition literacy, had set a weight loss goal in advance of her holiday. Similar to Isabel, she viewed eating healthier as a means of achieving this weight-loss goal, which led to the setting of a healthy food goal. This increased her healthy food involvement, which prompted engagement prior to her holiday. While she was on holiday, healthy food goals were viewed as less important and app use ceased. However, despite an increase in healthy food involvement when she returned, she decided not to re-engage with the app. She considered the personal investment required disproportionate to the value gained in relation to goal attainment, both in terms of healthy food and weight-loss goals. The process of monitoring calorie intake was considered onerous and had not delivered desired benefits:

> "(I) was expecting the phone to tell me what to eat and that would do the hard work and I'll just eat it, whereas I had to do the hard work and put it in".

Consequently, Faye terminated her use of the app and joined a fee-paying weight-management programme where she perceived that she received greater value for less personal investment:

> "being in [the programme], I found that supported me better [. . .] it tells me what I can and what I can't have [. . .] if I'm stuck I can have someone there to answer what I need [. . .] because they're always online".

This combination of a weekly face-to-face meeting and constant access to peers was viewed as valuable and warranted the investment required in relation to financial cost, time and effort. It is important to acknowledge that Faye had lower nutrition literacy than the majority of participants. It is possible that this influenced her ability to interpret the nutrition information provided and apply to personal behaviour. It may be that she had to invest substantial time and effort to use the app to achieve desired goals. Thus, an imbalance between perceived investment and perceived value may prompt disengagement. Personal resources, such as nutrition literacy, may influence the magnitude of the perceived imbalance and impact the propensity for disengagement.

Discussion

This exploration of the individual experience allowed for a broader examination of user engagement over time and suggests a need to extend the current conceptualisation of engagement in the digital health space. This research focussed on women from a lower socioeconomic background thereby addressing a gap in the current literature and providing a context-specific examination of user engagement. Health apps may be a useful tool for supporting behaviour change in lower socioeconomic groups (Graham *et al.*, 2016), but differences in engagement are seen by socioeconomic background (Brusniak *et al.*, 2020). It is important to build evidence on how continued engagement may be supported in this population group to support behaviour change and related health outcomes. The present findings have important theoretical implications in relation to user engagement and also offer valuable practical insights into effective health app design and their use as a behaviour change tool for women from a lower socioeconomic background.

This research prompts the need to reconsider the position of situational involvement throughout the engagement process. Current findings suggest that situational involvement may act as more than an antecedent for engagement and may be a trigger for different phases of engagement intensity. Heightened levels of situational involvement appeared to be associated with stronger levels of engagement while a reduction resulted in the engagement of a lower intensity, in line with the propositions of Vivek *et al.* (2012). Such fluctuations in intensity may comprise the different phases that are proposed to constitute the engagement process (Bowden, 2009; Hollebeek, 2011b). It is important to understand what causes such fluctuations and how stronger levels of engagement may be maintained. Brodie *et al.* (2013) pose that particular triggers may prompt transition between different engagement phases. Based on the current findings, it is proposed that situational involvement may constitute one such trigger. There is currently little distinction in the engagement literature between enduring and situational involvement. The present findings highlight the need for such clarification in future research. Such differentiation will help to clarify their specific and combined impact on the overall involvement response and engagement intensity.

Drawing on these findings, it is possible that prompting situational involvement or increasing the frequency of when the app is viewed as salient, may facilitate stronger levels of continued engagement. How this may be achieved is less clear. The use of push notifications or trigger messages may offer a solution. These are short text messages that are sent to the user from the app regardless of whether or not the user is directly interacting with the app. If a user is experiencing a period of low engagement, theory-driven messages targeting self-efficacy, knowledge and self-care may prompt re-evaluation by the user, which may highlight the need for increased involvement (Sittig *et al.*, 2020). This may

potentially increase levels of situational involvement and strengthen engagement once again.

It is important that notifications are based upon valid behaviour change theory (Sittig *et al.*, 2020), and are viewed as supportive, where the user retains autonomy, rather than evoke a negative emotional response (Dennison *et al.*, 2013; Morrison *et al.*, 2017). Perceived unequal power between the user and the provider may limit engagement (Majid, 2020). As consumers prefer personalised content in their health apps (Solbrig *et al.*, 2017), the content of notifications may be of greater relevance than their timing (De Leon *et al.*, 2014). Consequently, push notifications may facilitate an increase in situational involvement if appropriately designed. However, external factors such as financial constraints may impede the user's capacity to attain goals (Daniel, 2016; Wrosch *et al.*, 2003) and goal re-evaluation may lead to frustration and distress (Carver and Scheier, 1990). This illustrates the fine balance that must be achieved and the need for further exploration.

