Developing and evaluating MindMax: promoting mental wellbeing through an Australian Football League-themed app incorporating applied games (including gamification), psychoeducation, and social connectedness

A thesis submitted to fulfil requirements for the degree of

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by

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Table of contents

Declaration of originality

I certify that to the best of my knowledge, the intellectual content of this thesis is my own work, except where duly acknowledged in the text. This thesis has not previously been submitted for any degree at the University of Sydney, or any other University.

Furthermore, I certify that all the assistance received in preparing this thesis and sources has been acknowledged.

Vanessa Wan-Sze Cheng

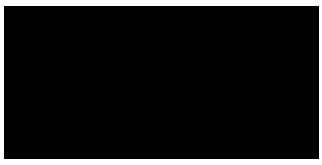
Date: June 24, 2019

Authorship attribution statement

This thesis principally represents the work of Vanessa Wan-Sze Cheng. The larger research project protocol was designed with Tracey Davenport, Daniel Johnson, and Kellie Vella. Vanessa Cheng was primarily responsible for all the work associated with the research that is reported in the chapters of this thesis, including ethics applications, trial management, data collection, data preparation, data analysis and interpretation, and manuscript drafting. Assistance in data analysis was also provided by Kellie Vella for Chapters 2 and 4, and assistance in data interpretation was provided by Tracey Davenport for Chapters 4 and 5. Finally, as reported in Chapter 3, an independent knowledge translation team affiliated with The University of Sydney's Brain and Mind Centre assisted the participatory design and user testing process.

In chapters that are published papers with multiple authors, each co-author also reviewed and provided comments on manuscript drafts, and approved the final versions of papers before submission and/or publication.

As supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statements above are correct.



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Additional relevant output during candidature

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Learnings and contributions from the work reported in this thesis, done by the candidate, also informed these additional peer-reviewed publications, conference presentations, and reports to stakeholder, which in turn further informed the material presented in the main body of this thesis.

Peer-reviewed publications

- Mitchell, J., Vella, K., Johnson, D., Peever, N., **Cheng, V.W.S.**, Davenport, T., Burns, J., Hickie, I., Kyle, A., Hedley, B., & Johnson, B. (2017, May). MindMax: Using videogames and sport to engage young men and improve wellbeing. *2nd Symposia on Computing and Mental Health*. in *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, Denver, United States.
- **Cheng, V.W.S.** (2017). Studying the Effectiveness of Game-Based Solutions in a Wellbeing App. In *Extended Abstracts Publication of the Annual Symposium on Computer-Human Interaction in Play* (pp. 691-694). Amsterdam, The Netherlands: ACM.
- Vella, K., Johnson, D., Peever, N., **Cheng, V.W.S.**, Davenport, T., & Mitchell, J. (2017). Motivating engagement with a wellbeing app using video games and gamification. Paper presented at the Annual Symposium on Computer-Human Interaction in Play Companion Workshop, Amsterdam, The Netherlands.
- Vella, K., Johnson, D., **Cheng, V.W.S.**, Davenport, T., Mitchell, J., Klarkowski, M., & Phillips, C. (2019). A Sense of Belonging: Pokémon GO and Social Connectedness. *Games and Culture*, *14*(6), 583-603. http://dx.doi.org/10.1177/1555412017719973

Conference presentations

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technologies for mental health and wellbeing. Presented at the 4th International Conference on Youth Mental Health, Dublin, Ireland.

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Conference posters

- **Cheng, V.W.S.** (2019, October). A retrospective of developing and evaluating MindMax, a sport-themed mental wellbeing app incorporating applied games, psychoeducation, and social connectedness. Poster presented at the 5th International Conference on Youth Mental Health, Brisbane, Australia.

Reports to stakeholder

As part of the work reported in this thesis, the candidate also substantially contributed to Section 7 (participatory design workshops), Section 8 (user experience testing), Section 10 (naturalistic

evaluation trial), and Appendices A, B, C, D, G, H of these internal reports. This work was later revised for publication and forms Chapters 2 and 3 of this thesis.

- Mitchell, J., Johnson, D., Vella, K., Klarkowski, M., Peever, N. (2018, January). *MindMax – Interim Research Report*. Internal report to Movember Australia. Unpublished.
- Mitchell, J., Johnson, D., Vella, K., Klarkowski, M., Peever, N. (2018, March). *QUT MindMax Research Report*. Internal report to Movember Australia. Unpublished.

List of abbreviations

This section lists all abbreviations used in this thesis (including chapters containing previously published material).

ABMT: Attentional bias modification training

AFL: Australian Football League

AFLPA: Australian Football League Players' Association

CD-RISC 10: Connor-Davidson Resilience Scale (10 items)

eHealth: Internet health

GHSQ: General Help-Seeking Questionnaire

mHealth: Mobile health

MVP: Minimum Viable Product

OIT: Organismic integration theory

PD: Participatory design

PSD: Persuasive systems design

RCT: Randomised controlled trial

RQ: Research question

SDT: Self-determination theory

UI: User interface

UX: User experience

WEMWBS: Warwick-Edinburgh Mental Wellbeing Scale

Abstract

Gamification is increasingly being used as a behavioural change strategy to increase engagement with apps and technologies for mental health and wellbeing. While there is promising evidence supporting the effectiveness of individual gamification elements, there remains little evidence for its overall effectiveness. Furthermore, a lack of consistency in how 'gamification' and related terms (such as 'applied games', an umbrella term of which gamification is one type) are used has been observed within and across multiple academic fields. This contributes to the difficulty of studying gamification and decreases its accessibility to people unfamiliar with applied games. Finally, gamification has also been critiqued by both game developers and by academics for its reliance on extrinsic motivators and for the messages that gamified systems may unintentionally convey. In this context, the aims of this thesis were fourfold: 1) to iteratively co-design and develop a gamified app for mental health and wellbeing, 2) to evaluate the eventuating app, 3) to consolidate literature on gamification for mental health and wellbeing, and 4) to synthesise findings into practical guidelines for implementing gamification for mental health and wellbeing.

Chapter 2 reports the first study which addresses the first aim of this thesis. Six participatory design workshops were conducted to support the development of MindMax, an Australian Football League (AFL)-themed mobile phone app aimed at AFL fans (particularly male ones) that incorporates applied games, psychoeducation, and social connectedness. Findings from these workshops were independently knowledge translated and fed back to the software development team, resulting in a MindMax prototype. This prototype was further tested with 15 one-on-one user experience testing interviews at three separate time points to iteratively refine MindMax's design and delivery of its content. The findings of this study suggest that broadly, participants endorsed a customisable user experience with activities requiring active user participation. These specifications were reflected in the continual software updates made to MindMax.

Chapters 3 and 4 report the second and third studies which address the second aim of this thesis. As regular content, performance, and aesthetic updates were applied to MindMax (following the

model of the wider tech industry), a naturalistic longitudinal trial, described in Chapter 3, was deemed to be the most appropriate systematic evaluation method. In this study, participants (n=313) were given access to MindMax and asked to use it at their leisure, and surveys were sent out at multiple time points to assess their wellbeing, resilience, and help-seeking intentions. Increases in flourishing (60-day only), sense of connection to MindMax, and impersonal help-seeking intentions were observed over 30 and 60 days, suggesting that Internet-based interventions like MindMax can contribute to their users' social connectedness and encourage their help-seeking.

The third study, described in Chapter 4, reports a secondary analysis of data collected for Chapter 3, and further explores participants' help-seeking intentions and their links to wellbeing, resilience, gender, and age. An explanatory factor analysis was conducted on Day 1 General Help-Seeking Questionnaire (GHSQ) data (n=530), with the best fitting solution resulting in three factors: personal sources, health professionals, and distal sources. In addition to providing more evidence that younger people aged 16–35 categorise apps and technologies for mental health and wellbeing like MindMax alongside other distal social sources such as phone helplines and work or school, our findings also suggest that the best way to target individuals who are least likely to seek help, particularly men, may be through these distal sources as well.

Chapter 5 reports the fourth study, which addresses the third aim. In order to consolidate literature on gamification for mental health and wellbeing, this systematic review identified 70 papers that collectively reported on 50 apps and technologies for improving mental health and wellbeing. These papers were coded for gamification element, mental health and wellbeing domain, and researchers' justification for applying gamification to improving mental health and wellbeing. This study resulted in two major findings: first, that the current application of gamification for mental health and wellbeing does not resemble the heavily critiqued mainstream application that relies on extrinsic motivators; and second, that many authors of the reviewed papers provided little or no justification for why they applied gamification to their mental health

and wellbeing interventions. While the former finding is encouraging, the latter suggests that the gamification of mental health and wellbeing is not theory-driven, and is a cause for concern.

Finally, to address the final aim of this thesis, all study learnings were synthesised into practical guidelines for implementing gamification for mental health and wellbeing. First, it is important to assess the suitability of implementing gamification into the intervention. Second, this implementation should ideally be integrated at a deeper, systemic level, with the explicitly qualified intention to support users, evidence-based processes, and user engagement with these processes. Third, it is important to assess the acceptability of this gamified intervention throughout its development, involving all relevant stakeholders (particularly representative end user populations). Fourth, it is important to evaluate the impact of this gamified intervention. Fifth, and finally, comprehensive and detailed documentation of this process should be provided at all stages of this process.

This thesis contributes to a growing literature on the increasing importance and relevance of Internet-based resources and apps and technologies for mental health and wellbeing, particularly for young people. Given the dominance of games in society and culture across history, and the increasing contemporary prominence of digital games (also known as video games) in particular, gamification is uniquely positioned to have the potential to make large contributions to mental health and wellbeing research. In this context, this thesis contributes a systematically derived operationalisation of gamification, an evaluation of a gamified app for mental health and wellbeing, and best practice guidelines for implementing gamification for mental health and wellbeing, thereby providing frameworks that future implementations of gamified mental health and wellbeing interventions and initiatives may find useful.

Chapter 1: Introduction

1.1. Overview

Gamification, most commonly defined as the application of game design principles in non-game contexts (Deterding, Dixon, Khaled, & Nacke, 2011), is growing increasingly popular as a behavioural change technique (Cugelman, 2013). Practically, however, and especially in tandem with mobile phone apps, the term may conjure up impressions of an often shallow, clingfilm-like application of 'gamification elements', most commonly badges, achievements, progress bars, and social comparison.

This chapter serves as an introduction to this thesis. First, I outline the potential of eHealth and mHealth, as well as their problems with attrition and adherence. I then contextualise gamification as one of many techniques used to encourage engagement and re-engagement with health and wellbeing interventions and initiatives. My focus then narrows to gamification for mental health and wellbeing, and I review current research on gamification and mental health, particularly in the context of its effectiveness. I then describe the problems with current conceptualisations and applications of gamification, including inconsistent use of terminology and the tendency of mainstream gamification to rely on competition and extrinsic rewards. I also argue that while gamification is mostly used to increase engagement, this is short-sighted, as gamification has the potential to support many other processes as well.

Then, I look to games, both digital and non-digital, to explore how sociological conceptualisations of games and play can drive gamification design. Specifically, I review debates on what games (of which digital games form a subset) are and demonstrate that the interaction of games with society is not a new, unprecedented phenomenon. I then review how games engage their players according to self-determination theory. Finally, I discuss the rhetoric implied by games and gamified systems, and how gamified apps and technologies for mental health and wellbeing can

be assessed for acceptability through participatory design (and co-design) methodologies. This chapter concludes with a summary and a statement of the aims of this thesis.

1.2. Contextualising gamification for health and wellbeing

1.2.1. The attrition problem with eHealth and mHealth

With the near-ubiquity of Internet access and computer ownership, whether in desktop, laptop, or mobile phone form (Australian Bureau of Statistics, 2018), and advances in Internet and communications technologies, infrastructures, and speed, Internet-based initiatives are increasingly being considered a cost- and resource-efficient method of delivering health interventions to the general population. eHealth and mHealth technologies (such as mobile phone apps and Web-based interventions) can be accessed from any location in the world with an Internet connection, and as such have the potential to overcome geographical, awareness, attitudinal, and potentially even financial barriers to access (Price et al., 2014). The flexibility of eHealth and mHealth technologies also means they can be deployed at any part of the treatment timeline (pre-, during, and post-treatment) and can serve a variety of roles such as education (including psychoeducation and skills training), symptom tracking, distraction from pain or unpleasant emotions, and communicating remotely with a therapist (Price et al., 2014). In tandem with face-to-face consultations and treatments, eHealth and mHealth technologies have the potential to fundamentally restructure the healthcare system.

However, while clinical evaluations of eHealth technologies have found beneficial effects on mental health and wellbeing (Spijkerman, Pots, & Bohlmeijer, 2016), potentially resulting in better outcomes than their face-to-face counterparts (Lappalainen et al., 2014), they have also observed considerable attrition rates. Notably, a review of Web-based interventions aimed at common mental disorders found highly variable rates of adherence to study protocol ranging from 3.37% to 100% (Brown et al., 2016). (The authors could not calculate more specific measures of adherence, such as dropout or module completion rates, due to variations in how studies reported adherence.) Attrition rates increase, and adherence rates decrease, further once

the technology is rolled out for public usage (Fleming et al., 2016). For example, a study comparing module completion in an online cognitive behavioural therapy intervention found that 66% of trial participants had completed two or more modules of the program, compared to only 15.6% of community participants (Christensen, Griffiths, Korten, Brittliffe, & Groves, 2004).

One approach to addressing these high attrition and low adherence rates is to adopt a proactive strategy of encouraging users to make contact, and then continually engage, with the intervention. Evidence from a meta-analysis on eHealth interventions supports this approach, finding that greater intended frequency of contact with an intervention is associated with decreased attrition rates (Kelders, Kok, Ossebaard, & Van Gemert-Pijnen, 2012). Many strategies have been proposed and employed in eHealth and mHealth to encourage engagement and re-engagement, including persuasive systems design (PSD; Oinas-Kukkonen & Harjumaa, 2009), supportive accountability (Mohr, Cuijpers, & Lehman, 2011), and gamification (Cugelman, 2013; Deterding et al., 2011; Huotari & Hamari, 2012).

The latter, gamification, is the focus of this thesis. Specifically, while gamification has been broadly applied for health and wellbeing, and for multiple purposes including engagement, education, and assessment, this thesis focuses on the application of gamification in apps and technologies for improving mental health and wellbeing.

1.2.2. Games, 'applied games', and 'gamification'

Games have been a constant presence in human culture across history, from prehistoric dice games to classic board games like chess, children's games like hopscotch, pencil-and-paper games like crosswords and Sudoku, and the more modern digital game (also known as a video game or videogame). Similarly, games and play have a long history of interacting with, and being applied to, non-game contexts, for example via lotteries, rituals, and organised sport (Caillois, 1958/2001). Any intentional instance of this would be classified as 'applied games', an umbrella term defined as the "implementation of a subject, inspired by and designed along a context- and user-centric transfer of design concepts and qualities from the game world" (Schmidt, Emmerich,

& Schmidt, 2015, p. 107). In order to establish relevance outside the field of game studies, and to group the various types of applied games by their similarities in design process and purpose, the term 'applied games' is deliberately broad in scope (Schmidt et al., 2015), and includes concepts such as, but not limited to, 'serious games', 'games-based learning', and 'gamification'.

Gamification has enjoyed significant popularity in the past decade in industry and academia, and is arguably the most well-known type of applied game (Hamari, Koivisto, & Sarsa, 2014; Johnson et al., 2016). The term 'gamification' has been used to describe multiple related, but distinct concepts in the past, such as converting other pieces of media into game format (Robertson, 2010) or as a cynical marketing ploy to co-opt all forms of applied games (as described by Bogost, 2014). However, recent academic consensus has settled on using it to describe the process that Deterding et al. (2011) define as "the use of game design elements in non-game contexts" (p. 2). This thesis also (partially) takes this approach. Real-world examples of gamification include the Nike+ system, which aims to promote regular running through socially competitive mechanics, and Code Academy, which rewards users who complete its educational courses with points and badges (Sicart, 2014).

Despite the growing consensus on what 'gamification' describes, deviations still exist in the literature (as observed by Seaborn and Fels, 2015). This may be partially due to gamification's explosive popularity, and the wide variety of disciplines from which its users and researchers come, all of whom approach it with their own biases. The unclear boundaries of the term 'gamification' are further exacerbated by its association with, and reliance on, the concept of 'games'. As games are such a universal, fundamental part of culture (Caillois, 1958/2001), and notoriously difficult to define (Stenros, 2016), it is only natural that different life, work, and research experiences would colour different individuals' interpretation of the term. The initial confusion in the literature surrounding the term 'gamification' and its sheer volume is an obstacle, at best, for those interested in gamification but who are unfamiliar with applied games.

Deterding et al.'s (2011) definition of 'gamification' places 'play' and 'games' in opposition to each other (Figure 1.1). This is consistent with sociologist Roger Caillois' conception of play as a spectrum between '*paidia*' (free, unstructured play) and '*ludus*' (rules-based, goal-directed play—that is, games). As shown in Figure 1.1, on a continuum of game vs. play and whole vs. parts, gamification (also referred to as 'gameful design' by Deterding et al., 2011) occupies the top-right quadrant. That is, it consists of parts of games (as opposed to games, including serious games, which are wholly games). Gamification is also positioned as conceptually opposite to toys (wholly play) and related, but distinct, to playful design (partially play).

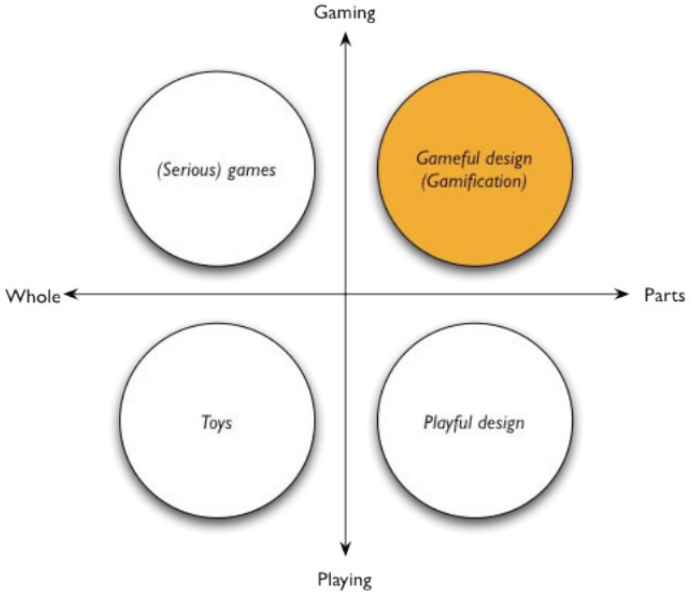

Figure 1.1. Gamification in relation to other forms of games and play (Deterding et al., 2011)

Deterding et al.'s (2011) definition is frequently cited in calls for applying gamification for health and wellbeing (e.g. Cugelman, 2013; King, Greaves, Exeter, & Darzi, 2013), which may have contributed to its dominance in eHealth and mHealth literature. However, alternate definitions for gamification exist. Huotari and Hamari (2012) propose one that is particularly suited for application to health and wellbeing, including mental health: "a process of enhancing a service with affordances[1] for gameful experiences in order to support [a] user's overall value creation"

[1] An affordance is a property of an object or experience that indicates how it can be interacted with. For example, an affordance of a cup is that it glass be used to scoop up or contain water for drinking. Alternatively, it can also be turned upside down and played as a musical instrument.

(p. 20). By placing the emphasis back on the *service* (Huotari and Hamari use this term in a general goods and services context), this definition complements the goals of health services research. While the Deterding et al. definition emphasises the *elements* of game design and is therefore useful as a (taxonomic) lens through which to approach *researching* gamification, the Huotari and Hamari definition is useful as a lens through which to *implement* it.

1.2.3. Gamification for mental health and wellbeing

Gamification is experiencing increasing application in eHealth and mHealth, often in the form of badges, leaderboards, points, and challenges (Miller, Cafazzo, & Seto, 2014). This section reviews the academic implementation of gamification for health and wellbeing, with a particular focus on mental health and wellbeing, before reviewing research on the general effectiveness of gamification and discussing issues that may hinder this research. While this thesis focuses broadly on apps and other technologies, the bulk of articles reviewing gamification for health and wellbeing limit their scope further (for example, to stress management mobile phone apps on the Google Play Store, Hoffmann, Christmann, & Bleser, 2017; or Web-based mental health interventions, Brown et al., 2016). Therefore, in the interest of clarity, and to ground individual review findings in context, I discuss specific review articles alongside their stated research scope.

In the field of physical health, gamification is commonly applied to physical fitness and diet (Lister, West, Cannon, Sax, & Brodegard, 2014) as well as chronic illnesses (AlMarshedi, Wills, & Ranchhod, 2017; Lazem, Webster, Holmes, & Wolf, 2015; Sardi, Idri, & Fernández-Alemán, 2017). Notably, Lister et al.'s (2014) review on physical fitness and diet mobile phone apps found that gamification was present in just over half of the sampled apps, and that just under a quarter of their sample contained more than three gamification elements (as defined by the authors).

Gamification has also made some headway into the mental health and wellbeing field. It has been applied to mood and resilience in the app Superbetter (Roepke et al., 2015), and also to anxiety disorders (Dennis & O'Toole, 2014; Miloff, Marklund, & Carlbring, 2015), tobacco and substance misuse (Earle, LaBrie, Boyle, & Smith, 2018; Struik, Bottorff, Baskerville, & Oliffe, 2018), and sleep

(Werner-Seidler et al., 2017). However, compared to physical health, there seems to be less uptake of gamification for mental health purposes. For example, a review on stress management apps in the Google Play Store found low levels of use of gamification (Hoffmann et al., 2017). Specifically, gamification was only employed in 32% of the sampled apps, and the apps that did use gamification tended to contain only one gamification element (as defined by the authors).

Comparing the results of Lister et al.'s (2014) and Hoffmann et al.'s (2017) reviews suggests that gamification seems to be less broadly applied for mental health purposes, in terms of both number of (mental) health domains and in number of gamification elements used. Furthermore, a recent systematic review of gamification in eHealth (the authors appear to include both computer- and mobile phone-accessed interventions, and both gamified interventions and serious games, in their scope) found no examples of gamification applied to mood disorders (Sardi et al., 2017). While gamified interventions targeting mood disorders have emerged in recent years (Bakker, Kazantzis, Rickwood, & Rickard, 2018; Fitzpatrick, Darcy, & Vierhile, 2017; Giosan et al., 2016; Pieters et al., 2017), the relative lack of gamification, both in breadth and depth of application, in mental health compared to physical health may reflect greater difficulty in its implementation. It could also reflect a reluctance to apply the commonly used gamification elements of reward, competition, and social comparison to mental health (Ahtinen et al., 2013; Jessen, Mirkovic, & Ruland, 2018). As discussed further in this section and in Chapter 5, it may also reflect a difference in how individual researchers conceptualise gamification (Seaborn & Fels, 2015).

However, while there is increasing interest in using gamification for health purposes, particularly to target low engagement with health interventions and improve adherence to health behaviours[2], there is a relative lack of research into how effective gamification is in increasing engagement and promoting favourable health outcomes (Sardi et al., 2017). As gamification is still an emerging

[2] Health behaviours are defined by Gochman (1997) as "those personal attributes such as beliefs, expectations, motives, values, perceptions, and other cognitive elements; personality characteristics, including affective and emotional states and traits; and overt behavior patterns, actions and habits that relate to health maintenance, to health restoration, and to health improvement" (p. 3).

area of inquiry, research into it has been exploratory and solution-focused instead of evaluative. For example, a review of games (the authors included gamification in their review) applied to diabetes could not draw a conclusive relationship between the usage of gaming concepts (including gamification) and clinical health outcomes (Lazem et al., 2015). Similarly, there is little to no evidence on whether the effects of gamification persist in the long-term (Cugelman, 2013; Sardi et al., 2017). In response, there have been calls for stronger evaluations of the effectiveness of gamification (Hoffmann et al., 2017).

What evidence there is for the effectiveness of gamification tends to be ambiguous. Indeed, there is no one accepted definition of effectiveness. A broad descriptive review of empirical studies on the effects of gamification (mostly limited to the fields of computer science, education, and management science) suggested that the implementation of gamification has positive general effects; however, the authors also suggest that this could potentially be due to a novelty effect, and that the removal of gamification could induce loss aversion (not wanting to lose already earned badges and points) and alienate currently engaged users as a result (Hamari et al., 2014). The authors also note possible confounding effects of the context of gamification and individual differences between users, and that the effects of gamification can be more complex than is assumed.

Within the health literature, one review on Web-based mental health interventions containing gamification found no significant overall difference in rates of adherence to interventions based on number of gamification features incorporated; however, the authors were limited by a lack of detail in reporting (of both adherence and gamification) in the papers reviewed (Brown et al., 2016). In comparison, a review on physical fitness and diet mobile phone apps found that while the presence of game elements (as defined by the authors) was associated with app popularity (as quantified by the number of app reviews), the presence of gamification (again, as defined by the authors) was not (Lister et al., 2014). Lister et al. argue that this could potentially be due to inappropriate and/or incomprehensive application of gamification strategies, such as a poor

balance between the effort needed to obtain a reward and the value of the reward itself. Importantly, while both reviews are broadly about gamification for health, they vary in how they conceptualise gamification, and in what they consider gamification elements or features. Furthermore, gamification terminology is not used consistently across broader fields (including but not limited to health and computer science).

It is clear that current evidence for the general effectiveness of gamification for health and wellbeing is inconclusive. Studies empirically testing individual elements of gamification, however, have produced stronger results suggestive of beneficial effects. For example, in a relatively large-sample (n=1,162), between-subjects study, Comello et al. (2016) found that using game-inspired feedback formats (progress bars and scorecards) across various health domains (e.g. tobacco use, physical activity) led to more positive comprehension and engagement outcomes in certain cases and non-inferior outcomes in others, supporting the adoption of this particular format of behavioural feedback. Similarly, there is evidence that the presence of badges (Hamari, 2017) and social comparison (measured through social media-esque 'likes'; Hamari & Koivisto, 2015) are individually associated with greater engagement with a gamified service. However, in their study comparing different versions of a pedometer app containing different functionalities, Zuckerman and Gal-Oz (2014) report that while a 'quantified' version providing behavioural feedback outperformed baseline (the app in an inactive state with no functionality or interactions), 'gamified' versions of the quantified app that added either virtual rewards (points) or social comparison (a leaderboard) did not outperform the quantified version. Notably, follow-up qualitative interviews in that study found that most participants did not see the points as meaningful. This could therefore be indicative, again, of inappropriate application of gamification techniques.