Engagement is typically viewed as a positively valenced psychological state (Hollebeek and Chen, 2014) but the present findings align with more recent research that acknowledges the presence of negatively valenced dimensions (Heinonen, 2018; Juric *et al.*, 2016). The present research supports the need to adopt a holistic perspective towards engagement and joins those calling for a greater acknowledgement of negatively valenced dimensions as simultaneous contributors to overall engagement intensity (Bowden *et al.*, 2016). Acknowledging the presence of both valenced dimensions may allow for an improved understanding of engagement as their collective contribution appears to influence engagement intensity and propensity for disengagement (Heinonen, 2018; Hollebeek and Chen, 2014). Some authors view negatively valenced dimensions as detrimental where it leads to disengagement (Dolan *et al.*, 2016; Hollebeek and Chen, 2014), which indeed was reflected in these findings. However, the present findings also suggest that negatively valenced expressions may not necessarily be disadvantageous for all users. Indeed, feelings of shame and guilt are considered powerful motivators in the context of engaging in self-regulation (Carver and Scheier, 2011; Lickel *et al.*, 2014). It is important to highlight that such negative affect may prompt a distancing of the self from the object (Lickel *et al.*, 2014), and careful consideration must be given to the potential detrimental impact on the individual.

A perceived imbalance between personal investment and value attained was a significant factor in disengagement. The perceived value attained is crucial as users continuously evaluate the personal investment required to attain desired value (O'Brien and Toms, 2008). As users attempt to reciprocate behaviours, thoughts and feelings in response to perceived benefits (Hollebeek, 2016), individual adaptations are made until a balance is achieved between value and investment to ensure the user feels confident and competent (Hollebeek, 2016; O'Brien and Toms, 2008). Perceived ease of use is continually cited as a key preference in consumer evaluations of health apps (Ball *et al.*, 2014; López *et al.*, 2017; Solbrig *et al.*, 2017), although this may vary depending on individual user perceptions (Brodie *et al.*, 2013). Consequently, the propensity for disengagement may be influenced by individual characteristics and personal resources, such as health literacy levels (Parikh *et al.*, 2020). This may be especially important for those from a lower socioeconomic background who may be less likely to possess sufficient nutrition-related resources (Adams *et al.*, 2015; Turrell and Kavanagh, 2006). This should be taken into consideration during health app design or additional support from a nutrition or health professional may be necessary for the successful use of health apps in this population group.

An individual's stage of behaviour change influences their motivation level and subsequently involvement intensity. Motivated individuals typically display higher levels of interest in those tools viewed as beneficial to goal attainment (Prochaska *et al.*, 2008), thus

representing a more involved individual (Zaichkowsky, 1985). Goal attainment may prompt a shift in motivation, and consequently involvement intensity, as the individual moves into a stage of behavioural maintenance (Kwasnicka *et al.*, 2016; Mastellos *et al.*, 2014). In the present context, this may result in reduced engagement or disengagement as the app is not viewed as relevant to behaviour goals. Furthermore, individuals with shorter-term explicit goals (those with body image higher-order goals in this sample) may more quickly disengage as their goals may be more promptly achieved. Therefore, it is essential that the individual user context and their out-of-app goals are considered as they are likely to influence the engagement process (O'Brien *et al.*, 2020). Further complexity may be added depending on how apps, and other tools, are used as part of broader health behaviour change (Cole-Lewis *et al.*, 2019).

It is important to acknowledge that disengagement may not necessarily constitute a "failure" of engagement. In the context of health apps, disengagement may represent the user's attainment of health goals or sufficient building of personal resources to implement change. Health apps differ from other apps as engagement expression or intensity may represent different outcomes depending on the condition, behaviour and individual. O'Brien *et al.* (2020) argue that a more holistic view of user engagement is required that considers the intended user and their related context. For example, increased use of a mental health app may represent worsening health and be a less desirable engagement indicator (O'Brien *et al.*, 2020). The optimal time for engagement is unknown and is likely to differ by individual user and engagement context (Michie *et al.*, 2017). Attention is often given as to what constitutes optimal engagement but, perhaps, there is a need to also consider what constitutes optimal disengagement. It is likely that "ideal" engagement progression is app specific (O'Brien *et al.*, 2020). Future research could explore this further and help identify how health apps can be designed to facilitate optimal engagement and support behaviour change.

While disengagement from the app may be a natural part of the behaviour change process if associated with goal attainment, there may be a need for continued engagement as the individual seeks to stabilise behaviour and avoid relapse as they enter the behaviour maintenance stage (Mastellos *et al.*, 2014). Health apps need to be designed appropriately to respond to user needs and facilitate the transition between different stages of behaviour change and support maintenance of the new behaviour. An app that adapts with the user as they progress through their behaviour change journey and meets their changing goals in different contexts is needed (Nicol *et al.*, 2020). This may address the fluctuating levels of situational involvement that influence engagement intensity and continued engagement. An initial step may be to identify the behaviour change techniques or processes of change (Michie *et al.*, 2013; Prochaska *et al.*, 2008) that are necessary to facilitate transition at each stage of the behaviour change journey, and how they may be best incorporated into an app. Additionally, the use of machine learning and environmental data may open up new avenues for more dynamic apps that are better tailored to the user and their individual context (Theilig *et al.*, 2019). While research in this area is currently limited, it offers exciting opportunities to examine app design, user engagement and behaviour change.

It is important to acknowledge that behaviour change and behaviour maintenance are theoretically distinct (Kwasnicka *et al.*, 2016; Rothman, 2000), and different intervention approaches are necessary. Although not specific to health apps, a number of intervention approaches to support behaviour maintenance are proposed by Kwasnicka *et al.* (2016). These include helping individuals to maintain behaviour maintenance motives, facilitating behaviour self-regulation, supporting habit and routine development and providing social support. It is likely that such approaches could be integrated into an app but further work is necessary to explore how this may be best achieved. Greater collaboration between health

behaviour scientists and app developers is recommended to address these particular gaps and to facilitate continued engagement and sustained behaviour change (Hingle and Patrick, 2016; Michie *et al.*, 2017).

The importance of individual user characteristics was clear. Differences in personal resources influenced the extent to which engagement was viewed as effortful or valuable to the user, which subsequently influenced the user's propensity for disengagement. Individual levels of situational involvement influenced the intensity of engagement expressed. As demonstrated elsewhere (Nicol *et al.*, 2020; Parikh *et al.*, 2020), user characteristics may shape the engagement process, which is an important consideration for practitioners. It suggests that a one-size-fits-all approach does not apply and emphasises the need for a person-centered approach to app development (Yardley *et al.*, 2015). As health professionals are interested in using apps as a means of facilitating healthier food behaviours (Chen *et al.*, 2017; Timon, 2018), it is important that they recommend those most likely to be engaging and effective for the individual. This will require a move beyond the use of standard socio-demographic measures, such as age and education (Bhuyan *et al.*, 2016; Bol *et al.*, 2018; Carroll *et al.*, 2017), when recommending health apps to individuals. Differences in engagement go beyond such traditional demographic boundaries (Bhuyan *et al.*, 2016; Marbach *et al.*, 2019) and a focus on an individual's personal resources may be more useful. Focussing on personal resources, such as nutrition literacy and motivation (König *et al.*, 2018), may better identify if a particular app may facilitate change for an individual or if additional and/or alternative resources are required. It is also important that healthcare professionals acknowledge the dynamic nature of user engagement and that different supports or personal resources may be required at different stages of the user journey to respond to user needs (Nicol *et al.*, 2020). Engagement is not a static and stable process but one that changes over time as the user and their context adapts.

Implications

The present research makes two clear contributions to the existing literature with both presenting interesting opportunities for future research. Firstly, the research suggests a need to reconsider the relationship between involvement and engagement and to more clearly distinguish between enduring and situational involvement in future research. Existing engagement literature (Brodie *et al.*, 2011; Leckie *et al.*, 2016) views involvement solely as an antecedent, but the present findings suggest that situational involvement may continue to influence engagement intensity over time as changing levels may trigger different phases of engagement. This finding contributes to existing knowledge as it builds on the work of Hollebeek (2011b), who proposed a dynamic model of engagement. In that model, the transition between different states of engagement intensity represented different phases of the engagement process. The present findings add to this perspective by proposing that changes in situational involvement may constitute one trigger for transition between different states.

The present findings also suggest that enduring and situational involvement may have different influences on the engagement process, thereby broadening the current conceptualisation of user engagement. There is, however, little distinction in the engagement literature between these two types of involvement. It may be necessary to clarify their particular roles in the engagement process in future research to better understand their particular roles. The potential importance of situational involvement highlights opportunities for future research. As this was an exploratory qualitative piece of research, there is a need to use quantitative methods to more specifically examine the relationship between situational involvement and engagement intensity over time. This will

help elucidate whether it does have an influence beyond initiation and act as a trigger for transition between engagement phases. There is also a need to examine the role of involvement, both enduring and situational, in alternative contexts to ensure the current findings have broader application than the present focus of health apps.