A taxonomy of gamification, and a systematic framework for evaluating it, would be a useful tool to advance gamification research in general, and research on its effectiveness in particular. Multiple taxonomies and frameworks for the application and study of gamification for health and

wellbeing, that vary in purpose and in which stage of research and development they are most suitable for, have been proposed (AlMarshedi et al., 2017; Hoffmann et al., 2017; Lister et al., 2014). While each gamification taxonomy varies slightly, they also share common elements, such as levels, rewards, social competition, points, and narrative. Hoffmann et al.'s (2017) taxonomy is particularly notable, as it groups its 17 gamification techniques into economic, social, performance-oriented, and embedding-focused domains. (This taxonomy is an adaptation of the 13 game elements and 6 gamification elements identified by Lister et al., 2014, in their review of physical fitness and diet apps.) With this taxonomy, Hoffmann et al. were able to identify that the stress management apps in their review relied mostly on performance-oriented (e.g. providing feedback) gamification techniques, and were hence able to recommend that other types of gamification techniques, such as embedding-focused, be applied to stress management apps in the future. This approach can be generalised to all types of mental health apps.

As mentioned earlier, however, conceptualisations of what gamification is vary between reviews, making them difficult to compare against each other. For example, while Brown et al. (2016) assign avatars[3] to their gamification feature 'Story/theme', Lister et al. (2014) consider them a 'game element' and Johnson et al. (2016) consider them a standalone 'gamification element'. Furthermore, Lister et al. and Johnson et al. consider avatars and story to be separate elements. This makes Brown et al.'s finding that 'Story/theme' was the most common gamification feature in their sample of Web-based mental health interventions difficult to interpret, especially as they do not provide any justification for why these two elements were combined into one feature in their review.

Taxonomies of gamification elements within eHealth and mHealth also deviate considerably from those identified in other fields, raising questions as to their validity. For example, while Hoffmann et al. (2017) list 'parallel communication systems' and '3-D environments' as gamification techniques, these techniques are not present in a comprehensive, 49-element taxonomy of

[3] A virtual representation of a player or user within the software or digital platform, that is usually customisable.

gameful design elements developed by researchers in the field of human-computer interaction (Tondello, Mora, & Nacke, 2017). Tondello et al.'s (2017) taxonomy also includes design elements that are not present in the other taxonomies reviewed above, such as 'signposting', 'Easter eggs', and 'collection'[4]. As one would reasonably expect close overlap, this raises questions as to whether existing taxonomies of gamification elements in eHealth and mHealth are sufficiently comprehensive. In the same vein, we must also evaluate whether we in eHealth and mHealth require high levels of detail (to the tune of 49 design elements) in our taxonomies.

Before we can use taxonomies as a framework to assess and validate our applications of gamification for health and wellbeing, therefore, it is important to ensure they are comprehensive, valid, and meaningful. To do so, we must outline, explore, and consider just what gamification actually entails.

1.2.4. What is 'gamification'?

Chapter 1.2.2 describes how the diverse origins of the term 'gamification' have led to difficulties in approaching the literature, particularly for researchers unfamiliar with game studies and applied games. Chapter 1.2.3 further demonstrates how differing conceptualisations of what gamification is, and what the elements of gamification are, make research exploring the effectiveness of gamification for health and wellbeing more challenging. It is clear that consensus must be reached in the health literature on what gamification is, and what it is not.

There is a widespread assumption (both within and beyond the health literature) that gamification is characterised by, or even entirely comprised of, real-time feedback, rewards, goal-setting, and social comparison and competition (Miller et al., 2014). Multiple reviews on gamification have found that these are the most commonly implemented gamification elements (Hamari et al., 2014; Sardi et al., 2017). Outside the health literature, this approach has been

[4] (from Tondello et al., 2017) "Signposting: Just-in-time cues show me the next possible actions or paths to follow; Easter eggs: Finding surprise content deeply hidden inside the application or game's structure; Collection: Completing collections of items or achievements with special meaning in the application or game."

termed the 'points, badges, and leaderboards' (or PBL) approach (Y.-k. Chou, 2015), 'BLAP gamification' (badges, levels/leaderboards, achievements, and points), and 'rewards-based gamification' (both Nicholson, 2015). In the health literature, this has been termed the 'behaviourist gamification' approach, based on reinforcing healthy habitual behaviour via prompts, repetition, and rewards (Lazem et al., 2015). There has been widespread critique of this application of gamification as being conceptually limited and potentially harmful (Y.-k. Chou, 2015; Nicholson, 2015).

When misapplied, this rewards-based approach to gamification has the danger of undermining the original purpose of the intervention (Nicholson, 2015). While the intent behind applying gamification is usually to harness the intrinsic motivation processes that characterise player engagement with games, if applied inappropriately gamification elements such as points, badges, and leaderboards can be experienced by users as extrinsic motivators (Mekler, Brühlmann, Tuch, & Opwis, 2017; Nicholson, 2015). Current applications of gamification rely almost entirely on such elements (Johnson et al., 2016) instead of elements that may be more suited for facilitating intrinsic motivation.

While extrinsic motivation refers to motivation derived from aiming towards a definable, external outcome, intrinsic motivation refers to motivation derived from internal curiosity or enjoyment (Ryan & Deci, 2000). According to self-determination theory (SDT; discussed in more detail in Chapter 1.3.2), satisfying our innate psychological needs of autonomy, competence, and relatedness facilitates our intrinsic motivation, while a lack of satisfaction of those needs undermines it (Ryan & Deci, 2000). Therefore, if extrinsic motivators (including but not limited to rewards, deadlines, directives, and competition) are perceived to be overly didactic (therefore decreasing experiences of autonomy), intrinsic motivation can be compromised (Ryan & Deci, 2000). Current applications of rewards-based gamification in health rely on extrinsic motivators and therefore have the potential to undermine the healthy habits they are attempting to encourage (McCallum, 2012). As most evaluations of gamification are conducted over relatively

short time frames, evidence on whether gamification leads to long-term behavioural change, or whether it facilitates short-term novelty effects, remains lacking (Cugelman, 2013; Hamari et al., 2014; Nicholson, 2015; Seaborn & Fels, 2015).

A further, more fundamental problem with PBL gamification is that there is nothing inherently *game-like* about these elements (Deterding, 2015). For example, in their study comparing quantified and gamified versions of a pedometer app, Zuckerman and Gal-Oz (2014) note that while goal-setting and real-time feedback have been considered by some researchers to be 'game elements', they are also common behavioural change techniques. However, the same argument can be made for what Zuckerman and Gal-Oz consider to be 'gamified elements': virtual rewards (in the form of points) and social comparison (in the form of a leaderboard). These are both present in the persuasive systems design (PSD) framework (Oinas-Kukkonen & Harjumaa, 2009), along with other commonly applied gamification elements such as badges ('praise' in PSD), social competition ('competition' in PSD), and, indeed, real-time feedback ('self-monitoring' in PSD). Bogost (2014) takes this argument further by pointing out that these elements are also present in everyday, non-gamified objects and processes including word processors (real-time feedback) and customer loyalty programs (rewards). In short, this approach to gamification reduces gamification to its elements and implies an assumption that individual gamification elements have additive, instead of synergistic, effects on the system or service[5] being gamified. This approach ignores that games are a system dependent on the interaction between users and all the components of the system (not just its surface elements), and trivialises motivation by assuming that game elements are inherently entertaining and that their addition is sufficient to make activities fun and engaging (Deterding, 2015).

Outside of academia, this focus on points and rewards has also been criticised by game designers as being reductionist and unreflective of the player experience (Ferrara, 2013; Robertson, 2010). Robertson (2010) in particular suggests that a better label for this approach would be

[5] As referred to by Huotari and Hamari (2012), i.e. in a general goods and services context.

'pointsification' and states that this approach "tak[es] *the thing that is least essential to games* and represent[s] it as the core of the experience" (para. 5; italics present in original). Sicart (2014) extends this point further in his critique of typical applications of gamification (in this case, the Nike+ system) as "offer[ing] an external acknowledgement of a *manifestation* of the good life, a shadow image of a virtuous practice" (p. 228; italics present in original). That is, typical applications of gamification reward *appearing to have done* the behaviour, rather than the behaviour (and its intrinsically enjoyable aspects) itself. These applications of gamification are unsuitable and unhelpful for the purposes of most would-be gamification adoptees, as they fail to represent the full motivational spectrum of how games engage. They are a case of lost potential.

1.2.5. Critiquing gamification for mental health and wellbeing

While consensus on how to define 'gamification' is still emerging, gamification continues to be implemented for mental health and wellbeing. This is despite the relative lack of evidence for its effectiveness and the considerable volume of critique directed at gamification, as reviewed in the previous section. Huotari and Hamari's (2012) definition of 'gamification' implies that how gamification can "enhanc[e] a service" should be considered before it is deliberately implemented "to support [a] user's overall value creation" (both p. 20). However, most descriptions of gamification for health and wellbeing do not appear to do this, instead referring to it solely as a way to increase engagement and providing only the justification that digital games (or video games) are popular (e.g. Cafazzo, Casselman, Hamming, Katzman, & Palmert, 2012; Dennis & O'Toole, 2014; King et al., 2013). In addition to being reminiscent of Seaborn and Fels's (2015) observation that gamification is frequently described as equivalent to other forms of games and applied games, this also suggests that gamification is seen by some as an efficient way to "strip-mine" games of their "useful" elements (Ferrara, 2013, p. 291). However, as argued above, this approach crucially fails to recognise that games are a system that players find engaging precisely because all components of the system (not just the individual elements) work together to create a satisfying player experience (Deterding, 2015). Furthermore, while gamification draws its inspiration and primary principles from games, Deterding et al.'s (2011) definition of

gamification as "the user of game design elements in non-game contexts" (p. 2) makes it clear that they are not the same thing.

While commonly recommended methods for applying gameful design have their flaws (Deterding, 2015), applications of gamification for health and wellbeing do not appear to adhere to even those methods. This suggests a lack of awareness of the controversy, a lack of consideration of the mechanisms that underlie how gamification and games work to engage the user or player, and a lack of communication and effective collaboration between researchers, software developers, and game designers. It may also reflect a (mistaken) assumption that any application of gamification will result in increased engagement (Cugelman, 2013; Deterding, 2015).

Furthermore, the focus on the ability of gamification to *increase engagement* implies an assumption that mere exposure to the intervention is sufficient to improve the targeted health outcome. However, research on eHealth therapies suggests this may not apply to mental health interventions, and that what is more important is whether the user engages fully (i.e. completes more educational modules, as opposed to logging in more frequently or spending more time in the app) with the intervention (Donkin et al., 2011). This is further complicated by evidence suggesting that in some cases, decreased engagement is not necessarily indicative of worse outcomes (Smith, Ploderer, Wadley, Webber, & Borland, 2017). For example, users of a program may disengage as they move on to more suitable alternatives (going to the gym instead of continuing to play an exercise video game), or feel they no longer need it (Schwanda, Ibara, Reynolds, & Cosley, 2011). Instead of straightforwardly being used to encourage ongoing engagement and re-engagement, gamification may be more helpful in encouraging more nuanced engagement. While this reframing of the importance of engagement is important for all health interventions, it is especially relevant for interventions intended for continuous use. What seems to be key is not whether, but *how* the user engages with the app.

In the context of the literature discussed above, inquiries into the effectiveness of gamification seem premature. Instead of 'does gamification promote engagement?', the question we should

really be asking may be, '*how* does gamification promote engagement?'. In order to answer this question, and to gain a better understanding of the key strengths of gamification and other forms of applied games, we need to turn to games themselves (Ferrara, 2013).

1.3. How do games engage?

1.3.1. What is a 'game'?

As described above, games are different from gamification. Specifically (and as mentioned in Chapter 1.2.2), something that is gamified contains parts of games—it is not a complete one (Deterding et al., 2011). But what, exactly, is a game?

In contemporary culture, the word 'game' most saliently conjures up impressions of digital games (also known as video games). The emergence and dominance of the label 'gamer' to describe someone (usually young and male; Duggan, 2015) who spends long amounts of time playing digital games points to their widespread dominance in contemporary culture, as does the presence of (digital) game devices in 93% of Australian households (Brand, Todhunter, & Jervis, 2017). Constant forecasts of the growth of the digital games (again, usually referred to as just 'games') software and hardware industry (Merel, 2017), as well as related industries such as esports (Kelly, 2018), have been used to bolster claims that digital games are the foundation of current Internet technologies and have played a role in preparing the human race for the new age of human-computer interaction (Meeker, 2017). Digital games are promoted, seemingly without consideration of the other types of games that precede and exist alongside them. In a reflection of this trend, most calls for gamification for health use the term 'game' when they appear to mean digital games (e.g. King et al., 2013).

In contrast, the distinction between digital and non-digital games is strongly delineated in the field of game studies (Aarseth, 2017). In his call for studying "videogames as videogames", Keogh (2014, p. 18) criticises a formalist focus on the classic game form and fundamental components of games as an overly purist approach that obscures the complex characteristics of digital games,

and emphasises that games and digital games are different cultural artefacts. However, a review of these fundamental, formal characteristics of non-digital games, especially in the context of exploring how to conceptualise gamification, is still important. While recent major industry reports have promoted (digital) games as "the most engaging form of social media" (Meeker, 2017, p. 114), they do not mention that the majority of humankind likely grew up playing games, both alone and with their peers, and that games and play are a fundamental cultural force embedded deeply in society (Caillois, 1958/2001). Therefore, one cannot understand games (and gamification by extension) without first examining the characteristics and intricacies of the game form.

The term 'game' is notoriously difficult to define (Stenros, 2016). Such is the vastness of possibility of the game form, with its complex specifications and exceptions, that some scholars do not attempt to qualify or formalise their definitions to include various characteristics or components at all, instead taking the position that games are what their players consider them to be (Simon, 2016). However, other scholars agree that games share common themes. In an attempt to outline the similarities and differences between the many definitions of the term 'game', Stenros (2016) systematically reviewed the literature and found they converge on several topics of interest that are briefly reviewed below.

In general, games feature *rules*, though the strictness with which they are imposed varies. Games also may or may not have a primary *purpose*. While a few definitions specify that the primary purpose of games is entertainment, one from the operational gaming tradition considers entertainment games as only one type of game (with the other four types being educational games, experimental games, research games, and operational games; Ståhl, 1983). Some definitions do not even consider games to have an explicit purpose at all (Costikyan, 1994; McLuhan, 1964). Another key aspect of games is their *duality*: they are both artefacts and activities (Stenros, 2016). While much debate exists on how, and whether, to distinguish between the two, both the act of playing a game as well as the game itself can be considered a 'game'. Games also have *players* (or

participating decision-making agents), though not always (such as in the case of zero-player games; Björk & Juul, 2012). Similarly, debate exists on whether games are *productive* (producing meaningful output) or not. Notably, Caillois (1958/2001) considers unproductiveness to be a key defining feature of play and games.

Perhaps more relevantly to gamification for (mental) health and wellbeing, games represent, but are also *separate* from, the world around them: they are a "voluntary safe action" with "slight consequentiality" (Deterding, 2013, p. 224). This "pretend context" allows for safer rehearsal of emotional regulation (and other types of adaptive regulation) strategies (Granic, Lobel, & Engels, 2014, p. 72), and can also serve educational purposes, for example by allowing exploration of complex situations (Schrier, 2017). This property of games is discussed further in Chapter 1.4.1.

Games also feature *conflict* (usually in the form of competition, bounded by rules), either between multiple players, between a player and their own self, or between a player and the game. Finally, games are *telic*, in that they lead to a definite end, usually by the satisfaction of certain goals or end (win) conditions (although notably, Caillois, 1958/2001, specifies that this end can also be a predefined time). Of course, this is challenged by the existence of certain (digital) game genres, such as the Massively Multiplayer Online Role-Playing Game (also known as MMORPG), that encourage continued play even after the conclusion of any narrative mode (Nicholson, 2014).

In his review, Stenros (2016) demonstrates that considerable debate and even opposing positions on each of these themes exist. However, he argues, it is this debate that shows their importance to how games can be conceptualised. While the contradicting positions on many of these themes may suggest that it is, at best, extremely difficult to produce a definition that includes all instances of games and excludes all instances of non-games while being informative, from Stenros's synthesis of his findings it is clear that games are much more than digital games, or even other forms of predigital games, such as board games, ball games, or word games. As tools of leisure, challenge, and simulation (for example, in the form of gambling, meritocracy, and entertainment),

games and game-like processes are a cultural construct that have served a wide variety of purposes in human culture for millennia (Caillois, 1958/2001).

According to French sociologist Roger Caillois (1958/2001), there are four types of play: *agon* (competition), *alea* (randomness and uncertain outcomes), *mimesis* (imitation; or pretending to be, or act for, someone or something else), and *ilinx* (the exhilaration of vertigo, for example via dancing or riding roller coasters). While not all types of play are present in every game, every game contains one or more of these types of play. Referring to this series of classifications, one can see that most mainstream applications of gamification, such as the 'PBL triad' (points, badges, and leaderboards; Chou, 2015), and also all the elements mentioned above—progress markers, achievement-based rewards, and so on—rely mostly on *agon* (Idone Cassone, 2016; Sicart, 2014). There is much room for designing and implementing gamification (and applied games more broadly) that takes advantage of the appeal of *alea*, *mimesis*, and *ilinx*, particularly in a way that supports the innate satisfaction of the activities the gamified service is intended to support (Sicart, 2014).

1.3.2. Need satisfaction

So far, I have argued that gamification is not just points, badges, and leaderboards, or even just the application of game elements. Instead, as Huotari and Hamari (2012) emphasise, it is the enhancement of a basic service through providing more game-like affordances (to increase the chance of users perceiving the experience of using the service as game-like). It therefore stands to reason that in order to fully understand gamification, we must understand games. In the previous section I briefly reviewed several defining themes of what makes a game a game, and discussed gamification in the context of Caillois's four types of play (Caillois, 1958/2001). In this section, I discuss how games, and gamification by extension, engage their players. While I provide a brief overview of self-determination theory (SDT) in Chapter 1.2.4, I review it in more detail here.

SDT, the dominant theory that informs the psychology of video game engagement (Przybylski, Rigby, & Ryan, 2010; Ryan, Rigby, & Przybylski, 2006), is a fundamental theory of human motivation (Deci & Ryan, 2000; Ryan & Deci, 2000). It proposes that humans are intrinsically motivated to pursue psychological growth through satisfying three innate psychological needs: autonomy, competence, and relatedness. Importantly, intrinsically motivated behaviours are not solely performed to satisfy these needs. Neither are behaviours leading to the satisfaction of these needs necessarily driven by intrinsic motivation (Deci & Ryan, 2000). This distinction is important as according to SDT, satisfying these innate psychological needs results in increased levels of psychological health and wellbeing.

Traditionally, the term 'intrinsic motivation' refers to motivation derived purely from the anticipation of internal satisfaction, and 'extrinsic motivation' refers to motivation derived purely from the anticipation of external reward (or punishment avoidance; Deci & Ryan, 2000). Traditional conceptualisations of extrinsic motivation portray it as non-autonomous, which would, according to SDT, thwart feelings of autonomy, decrease psychological wellbeing, and cease to be maintained once the individual stops being exposed to the external motivator. SDT (specifically a sub-theory of SDT named Organismic Integration Theory, or OIT) adds nuance to this approach by proposing multiple types of extrinsic motivations that vary along a continuum of external to internal perceived loci of causality (see Figure 1.2; Ryan & Deci, 2000, 2002). OIT specifies a pathway between extrinsic and intrinsic motivation and proposes that motivations to engage in behaviours can travel along this continuum (from external regulation to intrinsic regulation in Figure 1.2). Hence, according to OIT, extrinsically motivated behaviours are not always nonautonomous (or done involuntarily). While extrinsically motivated behaviours do not tend to persist once the motivator is removed (particularly in regulations with more externally perceived loci of control), extrinsic motivation can act as a path through which more internal behavioural regulation, and perhaps even intrinsic motivation to engage in the behaviour, can be achieved. This can result in more sustainable behaviours and improved levels of psychological wellbeing, and is hugely useful for designers of games and of health interventions.

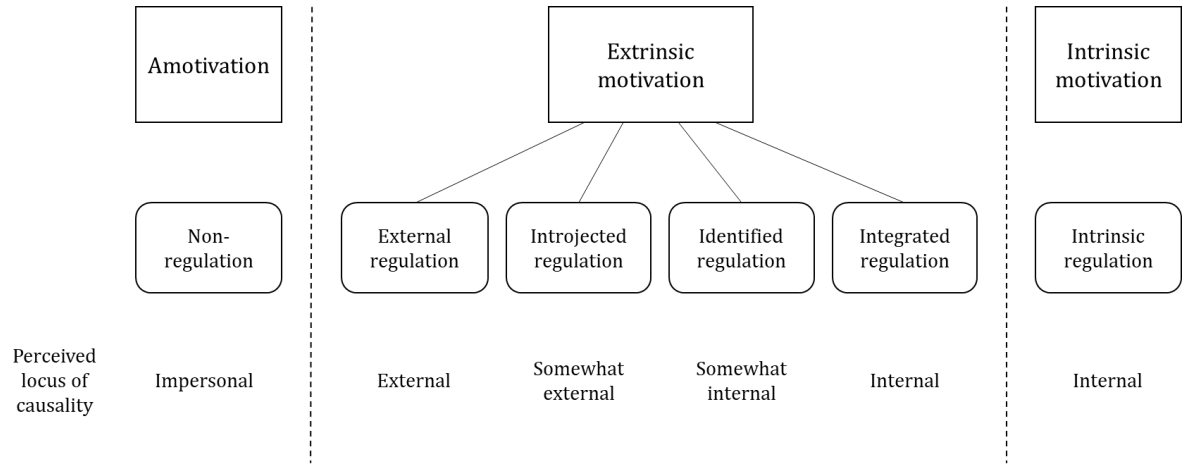

Figure 1.2. A condensed version of Ryan & Deci's (2000) taxonomy of human motivation

As shapers of a player's journey through the beginning, middle, and end of a game, game developers are experts at designing user (player) experience. The satisfaction of SDT needs is directly linked to subjective enjoyment of a game (Ryan et al., 2006), and game designers deliberately design their games to satisfy these needs. For example, in an interview with Matthew Sheffield (2008), game designer Hirokazu Yasuhara espouses various design philosophies that are clearly linked to SDT. Interestingly, though he does not reference Caillois by name, Yasuhara also references Caillois's four forms of play and endorses an approach of combining as many of these forms as possible. The importance Yasuhara places on ensuring "the player always feel[ing] like he's in control of his own fate" (Sheffield, 2008, p. 3) relates to autonomy, while his description of the innately enjoyable "process of actively sorting and bringing things under control" (Sheffield, 2008, p. 2) references competence. Finally, Yasuhara references relatedness through including ways for players to interact with in-game characters. These are all concrete examples that designers of gamified interventions can draw from when incorporating SDT and basic psychological need satisfaction into their designs. If done successfully, this can create an intervention that is intrinsically motivating and enjoyable to engage with.

1.4. Applying games to mental health

1.4.1. How games communicate

It is important to acknowledge that even as games reflect the world around them (Stenros, 2016), they are a work of fiction, and are inherently biased towards communicating certain views or beliefs, whether directly via plot, indirectly via lore, setting, and visual representations, or procedurally, via available actions such as rules and mechanics (Juul, 2013). Regardless of whether one is engaging with systems represented in games (for example, *Monopoly*) or gamified systems (such as the Nike+ system), some sort of message is being communicated to users of these systems. For example, by only providing functionality to record performance metrics (i.e. distance, duration, and location), the Nike+ system implicitly communicates that the other enjoyable aspects of running, such as the runner's high, or the mindful interaction between human and environment, are less important (Sicart, 2014). According to Sicart, the Nike+ system's gamification of running emphasises the result of running over the process. This can lead to users feeling pressured to log the types of data the gamified system rewards, potentially at the expense of what the user may instead personally find meaningful about running.

Games and gamified systems necessarily depict real-world processes through processes of abstraction, analogy, and imitation (Idone Cassone, 2016; Juul, 2013). These processes can range from simple, abstract loops of achievement and reward (e.g. completing a task to earn points), to more concrete activities that vary depending on the type of game. For example, a cooking game could depict 'preparing spaghetti with meatballs', a combat game could depict 'reloading a gun', and a sports game could depict 'scoring a goal'. Games and gamified systems relating more directly to mental health and wellbeing could depict activities and experiences such as 'reframing a thought', 'a day with clinical depression', 'injecting heroin intravenously', or 'managing a panic attack'. Players of these games, and users of these gamified systems, can interact with these represented experiences repeatedly and with less consequence. Given appropriate levels of reflection and critical thinking on the part of the players and users of these systems (Tyack &

Wyeth, 2017), this ability to rehearse and explore otherwise distressing or unsafe experiences has potential in supporting the learning of adaptive regulation strategies (Granic et al., 2014), increasing and deepening understanding of complex issues (Schrier, 2017), and even changing attitudes (Bogost, 2007).

Of course, due to processing and design constraints, and more importantly so as not to distract from the game or gamified system's intended message, these representations are necessarily abstracted (Juul, 2013). However, in the case of complex sociological issues such as mental health and wellbeing, and its intersections with other social categories such as (but not limited to) race, sexuality, and gender, too much abstraction may unintentionally communicate an undesired message. When representing the desired activity or experience, it is therefore important to strike a balance between depicting enough of the experience to make it meaningful and abstracting it sufficiently to maintain the clarity of the intended message and the smoothness of the user experience (UX). The ideal UX should not be offensive to either the player (by limiting them too much, or, conversely, providing so much guidance that it is perceived as patronising) or the group whose experience is being represented. The consultation of all relevant stakeholders (including but not limited to mental health researchers, intervention users, clinicians, software developers, and, where involved, game designers) is crucial for the success of gamification for mental health and wellbeing.

1.4.2. Participatory design

Participatory design (PD) and other co-design methodologies are gaining traction in eHealth and mHealth, particularly for mental health and wellbeing. Simply put, it is the involvement of end users in the design, development, and evaluation processes of technologies and interventions aimed at them. While the concept of user testing is not new, and calls for applying gamification for health and wellbeing also include recommendations to test that this application is appropriate (Cugelman, 2013), a key tenet of the philosophy of PD is that the target end user should be present at *all* stages of the design, development, and evaluation processes. This prevents their tokenistic

involvement either too early or too late in the process to achieve real impact (Orlowski et al., 2015). Involving end user populations at early stages of development, for example via evaluation of wireframes, prototypes, and design concepts (Ospina-Pinillos et al., 2018), can also help ensure that resources are not wasted on inappropriate solutions. In Australia, PD has been emphasised as a key strategy for the development of evidence-based interventions, particularly for youth mental health (Hagen et al., 2012) and for young men (Ellis et al., 2014).