The second contribution of this research relates to the importance of individual characteristics in shaping the engagement process. Differences in engagement at an individual level were demonstrated, both in relation to the type and intensity of engagement expressed. Findings highlight the need to consider the everyday life of the user, and their varied and multiple goals that change in salience over time. This has clear implications for health app design and the authors call for a greater focus on tailoring of health apps to support optimal engagement. Indeed, much research highlights consumers' preference for features that can be tailored to individual goals and personal resources (Alturki and Gay, 2019; Appleton *et al.*, 2019; Solbrig *et al.*, 2017). The ability to tailor an app according to preferred behaviour change strategies or relevant psychological measures may limit the potential detrimental effect on engagement and facilitate behaviour change (Gilliland *et al.*, 2015; Lyzwinski *et al.*, 2018; Perski *et al.*, 2017). A person-centered approach or participatory design (Spinuzzi, 2005; Yardley *et al.*, 2015) is essential to identify those factors, personal or app-specific, that may aid engagement at different stages. Such an approach may also offer insight into appropriate measures or indicators, of engagement and disengagement that are relevant to the intended user context.

The means in which tailoring is achieved must be carefully considered as it typically requires time and effort on behalf of the user (Blecker and Abdelkaf, 2006; Chang and Chen, 2009; Piller *et al.*, 2005). This may not be acceptable for all and a staged-approach to tailoring may be useful (Sigala, 2006). There is, however, little evidence currently available on how such a staged approach may be best achieved. This highlights an important area for future research. Integrating appropriate personal data from different apps and relevant sources may also support a tailored approach, although how this may be best achieved in the context of general data protection regulations is unclear. Future research could explore different options for tailoring in health app design, which may identify those approaches most likely to sufficiently engage different user groups and facilitate behaviour change.

Limitations

The present research was based upon the user's reflective experience. This allowed for the exploration of context-specific factors that may influence engagement (Gray, 2014), which was important given the dearth of research available in this specific context. The inclusion of app usage data may have been beneficial to provide an objective measure of engagement and examine its potential influence on the user experience. However, this was not available to the research team. Another proposed option was to incorporate daily records in which participants kept an account of engagement but this was considered too burdensome for the specific sample. Participants from a lower socioeconomic background are typically harder to retain in research studies (Bonevski *et al.*, 2014; Pescud *et al.*, 2015) and a balance between participant burden and data collection was necessary.

It is important to acknowledge the potential for selection bias in the sample population. The majority of participants had adequate nutrition literacy and may reflect a more health-conscious sample of individuals. All participants also reported that they were coping or living comfortably on their present income, which may suggest that financial resources were not an important barrier to healthy eating. Such characteristics may limit the transferability of findings to a broader lower socioeconomic population. It may, however, reflect those individuals that are most likely to avail of a health app in a real-life intervention setting, and

allows insight into their experience. Nevertheless, it is important to acknowledge the potential bias that may be introduced by the participant profile. It appeared that nutrition literacy may influence the engagement process. As this sample predominantly had adequate nutrition literacy, it may have influenced the elements of the participant experience that emerged as important. It is possible that a different group of participants may have identified alternative elements of the user experience as being of greater importance.

The apps used in this study were drawn from publicly available apps and chosen based on pre-defined criteria relating to the quality of nutrition information, the behaviour change techniques that were integrated and app user quality. Unfortunately, and as highlighted in our previous research (Flaherty *et al.*, 2018), the majority of health apps focus on weight management with healthy eating encompassed within this. This focus on weight loss may have been viewed as incongruent by some participants and influenced their engagement and the propensity for disengagement. While many participants had set goals in relation to weight loss, this may not have been the primary reason for app engagement. Therefore, it is possible that disengagement was more likely for some participants due to this potential disconnect between personal goals and the app's aim. Nevertheless, healthy eating was a component of each app, and thus, could aid behaviour change towards healthier food behaviour.

Note

1. Examples of occupations included in the eligible socioeconomic categories – non-manual: waitress, beautician, administration assistant; manual skilled: electrician, plasterer, butcher; semi-skilled: security guard, scaffolder, care assistant; unskilled: labourer, refuse collector, cleaner.

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