PD can help researchers to learn directly from their target end users how best to present and structure interventions for mental health and wellbeing, including content, tone, frequency, and module length, if applicable (Fleming et al., 2016). When brought to its natural extension, this co-designing process places target end users at the centre of the process, allowing them to directly contribute to, or specify guidelines for, developing the intervention. These end user guidelines can then be considered in tandem with evidence-based best practice. PD has been found to be an important and effective way of making sure that interventions and technologies are as current and suited to the target population as they can be (Ellis et al., 2014). Furthermore, as PD spans multiple phases (from the start to the end of the project), it can be conducted with a variety of research methodologies, including focus groups, PD (and co-design) workshops, surveys, and user testing (Hagen et al., 2012; Ospina-Pinillos et al., 2018). This triangulation of methods can help to support the validity of the ensuing findings.

PD can also be instrumental in obtaining and reflecting the priorities and concerns of the target end-user population into interventions designed with them, particularly those who have historically been marginalised (Hagen et al., 2012)—including but not limited to those with diverse genders and sexualities, Aboriginal and Torres Strait Islander peoples, and culturally and linguistically diverse people—and those who otherwise experience a sociological power imbalance. For example, while positive psychological interventions for children are usually adapted from existing interventions for adults, Yarosh and Schueller (2017) describe a scenario where PD was instrumental in finding key differences in how children conceptualise happiness

and wellbeing differently to adults and in obtaining new, more child-centric perspectives on how positive computing technologies for children should be designed. Similarly, as people with chronic conditions (including mental illness) are experts in their own experience, PD can facilitate the contribution of this lived experience to research in contextualised and rich detail (Jessen et al., 2018), allowing people with lived experience to directly influence the development of technologies and interventions for other people like them. PD can also help assist and confirm that the development of a particular intervention is appropriate for the target population's needs, particularly those who face barriers to seeking information or care, such as mental health stigma (Ellis et al., 2014). In cases where resources (including time and funds) are limited, PD may also be an efficient way of both identifying the best solution given adequate communication of these constraints, as well as reflecting the concerns of the target population back to other stakeholders such as health services. Notably, through the use of participatory design methodologies with veteran counselling service Open Arms (including veterans, health professionals, and administrative staff), LaMonica et al. (2019) were able to identify areas of the service pathway that could be improved, leading to rapid service change.

This approach has also been successfully used for applying games to mental health and wellbeing. Through using a PD methodology named 'experiential participatory and interactive knowledge elicitation', Sockolow et al. (2017) were able to obtain feedback on their proposed mHealth game's storyline from their target audience (13-to-17-year-old African American females from under-resourced communities). Specifically, through engaging with these young women, the authors were able to identify aspects of their prototype that their intended audience found off-putting (including background images, character body types, skin tone, and slang) and act on their participants' suggestions, increasing the credibility of the game with the target audience and the likelihood that they would play it. Though Sockolow et al. report on the development of a serious game and not a gamified intervention, a similar process for a gamified intervention could elicit insights into unforeseen problems with the intervention, brainstorm methods on how to address these problems, and confirm the acceptability of the intervention.

Finally, previous research shows the importance of bringing all stakeholders together—those with lived experience of mental illness (service users), those who deliver the care (clinicians and service workers), and those who study the phenomena (mental health researchers)—allowing all stakeholders to have an active, unique contribution to the final end product (LaMonica et al., 2019; Ospina-Pinillos et al., 2018). Naturally, when incorporating applied games into mental health interventions or initiatives, those who build and play games (game developers and players) should also be included in PD processes.

1.5. Summary

This chapter starts with a brief review of how gamification has been applied for mental health and wellbeing, including the rationale behind, and problems with, its adoption. Specifically, there is a lack of taxonomical and conceptual consensus on what 'gamification' is and what 'gamification elements' are, and a lack of evaluation on whether gamification is effective. Despite this, gamification is still widely used to increase user engagement with the app, technology, or service being gamified, an approach which may be short-sighted and not take advantage of its full potential.

I then briefly explore what games are and how they engage players through need satisfaction processes. With reference to classic theory on games and play, I argue that the interaction between games and society is not unprecedented in, and is instead fundamental to, human history, and that current mainstream examples of gamification rely too much on competition (*agon*).

Finally, I conclude with some remarks on the process of implementing gamification for mental health and wellbeing. Specifically, I argue that all games and gamified systems implicitly communicate certain beliefs and messages, and that stakeholder consultation (ideally via PD) is key to ensure that gamified apps, technologies, or systems for mental health and wellbeing are acceptable to all parties involved, particularly end user populations.

1.6. Thesis aims

The literature reviewed in this chapter demonstrates significant gaps in research, particularly in the implementation and evaluation of gamification for mental health and wellbeing, and the lack of consistency in terminology within and across academic fields. Based on this, this thesis has the following aims:

1. to iteratively co-design and develop a gamified app for mental health and wellbeing,
2. to evaluate the eventuating app, MindMax,
3. to consolidate literature on gamification for mental health and wellbeing, and
4. to synthesise findings into practical guidelines for implementing gamification for mental health and wellbeing.

Chapter 2: Co-designing and user testing MindMax

Cheng, V.W.S., Davenport, T., Johnson, D., Vella, K., Mitchell, J., & Hickie, I.B. (2018). An App That Incorporates Gamification, Mini-Games, and Social Connection to Improve Men's Mental Health and Well-Being (MindMax): Participatory Design Process. *JMIR Mental Health*, *5*(4): e11068, doi: 10.2196/11068.

2.1. Abstract

Background: Men have different mental health needs as compared with women, and women make up the primary audience of most digital mental health interventions. An Australian football-themed (specifically Australian Football League, AFL) app named MindMax incorporating psychoeducation, gamification, mini-games, and social connection was developed in an effort to address this issue.

Objective: The aim of this study was to identify the best way to structure and present MindMax, an app that aims to deliver psychoeducational modules, and create a Web-based community centering on well-being, AFL, and video games for men aged 16 to 35 years who are interested in AFL or video games.

Methods: We conducted 6 participatory design (PD) workshops with people aged 16 to 35 years in 3 cities in Australia, to identify the best way to present MindMax, and contracted a digital development agency to develop MindMax. We then iteratively tested MindMax prototypes with 15 user experience testing interviews across 3 separate time points: 2 before app launch and 1 after app launch.

Results: A total of 40 individuals (25 male and 15 female) participated in the PD workshops, and a total of 15 individuals (10 male and 5 female) participated in user experience interviews. Broadly, participants expressed a preference for activities requiring active engagement that practiced useful skills. They were also sensitive to how content was presented and wanted the ability to customize their own app experience. Although participants agreed that social motivations were important for engagement with an app, they recommended not to mimic existing social networks.

Conclusions: In basing itself strongly within the AFL subculture and by incorporating gamification as well as mini-games, MindMax aimed to tackle mental health help-seeking barriers for people who enjoy AFL or video games, with a particular emphasis on men, and to provide

psychoeducation on strategies to increase mental health and well-being. If MindMax is successful, this would indicate that generalizing this approach to other traditional sporting codes and even competitive video gaming leagues (esports) would be fruitful.

2.2. Introduction

2.2.1. Men's Well-Being and Internet Interventions

As participants in mental health research are heavily biased toward being female [1,2], research outcomes may not be fully generalizable to men. A growing body of evidence suggests that men's experiences of mental health problems and treatment differ to those of their female counterparts [3,4]. For example, young men have higher rates of suicide prevalence and lower rates of mental health literacy and health care service access than young women [1,3]. Furthermore, women are more receptive to structured internet health interventions than men [4]. This problem is especially urgent for young people as most mental health problems are developed during young adulthood [5]. Furthermore, mental health outcomes at a young age persist and potentially worsen in the long term, even among those receiving clinical care [6]. A targeted approach to improving mental health that aims to give younger people the tools to manage their own well-being would be helpful in addressing this issue.

Western norms of masculinity (in particular, the emphasis on self-reliance and on silently coping with psychological distress) act as barriers to help seeking [7] and contribute to the worse outcomes displayed by young men. This is exacerbated by the small but significantly higher tendency for young men to avoid addressing their friends' mental health problems directly and to avoid recommending they seek help from external sources, relative to their female peers [8]. Furthermore, the high levels of mental health stigma that persist in young men and their negative perceptions of mental health professionals work in tandem with the previous to contribute to high reluctance to formally seek help from mental health professionals [7]. Instead, young men tend to seek informal help from the internet, with 1 study on 16- to 24-year-old men finding nearly 55% of their sample reported having done so [7]. The same study further reports that,

within their sample, younger men were more likely to seek informal help from the internet than older men.

An approach to internet interventions that enables and informs such informal help seeking would be a natural fit to this pattern of behavior. An evidence-based approach toward men's mental health and well-being that addresses the problems outlined above should therefore be (1) accessible on the internet, (2) action-based and informal (not clinical), (3) anonymous with the potential for social connection, (4) self-directed, and (5) based in subcultures men are already present in [7]. Importantly, women should not be excluded as in addition to benefiting from the intervention themselves, they can also act as supportive others, connecting these interventions and other mental health initiatives to the men in their lives.

Sports and video games are mainstream topics with significant male fan bases. The sporting code that is the focus of this study, Australian Football League (AFL), is a type of Australian football and enjoys the support of 6 million people across Australia [9]. Similarly, a recent nationwide survey reports that over three-quarters of Australians aged 15 to 34 years play video games and that 70% of all men surveyed were video game players [10]. Both cultures are further combined in esports (competitive video gaming) [11]. esports is a growing industry popular among younger people, with nearly as many millennials preferring watching their favorite esport to watching their favorite traditional sport (40% vs 42%) [12]. Furthermore, many sporting leagues including AFL have partnered with esports teams [11] and video game companies to host esports events [13]. Although they remain distinct subcultures, sports and video games are highly compatible, mainstream in the general population, and well suited to utilization in a mobile health (mHealth) app intended to promote mental health and well-being.

2.2.2. Gamification and Applied Games

The general usage of games and game features for nonentertainment purposes is known as "applied games" [14]. This includes not just applying commercial video games outside of an entertainment context, for example, psychological therapy [15], but also serious games (video

games developed for a primary purpose other than player enjoyment [16]) and gamification [17,18]. In the same way that traditional video game design works to engage both the extrinsic and intrinsic motivation of its players, applied games have inherent "effectiveness potential" [19], where users of interventions that incorporate applied games can be motivated to explore the intervention deeper for additional motivations besides self-improvement. Furthermore, the inherent design characteristics of video games have been shown to be complementary to subjective well-being concepts, for example, the Seligman positive emotions, engagement, relationships, meaning, and achievement (PERMA) model [20,21]. There is also evidence for a positive impact of moderate video game play on well-being [22-25].

Gamification, in particular, has been named a promising strategy with which to promote engagement in digital health interventions [19,26,27]. Although the most well-known gamification elements are points, badges, and leaderboards [28], prioritizing these elements can undermine the complex series of cognitive, emotional, and social affordances that make games intrinsically motivating and enjoyable to play [29]. The most successful mHealth initiatives that incorporate gamification have been carefully designed to include both extrinsic and intrinsic motivators [30,31].

The term *gamification* has been defined as the "use of game design elements in non-game contexts" [17] as well as "a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation" [18]. The latter definition by Huotari and Hamari is particularly useful in an mHealth (both mental and physical health) context, with "value creation" potentially being the improvement of the user's health; the adoption of health behaviors; the provision of a fun, engaging educational experience; or all of the above. This definition also emphasizes the goal of gamification rather than its methods and recognizes that what some individuals may term "game design elements" may not be considered as such by others, complementing the overlap between gamification and other health behavioral change frameworks such as persuasive systems design [32]. Finally, this definition is drawn from a

service marketing approach. By viewing the digital health intervention as a core service, it becomes easier to visualize how the components of this service can be enhanced with motivational affordances. Approaching applied games (including gamification) from this perspective could thus lead to a more compatible and natural integration of applied games (including gamification) into mental health care.

Although empirical study of the effects of gamification is still in its infancy, there is evidence, albeit outside of health, that it leads to higher and more involved user engagement with an app or service [33,34]. However, the impacts of gamification within electronic health and mHealth remain poorly understood [35-37]. Although application varies by health domain, many mHealth apps do not utilize gamification [36], and those that do tend to contain limited applications of it [38]. As evidence of individual differences in gamification element preferences is emerging [39], it is clear that to provide the enjoyable and engaging experiences initially hoped for, when gamification (and applied games in general) is applied to mHealth, it must be with due consideration.

2.2.3. Participatory Design and Knowledge Translation

Although researcher-led mHealth initiatives have a key strength in applying evidence-based best practice, it is often at the expense of user experience. It is difficult to compete with large corporations who invest millions of dollars into creating seamless, intuitive, and engaging user experiences to entertain their consumers. This level of investment is near impossible in academia, which may result in a jarring experience for users accustomed to a contemporary internet experience [40]. Another key tension within mHealth initiatives is that their aims and objectives often act as barriers to uptake, especially among populations that engage the most in behaviors the intervention hopes to reduce (eg, drinking alcohol [41]). It is important to identify how best to present the health and therapeutic content of mHealth initiatives to the target audience. One method of achieving this is through participatory design (PD) [42].

The key principle of PD is to involve all stakeholders of a project in an iterative cycle of design and development [43,44]. This allows them to influence its design to better suit their past, present, and future needs, ideally leading to higher effectiveness and engagement among the target population [1]. Furthermore, when executed well, PD methodologies increase the acceptability of interventions to stakeholders [44] and can be harnessed to make knowledge translation of research outcomes more efficient [43,45]. This is especially important in mHealth, as given the rapid pace of technological development, the field must reduce the lag between health research and translation as much as possible.

2.2.4. Study Context and Objectives

As part of its daily operations, the Australian Football League Players' Association (AFLPA) offers mental health and well-being training to more than 800 players across the National League [46]. This training focuses primarily on resilience and well-being. Well-being is a separate construct of positive mental health that is distinct to mental illness [47]. A focus on well-being is more broadly applicable to the general population as both people with and without mental illness can directly benefit from learning how to maintain and improve their well-being. Notably, increasing subjective well-being leads to improvements in individuals' lives, such as healthier relationships, more positive emotions, increased feelings of autonomy, and increased self-acceptance [21].

In collaboration with Queensland University of Technology and The University of Sydney's Brain and Mind Centre, the AFLPA obtained funding to execute a multipronged initiative to improve mental health and well-being, focusing on men aged 16 to 35 years but not excluding other groups of people [48]. The app resulting from this collaboration was named MindMax and aimed to deliver a modified version of the AFLPA's existing mental health programs in a portable, digital format. The target audience is hence men aged 16 to 35 years who are interested in AFL or video games.

MindMax was designed according to the 5 recommendations made by previous research [7] outlined in the first section of the Introduction. For example, educational content was split into

multiple small modules lasting around 10 min each, to enable self-directed learning and to give users a choice in what aspects of their well-being they wish to focus on [40]. A secondary aim of MindMax was to create a Web-based community centering on well-being, sports (in this case AFL), and video games. To achieve this aim, the AFLPA engaged a select number of AFL players as ambassadors for the app. Their role would include being spokesperson within the app modules and community area as well as promoting the app to the AFL industry and general public.

Although the basic components of MindMax were drawn from the literature and decided on by researchers and the AFLPA, it was unclear how best to present them in a way that would be acceptable to the target audience. The aim of this study was, therefore, to use PD and user testing methodologies on multiple iterations of MindMax to obtain key insights from end users on how best to present its content, design, and features.

2.3. Methods

2.3.1. Participant Recruitment

Our recruitment strategies consisted of putting up posters, distributing postcards, and advertising in student mailing lists. We also asked affiliated organizations to assist in recruitment for locations not in Sydney. We reimbursed PD workshop participants with a gift voucher worth Aus $50 and user experience interview participants with a gift voucher worth Aus $30 to thank them for volunteering their time and expertise. The University of Sydney's Human Research Ethics Committee (Protocol No. 2016/652) approved this project before the start of research activity.

2.3.2. Phase 1: Participatory Design Workshops

2.3.2.1. Design

The PD methodologies used in this study are based on recommendations by the Young and Well Cooperative Research Centre [44]. Specifically, we adapted the iterative PD and knowledge translation methodology used by Ospina-Pinillos et al [45] to fit the needs of our project.

In phase 1, we held 2 PD workshops in each of 3 Australian capital cities in early September 2016, making 6 workshops in total. The aim of these workshops was to identify how best to frame the well-being concepts discussed in MindMax and, more broadly, how to structure a mental health and well-being app to the intended audience. Moderators took notes during the workshops. Workshops lasted 3 hours and consisted of 3 stages: discovery, evaluation, and prototype.

2.3.2.1.1. Discovery

Workshop moderators facilitated participant discussion of their knowledge and usage of and preferences for, health and well-being apps/websites. Specifically, participants discussed their preferences for app design and content, their social usage of health and well-being apps, applying gaming concepts to mental health and well-being, and data tracking and privacy. Although moderators focused on mental health in particular, both mental and physical health were discussed.

2.3.2.1.2. Evaluation

Moderators then presented screenshots of existing health and well-being apps/websites to participants for their critical evaluation. These apps were a combination of popular commercial health and well-being apps (including physical health) as well as output of previous academic and government mental health and well-being mHealth projects. Screenshots portrayed a variety of features of interest, including social connection (dashboard and community pages), gameful elements (mini-games, challenges, and progress bars), and psychoeducation. Marker pens were provided for participants to annotate the screenshots.

2.3.2.1.3. Prototype

Finally, in the context of the previous 2 stages of discussion, moderators asked participants to design concepts, specifications, or potential user journeys for a mental health and well-being app. Sketchbooks and marker pens were provided for this activity.

2.3.3. Phase 2: Knowledge Translation

Following the PD workshops, all moderator notes and participant artifacts (produced during the evaluation and prototype stages) were collated and analyzed by an independent knowledge translation team consisting of a group of young people (aged under 25 years) who were short-term interns at The University of Sydney's Brain and Mind Centre. The team adopted an approach similar to descriptive content analysis [49], manually coding the notes and artifacts by 3 overarching semantic themes: content (the information and activities within the app), design (the visual design of the app), and features/concept (the conceptual design and features of the app). The team then used these themes and codes as guidelines to produce a knowledge-translated design of MindMax (see Figure 2.1).

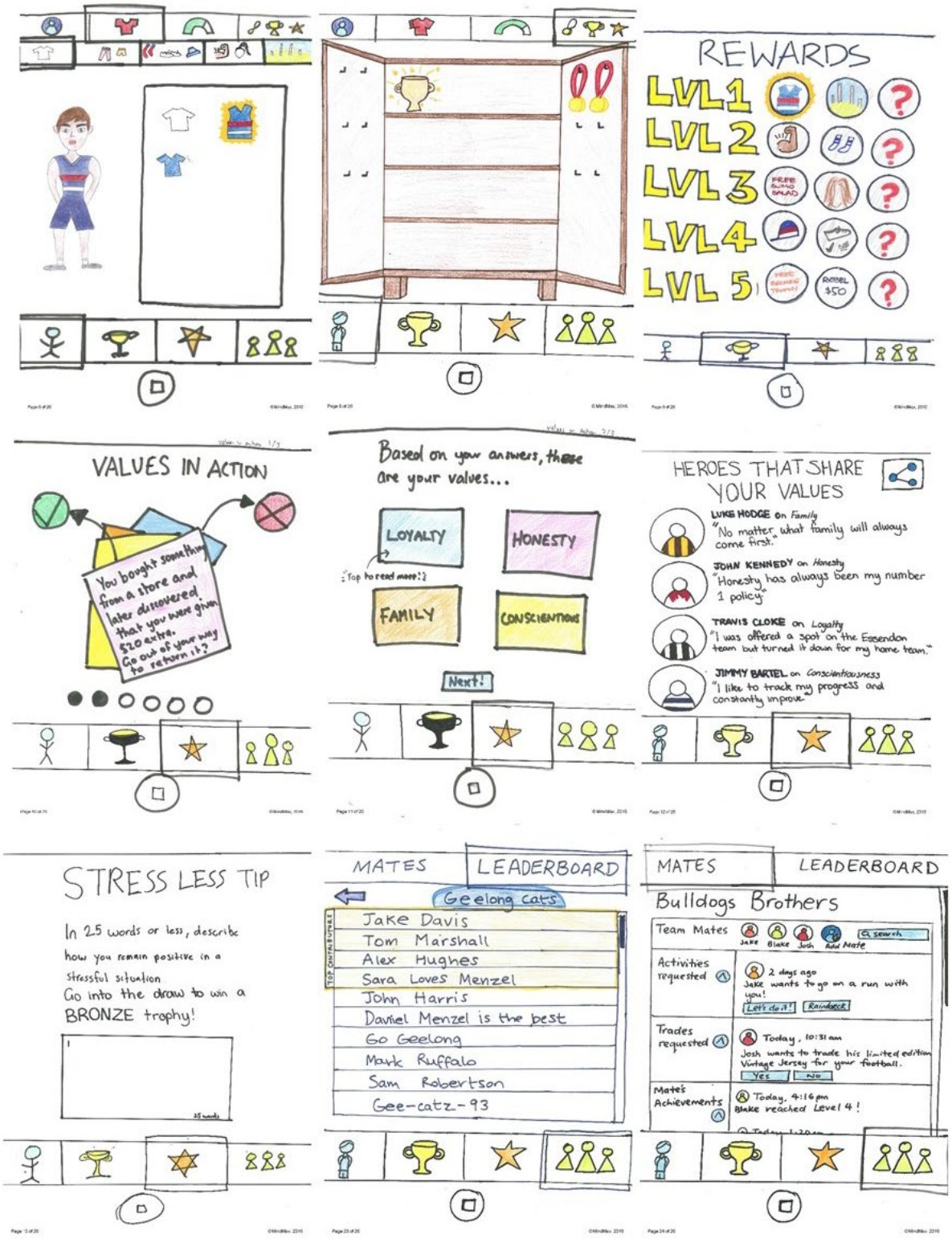

Figure 2.1. Selected sketches from the knowledge translated design of MindMax.

2.3.4. Phase 3: User Experience Testing Interviews

2.3.4.1. Timeline and App Details

We presented the outcomes of the PD workshops and the resulting knowledge translation to the AFLPA, who concurrently contracted a digital agency (Long Division Digital, Melbourne) to produce a prototype of MindMax, drawing principles from the outcomes as appropriate and feasible. This prototype and further iterations were tested in one-on-one user experience interviews at The University of Sydney's Brain and Mind Centre across 3 time points: December 2016, March 2017, and November 2017. MindMax was launched to the public in June 2017. Hence, 2 time points were before launch and 1 time point was after launch. Drawing on previous recommendations in user experience research [50], we aimed for a total of 15 participants (5 participants per round) to allow for as many insights to be captured across multiple iterations of MindMax, as efficiently as possible.

During the first time point, we tested a hybrid Web-based prototype with limited functionality, and the moderator assisted participants in accessing the app build through a mobile phone internet browser. At this point, only the *Fit Minds* psychoeducational module was available. During the second time point, we tested an in-progress native build with greater functionality (see Figure 2.2). At this point, 3 psychoeducational modules were available: *Fit Minds*, *Values*, and *Thoughts*. During the third time point, which was 5 months after MindMax was launched on the App Store and Google Play Stores, we tested an updated version of MindMax (see Figure 2.3) and asked participants to download it onto their mobile phones. At this point, 5 psychoeducational modules were available: *Fit Minds*, *Values*, *Thoughts*, *Mindfulness*, and *Emotions*, as well as "Flick Footy," a casual game involving kicking a football to score goals.

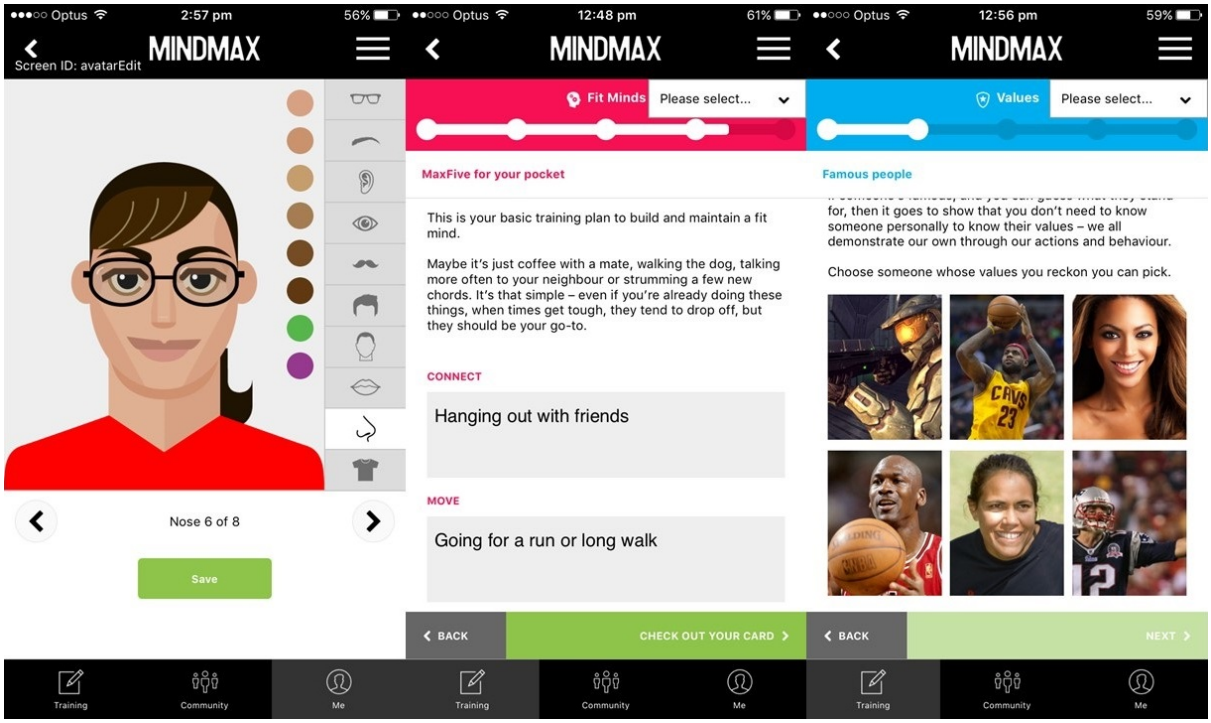

Figure 2.2. The beta build tested in March 2017. Left: the avatar creation process; Middle: a goal-setting activity in *Fit Minds*; Right: an activity in *Values*.

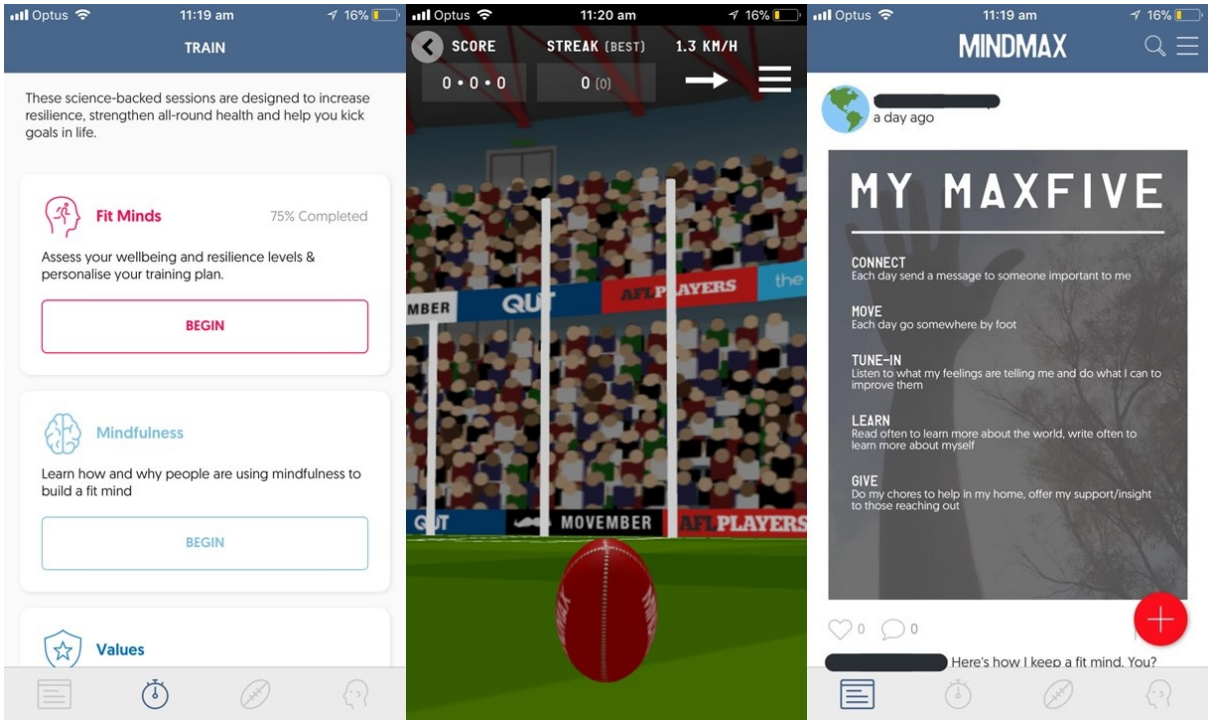

Figure 2.3. The updated launch version tested in November 2017. Left: the psychoeducational module selection screen following a layout change; Middle: the new goal-kicking casual game, 'Flick Footy', which cost 'footies' to play. 'Footies' are earned by interacting with the social or psychoeducational components; Right: an anonymised example of a 'shareable' generated by a user after completing *Fit Minds*.

Along with the social component (community feed), the psychoeducational modules and Flick Footy formed the reward system within MindMax, where completing psychoeducational modules and posting in the community feed earned users points, called "footies," which could then be spent to play Flick Footy. In addition to this, modules also contained mini-games (see Figure 2.4) that aimed to allow users to interact with the lessons in a more active way.

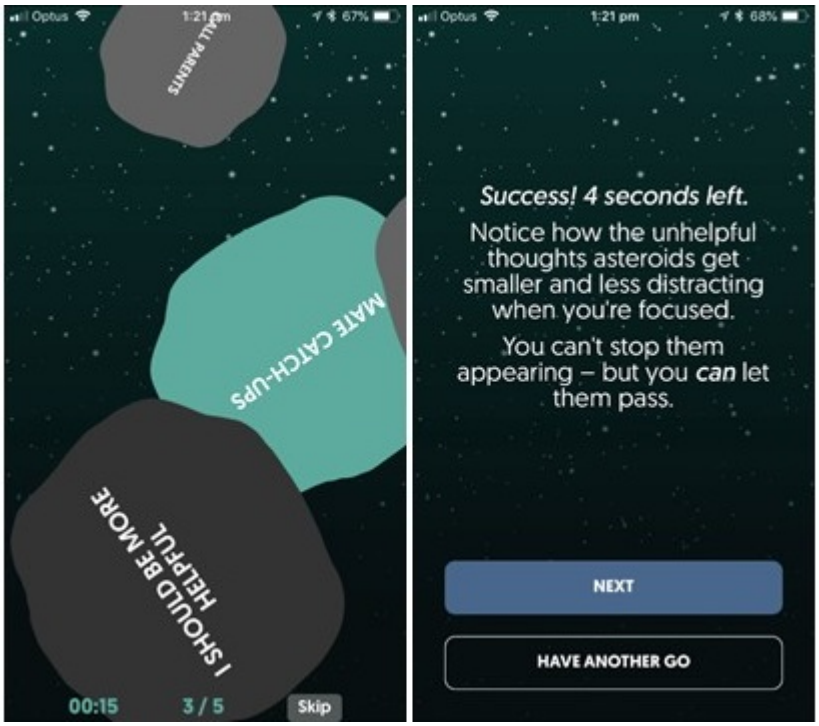

Figure 2.4. An example of a mini-game used to illustrate the concept of letting unhelpful thoughts pass, in *Thoughts*.

Psychoeducation modules were accessible through a tab named "Train/Training" (depending on the version of MindMax) and were designed to last around 10 min. They consisted of information pages, interactive activities, and videos that contained information about the module topic and featured AFL players as spokespersons. The videos with AFL players were a montage of informal interviews relating to the module topic and were presented as a way to get to know another side of the player. During certain points of each module, shareable content (a "shareable") was generated and posted to the community feed. These posts could be toggled to display to all MindMax users (*public*) or to the user only (*private*).

Fit Minds was an introductory module with the objective of creating a "MaxFive" plan to improve well-being, *Values* aimed to help users identify their values and ways to act upon them, *Thoughts* aimed to help users identify and deal with unhelpful thoughts (including a mini-game illustrating the concept of letting unhelpful thoughts pass by; see Figure 2.4), *Mindfulness* aimed to introduce users to mindfulness meditation, and *Emotions* aimed to help users gain a better understanding of their emotions and how to deal with negative emotions. The *Mindfulness* and *Emotions* modules contained 2 guided audio meditation tracks recorded with 2 different AFL player ambassadors, and users could choose which player to meditate with. Information was presented in a casual, masculine tone to reflect the target audience of the app (men aged 16 to 35 years interested in AFL or video games).

Finally, although this study details the iterative design and development process of MindMax, a more in-depth explanation of the theory behind MindMax, including its applied games components, has been previously published [48]. As per the recommendations of Tondello et al [51], MindMax was also designed to incorporate multiple types of applied games to appeal to a wide variety of users.

2.3.4.2. Interview Protocol

User experience testing interviews followed a semistructured format. We first collected demographic information, specifically gender, age, mobile phone model, and operating system, and how many hours per week participants spent playing video games and watching AFL matches. We then explained to participants that interviews would be conducted using a think-aloud protocol, where participants verbalize their thoughts while completing a series of predetermined tasks. Although there are weaknesses with think-aloud protocols, such as their reliance on participant subjectivity and their inability to capture subconscious cognitive processes, concurrent think-aloud protocols nonetheless have the ability to capture crucial insights at a low cost [52]. The predetermined tasks included procedures such as registering an account, creating an avatar, playing a casual game, and completing psychoeducation modules. The predetermined

task list spanned all contemporarily available app features and was hence updated for each subsequent time point.

Participants were allowed to complete the tasks in their preferred order. They were given flexibility as to which modules they chose but were on occasion directed to complete specific modules to ensure an even spread of feedback. All participants completed at least two modules. Although participants were given the opportunity to ask questions during the interview, they were encouraged to complete the tasks unprompted and to the best of their ability. A researcher typed notes of the process.

2.4. Results

2.4.1. Participant Characteristics

Due to the convenience sampling strategy employed while recruiting for PD workshops (phase 1), participants naturally tended toward video game design students in Brisbane, AFLPA-affiliated individuals in Melbourne, and mental health and technology academics and students in Sydney. In Brisbane and Melbourne, the workshops were divided into 2 groups: aged 16 to 25 years and aged 26 to 35 years. Workshop and participant characteristics are summarized in Table 2.1 and listed in the chronological order they were conducted.

Table 2.1. Participatory design workshop and participant characteristics.

Workshop (n), (n=40)	Location	Age group (years)	Gender split	Recruitment pool
1 (6)	Melbourne	16-25	3 males, 3 females	AFLPA[a]-affiliated individuals
2 (5)	Melbourne	26-35	3 males, 2 females	AFLPA[a]-affiliated individuals
3 (10)	Sydney	Mixed	4 males, 6 females	Mental health and technology academics and research students
4 (4)	Sydney	Mixed	2 males, 2 females	Mental health and technology academics and research students

5 (8)	Brisbane	16-25	8 males	Video game design and research students and staff
6 (7)	Brisbane	26-35	5 males, 2 females	Video game design and research students and staff

AFLPA: Australian Football League Players' Association.

Table 2.2 shows the characteristics of the user experience testing interviews and participants (phase 3). One participant (aged 39 years) at the second time point (March 2017) was discovered not to fall within the age range of the target audience, but we made the decision to proceed to gain any relevant insights the participant had to offer toward making the app more broadly accessible. Finally, to eliminate the possibility of bias arising from previously brainstorming this topic at length, user experience interviewees were different across all time points and none had previously attended any MindMax PD workshops.

Table 2.2. User experience testing interview and participant characteristics.

Time point	Participant	Age (years)	Gender	Mobile phone (operating system, OS)	Video game play (hour/week)	AFL[a] match watching (hour/week)
December 2016: Web-based alpha prototype (n=4)	P1	29	Female	iPhone 6 (iOS 10.1)	0	1
	P2	33	Female	iPhone 5 (iOS 9)	0.5	1
	P3	26	Male	iPhone 6 (iOS 10.1)	1	1
	P4	29	Female	Samsung S7 Edge (Android; OS unsure)	0	0
March 2017: native app beta (n=5)	P5	19	Male	iPhone 6 (iOS 10.2.1)	1	2
	P6	24	Male	iPhone 6 (iOS 10.2.1)	20	2
	P7	39	Female	iPhone 6 (iOS 10.2.1)	20	0
	P8	21	Female	iPhone 6 (iOS 10.2.1)	3	0

	P9	20	Male	iPhone 6 (iOS 10.2.1)	30	0
November 2017: native app 5 months after launch (n=6)	P10	19	Male	Xiaomi RedMe Note 4 (Android 6.0)	5	0
	P11	22	Male	Oneplus 3T (Android 6.0)	5	0
	P12	22	Male	Samsung S5 (Android 6.0.1)	5	0
	P13	22	Male	Samsung J7 Prime (Android 6.0.1)	20	0
	P14	22	Male	Samsung Galaxy S5 (Android 6.0.1)	1 on average; 3 in holidays	0
	P15	20	Male	iPhone 5 (iOS 11.0.3)	24	0

[a]AFL: Australian Football League.

2.4.2. Participatory Design Workshop: Descriptive Content Analysis

App likes and dislikes were collected directly during the evaluation phase of PD workshops, where we asked participants to annotate screenshots of multiple existing health and well-being apps/websites. These preferences were coded by an independent knowledge translation team consisting of young people (younger than 25 years) according to the semantic themes content, design, and features/concept. Codes that were observed 3 or more times are presented below.

2.4.2.1. Content

Compared with the other 2 semantic themes, content had the least observations. The most frequently observed preference was that participants disliked activities perceived to be "useless", "anticlimactic", "simplistic", "condescending", "childish", or "boring". Although they were receptive to activities promoting self-reflection, participants disliked vague suggestions (eg, "do something kind for yourself") and liked having examples of how to do so. Ultimately, participants preferred information that was clear, nonrepetitive, and instructive (not descriptive—"tell me how, not why"). Although participants appreciated explanations for how an activity would benefit

them, they preferred this information to be contained within a collapsible content box they could open if desired.

2.4.2.2. Design

Participants overwhelmingly expressed dislikes of excessive blank space and also excessive amounts of text. “Gimmicky” user interfaces (UIs) and graphics received more criticism for looking “childish” and “cheap” than praise for looking “interesting” and having “cool colours”. Furthermore, dark colors such as dark green and brown were criticized for being “depressing” and “ugly”. Instead, participants preferred more conservative UIs with multiple pleasant colors (eg, pastel colors or light to medium blue) paired with simple graphics and names that clearly described the purpose and features of the app. Finally, participants liked how one app listed the number of people that had joined a particular psychoeducational course, as it showed the course appeared to be popular and, therefore, worth trying.

2.4.2.3. Features/Concept

A large number of participants liked the idea of graphs and similar indicators such as goal progress bars, finding it motivational to track their progress. Similarly, a large number of participants also liked the concept of challenges/missions, encouraging them to go beyond their comfort zone. Quizzes attracted both positive and negative feedback, though the former was greater than the latter. Although participants liked having long-term goals and unlockable achievements, their reaction to rewards was ambivalent. Those who liked the concept felt they were “helpful and keep people coming back,” whereas those who did not found there to be “no reward for the player outside of a small number going up.” Participants also liked the skeuomorphic activities in several of the presented apps/websites, where participants could interact with the object on the screen similar to real life (such as scrunching up a piece of paper).

Finally, although competition was seen as “motivating” and “healthy” in the context of a physical health app, participants were ambivalent toward how it, and other types of social sharing options, could be implemented in mental health contexts. Participants felt that any social option that

mimicked a major social network would be redundant and that they would not use it. Participants also felt that compared with physical health, mental health was a more private issue that complicated social sharing, both for the sharer and the people they would be sharing their mental health status with. In particular, participants raised the inappropriateness of such features for someone with poor mental health or who was in distress. Instead, participants suggested that social features be used to promote social connection and communication. That is, they should be "supportive rather than competitive."

2.4.2.4. Other Insights

Furthermore, participants emphasized the importance of being able to customize their app experience, for example, through being able to customize their display image or avatar (if appropriate) or by having their responses to in-app questions influence their app notifications or recommendations. Participants also suggested the incorporation of design elements common to video games, including regular content updates, events, team competitions, and cosmetic digital rewards (eg, avatar hairstyles or clothing). Finally, the issue of mental health stigma was raised, and participants suggested the app have a function for facilitating conversations between men, for example, scheduling real-life activities between friends, where difficult topics could be broached in shoulder-to-shoulder conversations. Participants also specified that the app should adopt an approach of self-improvement, rather than fixing a deficiency.

2.4.3. User Experience Testing Interviews

2.4.3.1. Summary Across Time Points

Below, we present insights participants expressed during the user experience testing interviews and relevant quotes.

At alpha and beta build, participant feedback comprised identifying software bugs and glitches, criticizing unintuitive UIs and unclear wording, and raising privacy concerns. However, participants also expressed appreciation for the opportunity to see a more personal side of AFL athletes and for the underlying concept of the app:

It's great! I like the idea and concept of it. Mindfulness, wellbeing. What it's trying to achieve. [P5]

[It was] entertaining, kinda helpful – showed me a lot of values I didn't know about – so, informative, engaging. [P9]

At 5 months after launch, negative participant feedback included identifying software bugs and glitches as well as questioning whether the social component would be used and critiquing its similarity to existing social networks such as Instagram.

However, most participants at this time point found MindMax to meet their user experience standards and to be an overall positive experience that provided some value:

I think overall this app is just for people to try out for curiosity. [...] Sometimes you want to say things to vent, but you can't really say things to an app. This is like the fries, if the psychologist is a Big Mac. [P13]

It's nice to have prominent masculine role models showing it's okay to express emotion. Actively saying it's okay to do so seems like a good thing to do for males in general. [P14]

Privacy concerns were raised across all time points. Although participants felt the information they provided MindMax was not particularly sensitive (and some provided false information to MindMax as a further precaution), they were worried that this information would be mistreated (eg, sold to marketers).

2.4.3.2. Content and Delivery

A total of 2 participants were red-green color blind and expressed that the colors used within MindMax were easy to differentiate.

There was a wide range of reactions to the casual tone of the app. Some participants appreciated it:

Good sense of humour. It like makes you feel relaxed. [P5]

If it's too formal, I feel a bit of pressure. [P6]

However, on the other hand, some disliked it:

It's cringey, like those Facebook memes. Makes me take it less seriously. [P14]

Participants also asked for more detail and specific, contextualizing examples:

Having an example [...] guidance as to what kind of behaviours are definitive of these values. [...] [Something] more personalised to my chosen value. [P14]

Videos were commonly skipped or watched for only the first few seconds. Participants requested the ability to rewind and fast-forward through videos and an indication of what to expect (through subtitles or a transcript). Although all videos were a maximum of 90 seconds long, they were still considered too long:

Once I see a video, I think "this is going to take a while." Maybe if there was the length of the video on the bottom left or bottom right. If it was like 10 seconds I might watch it. [P11]

On 1 occasion, a participant skipped a video that contained key context explaining a later activity in the module, leading to brief confusion.

2.4.3.3. Interactive Activities

MindMax's psychoeducational modules contained a variety of short interactive activities illustrative of the information in the modules. These activities ranged from uploading selfies and creating "shareables" (eg, a "MaxFive" plan for improving well-being) to share on the community feed, to more in-depth, reflective activities such as guided meditation.

Participant reactions to the social activities were mixed. Although some participants thought they were *different* and *new*, others felt they were inappropriate:

There's places for selfies and this is not one of them. [P9]

(In response to negative feedback to the tone of the activity and privacy concerns, the selfie activity was removed in the launch version of the module.)

Participants who completed the *Mindfulness* and *Emotions* modules tended to skip the guided meditation activity halfway through but were also overall more positive about the activity:

> *That was pretty cool. [...] I don't meditate usually so this was a nice experience.* [P11]

Overall, participants were more positive about activities that required more focus and active participation, particularly in the context of MindMax's psychoeducational modules being presented as *Training*:

> *If I didn't have to physically write the postcard it wouldn't have resonated so much.* [P15]

> *The Mindfulness module fits the concept of "Train" the most. Thinking of a motivational quote and putting it on a picture isn't training.* [P11]

2.4.3.4. Avatar

All female participants perceived avatar customization choices to lack feminine options and expressed feelings of alienation:

> *None of the options look like me, so I'll make something that's representative of something else.* [P4]

This was exacerbated by the default avatar (presented as a base for users to customize) having a mustache. Female participants preferred starting with a blank avatar to this. Male participants did not report feeling alienated by the avatar customization choices.

Although participants preferred the freedom of being able to upload their own profile picture, the majority recognized that uploaded pictures would be difficult to moderate and that avatars provided increased anonymity.

2.4.3.5. Social

Some participants were wary about posting content to the community feed, expressing not only privacy concerns but also more general image management concerns:

> *(While filling in a shareable)*

I guess this would be posted to the main board or something?

Facilitator: Yes.

Ah. So I don't want to write something too silly. [P15]

Overall, participants were negative toward the social component of the app, thinking it was unnecessary and that neither they nor anyone else would use it:

Why care about likes, I'm here to improve mental wellbeing. [P12]

Everything's on Facebook already. I don't use any other apps other than Facebook to communicate with others. [P15]

When asked, most said they would not consciously post anything to the feed (beyond shareables, which were automatically posted through completing modules), though they were more willing to interact with posts on the feed.

Ultimately, participants wanted to use the app with people they already knew or had something in common with:

I just realised you can't friend people in this, which, I don't know. With AFL. If I used it a bit longer I would have eventually thought "Why can't I join a group of just my AFL team rather than everyone?" [P11]

[I would like to see] a concept of Circles or Groups [...] I want a way to connect with friends. Like if a few of your friends had similar goals – or putting people with similar goals in a community together. [P5]

2.4.3.6. Applied Game Elements

Most participants stated they had never seen games combined with mental health and well-being before and expressed appreciation for the concept. When prompted to spend a "footy" (earned by completing psychoeducational modules and posting in the community feed) to play the casual game Flick Footy, participants at the final time point found the controls intuitive and the

experience enjoyable. However, although it was broadly enjoyed, some participants also found it unoriginal and potentially not compelling enough to keep them using MindMax.

One participant found the integration of games and gameful elements within MindMax clumsy and half-hearted:

> *The app makes it seem the video games section is important, but it's more than secondary – it's so far from the general approach of the app that it seems put in in the last minute. Which is fine, but don't make it seem so important.* [P14]

The same participant also questioned whether it was appropriate to tie such a simple game so strongly to MindMax's reward system:

> *I like video games, and these are very rudimentary, not very interactive, not very engaging [...] if these are the rewards for the activity you're doing it's a low reward for something so personal that you have to engage in. Games kind of cheapen the experience.* [P14]

2.5. Discussion

2.5.1. Principal Findings

This series of studies aimed to use PD and user testing methods to determine the best way to present MindMax, an AFL-themed app aiming to deliver psychoeducation on mental health and well-being and to create a Web-based community centering on well-being, AFL, and video games. Our results suggest that the concept of combining mental health and well-being with sports and video games was well received by users. Participants gave further insights throughout MindMax's development period that future mental health and well-being mHealth initiatives can learn from, whether or not they intend to incorporate applied games.

A consistent finding across PD workshops and user experience interviews was that participants did not have strong feelings about what content was presented, but rather how it was presented. Although participants found being presented with too much information at once off-putting, they

did not want to be deprived of additional, contextualizing content as a result. Instead, they wanted to be able to control the flow of information, for example, through collapsible content boxes, and to have alternate modes of information, for example, through video subtitles and transcripts. Videos, in particular, were skipped on multiple occasions. This, along with previous research [4], suggests that key information should be presented in a variety of mediums in a way that minimizes repetitiveness.

Participants were sensitive to the formality (and lack thereof) of the various tones adopted by the health and well-being apps presented in PD workshops and in MindMax. Although a formal tone was perceived as intimidating, participants considered an informal tone less pressuring, but some also took the content less seriously as a result. Participants also did not want the tone to be patronizing or paternalistic and yet appreciated specific, direct instructions. Careful writing is needed to achieve this balance. Appropriate levels of formality and prescriptiveness likely vary based on the target audience and must be tested thoroughly with target users. Participants also expected a personalized experience [40], anticipating that MindMax would remember information they entered about themselves (eg, gender or the value they wanted to affirm) and that it would use that information in ways to help the user improve their well-being.

We also observed that participants preferred activities that required active engagement and practiced useful skills, paralleling earlier research on the topic [7]. Activities such as guided meditation and writing a postcard to a loved one, which required comparatively more effort to complete, were better received than activities such as posting a selfie or choosing a quote from a preselected set of quotes. This suggests that our initial intention of reducing cognitive effort and making modules as easy to complete as possible was ineffective and may have undermined the purpose of MindMax. Instead, these findings suggest that user effort should be funneled toward completing activities.

Participants appreciated fun touches to app design (eg, skeuomorphic interactions), but ultimately the majority of participants seemed to prioritize the functional aspects of health apps,

such as the ability to track their own health and well-being and information on how to improve their health and well-being. This does not mean there is no room for fun and enjoyment in mental health and well-being apps (multiple successful implementations of gamification in mental health and well-being [30,31] support this). Rather, any implementation of playfulness or supplementary conceptual flavor should be considered and tested carefully.

2.5.2. Social and Applied Game Elements

Participants overall agreed that social motivations were important to attract and keep them engaged with a mental health and well-being app and that they would prefer the social component to be in relation to their existing social networks. Although they found social comparison and competition (both common gamification features [28]) motivating for improving physical health, they felt that incorporating comparison and competition in a mental health and well-being app could be inappropriate, particularly in cases where the user or someone in their network was in distress. During user experience testing, we observed image management behaviors where participants moderated how they expressed themselves as they were conscious of their potential audience. This was not a desired user behavior and could potentially undermine the improvement of mental health and well-being.

In PD workshops, participants suggested that MindMax and similar apps should complement and enable, rather than emulate, online and offline social connection. Crucially, this social component should be a different experience compared with using a mainstream social networking service. This was difficult to implement in practice, and MindMax ended up failing to follow this recommendation, instead implementing a community feed that user experience interviewees found extremely similar to Instagram. However, future conceptualizations of a social component could draw inspiration from cooperative games and incorporate more gamification elements that appeal to multiple types of users (players), such as social discovery, gifting, and unlockable content [51].

Our user experience interviewees, mostly experienced video game players, also expressed concerns that MindMax's implementations of applied games lacked depth, which undermined their user experience. Their familiarity with video games may have contributed to their reduced interest in Flick Footy, which was a simple casual game with only 1 aim (score as many goals as possible). In addition to offering a unique, engaging experience, a more sophisticated implementation of cooperative game mechanics could potentially address these concerns and increase MindMax's appeal to more hardcore video game fans.

2.5.3. Limitations

The largest limitation of our findings is that during the user experience interview stages, we recruited locally (in Sydney) and therefore found it difficult to recruit AFL fans. However, much of our feedback was not AFL-related and would be useful to anyone designing an app incorporating applied games for mental health and well-being. MindMax's usage analytics will give an indication of how people interested in AFL perceive and use MindMax and will be the focus of future investigation.

Another limitation is that although the iterative nature of our user testing allowed us to evaluate and improve on subsequent versions of MindMax, in practice, we were limited by financial, technological, and organizational constraints. The time frame of the grant required that development work occur in tandem with the user testing reported in this study. As a result, many features recommended by participants were determined to be unfeasible and descoped. For example, the social component that heavily resembled Instagram was implemented as ultimately there were not enough resources or time to create and implement an alternate concept for the social component. Similarly, although our female participants' dissatisfaction with the masculine tone of the app was noted, it was not directly actioned given the focus of the project on reaching men in the target age demographic. Finally, given the need to prioritize basic functionality and content inclusion initially, the amount of time available for applied game design and development was reduced, which is reflected in the negative feedback on the games from interviewees with

significant video games experience. Although it is also possible that the casual games in MindMax may never have appealed to more experienced video game players, more PD involving more stakeholders than just the research team and potential end users may have led to a smoother development process.

However, participant feedback, especially late-stage feedback, was able to be incorporated later in the project. MindMax underwent continual improvements beyond the time frame covered in this study, introducing new features and events until February 2018. This included new psychoeducational modules, redesigns of UI and existing modules, trophies, team functionality, and a "Flick Footy Max" campaign in December 2017 to promote engagement with the app. In "Flick Footy Max," MindMax users competed to score the highest in "Flick Footy" to win a PlayStation 4 Pro and a MindMax-themed AFL football. Participant feedback hence continued to influence the development of MindMax beyond what is described in this study.

2.5.4. Future Applications

MindMax is based in both the AFL and video games subcultures, with the aim of appealing to men who enjoy these subcultures [7]. Although we encountered some difficulties during development, many of which are inevitable on projects with defined time frames and funding windows, we ultimately produced an app containing psychoeducation, applied game elements, and a social component that was considered by user experience interviewees to be satisfactory. We plan to analyze the impact of MindMax via usage analytics and multiple time point survey data assessing users' levels of well-being and judgments of MindMax's usability.

Lessons learned from MindMax can be broadly applied to any app intending to help users improve their mental health and well-being, especially those planning to incorporate applied games. They can also be extended to other traditional sporting codes such as cricket, rugby, and soccer, and furthermore, to esports. The increasing collaboration between traditional sports and esports [13] and the growing popularity of esports among younger people [12] may make a broad sports approach including esports suitable to apply to youth mental health. Finally, in the same way that

traditional sporting codes such as AFL, rugby union, rugby league, and cricket are now promoting awareness of mental health problems, esports leagues can consider doing the same.

2.5.5. Conclusions

This study details the PD workshops and user experience testing that was conducted to obtain insights on how best to present MindMax. As an AFLPA initiative funded by Movember, MindMax presents a novel approach to evidence-based mental health and well-being education focusing on Australian men aged 16 to 35 years who enjoy AFL or video games. MindMax incorporates applied games and is couched in the Australian rules football (specifically AFL) subculture. If the implementation of MindMax is successful, there is the potential to generalize its model to other sporting codes such as rugby and cricket and even to partner with esports initiatives.

2.5.6. Acknowledgments

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2.5.7. Conflicts of Interest

Professor Ian Hickie was an inaugural Commissioner on Australia's National Mental Health Commission (2012-18). He is the Co-Director, Health and Policy at the Brain and Mind Centre (BMC), University of Sydney. The BMC operates an early-intervention youth service at Camperdown under contract to headspace. Professor Hickie has previously led community-based and pharmaceutical industry-supported (Wyeth, Eli Lily, Servier, Pfizer, and AstraZeneca) projects focused on the identification and better management of anxiety and depression. He was a member of the medical advisory panel for Medibank Private until October 2017, a board

member of Psychosis Australia Trust, and a member of Veterans Mental Health Clinical Reference group. He is the Chief Scientific Advisor to, and an equity shareholder in, Innowell. Innowell has been formed by the University of Sydney and PwC to deliver the Aus $30 million Australian Government-funded "Project Synergy." Project Synergy is a 3-year program for the transformation of mental health services through the use of innovative technologies. None of the other authors declare any conflicts of interest.

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Chapter 3: Naturalistically evaluating MindMax

Cheng, V.W.S., Davenport, T., Johnson, D., Vella, K., Mitchell, J., & Hickie, I.B. (submitted for re-review). Naturalistic evaluation of a sport-themed mental health and wellbeing app aimed at men (MindMax), that incorporates applied video games and gamification. *Internet Interventions*.

3.1. Abstract

Introduction: While men display lower help-seeking rates than women, there is a lack of mental health interventions targeting men. To address this issue, we developed a smartphone app named MindMax, an Australian Football League (AFL)-themed app containing psychoeducational modules teaching strategies derived from positive psychology and acceptance and commitment therapy. MindMax also incorporates gamification, casual video games, and social connection and is intended to appeal to male Australians interested in AFL. This study reports results from a naturalistic trial intended to investigate whether using MindMax was associated with improved wellbeing, resilience, and help-seeking intentions.

Methods: We conducted a naturalistic trial from July 2017 to May 2018, where participants were given access to MindMax to use as they wished, and asked to answer wellbeing surveys at multiple time points. As we employed a customised version of the General Help-Seeking Questionnaire (GHSQ), we conducted an exploratory factor analysis and extracted two factors that we interpreted as 'personal help-seeking' and 'impersonal help-seeking'. Mixed design MANOVAs were conducted with flourishing, resilience, personal help-seeking, impersonal help-seeking, relatedness, and sense of connection (self-group overlap) to the MindMax community to assess change between Day 1–30 and Day 1–60.

Results: 313 participants (174/313, 55.6% female; 131/313, 41.9% male) completed the survey at baseline and at least one follow-up survey. We observed significant 30-day and 60-day increases in impersonal help-seeking intentions and sense of connection to the MindMax community, and 60-day increases in flourishing. 30-day increases in sense of connection were highest in our male participants with high base wellbeing, present in our female participants, and not present in our male participants with low base wellbeing. 60-day increases in sense of connection were higher in high-wellbeing participants than in low-wellbeing participants.

Discussion/Conclusion: Our findings are encouraging as they could be attributed to participants' exposure to MindMax. However, they could also be attributed to other factors that may also have

motivated trial participation. Future research can consider investigating more explicitly the role of conformity to masculine norms and how that may affect uptake of mHealth technologies and help-seeking behaviour.

3.2. Introduction

3.2.1. Men's mental health and help-seeking

Previous research has identified that Australian men have mental health experiences and needs that are different to those of Australian women, including prevalence of mental health problems (Rice, Purcell & McGorry 2018), reduced help-seeking (Ellis et al. 2014), and being less comfortable with structured Internet health interventions (Batterham & Calear 2017). Pressures to uphold traditional masculine values, such as stoicism, toughness, aggression, and self-sufficiency, act in tandem with multiple factors, such as higher mental health stigma, lower mental health literacy, and poorer emotional competence (Corrigan & Watson 2007; Ellis et al. 2014). These contribute to lower rates of help-seeking for mental health problems in Australian men compared to women (Ellis et al. 2013; Rice, Purcell & McGorry 2018). Some research has shown that younger Australian men in particular are comfortable managing and seeking help for their mental health anonymously and from informal sources like the Internet (Ellis et al. 2013). There is a need for targeted initiatives (including awareness campaigns and intervention programmes) proactively aimed at men to facilitate their help-seeking for mental health problems (Rice, Purcell & McGorry 2018).

Resilience, or the ability to adapt to stressful situations, has been positively linked to higher levels of psychological wellbeing (Souri & Hasanirad 2011). In a similar vein, poorer mental health is linked to lower levels of seeking help for mental health problems (Rickwood et al. 2005). Recent research shows that Australian males who behave according to rigid, traditional views of masculinity are more likely to display unfavourable mental health outcomes, including higher rates of negative affect and suicide ideation (Rice, Purcell & McGorry 2018; The Men's Project & Flood 2018), and lower rates of help-seeking (Seidler et al. 2016; Wong et al. 2017). A meta-

analysis by Wong et al. (Wong et al. 2017) suggests this may be attributable to three dimensions of conformity to masculine norms in particular: self-reliance, power over women, and being a playboy. While they found strong associations between these dimensions and increased negative mental health, decreased positive mental health, and decreased help-seeking, they found no such associations for the other two dimensions: primacy of work and risk-taking (Wong et al. 2017). This points towards the multifaceted nature of masculinity and suggests that offering more varied, healthy, and flexible alternatives of masculinity, and role models championing these alternatives, may be fruitful (Schlichthorst et al. 2018; The Men's Project & Flood 2018). According to evidence-based recommendations, mental health interventions tailored to men should be informal and action-based (as opposed to talk-based) and focused on building strengths (as opposed to reducing deficiencies) (Ellis et al. 2012; Ellis et al. 2013). Furthermore, couching such interventions within subcultures men are already present in reduces the burden on them to engage in help-seeking actions that many men, especially those with poorer mental health outcomes, may perceive as being a threat to their masculinity (Rice, Purcell & McGorry 2018).

Drawing heavily from these recommendations, the University of Sydney and Queensland University of Technology partnered with the Australian Football League Players' Association (AFLPA), The Mind Room, and the Young and Well Cooperative Research Centre to build a mobile phone application named MindMax. MindMax is an AFL-themed app that combines psychoeducation, social connection, and applied games (including gamification and casual games), aimed at men aged 16 to 35 years who are interested in the Australian Football League (AFL) and/or video games. While MindMax is aimed at encouraging access to mental health information and minimising barriers to help-seeking for younger men, it is also intended to be used by everyone.

3.2.2. App overview

MindMax is made up of three main components: psychoeducational (wellbeing training modules), social (a community feed), and play (a goal-kicking casual game named *Flick Footy*). These

components are supplemented by gamification, in which *Flick Footy* costs 'footies' (in-app currency) to play, and these 'footies' are earned through completing training modules and interacting with other users through posting or commenting in the community feed. The wellbeing training modules are based on positive psychology as well as acceptance and commitment therapy principles and cover a range of topics, including values, mindfulness, and strategies for dealing with unhelpful thoughts and emotions. We have previously written a more in-depth description of MindMax's structure (Cheng et al. 2018), as well as its applied games specifications and design rationale (Mitchell et al. 2017).

Participants who were representative of MindMax's intended end users were able to influence its features and design specifications throughout its development process through participatory design workshops and regular user testing (Cheng et al. 2018). Finally, MindMax was updated regularly across its development life with additional content, as well as performance and design fixes (Cheng et al. 2018).

3.2.3. Study aim

This study aimed to investigate whether we would observe a change in study participants' flourishing, resilience, help-seeking intentions, and/or sense of connection to the MindMax community across time, and whether gender and base wellbeing influenced any such change. This change was evaluated with two separate mixed design MANOVAs, one comparing baseline scores with 30-day scores, and the other comparing baseline scores with 60-day scores. In a mixed design MANOVA, with time as the within-subject factor and gender and base wellbeing as the between-subjects factors, a significant change would be indicated by a significant main effect of time, and/or significant higher-order interaction effects between time and one or more between-subjects factors.

3.3. Methods

3.3.1. Ethical approval

This study received ethical approval from The University of Sydney's Human Research Ethics Committee (Protocol No. 2016/652).

3.3.2. Design

Mohr et al. (2015) argue that in today's rapidly changing technological landscape, it is impractical to evaluate static versions of apps and other behavioural intervention technologies, as these interventions run the risk of becoming obsolete after often lengthy evaluations. Instead, the authors recommend evaluating the intervention principles that drive the technology, while reporting all changes made to the intervention. For these reasons, and to accommodate MindMax's development schedule, we conducted a single-arm, naturalistic longitudinal trial to evaluate the ongoing development of MindMax.

Once ready, the Minimum Viable Product (MVP) version of MindMax was simultaneously released for the public and deployed into trial. Data from this trial and other associated data (including usage analytics and user testing) was used to direct MindMax's maturation into a more developed product. As described in our previous publications (Cheng et al. 2018), content and performance updates were made until February 2018, including additional psychoeducational modules, new casual games, aesthetic improvements, trophies and team functionality, and a 'Flick Footy Max' competition in December 2017, where a Playstation 4 Pro and a MindMax-themed football were offered as prizes to users who scored the highest in the 'Flick Footy' casual game. We hence applied multiple updates to MindMax across the duration of the trial with the aim of improving its delivery of intervention principles.

3.3.3. Participants

We recruited participants from 14 July 2017 to 28 February 2018, according to these inclusion criteria: aged 16–35 years, resident in Australia, and having access to a mobile phone or other

mobile device that could access the Internet and run MindMax. Participants were recruited via paid and unpaid advertising on social media (Facebook, Twitter, and Instagram) and posters displayed on and around the authors' affiliated institutions. While study advertising varied in wording across social media platform and physical medium, all advertising introduced MindMax as a wellbeing app, asked participants for their help to research wellbeing, and informed participants that they would receive vouchers for their time and feedback. All advertisements also directed potential participants to a website specifically set up to act as a portal to the study. This website once again explained what participation in the study would involve before linking to the baseline (Day 1) survey, and was deactivated following the close of participant recruitment.

In early stages of recruitment, a minority of participants were also recruited directly from the MindMax app via a banner overlay on the social feed.

3.3.4. Procedure

The naturalistic longitudinal trial ran from 14 July 2017 to 9 May 2018. After screening, obtaining informed consent, and presenting the baseline (Day 1) survey (through the study portal website described in Section 2.3), we directed participants to the MindMax homepage and asked them to "*download MindMax, create an account, and use it as you wish*". This was done as MindMax was managed and distributed by the AFLPA. Importantly, as MindMax was also made publicly available at the same time, trial participants could interact with both other trial participants as well as the organic user base (i.e. those who came to begin using the app by means other than recruitment into the naturalistic trial). More information on the organic user base is reported by Vella et al. (2018).

We specified that when registering for MindMax, participants should use the same email address they had used to complete the survey. Email addresses from the baseline survey were checked against those in the MindMax database and sent a reminder to register for a MindMax account if the participant had not done so within three days of completing baseline. Only those email addresses who could be matched with an email address in the MindMax database were invited to

complete follow-up surveys (Day 30, Day 60, Day 90, and Close of Study). However, due to low sample sizes, we report only the first three time points (Day 1, Day 30, Day 60) in this paper. We sent up to two reminder emails, with three-day waits in between, if the participant did not respond to the initial survey invitation email. Participants were reimbursed AU$10 for each survey completed as a recognition of their time and effort spent participating in the study.

3.3.5. Measures

We collected participant demographics at baseline (Day 1), and self-reported wellbeing, resilience, and help-seeking intentions at Days 1, 30, and 60. Specifically, the following measurements were collected:

- Mental wellbeing, through the 14-item Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) (Tennant et al. 2007).
- Psychological flourishing, through the seven-item Flourishing scale (Diener et al. 2010).
- Resilience, through the 10-item Connor-Davidson Resilience scale (CD-RISC 10) (Campbell-Sills & Stein 2007).
- Help-seeking intentions, through the personal-emotional items of the General Help-Seeking Questionnaire (GHSQ) (Wilson et al. 2005). Following the recommendations of the scale creators, who encourage modification of the GHSQ to fit study aims (Deane & Wilson 2007), these items were further adapted as follows: the items for 'teacher', 'pastor/priest', and 'youth worker' were not administered, and an item for 'someone online, who you don't know personally' was added, as such people have recently emerged as a common source of help (Ellis et al. 2013). We also added a 'MindMax' item, and an 'Other' item with free text input, coding back responses to the relevant items if required, leading to a total of 11 items.
- Sense of connection to the MindMax community, through the one-item Assessment of Self-Group Overlap (Schubert & Otten 2002), which we adapted by replacing the word 'group' with the word 'MindMax'. This question presents participants with seven images which

vary in representations of social distance. A value of '1' indicates the furthest distance between the self and the MindMax community and a value of '7' indicates total overlap of the self and the MindMax community.

Table 3.1 presents the range and validation means and standard deviations (SDs; if available) of each scale. All reported means and SDs are taken from their original validation studies (which were performed with non-Australian samples), with the exception of the WEMWBS where we present Australian population data (Davies, Knuiman & Rosenberg 2016). These means and SDs are hence presented only to provide a frame of reference. With the exception of the adapted GHSQ and the adapted Assessment of Self-Group Overlap, all scales used have established strong reliability.

Table 3.1. Scale range and validation means/SDs

Scale	Range	Mean (SD)
WEMWBS[a]	14–70	52.8 (6.8)
Flourishing	8–56	44.97 (6.56)
CD-RISC 10	0–40	27.21 (5.84)
GHSQ (adapted)	11–77	N/A
Self-group overlap (adapted)	1–7	N/A

[a]WEMWBS mean provided is for age group 18–29 years

Finally, we were able to link participants' survey data with their usage data in the MindMax database. This enabled us to quantify their usage of MindMax, which we measured with the total number of seconds MindMax was open on their mobile phone or other mobile device. This figure reports the total duration of all of a user's sessions recorded in the database, with each session having an error of +/- 1–29 seconds. More specific details on the error associated with MindMax session timings are reported in a previous publication (Vella et al. 2018).

3.3.6. Analysis

3.3.6.1. Extracting GHSQ factors through an exploratory factor analysis

The authors of the GHSQ have suggested multiple ways to score it and also encourage it to be customised to better fit a research study's needs (Deane & Wilson 2007). While this increases the utility of the GHSQ, it has also led to inconsistencies in reported factor structures and varying reports of scale reliability and validity (Hammer & Spiker 2018). For this reason, after re-coding 'Other' string responses to the appropriate item (e.g. a specification of 'Grandad' was coded back to the 'Other relative' item), we ran an exploratory factor analysis using Mplus version 8.2 (Muthén & Muthén 1998-2017), with an estimation method of diagonally weighted least squares (referred to as WLSMV in Mplus) and a direct oblimin rotation (delta=0), on the polychoric correlation matrices on our sample's (n=313) Day 1 GHSQ responses. Polychoric correlations were chosen as they are more resistant to bias than Pearson correlations (Garrido, Abad & Ponsoda 2013). We also excluded the 'MindMax' item from this factor analysis and subsequent MANOVAs for clarity of interpretation. As can be seen in Table 3.2, all included items had a factor loading of greater than .4, and therefore none were removed.

Table 3.2. Two-factor rotated[a] loadings, correlations, and communalities of our GHSQ items (n=313)

	Personal	Impersonal	Communality
Intimate partner	**.446[b]**	-.110	.184
Friend	**.547[b]**	-.198[b]	.280
Parent	**.667[b]**	.069	.475
Other relative	**.543[b]**	.218[b]	.406
Mental health professional	-.005	**.735[b]**	.539
Phone helpline	.041	**.789[b]**	.641
Doctor/general practitioner	.074	**.788[b]**	.657
Someone online, who you don't know	-.140[b]	**.676[b]**	.425
Personal factor correlation	1		
Impersonal factor correlation	.269[b]	1	

[a]Estimation method WLSMV, with direct oblimin rotation
[b]p<.05

Bartlett's test of sphericity was significant, and the two-factor model displayed excellent fit (CLI=.983, TLI=.963). The first factor, which we termed 'personal help-seeking', was comprised of the items 'intimate partner', 'friend', 'parent', and 'other relative'. The second factor, which we termed 'impersonal help-seeking', was comprised of the items 'mental health professional', 'phone helpline', 'doctor/general practitioner', and 'someone online, who you don't know personally'. We calculated the Cronbach's alpha statistic for both factors and while it was high for impersonal help-seeking (α=.800), it was lower for personal help-seeking (α=.581). Additionally, the post-extraction communality for 'intimate partner' was below the accepted standard of .200 (Child 2006). For these reasons, while we analysed the GHSQ as two subscale scores, our findings should be interpreted with some reservation. Both subscales have a minimum score of '4' and a maximum score of '28'.

3.3.6.2. Primary analyses

Our primary analyses followed a modified intention-to-treat principle, whereby all possible casewise comparisons between Day 1 and Day 30, and Day 1 and Day 60, were performed, regardless of whether or not the participant had used MindMax (defined as logging at least one session lasting more than 0 seconds). The main sample hence consists of participants who completed Day 1 and either Day 30, Day 60, or both. This method was chosen because as all items within a survey (except demographics) were compulsory to answer, missing data would follow a file-matching pattern (all data would either be absent or present at each time point). Hence, two separate comparisons would maximise sample size, guard against overly small cell sizes, and ensure ease of analysis and interpretation. Imputation of missing data was not performed as previous research has found that imputing between-wave missing data results in no improvement, or even an increase, in standard error (Young & Johnson 2015).

Analyses consisted of two 2 (time) x 2 (gender) x 2 (base wellbeing) mixed design MANOVAs assessing the impact of time (MANOVA 1: Day 1 vs. Day 30; MANOVA 2: Day 1 vs. Day 60), gender, and base wellbeing on participants' flourishing, resilience, personal help-seeking intentions,

impersonal help-seeking intentions, and sense of connection to the MindMax community. Of our between-subjects factors, gender was split between males and females, and base wellbeing was split by the median of our sample's (n=313) Day 1 WEMWBS score (median=49).

3.3.6.3. Assumptions testing

We tested the assumptions of the mixed methods MANOVA for both comparisons (MANOVA 1 and MANOVA 2). For both MANOVAs, homogeneity of variance (Levene's test) and of variance-covariance matrices (Box's test) were violated for multiple cells, but the MANOVA is noted to be robust against such violations (O'Brien & Kaiser 1985). Due to small cell sizes, we removed participants who were neither male nor female (n=6 for MANOVA 1, and n=7 for MANOVA 2) from the analysis.

Each of the dependent variable distributions in each cell of MANOVAs 1 and 2 was checked for normality. As the MANOVA is relatively robust to mild violations of normality (O'Brien & Kaiser 1985), our criteria were kurtosis and skewness *z*-scores of *z* less than seven. Normality was severely violated for flourishing and self-group overlap, necessitating an inverse square root transformation for the former and a logarithmic transformation for the latter.

Each cell was also checked for univariate outliers (n=13 for MANOVA 1, and n=11 for MANOVA 2), and the subsamples were checked for multivariate outliers. We identified six multivariate outliers in the MANOVA 1 subsample (all except one case also identified as univariate outliers), and six multivariate outliers in the MANOVA 2 subsample (all except three cases also identified as univariate outliers). Hence, in total, 14 univariate and multivariate outlier cases were identified for MANOVA 1 and 14 univariate and multivariate outlier cases were identified for MANOVA 2. The outlying cases of both groups overlapped but were not fully identical.

To assess the impact of transformation and outliers on our findings, we conducted three sensitivity analyses: transformed; excluding outliers; and transformed excluding outliers.

All other assumptions of the mixed-methods MANOVA were satisfied. Table 3.3 shows correlations between the dependent variables, organised by time point.

Table 3.3. Correlations between dependent variables

	Dependent variable	Flourishing	CD-RISC 10	GHSQ (personal)	GHSQ (impersonal)	Self-group overlap
Day 1	Flourishing	1				
	CD-RISC 10	.616[b]	1			
	GHSQ (personal)	.360[b]	.311[b]	1		
	GHSQ (impersonal)	.093	.080	.223[b]	1	
	Self-group overlap	.103	.105	.075	.137[a]	1
Day 30	Flourishing	1				
	CD-RISC 10	.698[b]	1			
	GHSQ (personal)	.450[b]	.302[b]	1		
	GHSQ (impersonal)	.113	.087	.310[b]	1	
	Self-group overlap	.204[a]	.184[a]	.316[b]	.417[b]	1
Day 60	Flourishing	1				
	CD-RISC 10	.616[b]	1			
	GHSQ (personal)	.496[b]	.357[b]	1		
	GHSQ (impersonal)	.078	.061	.347[b]	1	
	Self-group overlap	.119	.191[a]	.267[b]	.477[b]	1

[a]p<.05
[b] p<.001

3.4. Results

3.4.1. Participant characteristics

Figure 3.1 shows participant flow from recruitment to analysis.

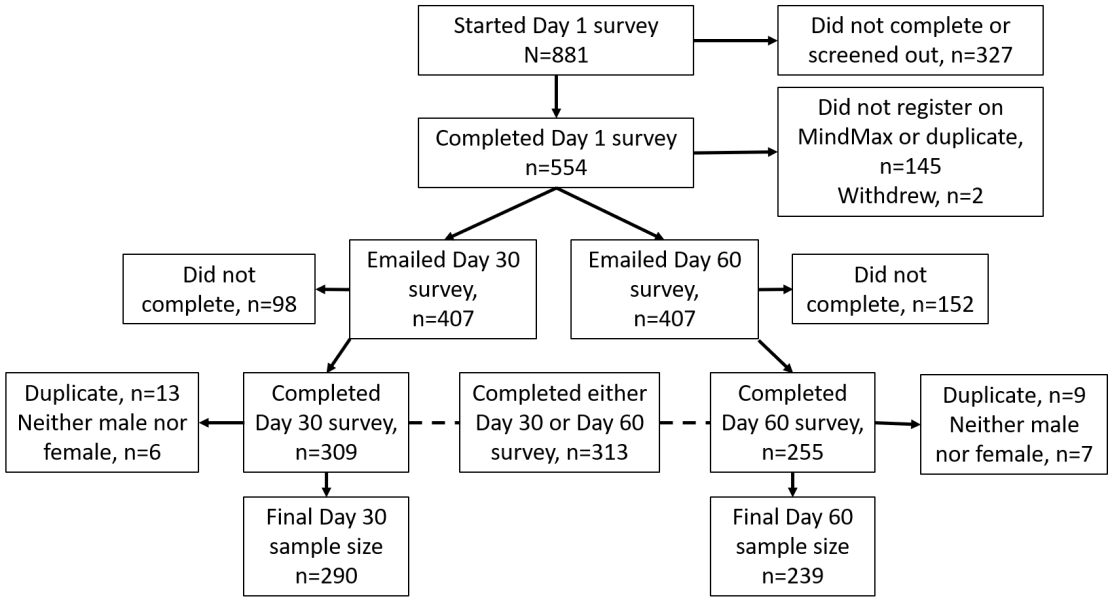

Figure 3.1. Participant flow

Table 3.4 displays sample age, base wellbeing, and app usage data, including range, means, medians, and SDs; while Table 3.5 displays other demographic frequency information. The subsamples analysed in MANOVA 1 and MANOVA 2 did not display a significant difference in demographics compared to the main sample. Non-completers of at least one follow-up survey (Day 30 or Day 60) also displayed no difference in demographics compared to the main sample apart from being more likely to have ever played video games (95.4% vs. 85.6%). For readability, we collapsed the following categories in Table 3.5 under the label 'Not in work': 'Unemployed/looking for work', 'Home duties', 'Not working and currently receiving sickness allowance/disability support pension', and 'Volunteer work'. Similarly, an endorsement of 'AFL involvement' covers participant identification to any of these labels: 'Amateur player', 'Administration', 'Supportive other', or 'Fan'.

Table 3.4. Sample demographic means, medians, and SDs (n=313)

Characteristic	Range	Mean (SD)	Median
Age (years)	16–35	23.4 (5.38)	23.0
Day 1 Wellbeing (WEMWBS)	19–70	47.9 (10.1)	49.0
Total usage (minutes)[a]	0–638	18.6 (47.3)	5.37

[a]+/- 1–29 seconds. 6 participants did not generate usage data.

Table 3.5. Other self-reported sample demographic frequencies (n=313)

Characteristic		n (%)[a]
Gender	Male	131 (41.9%)
	Female	174 (55.6%)
	Other	8 (2.60%)
Highest level of education	Primary school	1 (.300%)
	Junior high school	7 (2.20%)
	Senior high school	117 (37.4%)
	Certificate/diploma	70 (22.4%)
	Degree	94 (30.0%)
	Postgraduate degree	24 (7.70%)
Ethnic background most identified with	English	48 (15.3%)
	Irish	10 (3.2%)
	Scottish	2 (.6%)
	Italian	7 (2.2%)
	German	2 (.60%)

	Chinese	28 (8.9%)
	Australian	138 (44.1%)
	Other	69 (22.0%)
Aboriginal and/or Torres Strait Islander	Yes	2 (.60%)
	No	307 (98.1%)
Current main activities	Full-time work	92 (29.4%)
	Part-time work	39 (12.5%)
	School student	41 (13.1%)
	Tertiary education	92 (29.4%)
	Not in work	47 (14.6%)
Ever played video games	Yes	268 (85.6%)
	No	45 (14.4%)
AFL involvement	Yes	145 (46.6%)
	No	166 (53.0%)

[a]Percentages do not sum to 100 due to rounding and also as participants could also state that they did not know or choose not to answer

3.4.2. Missing data

As shown in Figure 3.1, a considerable amount of dropout and protocol deviation (whether by not downloading MindMax, or by not answering follow-up surveys) was observed after Day 1. As those who only completed Day 1 (241/554, 43.5%) did not differ significantly in demographics to those who completed Day 1 and at least one follow-up survey (313/554, 56.5%), we judged it more appropriate to drop them from analysis instead of imputing large amounts of data.

Little's MCAR test was run on the remaining sample (n=313) at both item and scale levels. Neither test returned a significant result. Hence, the data of this group was assumed to be missing completely at random and we proceeded to apply complete case analysis (in the form of 2 separate MANOVAs).

3.4.2. Analysis

3.4.2.1. Overall

Tables 3.6 and 3.7 present the (untransformed) subsample means and SDs for all outcome variables in MANOVAs 1 and 2, split by the between-subjects factors (gender and base wellbeing).

Table 3.6. Dependent variable observed means (*SD*) for MANOVA 1 (Day 1 to Day 30)

Dependent variable		Total (n=290)	Male (n=124)	Female (n=166)	Low WB[a] (n=141)	High WB[a] (n=149)
Flourishing	Day 1	41.9 *(7.16)*	42.4 *(7.21)*	41.6 *(7.12)*	37.9 *(7.01)*	45.8 *(4.84)*
	Day 30	42.1 *(7.74)*	42.6 *(7.41)*	41.8 *(7.98)*	39.1 *(7.70)*	45.1 *(6.58)*
CD-RISC 10	Day 1	26.1 *(7.16)*	27.4 *(6.82)*	25.2 *(7.28)*	22.6 *(7.36)*	29.5 *(5.10)*
	Day 30	26.2 *(6.84)*	27.7 *(6.33)*	25.0 *(7.00)*	23.2 *(7.03)*	29.0 *(5.35)*
GHSQ (personal)	Day 1	18.1 *(4.70)*	17.7 *(4.53)*	18.4 *(4.81)*	16.3 *(5.03)*	19.8 *(3.61)*
	Day 30	18.2 *(4.51)*	18.3 *(4.66)*	18.2 *(4.41)*	16.7 *(4.88)*	19.6 *(3.62)*
GHSQ (impersonal)	Day 1	13.7 *(6.09)*	15.0 *(6.87)*	12.7 *(5.23)*	12.1 *(4.99)*	15.1 *(6.67)*
	Day 30	14.2 *(6.08)*	15.7 *(6.81)*	13.1 *(5.22)*	12.9 *(5.50)*	15.5 *(6.35)*
Self-group overlap	Day 1	1.80 *(1.31)*	1.96 *(1.38)*	1.69 *(1.25)*	1.68 *(1.40)*	1.92 *(1.22)*
	Day 30	2.56 *(1.57)*	3.01 *(1.67)*	2.23 *(1.40)*	2.12 *(1.38)*	2.98 *(1.62)*

[a]WB=wellbeing

Table 3.7. Dependent variable observed means (*SD*) for MANOVA 2 (Day 1 to Day 60)

Dependent variable		Total (n=239)	Male (n=100)	Female (n=139)	Low WB[a] (n=119)	High WB[a] (n=120)
Flourishing	Day 1	42.3 *(6.81)*	42.9 *(6.42)*	41.8 *(7.06)*	38.8 *(6.72)*	45.8 *(4.85)*
	Day 60	43.3 *(6.91)*	43.6 *(6.88)*	43.1 *(6.95)*	40.5 *(7.00)*	46.1 *(5.57)*
CD-RISC 10	Day 1	26.2 *(6.79)*	27.6 *(6.14)*	25.2 *(7.08)*	23.2 *(6.93)*	29.2 *(5.16)*
	Day 60	26.2 *(6.07)*	27.5 *(5.69)*	25.3 *(6.20)*	24.0 *(6.38)*	28.4 *(4.85)*
GHSQ (personal)	Day 1	18.0 *(4.63)*	17.8 *(4.45)*	18.2 *(4.76)*	16.2 *(4.92)*	19.8 *(3.51)*
	Day 60	18.3 *(4.72)*	17.6 *(5.03)*	18.7 *(4.44)*	16.7 *(5.21)*	19.8 *(3.59)*
GHSQ (impersonal)	Day 1	13.3 *(5.78)*	14.6 *(6.57)*	12.4 *(4.94)*	11.8 *(4.86)*	14.8 *(6.24)*
	Day 60	14.5 *(5.43)*	15.5 *(5.62)*	13.7 *(5.18)*	13.1 *(4.96)*	15.8 *(5.58)*
Self-group overlap	Day 1	1.92 *(1.41)*	2.17 *(1.44)*	1.75 *(1.36)*	1.81 *(1.54)*	2.04 *(1.27)*
	Day 60	2.79 *(1.60)*	3.24 *(1.62)*	2.46 *(1.52)*	2.26 *(1.39)*	3.31 *(1.63)*

[a]WB=wellbeing

Table 3.8 presents the multivariate effects of time, and higher-order interaction effects between time and other between-subjects factors for MANOVA 1 (comparing Day 1 to Day 30) and

MANOVA 2 (comparing Day 1 to Day 60). We present partial eta squared values as measures of effect size, to be interpreted according to Cohen's recommended scales of magnitude (partial η^2=.010, .059, and .138 for small, medium, and large effects respectively) (Cohen 1988; Richardson 2011). Pillai's Trace is an appropriate statistic to report due to the violation of homogeneity of variance-covariance matrices; however, as it is identical to partial eta squared in a repeated-measures MANOVA, we do not report it additionally. Finally, as two MANOVAs were conducted all *p*-values were assessed to a Bonferroni-corrected significance value of *p*=.025.

Table 3.8. Multivariate and univariate effects of time and interaction effects for MANOVAs 1 and 2

	MANOVA 1 (Day 1–30; n=290)			**MANOVA 2 (Day 1–60; n=239)**		
	Df	Partial η^2	*F* value	Df	Partial η^2	*F* value
Time	**5, 282**	**.177**	**12.117[a]**	**5, 231**	**.246**	**15.048[a]**
Flourishing	1, 286	.002	.600	1, 235	.022	5.402[a]
CD-RISC 10	1, 286	.000	.141	1, 235	.000	.056
GHSQ (personal)	1, 286	.001	.341	1, 235	.003	.696
GHSQ (impersonal)	1, 286	.019	5.478[a]	1, 235	.062	15.491[a]
Self-group overlap	1, 286	.169	58.260[a]	1, 235	.201	59.043[a]
Time x Gender	**5, 282**	**.025**	**1.421**	**5, 231**	**.010**	**.453**
Flourishing	1, 286	.001	.358	1, 235	.001	.132
CD-RISC 10	1, 286	.004	1.282	1, 235	.000	.032
GHSQ (personal)	1, 286	.012	3.336	1, 235	.005	1.171
GHSQ (impersonal)	1, 286	.002	.482	1, 235	.001	.128
Self-group overlap	1, 286	.012	3.370	1, 235	.003	.674
Time x Base wellbeing	**5, 282**	**.072**	**4.386[a]**	**5, 231**	**.096**	**4.894[a]**
Flourishing	1, 286	.021	6.097[a]	1, 235	.010	2.352
CD-RISC 10	1, 286	.012	3.406	1, 235	.023	5.621[a]
GHSQ (personal)	1, 286	.008	2.238	1, 235	.004	.832
GHSQ (impersonal)	1, 286	.004	1.068	1, 235	.004	.859
Self-group overlap	1, 286	.038	11.248[a]	1, 235	.056	13.817[a]
Time x Gender x Base wellbeing	**5, 282**	**.047**	**2.803[a]**	**5, 231**	**.053**	**2.567**
Flourishing	1, 286	.001	.422	1, 235	.001	.183
CD-RISC 10	1, 286	.000	.068	1, 235	.000	.054
GHSQ (personal)	1, 286	.001	.178	1, 235	.004	1.049
GHSQ (impersonal)	1, 286	.009	2.511	1, 235	.041	10.040[ab]
Self-group overlap	1, 286	.029	8.397[a]	1, 235	.006	1.473

[a]p<.025
[b]Not followed up on due to multivariate non-significance

3.4.2.2. MANOVA 1 (Day 1 vs. Day 30)

3.4.2.1.1. 30-day change in impersonal help-seeking

Alongside the observed impersonal help-seeking means on Day 1 and Day 30 (Table 3.6), the significant univariate main effect of time on impersonal help-seeking in MANOVA 1 (Table 3.8) indicates an increase in participants' impersonal help-seeking intentions from Day 1 to Day 30. Pairwise comparisons found an increase of .720 (95% CI=.114–1.33) in impersonal help-seeking estimated marginal means, p=.020.

3.4.2.1.2. Effect of base wellbeing on 30-day change in flourishing

Figure 3.2 shows flourishing scores on Day 1 and Day 30, split by base wellbeing. Alongside the observed means of flourishing split by base wellbeing (Table 3.6) and the univariate significance of the time x base wellbeing interaction effect on flourishing in MANOVA 1 (Table 3.8), it suggests an increase in low-wellbeing participants but a decrease in high-wellbeing participants. However, pairwise comparisons found a nonsignificant change in both the low-wellbeing group and the high-wellbeing group, p>.025, suggesting that this pattern of results is due to chance.

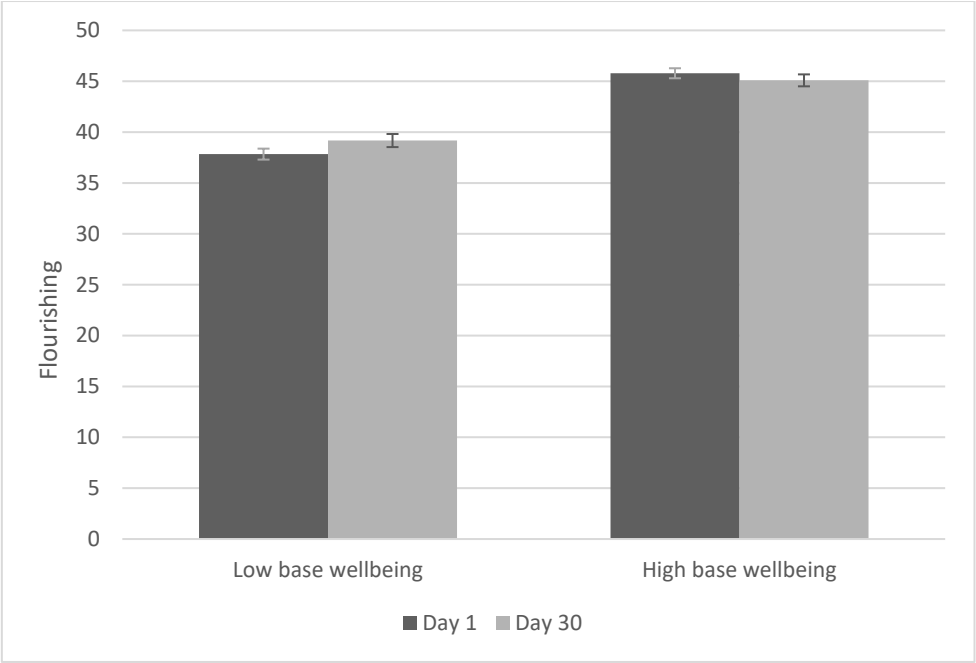

Figure 3.2. Estimated marginal mean flourishing scores across time, split by base wellbeing. Error bars show unpooled standard error of the mean (SEM). Asterisks indicate significant differences across time. (None present in Figure 3.2.)

3.4.2.1.3. Effects of gender and base wellbeing on 30-day change in self-group overlap

Alongside the observed self-group overlap means on Day 1 and Day 30 (Table 3.6), the significant univariate main effect of time on self-group overlap in MANOVA 1 (Table 3.8) indicates an increase in participants' sense of connection to the MindMax community from Day 1 to Day 30. However, the significant interaction effects of time x base wellbeing and time x gender x base wellbeing on self-group overlap in MANOVA 1 suggest that this increase may be driven by certain groups. We followed up the time x gender x base wellbeing interaction to investigate this further.

Figure 3.3 shows self-group overlap scores on Day 1 and Day 30, split by gender and base wellbeing. It suggests that self-group overlap increased more in high-wellbeing males compared to low-wellbeing males and females in general. To test this, we split the sample by gender and conducted mixed design MANOVAs on each subsample. The time x base wellbeing interaction had a medium-to-large, significant effect on self-group overlap scores in male participants, $F(1,122)=12.1$, $p=.001$, partial $\eta^2=.090$, and a negligible, nonsignificant effect in female participants, $F(1,160)=.962$, $p>.025$, partial $\eta^2=.029$). This suggests that base wellbeing only influenced the change in self-group overlap in our male participants. Pairwise comparisons found an increase of 1.49 (95% CI=1.14–1.83) in self-group overlap estimated marginal means in high-wellbeing males, $p<.001$, and an increase of .505 (95% CI=.191–.819) and .592 (95% CI=.228–.955) in low-wellbeing and high-wellbeing females respectively, both $p=.002$. The change in self-group overlap in low-wellbeing males was nonsignificant, $p>.025$, which suggests it is due to chance.

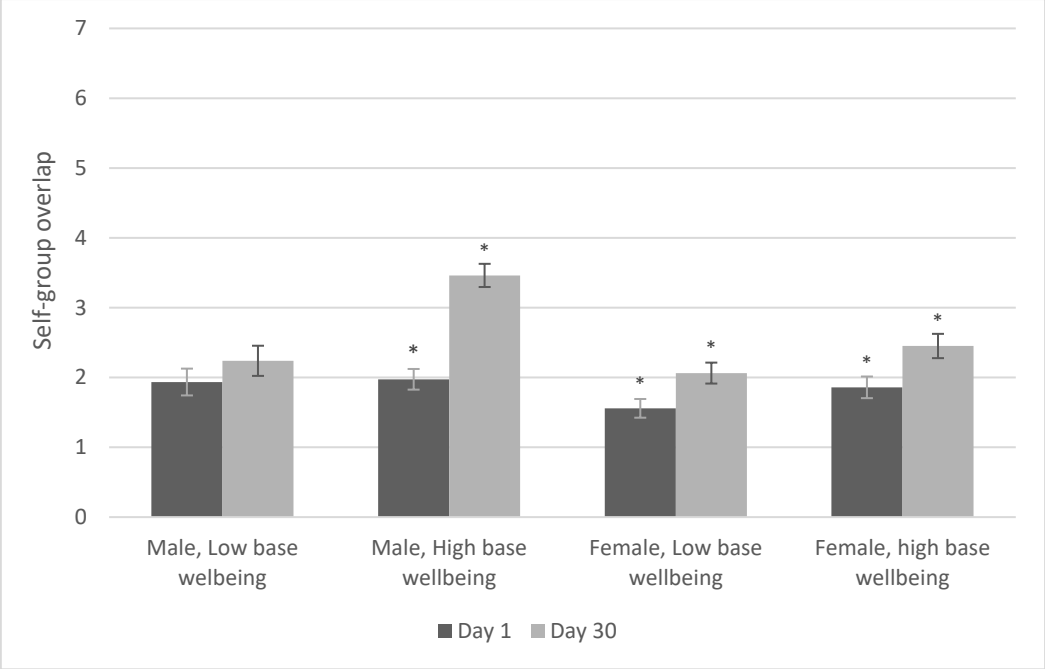

Figure 3.3. Estimated marginal mean self-group overlap scores across time, split by gender and base wellbeing. Error bars show unpooled SEM. Asterisks indicate significant differences across time.

3.4.2.3. MANOVA 2 (Day 1 vs. Day 60)

3.4.2.3.1. 60-day change in flourishing

Alongside the observed flourishing means on Day 1 and Day 60 (Table 3.7), the significant univariate main effect of time on flourishing in MANOVA 2 (Table 3.8) indicates an increase in participants' flourishing from Day 1 to Day 60. Pairwise comparisons found an increase of 1.01 (95% CI=.154–1.87) in flourishing estimated marginal means, p=.021.

3.4.2.3.2. 60-day change in impersonal help-seeking

Alongside the observed impersonal help-seeking means on Day 1 and Day 60 (Table 3.7), the significant univariate main effect of time on impersonal help-seeking in MANOVA 2 (Table 3.8) indicates a non-chance increase in participants' impersonal help-seeking intentions from Day 1 to Day 60. Pairwise comparisons found an increase of 1.35 (95% CI=.674–2.03) in impersonal help-seeking estimated marginal means, p<.001.

3.4.2.3.3. Effect of base wellbeing on 60-day change in self-group overlap

Alongside the observed self-group overlap means on Day 1 and Day 60 (Table 3.7), the significant univariate main effect of time on self-group overlap in MANOVA 2 (Table 3.8) indicates a non-

chance increase in participants' sense of connection to the MindMax community from Day 1 to Day 60. However, the significant interaction effect of time x base wellbeing on self-group overlap suggests that this increase may be influenced by level of base wellbeing. We followed up the time x base wellbeing interaction to investigate this further.

Figure 3.4 shows self-group overlap scores on Day 1 and Day 60, split by base wellbeing. Pairwise comparisons found an increase of .439 (95% CI=.119–.757) in self-group overlap estimated marginal means in low-wellbeing participants, p=.007, and an increase of 1.26 (95% CI=.963–1.56) in high-wellbeing participants, p<.001. The significant interaction suggests that the higher increase in high-wellbeing participants is not due to chance.

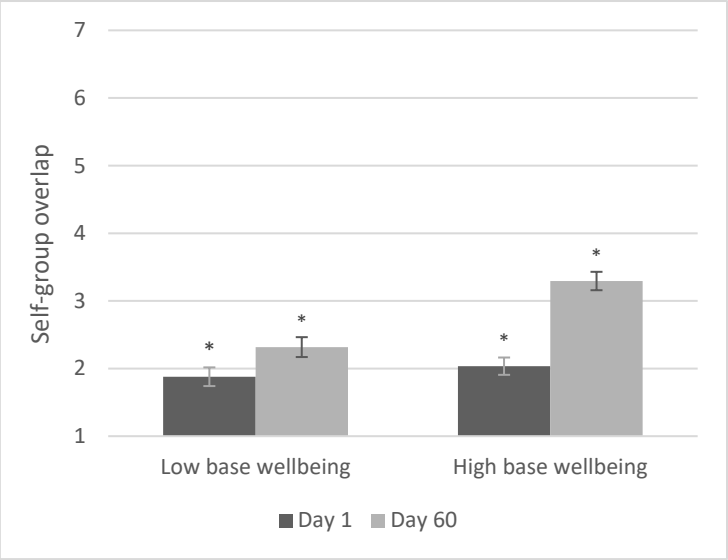

Figure 3.4. Estimated marginal mean self-group overlap scores across time, split by base wellbeing. Error bars show unpooled SEM. Asterisks indicate significant differences across time.

3.4.2.3.4. Effect of base wellbeing on 60-day change in resilience

Finally, Figure 3.5 shows resilience scores on Day 1 and Day 60, split by base wellbeing. Alongside the observed means of resilience split by base wellbeing on Day 1 and Day 60 (Table 3.7) and the univariate significance of the time x base wellbeing interaction effect on resilience in MANOVA 2 (Table 3.8), it suggests an increase in low-wellbeing participants but a decrease in high-wellbeing participants. However, pairwise comparisons found a nonsignificant change in both the low-

wellbeing group and the high-wellbeing group, p>.025, suggesting that this pattern of results is due to chance.

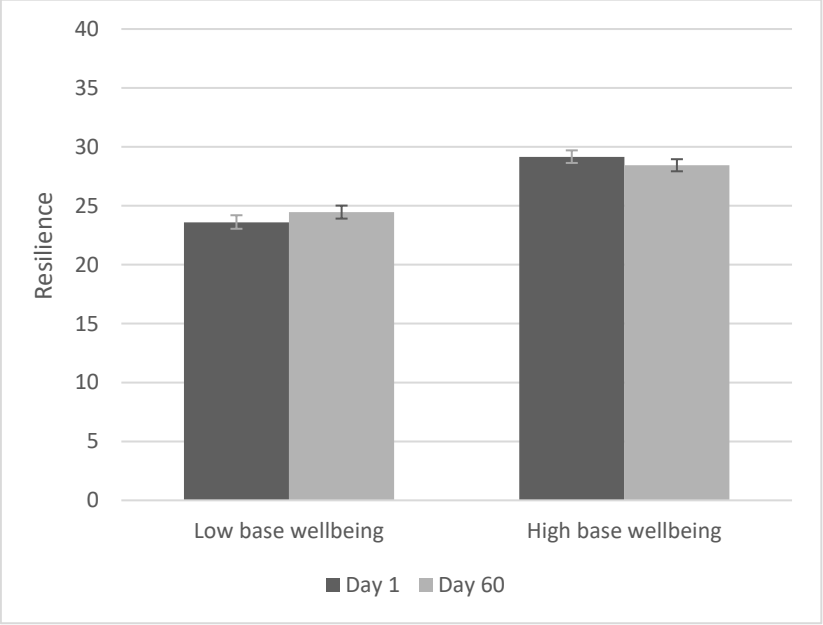

Figure 3.5. Estimated marginal mean resilience scores across time, split by base wellbeing. Error bars show unpooled SEM. Asterisks indicate significant differences across time. (None present in Figure 3.5.)

3.4.3. Sensitivity analyses

Sensitivity analyses were performed to assess the impact of transforming our sample's flourishing and self-group overlap data, as well as the impact of removing univariate and multivariate outliers, for MANOVA 1 and MANOVA 2. All significant main effects of time identified in the primary analysis were also present in the sensitivity analyses.

Transformation of our skewed variables (flourishing and self-group overlap) did not lead to any changes in statistical significance for any of the group differences reported above. However, removal of outliers did. In MANOVA 1 (change between Days 1–30), the time x base wellbeing and time x gender x base wellbeing interaction effects on self-group overlap were nonsignificant when outliers were removed, and a significant time x gender interaction effect was detected at a multivariate level, $F(5, 266)=3.208$, $p=.008$, partial $\eta^2=.057$, and at a univariate level for self-group overlap, $F(1, 270)=11.781$, $p=.001$, partial $\eta^2=.042$. Pairwise comparisons found an increase of

1.19 (95% CI=.919–1.46) in self-group overlap estimated marginal means in male participants, $p<.001$, and an increase of .580 (95% CI=.359–.801) in female participants, $p<.001$.

In MANOVA 2 (change between Days 1–60), the univariate time x base wellbeing interaction effect on self-group overlap was no longer present once a logarithmic transformation was applied and outliers were removed (but it was present in both the transformed-only analysis and the outliers-removed analysis).

3.5. Discussion

3.5.1. Primary result

In this naturalistic study, we provided participants with access to MindMax, which they used as they wished. The aim of this study was to identify whether we would observe a change in participants' flourishing, resilience, help-seeking intentions, and sense of connection to the MindMax community across time, and whether gender and base wellbeing influenced any such change. Two mixed design MANOVAs were conducted to assess 30-day change from baseline and 60-day change from baseline. We identified 30-day increases in impersonal help-seeking intentions and sense of connection to the MindMax community, and 60-day increases in flourishing, impersonal help-seeking intentions, and sense of connection to the MindMax community. While the 30-day increase in impersonal help-seeking intentions and 60-day increase in flourishing and impersonal help-seeking intentions were observed across the sample, both the 30-day and 60-day increases in sense of connection were influenced by either one or both of our between-subjects factors (gender and base wellbeing).

Specifically, the 30-day increase in sense of connection was highest in our male participants with high (above median) base wellbeing. A smaller increase was also observed in our female participants regardless of their level of base wellbeing. We observed no increase in male participants with low base wellbeing.

Gender did not influence 60-day increases in sense of connection to the MindMax community; however, we observed a smaller increase in low-wellbeing participants than in high-wellbeing participants.

The various interaction effects involving time, gender, and base wellbeing on self-group overlap were not robust against corrections for extreme positive skew, and could therefore also be attributed to chance, unique participant circumstances (for the outlying cases), or a lack of statistical power. However, the 30-day and 60-day increases in impersonal help-seeking intentions and sense of connection to the MindMax community, and the 60-day increase in flourishing remained robust. We can hence confidently state that these constructs increased over the 30-day and 60-day intervals in which our participants were given the opportunity to use MindMax.

3.5.2. Help-seeking intentions

In this study, participants' personal help-seeking scores were the sum of their willingness to seek help for personal-emotional problems from their 'intimate partner', 'friend', parent', or 'other relative', while their impersonal help-seeking scores were the sum of their willingness to seek help for personal-emotional problems from their 'doctor/general practitioner', 'mental health professional', 'phone helpline', and 'someone online, who you don't know personally' (Table 3.2). As shown in Table 3.6, participants' personal help-seeking scores trended higher than their impersonal help-seeking scores (although this difference was not assessed statistically). In conjunction with this, male participants showed a trend of having higher impersonal help-seeking scores than female participants, while the pattern was opposite for personal help-seeking scores. Finally, consistent with previous research (Rickwood et al. 2005), low-wellbeing participants had lower help-seeking scores than high-wellbeing participants.

We observed an overall increase in impersonal help-seeking intentions over 30 days and 60 days from baseline, regardless of gender and base wellbeing (Table 3.6; Table 3.7). MindMax's target audience is younger men interested in AFL and/or video games, and MindMax features young

male role models and uses a casual masculine tone. It addresses the lack of mental health apps aimed specifically at a younger male audience (Rice, Purcell & McGorry 2018). As Australian men exhibit low rates of help-seeking despite their level of need (Rice, Purcell & McGorry 2018), our observed increase in impersonal help-seeking among our male participants is encouraging. Furthermore, our results suggest that this gender-specific targeting did not seem to have had any adverse effect on our female participants' intentions to seek help from informal sources.

While an exploratory factor analysis conducted on our GHSQ items (Table 3.2) provided support for grouping these sources together, it must be noted that the overall solution was not ideal due to lower-than-desired commonality of the item 'intimate partner' and internal consistency of the items making up the personal help-seeking factor. However, there were no such problems with the impersonal help-seeking factor and its associated items. With these qualifications in mind, the grouping of 'someone online' with the other, more formal sources (Ellis et al. 2013) in the same factor suggests that people who endorse or reject these items may not do so due to their perceived authority, or clinical or service-related nature, but rather their distance from their personal sphere. This is not surprising when viewed in the context of research on the links between threatened masculinity, shame, and how these interact with mental health stigma to discourage help-seeking (Rice, Purcell & McGorry 2018), and may be indicative of a shift in help-seeking patterns.

3.5.3. Sense of connection to the MindMax community

We observed an overall increase in sense of connection to MindMax (self-group overlap) over 30 days and 60 days from baseline (Tables 3.6–3.8). While this increase appeared to be driven by gender and base wellbeing (with the largest increases observed in our male participants and our participants with high base wellbeing), these interaction effects were not robust to sensitivity analyses excluding outliers, and could therefore be due to exceptional cases. Regardless, the overall increase we observed is encouraging, as it suggests that MindMax was successful in creating a community of users.

Our primary analysis detected no significant 30-day increase in sense of connection to the MindMax community in our male participants with low base wellbeing (Figure 3.3). A possible explanation for this may be the tendency of low-wellbeing individuals to feel more isolated and withdraw from prosocial activity (Deci & Ryan 2000), compounded with the tendency for men to have lower levels of emotional competence than women in general (Ellis et al. 2014). However, the interaction effect between time, gender, and base wellbeing on self-group overlap was not present when assessing 60-day change in sense of connection to the MindMax community. This indicates that being male did not adversely influence this increase, and suggests that men with lower wellbeing may take longer to establish a meaningful sense of connection. Alternatively, as assessments of 30-day change and 60-day change only included participants who answered surveys at those time points, it may be reflective of the characteristics of the subgroups. We note, however, that demographic characteristics did not differ across subgroups (Chapter 3.4.1).

It is also encouraging that our female participants endorsed an increased sense of connection to the MindMax community, despite female participants in an earlier study expressing a lack of identification with its masculine tone (Cheng et al. 2018). While MindMax is not a perfect example of a gender-synchronised intervention as recommended by Rice and colleagues (Rice, Purcell & McGorry 2018), this finding suggests that it at least does not actively create barriers for its female users.

3.5.4. Flourishing

Finally, we observed an overall increase in flourishing over 60 days from baseline (Table 3.7; Table 3.8). However, no change was observed 30 days from baseline. This suggests that a longer amount of time was required to achieve significant increases in flourishing across all subgroups (split by gender or base wellbeing). An alternative explanation is that the same background factors that influenced individuals into continued participation in the trial (by answering surveys 60 days after baseline) could also have contributed to this increase. Regardless, it is again an

encouraging observation that may point to MindMax's usefulness in a grander strategy for improving mental health and wellbeing.

3.5.5. Limitations and future research

There are several limitations to this study that must be considered alongside the above reported findings. First, this trial was naturalistic by design, with one condition. As a result, these findings are observational and we cannot make claims about the impact of the absence or presence of participants' exposure to MindMax. While the 30-day and 60-day increases in impersonal help-seeking intentions, sense of connection to the MindMax community, and flourishing could be due to exposure to MindMax and its content, they could also be due to an underlying factor that could have influenced both participants' enrolment in this study and their subsequently observed changes. The single-arm design also meant that we were unable to test MindMax's intervention principles against other principles or even a control condition, and that MindMax's efficacy and effectiveness would have to be fully tested through a randomised controlled trial.

However, a strength of this design is that it accommodated natural usage patterns, leading to increased external validity, and further allowed us to observe participants' usage. Our results are hence able to be interpreted in the context of app usage (although small cell sizes prevent it from being used as a predictor variable). We have published research focusing more specifically on participant usage of, and engagement with, MindMax (Vella et al. 2018), and plan to explore usage and wellbeing more fully in future publications.

The use of median splits to form analysis groups leads to an increased risk of regression to the mean. Certain patterns of change we observed over time (Figure 3.2; Figure 3.5) are consistent with, and may be explained by, this pattern.

We also observed a considerable amount of dropout (though at a rate characteristic of eHealth evaluations; Fleming et al. 2018), particularly after Day 1. Hence, full implementation of intention-to-treat analysis principles was not possible, particularly as previous research has found that imputing entire waves of data has no real impact on analysis efficiency (Young &

Johnson 2015). Therefore, the results of this study cannot be generalised outside the context of participants who had been given the opportunity to use MindMax and who had answered the surveys at the time points specified. Missing data was also observed within the analysis sample (n=313), though Little's test suggests that it was missing completely at random. However, sensitivity analyses assuming a less random type of missingness (e.g. missing at random) could not be performed for the same reason stated above.

MindMax also changed across the duration of the trial, with multiple functional and aesthetic updates applied to the app (described in Chapter 3.3.2). While these changes could have adversely affected users (including participants of this study), all these changes intended to improve MindMax's content delivery, and the delivery of the intervention principles through which it aimed to effect wellbeing, resilience, help-seeking intentions, and sense of connection to the MindMax community. Furthermore, as constant updates to content and delivery are actually the norm in the wider, non-academic delivery of electronic services, this resulted not only in greater ecological validity, but also increased MindMax's ability to remain relevant to its users (Fleming et al. 2016; Mohr et al. 2015). Of course, it is also possible that the varying versions of MindMax throughout the trial each had slightly different effects, which may have affected our results. It must also be noted that the current version of MindMax is not the same version that was evaluated in the research reported in this paper.

Of note is the demographic distribution of the naturalistic trial sample. Just over half the sample was female (Table 3.5), which may reflect the higher level of interest women tend to have in eHealth programmes (Batterham & Calear 2017) and in participating in research trials (Diviak et al. 2006). Additionally, less of the participants were involved with AFL (whether as players, staff, or fans) than compared to the organic (i.e. non-trial, as MindMax was available to the public during the trial) user base, which may have been due to the modality of trial recruitment (i.e. online advertising, and paper advertising in the Australian states of Queensland and New

South Wales, where AFL is not as popular). Mentioning vouchers in recruitment materials may also have influenced decisions to participate in, and therefore the results of, this study.

The naturalistic trial sample differs demographically from MindMax's organic user base, which expressed a high mean level of interest in AFL and was over 80% male (Vella et al. 2018). Again, this suggests that in general (beyond the context of an evaluation trial), MindMax succeeded at appealing to its target population. Furthermore, given that some increases we observed in our trial participants were higher in males (e.g. sense of connection to the MindMax community), these effects are not likely to be diminished, and may even be magnified, in MindMax's organic user base. While most observed effect sizes were small, in population-wide initiatives that apps like MindMax have the potential of becoming, small effects may result in considerable aggregate gains.

Finally, as this study focused primarily on wellbeing, we were unable to obtain data on our participants' conformity to masculine norms, particularly harmful ones (The Men's Project & Flood 2018). Future research can consider investigating how this may influence mHealth engagement, and how these may affect help-seeking behaviours.

3.5.6. Conclusion

This article reports the changes we observed in participants who were given the opportunity to use MindMax, an AFL-themed app that combines psychoeducation, social connection, and applied games. We asked participants to use MindMax at their leisure and assessed their 30-day and 60-day change from baseline in their wellbeing, resilience, and help-seeking scores. As recommended by its developers, we customised the GHSQ (Deane & Wilson 2007; Wilson et al. 2005), and an exploratory factor analysis revealed two factors: personal and impersonal help-seeking. We observed 30-day increases in impersonal help-seeking intentions and sense of connection to the MindMax community, and 60-day increases in impersonal help-seeking intentions, sense of connection to the MindMax community, and flourishing. MindMax attempts to address the lack of mental health initiatives aimed directly at younger men (Rice, Purcell & McGorry 2018; Seidler et

al. 2016), incorporating co-design throughout its development (Cheng et al. 2018). In addition to exploring the impact of such initiatives on male help-seeking, future initiatives targeting men could also benefit from directly investigating the role of conformity to masculine norms and how rigid adherence to harmful aspects of masculinity may impact the effect of mental health and wellbeing interventions on an individual.

3.6. Acknowledgements

We thank all study participants for contributing to this research, Nikki Peever for her assistance on obtaining and interpreting usage analytics, Paulina Barranco for assisting with running the trial, members of the youth mental health technology research team at the University of Sydney's Brain and Mind Centre for providing advice and moral support, and reviewers for their critical appraisal of the paper. The MindMax project was a collaboration funded by Movember Association, led by the AFL Players' Association and supported by Queensland University of Technology, The University of Sydney (via the former Young and Well Cooperative Research Centre headed by Professor Jane Burns), and The Mind Room.

3.7 Conflicts of Interest

IBH was an inaugural Commissioner on Australia's National Mental Health Commission (2012-18). He is the Co-Director, Health and Policy at the Brain and Mind Centre (BMC), University of Sydney. The BMC operates an early-intervention youth services at Camperdown under contract to headspace. Professor Hickie has previously led community-based and pharmaceutical industry-supported (Wyeth, Eli Lily, Servier, Pfizer, AstraZeneca) projects focused on the identification and better management of anxiety and depression. He was a member of the Medical Advisory Panel for Medibank Private until October 2017, a Board Member of Psychosis Australia Trust, and a member of Veterans Mental Health Clinical Reference group. He is the Chief Scientific Advisor to, and an equity shareholder in, Innowell. Innowell has been formed by the University of Sydney and PwC Australia to deliver the Aus $30m Australian Government-funded 'Project Synergy'. Project Synergy is a three-year program for the transformation of mental health

services through the use of innovative technologies. None of the other authors declare any conflicts of interest.

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3.9. Appendix 1

Note: This appendix contains further discussion of the results reported in this chapter. As the manuscript that makes up the main body of this thesis is currently undergoing re-review, this appendix is included only in this thesis.

Further comments on 60-day increase in flourishing

As no clinical cutoff points have been identified for the Flourishing scale used in this study, the clinical significance of the observed 60-day increase in flourishing is unclear. A comparison can be made, however, between the observed 60-day mean (mean=43.3) and the mean reported in the scale norms (mean=44.97; Table 3.1). Study participants' mean flourishing was still below those of similarly aged people (albeit from the USA; Diener et al. 2010). Future research could consider using scales with clinically significant cutoff points identified in the population of interest to allow for easier interpretability.

Posthoc analyses of the influence of app usage on wellbeing and help-seeking changes

Although usage could not be included in the MANOVAs as a between-subjects variable due to cell sizes, post-hoc analyses were conducted whereby the main sample (n=313) was filtered based on whether they had used MindMax for ten minutes or less (low usage), or more than ten minutes (high usage). This duration was chosen as it is the estimated duration of the average MindMax psychoeducation module. Due to low sample sizes for the high usage subgroup (n=84 for Day 1–30; n=71 for Day 1–60), a repeated-measures MANOVA with time as the sole factor was conducted.

Table 3.9.1 presents means and SDs split by usage, while Table 3.9.2 presents the multivariate and univariate effects of time for both comparisons. As these analyses were preliminary and post-hoc, they were assessed to a significance level of $p<.05$, with the caveat that they are indicative of trends of interest only.

Table 3.9.1. Dependent variable observed means (*SD*) for low vs. high usage participants

Dependent variable		Day 1–30 (n=290)		Day 1–60 (n=239)	
		Day 1	Day 30	Day 1	Day 60
Flourishing	Low usage	42.3 *(7.26)*	42.4 *(7.91)*	42.6 *(6.76)*	43.4 *(7.02)*
	High usage	41.1 *(6.88)*	41.5 *(7.31)*	41.6 *(6.92)*	43.1 *(6.68)*
CD-RISC 10	Low usage	26.2 *(7.03)*	26.45 *(6.67)*	26.0 *(6.54)*	26.2 *(5.95)*
	High usage	26.1 *(7.49)*	25.5 *(7.25)*	26.7 *(7.38)*	26.3 *(6.40)*
GHSQ (personal)	Low usage	18.2 *(4.75)*	18.3 *(4.38)*	18.2 *(4.60)*	18.4 *(4.54)*
	High usage	17.9 *(4.59)*	17.9 *(4.83)*	17.6 *(4.69)*	17.9 *(5.12)*
GHSQ (impersonal)	Low usage	14.1 *(6.47)*	14.7 *(6.41)*	13.7 *(6.13)*	15.1 *(5.43)*
	High usage	12.6 *(4.90)*	13.1 *(5.04)*	12.3 *(4.73)*	13.0 *(5.19)*
Self-group overlap	Low usage	1.81 *(1.32)*	2.74 *(1.68)*	1.98 *(1.45)*	2.95 *(1.65)*
	High usage	1.79 *(1.28)*	2.12 *(1.11)*	1.79 *(1.31)*	2.41 *(1.43)*

Table 3.9.2. Multivariate and univariate effects of time for low vs. high usage participants

Day 1–30		**Low usage (n=206)**			**High usage (n=84)**		
		Df	Partial η^2	*F* value	Df	Partial η^2	*F* value
Time		**5, 201**	**.235**	**12.315[a]**	**5, 79**	**.115**	**2.046**
	Flourishing	1, 205	.000	.076	1, 83	.004	.304
	CD-RISC 10	1, 205	.003	.581	1, 83	.011	.882
	GHSQ (personal)	1, 205	.001	.267	1, 83	.000	.019
	GHSQ (impersonal)	1, 205	.013	2.670	1, 83	.015	1.250
	Self-group overlap	1, 205	.228	60.632[a]	1, 83	.070	6.214[ab]
Day 1–60		**Low usage (n=168)**			**High usage (n=71)**		
		Df	Partial η^2	*F* value	Df	Partial η^2	*F* value
Time		**5, 168**	**.272**	**12.188[a]**	**5, 66**	**.280**	**5.128[a]**
	Flourishing	1, 167	.012	2.093	1, 70	.077	5.870[a]
	CD-RISC 10	1, 167	.002	.374	1, 70	.007	.482
	GHSQ (personal)	1, 167	.002	.376	1, 70	.005	.338
	GHSQ (impersonal)	1, 167	.061	10.878[a]	1, 70	.021	1.470
	Self-group overlap	1, 167	.227	49.057[a]	1, 70	.159	13.188[a]

[a]p<.05
[b]Not followed up on due to multivariate non-significance

There was a notable female majority in the high-usage subgroup in both the Day 1–30 (75% female; 63/84) and Day 1–60 comparisons (73% female; 52/71). This imbalance was not

present in the low-usage subgroup in the Day 1 – 30 (50% female; 103/206) comparison and less prominent in the Day 1–60 (52% female; 87/168) comparison.

Table 3.9.2 shows that increases in sense of belonging to MindMax were broadly present in all participants regardless of usage, and that they were stronger in low-usage participants. This unexpected finding can perhaps be attributed to the characteristics of the high-usage subgroup, which were mostly females with lower levels of wellbeing. As Chapter 3 argues, such individuals would have experienced lower increases in self-group overlap scores.

Table 3.9.2 also indicates a 60-day increase in impersonal help-seeking intentions in the low usage subgroup, but not the high usage subgroup. While this (and the lack of statistical significance in the 30-day comparison) could be attributed to smaller sample sizes (especially given the trend of increasing impersonal help-seeking intentions in all subgroups; Table 3.9.1), it may also suggest that mere exposure to helpful principles (e.g. participating in a research trial evaluating an mHealth app, or spending one brief session using an mHealth app) may be sufficient to influence impersonal help-seeking intentions (and self-group overlap).

Finally, a significant increase in flourishing was only observed in high-usage participants. That a significant medium-to-large effect (as quantified by Cohen) was found in the smallest subgroup is encouraging and suggests that the 60-day increase in flourishing reported in Chapter 3 may be almost entirely driven by participants who used MindMax for more than 10 minutes. While firm conclusions cannot be drawn regarding causality (as acknowledged in the main body of this chapter), these are encouraging results.

Further detail on MindMax content

MindMax provides users who need more support with a list of possible resources (such as MensLine Australia, Suicide Call Back Service, and Lifeline Australia). Additionally, content generated by users (such as the shareables described in Chapter 2.3.4) was moderated. The casual, generally positive tone of these shareables and the framing of MindMax as a wellbeing community may also have contributed to the slower increase of sense of belonging to the

MindMax community in male users with low base wellbeing, as they may have felt alienated and not represented by the app.

Factor analysis of the General Help-Seeking Questionnaire (GHSQ)

Chapter 3 reports an exploratory factor analysis (EFA) on a limited pool of GHSQ items that was conducted for the purpose of identifying how best to score the GHSQ. However, as multiple items were excluded from analysis (particularly the MindMax item) I was interested in investigating the factor structure of the full version of the GHSQ (as described in Chapter 3.3.5). Conducting an EFA on all available GHSQ responses (including those who only answered Day 1) could maximise the amount of data analysed (including that of people who were neither male or female, who were excluded from the analyses reported in Chapter 3), as well as take advantage of this study's longitudinal design to increase the validity of EFA results, Hence, I conducted a more comprehensive, robust EFA on multiple time points of GHSQ data, which is reported in the next chapter (Chapter 4).

Chapter 4: Young people's help-seeking in the Internet age

Cheng, V.W.S., Davenport, T., Johnson, D., Vella, K., & Hickie, I.B. (submitted). Understanding young people's conceptualisations of mental health help-seeking in the Internet age through exploratory factor analyses. *Journal of Health and Social Behavior.*

4.1. Abstract

As young people display low rates of mental health help-seeking, understanding how they view help-seeking sources is crucial. In a secondary analysis of existing longitudinal data, we conducted exploratory factor analyses on young people's (aged 16–35 years) responses to the General Help-Seeking Questionnaire (GHSQ) at Day 1 (*n*=530), Day 30 (*n*=296), and Day 60 (*n*=246), identifying three factors (F1: '*personal sources*', F2: '*health professionals*', F3: '*distal sources*'). Hierarchical regression analyses identified gender, age, mental wellbeing, relatedness, resilience, and life satisfaction as predictors of Day 1 factor scores. Post-hoc examination of the subsample endorsing intentions not to seek help found lower mean F1 and F2 scores and a higher mean F3 score compared to the full sample. Our results suggest that young people group Internet-based sources with other distal sources (e.g. helplines). Mental health initiatives should consider the importance of distal help-seeking sources, particularly for men with low social connectedness.

4.2. Background

Despite the fact that most mental illnesses emerge during young adulthood (Patel et al. 2007) and may lead to considerable functional deterioration (Iorfino et al. 2018), young people are the least likely age group to seek professional help (Rickwood, Deane and Wilson 2007). Young Australian men in particular display reduced help-seeking rates relative to their level of mental health need (Ellis et al. 2013, Ellis et al. 2014, Rice, Purcell and McGorry 2018), an observation that may be attributed to individual levels of conformity to unhealthy masculine norms (Seidler et al. 2016, Wong et al. 2017). Previous research also suggests young men experience a potential catch-22 situation of being reluctant to engage with a help-seeking friend, while only being willing to seek help from professional sources if advised to do so by friends (Ellis et al. 2013). While encouraging attitude change, reducing mental health stigma, and promoting healthy expressions of masculinity (Schlichthorst et al. 2018) are important in the long term, in the short term alternative ways of encouraging help-seeking must be investigated. While Internet-based resources are increasingly being endorsed and used (Ellis et al. 2013), there is nuance in how

young people view and seek help on the Internet (Chan et al. 2016). However, there is evidence that Web-based resources are particularly attractive to young people with probable serious mental illness (Mission Australia 2017). Gaining a better understanding of how young people view help-seeking, particularly in an age of increasing Internet dominance, can provide guidance on tailoring mental health initiatives more closely to the behaviour of young people. Conducting exploratory factor analysis on the General Help-Seeking Questionnaire (GHSQ) with a sample of young people is one way of achieving this.

The GHSQ is commonly used to assess help-seeking intentions for mental health problems and can be assessed at item level or by aggregating appropriate items into a composite help-seeking score (Deane and Wilson 2007, Wilson et al. 2005). It is a self-report measure administered on a seven-point Likert scale. Its developers have encouraged researchers to customise it to their intended sample by adding and subtracting items (help-seeking sources) as needed (Deane and Wilson 2007). While this has contributed to the GHSQ's lack of an established factor structure (Hammer and Spiker 2018), it also makes the GHSQ a flexible tool that has the potential to capture the constantly changing facets of help-seeking.

As part of the evaluation of a mHealth app for mental health and wellbeing named "MindMax", we conducted a naturalistic evaluation trial, administering surveys to participants at up to five time points (Cheng et al. submitted for re-review). MindMax is an Australian Football League-themed mobile app incorporating gamification, casual video games, wellbeing psychoeducational modules, and a social connection component, and aims to promote discussion around improving mental health and wellbeing (Cheng et al. 2018, Mitchell et al. 2017). In this trial, the GHSQ was administered at each time point.

As part of this primary analysis (Cheng et al. submitted for re-review), we conducted a preliminary exploratory factor analysis with an estimation method of diagonally weighted least squares (WLSMV) and a direct oblimin rotation (delta=0) on a subsample (n=313) of our Day 1 GHSQ responses, excluding certain items as they were not relevant to our primary research

question. The resulting solution consisted of two factors: *personal help-seeking* (intimate partner, friend, parent, and other relative) and *impersonal help-seeking* (mental health professional, phone helpline, doctor/GP, and a stranger on the Internet). However, there were problems with the solution, including low communality in one item (*intimate partner*) and below desired internal consistency in the *personal help-seeking* subscale. Finally, as participants who did not register for a MindMax account were excluded from the primary study, the sample size of the initial exploratory factor analysis was halved.

Common factor analysis (CFA) procedures assume that all variables (items) have a continuous normal distribution, an assumption that is violated for ordinal (Likert) data, as it is neither continuous nor likely to be normal. Additionally, previous research has shown that conducting CFA procedures on ordinal items with the standard Pearson correlation matrix results in bias (Holgado–Tello et al. 2008). Instead, statisticians recommend factor analysing the more theoretically sound polychoric correlation matrices of ordinal variables, a method that is relatively more robust against skewness (Garrido, Abad and Ponsoda 2013).

This study hence aims to conduct a more robust exploratory factor analysis on the full set of GHSQ responses. It is a secondary, exploratory analysis of the data. As GHSQ data was collected over multiple time points, it will also be possible to compare factor loadings and structures across time. By doing so, we hope to conceptualise how younger Australians (aged 16 to 35 years) seek help for personal or emotional problems, including mental health problems. Furthermore, as the item "MindMax" was administered across multiple time points (before and after participants' exposure to MindMax), it will also be possible to see where MindMax is positioned as a source of help, and whether this changes across time. Finally, after the identification of a factor structure, we aim to generate factor scores for each participant at Day 1. As factor scores represent an individual case's placement on the latent factors identified from factor analysis (DiStefano, Zhu and Mîndrilă 2009), regression analyses attempting to predict these scores from demographic information and

wellbeing scores may shed light into which avenues may be most promising to target when addressing young people's low rates of help-seeking behaviour.

4.3. Data and Methods

4.3.1. Participants

Survey answers were collected from participants between 14 July 2017 and 9 May 2018 as part of the primary study (Cheng et al. submitted for re-review), at five time points: Day 1, Day 30, Day 60, Day 90, and Close of Study. To qualify for trial inclusion, participants had to be aged 16 to 35 years, reside in Australia, and have access to a mobile phone or other MindMax-compatible mobile device. (For a full description of recruitment and data collection, please see the primary study.) Data collection followed protocol approved by The University of Sydney's Human Research Ethics Committee (Protocol No. 2016/652).

Due to attrition in the primary study resulting in low sample sizes at later time points, only data from the first three time points were analysed in this secondary study. While the primary study aimed to evaluate the effect of using MindMax, and hence excluded participants who did not register for a MindMax account (Cheng et al. submitted for re-review), for this secondary study these participants were included (at Day 1 only, as in the primary study these noncompliant participants were excluded at subsequent time points).

4.3.2. Measures

The following measures were included in this study: the personal-emotional items of the GHSQ (Wilson et al. 2005), Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) (Tennant et al. 2007), Flourishing scale (Diener et al. 2010), 10-item Connor-Davidson Resilience Scale (Campbell-Sills and Stein 2007), Basic Psychological Need Satisfaction in General (Relatedness subscale) (Deci and Ryan 2000, Gagné 2003), and one item assessing life satisfaction (Cheung and Lucas 2014). Apart from the GHSQ, which we analysed at all three time points, all other data was analysed at Day 1 only.

We asked participants to answer the personal-emotional items of the GHSQ ("If you were having a personal or emotional problem, how likely is it that you would seek help from the following people?"). The scale is assessed on a seven-point Likert scale, with 1 indicating "extremely unlikely", 3 indicating "unlikely", 5 indicating "likely", and 7 indicating "extremely likely". As the GHSQ developers encourage customisation of the scale to fit individual research requirements (Deane and Wilson 2007), we modified the GHSQ to include the additional sources "someone online, who you don't know", "MindMax", and an "other" item with an optional free text input that became available if the participant responded 4 or above. We also did not administer the "teacher", "pastor/priest", and "youth worker" items.

4.3.3. Pre-analysis

To prepare the GHSQ data for analysis, free text responses to the "other" item were inspected and coded back when necessary (e.g. a specification of "Grandad" was coded back to the "Other relative" item). At this stage, we excluded the "nobody" item from the factor analysis as this was not a help-seeking source. The 10 remaining items included in the factor analysis were: "intimate partner", "friend", "parent", "other relative", "mental health professional" (shortened to "MH professional"), "phone helpline", "doctor/general practitioner" (shortened to "doctor/GP"), "someone online, who you don't know" (shortened to "online stranger"), "MindMax", and "other". Bartlett's test of sphericity was significant at all time points.

To determine how many factors to extract, we conducted parallel analysis with principal component analysis extraction on the polychoric correlation matrix (Appendix A) of our GHSQ responses at each time point. While there exists debate on which types of parallel analysis are suitable for ordinal variables, this particular method has been found to be the most accurate, albeit still with a moderate tendency to underfactor at low factor loadings, a low variable-to-factor ratio, and moderate-to-high factor correlations (Cho, Li and Bandalos 2009, Garrido, Abad and Ponsoda 2013). Both mean and 95th percentile eigenvalues of the random datasets were generated for comparison. All iterations of parallel analysis suggested two factors. We therefore

proceeded under the assumption that the factor structure for our GHSQ data consists of two to three factors.

4.3.4. Factor analysis and factor scores

We conducted exploratory factor analyses using MPlus version 8.2 (Muthén and Muthén 1998-2017) on the polychoric correlation matrices of the GHSQ at Day 1, Day 30, and Day 60, specifying an estimation method of diagonally weighted least squares (also known as robust weighted least squares or WLSMV). An oblimin rotation (delta=0) was chosen to allow factors to correlate. This process also generated factor scores using the Bayesian modal posterior estimation method (also known as maximum a posteriori probability/MAP).

4.4. Results

4.4.1. Descriptives

Table 4.1 shows descriptive and individual GHSQ response data at all three time points. Skewness for all GHSQ responses was moderate-to-low (<±1), except for item 1 ("intimate partner") at Day 60, which had a skewness statistic of -1.105. Notably, the "Nobody" item was not reverse scored (i.e. a response of 7 would indicate the greatest agreement for not seeking help from anyone).

Table 4.1. Sample descriptive and individual GHSQ item response data at Day 1, Day 30, and Day 60

		Day 1	Day 30	Day 60
N		530	296	246
Gender (%[a])	Male	224 (42.3%)	124 (41.9%)	100 (40.7%)
	Female	291 (54.9%)	166 (56.1%)	139 (56.5%)
	Other	12 (2.3%)	6 (2.0%)	7 (2.8%)
Age mean (SD)		23.4 (5.39)	23.5 (5.33)	23.5 (5.39)
Day 1 WEMWBS mean (SD)		47.0 (9.98)	48.0 (9.97)	47.9 (9.78)
GHSQ item mean (SD)	Intimate partner	5.13 (1.74)	5.14 (1.73)	5.22 (1.75)
	Friend	4.79 (1.61)	4.86 (1.48)	4.81 (1.58)
	Parent	4.17 (1.86)	4.31 (1.82)	4.43 (1.71)
	Other relative	3.45 (1.88)	3.80 (1.96)	3.77 (1.85)
	MH professional	3.95 (1.83)	4.28 (1.82)	4.26 (1.71)
	Phone helpline	2.74 (1.77)	3.16 (1.94)	3.31 (1.89)
	Doctor/general practitioner	3.51 (1.79)	3.75 (1.80)	3.90 (1.66)
	Online stranger	2.75 (1.86)	3.13 (1.96)	3.04 (1.90)
	MindMax	2.91 (1.65)	3.21 (1.92)	3.15 (1.85)
	Nobody[b]	3.39 (1.91)	3.36 (2.01)	3.24 (1.95)
	Other	2.62 (1.76)	2.80 (1.89)	2.61 (1.74)

[a]Table percentages do not add up to 100 due to missing values

[b]This item was dropped from subsequent exploratory factor analyses for theoretical reasons

Of note is the "Other" item, where participants were invited to specify the help-seeking source via a free text input box only if they responded 4 or higher. Our observed mean response value to this item was low and not all eligible participants specified their help-seeking source. Of the small number of free text responses specified, most listed either work ("boss", "colleague") or school ("teacher", "coach") sources.

Figures 4.1 and 4.2 show individual Day 1 GHSQ responses split by gender and median age (Md=23). In Figure 4.1, responses from participants who were neither male nor female could not be represented due to low group size (n=12).

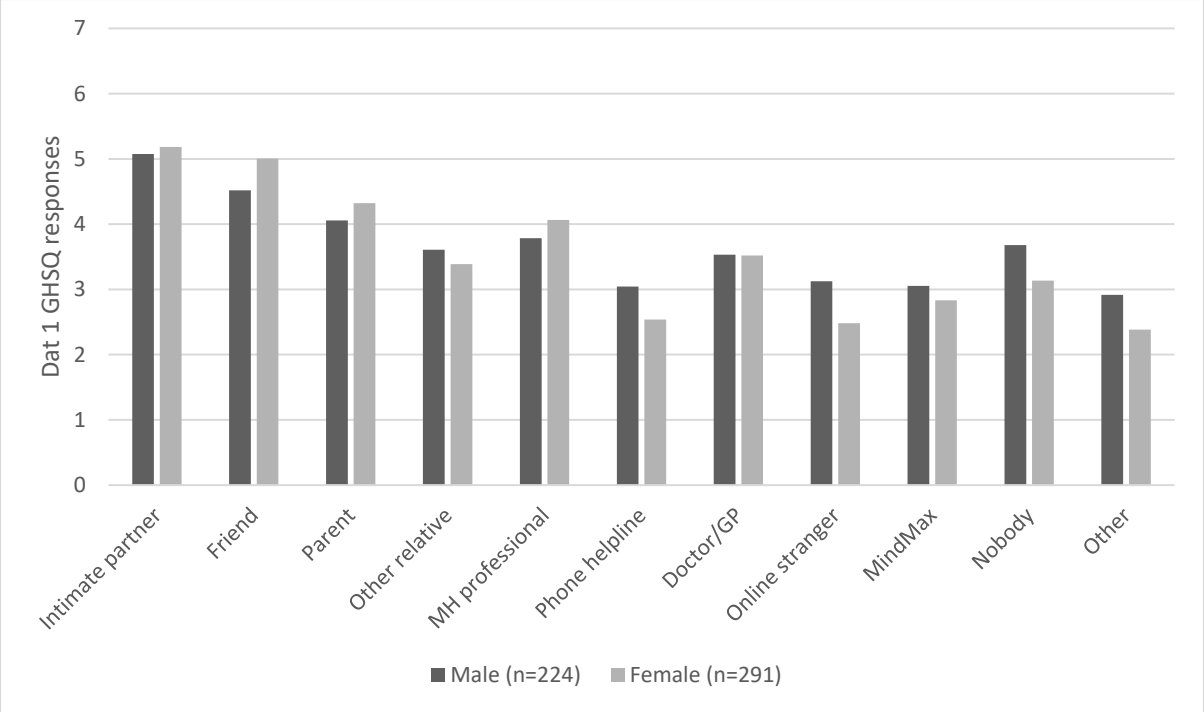

Figure 4.1. Day 1 GHSQ scores split by gender

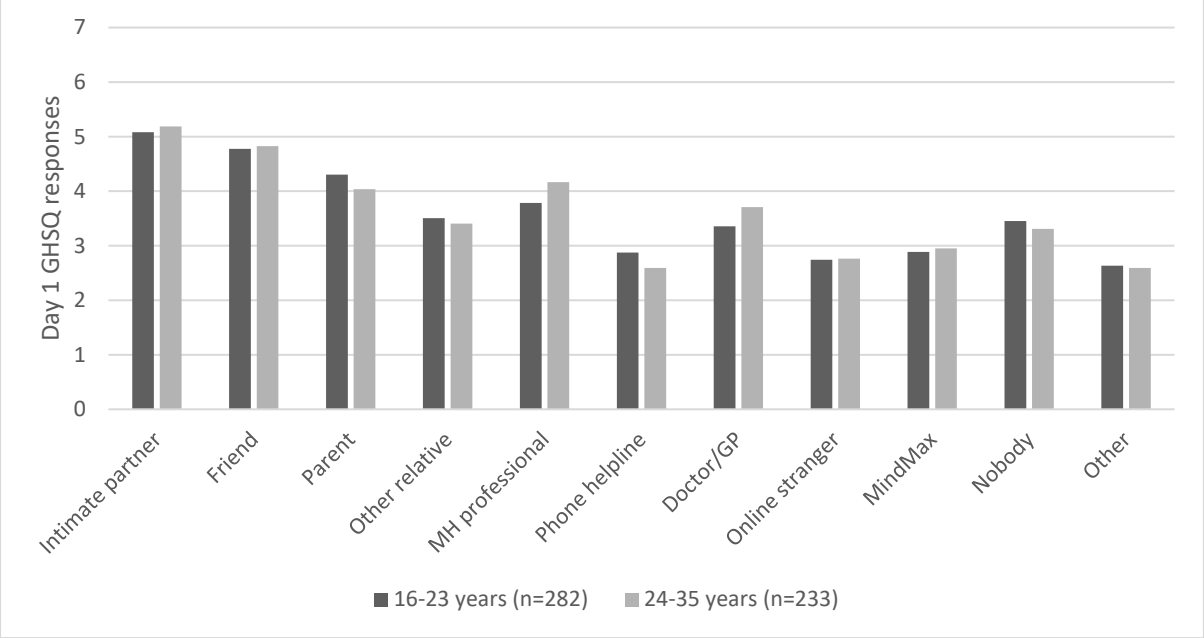

Figure 4.2. Day 1 GHSQ scores split by median age

4.4.2. Factor analysis

We ran exploratory factor analyses on 10 GHSQ items and obtained solutions for both two-factor and three-factor structures, which are shown in Tables 4.2 and 4.3 alongside item communalities and factor correlations.

Table 4.2. Two-factor rotated loadings (probit regression coefficients), correlations and communalities

	Day 1 (*n*=530)			Day 30 (*n*=296)			Day 60 (*n*=246)		
	F1	F2	c	F1	F2	c	F1	F2	c
Intimate partner	**.530***	-.110*	.263	**.404***	-.137*	.142	**.607***	-.100*	.343
Friend	**.575***	-.143*	.309	**.364***	-.118	.116	**.528***	-.091	.260
Parent	**.671***	.073*	.480	**.689***	-.071	.444	**.562***	.013	.320
Other relative	**.521***	.246*	.397	**.569***	.277*	.513	**.482***	.291*	.397
MH professional	.056	**.661***	.459	.276*	**.582***	.531	**.321***	**.422***	.358
Phone helpline	.071*	**.760***	.609	.089	**.768***	.646	.180*	**.636***	.503
Doctor/GP	.098*	**.750***	.609	**.335***	**.638***	.673	.264*	**.563***	.473
Online stranger	-.128*	**.686***	.442	-.152	**.839***	.635	-.108	**.824***	.640
MindMax	-.079*	**.772***	.572	-.055	**.803***	.616	-.050	**.861***	.720
Other	-.014	**.673***	.449	-.076	**.707***	.467	-.049	**.591***	.335
F1 correlation	1			1			1		
F2 correlation	.253*	1		.359*	1		.287*	1	

[a]Robust weighted least squares (also known as DWLS or WLSMV), with direct oblimin rotation
[b]*p<.05

Table 4.3. Three-factor rotated loadings (probit regression coefficients), correlations and communalities

	Day 1 (*n*=530)				Day 30 (*n*=296)				Day 60 (*n*=246)			
	F1	F2	F3	c	F1	F2	F3	c	F1	F2	F3	c
Intimate partner	**.506***	.108	-.228*	.272	**.377***	.078	-.205*	.144	**.626***	-.005	-.088	.371
Friend	**.550***	.107	-.265*	.322	**.338***	.076	-.182	.117	**.501***	.070	-.124	.257
Parent	**.672***	.019	.043	.472	**.699***	.034	-.114	.465	**.571***	.031	.006	.342
Other relative	**.595***	-.103*	**.328***	.482	**.661***	.019	.241*	.616	**.541***	.006	.300*	.466
MH professional	-.018	**.826***	-.022	.655	-.025	**.868***	-.037	.694	.051	**.759***	-.097*	.535
Phone helpline	.104*	**.339***	**.503***	.613	.033	**.360***	**.509***	.649	.046	**.423***	**.380***	.519
Doctor/GP	.062	**.680***	.183	.668	.084	**.765***	.085	.743	-.023	**.752***	.090	.633
Online stranger	-.060	.061	**.673***	.490	-.076	.094	**.757***	.636	-.057	.082	**.763***	.635
MindMax	-.025	.233*	**.612***	.585	.082*	-.048	**.833***	.692	.032	-.005	**.887***	.797
Other	.069	-.007	**.722***	.541	.013	.018	**.686***	.493	.032	-.054	**.634***	.378
F1 correlation	1				1				1			
F2 correlation	.244*	1			.430*	1			.244*	1		
F3 correlation	.200*	.573*	1		.327*	.652*	1		.363*	.533*	1	

[a]Robust weighted least squares (also known as DWLS or WLSMV), with direct oblimin rotation
[b]*p<.05

In the two-factor solution, cross-loading was observed for the "doctor/GP" item at Day 30 and the "mental health professional" item at Day 60. While the former has a strong primary loading of .638, the latter has a smaller primary loading of .422. In the three-factor solution, cross-loading was observed for the "other relative" item at Day 1, and the "phone helpline" item at all time points. Similarly, while the former has a relatively strong primary loading of .595, the comparative

strength of the "phone helpline" primary loadings are weaker (.423 to .509). Also, while the primary loading of "phone helpline" falls under F3 on Days 1 and 30, its primary loading switches to F2 at Day 60.

Table 4.4 shows the fit indices of the two-factor and three-factor solutions across time. These fit indices were chosen due to their consistent relative reliability with categorical/ordinal items compared to other fit indices such as the RMSEA and the SRMR (Garrido, Abad and Ponsoda 2016). An examination of Table 4.4 shows that while the three-factor solution consistently shows adequate goodness-of-fit to our GHSQ data (CFI and TLI more than .95), the two-factor solution does not. Based on this and the established tendency of parallel analyses to underfactor when dealing with ordinal data with a low variable-to-factor ratio and moderate factor correlation (Garrido, Abad and Ponsoda 2013), we deemed a three-factor solution most appropriate for our data. While we observed the item "phone helpline" crossing factors (falling under F3 on Days 1 and 30 and under F2 at Day 60), it is possible that trial participation may have influenced our sample's responses at later time points. Hence, for this reason and given the larger sample size at Day 1, for the remainder of the study we will focus on the Day 1 factor loadings. We reviewed the individual items loading on each factor at Day 1 and propose the following factor labels: *personal sources* for F1, *health professionals* for F2, and *distal sources* for F3.

Table 4.4. Goodness of fit indices for two-factor and three-factor solutions across time

	Day 1 (*n*=530)	Day 30 (*n*=296)	Day 60 (*n*=246)
Two-factor solution			
CFI	.952	.951	.927
TLI	.917	.916	.874
Three-factor solution			
CFI	.992	.983	.981
TLI	.980	.957	.954

4.4.3. Hierarchical regression analyses on factor scores

To explore the implications of the derived factor structure, we generated factor scores that represent how strongly individual participants score on the latent traits that drive loading on the identified factors. We conducted hierarchical regression analyses attempting to predict the three

GHSQ factor scores at Day 1 with these variables: gender, age, flourishing, resilience (CDRS), mental wellbeing (WEMWBS), relatedness, and life satisfaction. Notably, the single-item satisfaction with life scale is reverse coded so that unlike flourishing, resilience, mental wellbeing, and relatedness, a lower value for life satisfaction indicates higher levels of life satisfaction. Due to small group sizes, participants who were neither male nor female (*n*=15 including missing data) could not be included in the regression analyses. Outliers were observed in the regression analysis predicting F1 (*personal sources*); however, removing these outliers did not change the significance of any predictor variables. Tables 4.5, 4.6, and 4.7 hence present values from the analyses including these outliers. All other assumptions for multiple regression were met.

Table 4.5. Hierarchical regression analysis predicting F1 (*personal sources*) scores at Day 1 (*n*=515)

	Model 1			Model 2		
Variables	*B*	*SEB*	*β*	*B*	*SEB*	*β*
Gender	.116	.072	.071	.191	.065	.117*
Age	-.006	.007	-.042	.010	.006	.064
Day 1 Flourishing				.003	.007	.025
Day 1 Resilience				-.010	.006	-.088
Day 1 Mental wellbeing				.033	.005	.405**
Day 1 Relatedness				.014	.005	.147*
Day 1 life satisfaction				-.096	.046	-.098
Adjusted R^2	.007			.252		
F for change in R^2	1.783			35.015**		

*p<.05, **p<.001

Table 4.6. Hierarchical regression analysis predicting F2 (*health professionals*) scores at Day 1 (*n*=515)

	Model 1			Model 2		
Variables	*B*	*SEB*	*β*	*B*	*SEB*	*β*
Gender	.035	.078	.020	.062	.080	.036
Age	.007	.007	.044	.015	.007	.091*
Day 1 Flourishing				.001	.008	.008
Day 1 Resilience				-.023	.007	-.193*
Day 1 Mental wellbeing				.019	.007	.222*
Day 1 Relatedness				-.007	.006	-.062
Day 1 life satisfaction				-.056	.057	-.053
Adjusted R^2	-.002			.025		
F for change in R^2	.589			3.797*		

*p<.05, **p<.001

Table 4.7. Hierarchical regression analysis predicting F3 (*distal sources*) scores at Day 1 (*n*=515)

	Model 1			Model 2		
Variables	*B*	*SEB*	*β*	*B*	*SEB*	*β*
Gender	-.280	.075	-.162**	-.212	.076	-.123**
Age	-.008	.007	-.047	.002	.007	.011
Day 1 Flourishing				-.007	.008	-.059
Day 1 Resilience				-.020	.007	-.166*
Day 1 Mental wellbeing				.025	.006	.287**
Day 1 Relatedness				-.016	.006	-.159*
Day 1 life satisfaction				-.118	.054	-.113*
Adjusted R^2	.024			.085		
F for change in R^2	7.370*			7.843**		

*p<.05, **p<.001

In all regression analyses, gender and age (in years) were entered as predictor variables in Model 1, and the wellbeing and resilience variables were entered as further predictor variables in Model 2. Gender was a dichotomous variable, with "1" being male and "2" being female, while the other variables were, for the purposes of the regression analyses, continuous. Model 1 (containing gender and age only) was not statistically significant for F1 (*personal sources*) and F2 (*health professionals*), $p>.05$, but was statistically significant for F3 (*distal sources*), $F(2,512)=7.37$, $p=.001$. Adding the wellbeing and resilience variables (Model 2) contributed to a statistically significant change in R^2 for all models, shown in Tables 4.5 to 4.7. Model 2 was statistically significant for all factor scores; F1: $F(7,507)=25.69$, $p<.001$, F2: $F(7,507)=2.885$, $p=.006$, F3: $F(7,507)=7.848$, $p<.001$.

4.4.4. Post-hoc analyses

To further explore help-seeking intentions in those least likely to seek help, we compared mean factor scores of the whole Day 1 sample (*n*=530) against cases who endorsed the "Nobody" item (answering 5 to 7, or "likely" to "extremely likely"; *n*=170), shown in Table 4.8.

Table 4.8. Mean Day 1 factor scores (*n*=530) *vs.* the subsample endorsing the "Nobody" item (*n*=170)

Factor	Full sample mean (SD)	Subsample mean (SD)
F1 (personal sources)	-.001 (.819)	-.336 (.894)
F2 (health professionals)	.001 (.869)	-.090 (.989)
F3 (distal sources)	.017 (.856)	.119 (1.07)

Relative to our whole sample, we observed lower mean F1 (*personal sources*) and F2 (*health professionals*) scores in our subsample participants (who are less likely to seek help), and a higher mean F3 (*distal sources*) score.

4.5. Discussion

4.5.1. Overall

This exploratory study aimed to use factor analysis techniques to investigate how younger people aged 16 to 35 years conceptualise help-seeking, and is a secondary analysis of data originally collected for a naturalistic trial to evaluate the impact of using an app for mental health and wellbeing (named MindMax). We conducted three separate exploratory factor analyses on GHSQ response data at three time points (Day 1, Day 30, Day 60). We also generated Day 1 factor scores that represent an individual participant's placement on the latent traits driving the identified factors, and tested whether these factor scores could be predicted by gender, age, and wellbeing and resilience scores.

In general, our participants highly endorsed seeking help from an intimate partner, friend, or parent, were less willing to seek help from another relative, mental health professional, or doctor/GP, and did not endorse seeking help from a phone helpline, an online stranger, MindMax, or other sources not previously specified. As shown in Table 4.1, most items, particularly "other relative", "MH professional", "phone helpline", "online stranger", and "MindMax" displayed a trend of an increase in intentions over time. An evaluation of such outcomes including help-seeking intentions can be found in our primary study (Cheng et al. submitted for re-review).

Following an exploratory factor analysis, we reviewed inter-item correlations, rotated factor loadings, factor correlations, and fit indices across three time points (Day 1, Day 30, Day 60), shown in Tables 4.2 to 4.4. From these, we determined a three-factor solution to fit our data best. The first factor, *personal sources*, was made up of four items: "intimate partner", "friend", "parent", and "other relative". The second factor, *health professionals*, was made up of two items: "mental

health professional" and "doctor/GP". The third factor, *distal sources*, was made up of four items: "phone helpline", "online stranger", "MindMax", and "other". Notably, this final three-factor structure does not distinguish Internet sources from other, non-Internet sources such as phone helplines. It also suggests that the willingness (or lack thereof) of our participants to seek help from these types of sources may be related to their relative distance from personal spheres and lack of clinical authority.

We generated factor scores representing placement along the latent traits that drive our identified factors and attempted to predict them with gender, age, and wellbeing and resilience scores originally measured for our primary study (Cheng et al. submitted for re-review). Specifically, the wellbeing variables consisted of flourishing, mental wellbeing, relatedness, and life satisfaction. As shown in Tables 4.5 to 4.7, the regression models containing gender, age, and all wellbeing and resilience variables (Model 2) were statistically significant for all three factor scores. Adjusted R^2 values of the final models were R^2=.252 for F1 (*personal sources*), R^2=.025 for F2 (*health professionals*), and R^2=.085 for F3 (*distal sources*). Put more plainly, our demographic, wellbeing, and resilience variables combined accounted for 25.2% of the variance in intentions to seek help from *personal sources*, 2.5% of the variance in intentions to seek help from *health professionals*, and 8.5% of the variance in intentions to seek help from *distal sources*. The addition of wellbeing and resilience variables also resulted in a statistically significant change in R^2 for all factor scores (Tables 4.5 to 4.7). This suggests that in general, our participants' wellbeing and resilience levels had a significant influence on their intentions to seek help for personal or emotional problems. An examination of the standardised beta coefficients in Model 2 for each regression analysis, however, points to the complexity of the relationship between gender, age, wellbeing, resilience, and help-seeking intentions.

Gender significantly predicted intentions to seek help from *personal sources* (Table 4.5). While extensive interpretation of the standardised beta coefficient is not possible as gender was a dichotomous variable, from its sign we can see that our female participants were more likely to

endorse seeking help from *personal sources*, relative to our male participants. Interestingly, gender was not significant in Model 1, and only became significant when considered alongside wellbeing and resilience variables in Model 2. This may be an artefact of the males in our sample generally displaying higher levels of mental wellbeing (WEMWBS) than females (Appendix B), confounding the regression analyses displayed in Table 4.5 as a result. Mental wellbeing and relatedness scores also significantly predicted intentions to seek help from *personal sources*. Specifically, higher levels of mental wellbeing and relatedness were associated with higher likelihood of intending to seek help from *personal sources*. This aligns with existing literature that links mental wellbeing, social connectedness, and help-seeking (Mission Australia 2017, Rickwood and Braithwaite 1994), and is an expected finding.

In contrast, gender was not a significant predictor of intentions to seek help from *health professionals* (Table 4.6). This contradicts previous findings that young men are less willing to seek help from health professionals (Mission Australia 2017) than young women and may be indicative of a shift in how younger people, particularly young men, view help-seeking for mental health problems. Instead, age and mental wellbeing scores positively predicted intentions to seek help from *health professionals*, while resilience (CDRS-10) negatively predicted it. The negative relationship between resilience and help-seeking intentions is not surprising, and suggests that individuals with lower resilience may be aware of this and are more likely to seek help as a result. An important caveat to this is that the adjusted R^2 for the final model (Model 2; Table 4.6) was only .025 (predicting 2.5% of the variance in factor score), suggesting that at least with respect to health professionals, these effects are extremely weak.

Finally, gender (specifically being male) significantly predicted intentions to seek help from *distal sources* (Table 4.7), a finding that mirrors current help-seeking literature (Ellis et al. 2013). Additional significant predictors for this factor score included resilience, mental wellbeing, relatedness, and life satisfaction. When comparing Table 4.7 to Tables 4.5 and 4.6, we can see that the effects of resilience and mental wellbeing on intentions to seek help from *distal sources* are

similar to those for *health professionals* (and, to an extent, *personal sources*). The effect of life satisfaction on intentions to seek help from *distal sources* also follows a similar trend, as a lower life satisfaction score (indicating higher levels of satisfaction) is associated with a higher *distal sources* factor score. Of note, however, is the negative coefficient of relatedness. Specifically, having a lower relatedness score predicted a higher *distal sources* factor score, which is not surprising as those with less feelings of connectedness (Deci and Ryan 2000) may lack ready, or comfortable, access to personal help-seeking sources, and would be more willing to seek help from distal sources as a result (Rickwood and Braithwaite 1994). As above, it is important to be aware that adjusted R^2 for the final model was .085 (Table 4.7). However, these findings also support the usefulness of distal sources such as phone helplines and the Internet for potentially struggling individuals, particularly males, with low levels of social connectedness.

To further investigate those in our sample who were not likely to seek help for their personal or emotional problems, we identified participants who answered "likely" to "extremely likely" to the "nobody" item of the GHSQ at Day 1 and compared their mean factor scores to those of the whole sample. As Table 4.8 shows, those in our subsample scored lower, on average, in intentions to seek help from personal sources and health professionals, and higher in intentions to seek help from distal sources. This further suggests that in addition to current efforts to improve mental health literacy and promote help-seeking from health professionals, we should not overlook the helpful, gateway (Mission Australia 2017, Rickwood, Deane and Wilson 2007) role of distal help-seeking sources.

4.5.2. Strengths and limitations

The strengths of this study include that it analyses longitudinal data (spanning 60 days) and links individual participants' GHSQ responses with a variety of wellbeing (including mental wellbeing, flourishing, relatedness, and life satisfaction) and resilience measures, with the associated increases in test-retest reliability and construct validity. However, there are multiple limitations that must be acknowledged.

Importantly, this study was a secondary analysis of already collected data, and as such is purely exploratory. Furthermore, the data analysed in this study was collected for a naturalistic longitudinal trial, where participants were invited to answer follow-up surveys at multiple time points regardless of whether they had completed previous follow-up surveys. Hence, while all participants answered the Day 1 survey, not every participant answered all time points. Nonetheless, as demographic proportions remained consistent across the time points (Table 4.1), we felt it appropriate to compare this data longitudinally. However, we acknowledge that trial participation may have influenced participant responses, particularly at later time points.

We also identified multiple cross-loading items in both the two-factor and three-factor solutions (Tables 4.2 and 4.3). However, while the cross-loading items in the two-factor solution ("mental health professional" and "doctor/GP") do not make conceptual sense, the cross-loading items in the three-factor solution ("other relative", "phone helpline") do. Notably, "phone helpline" cross-loaded at all three time points on the factors *distal sources* and *health professionals*. This is not surprising as many phone helplines are managed and organised by clinically trained staff but staffed by trained layperson volunteers. The item "phone helpline" also switched primary loadings from *distal sources* to *health professionals* at Day 60, which may have been influenced by potential exposure to mental health concepts within MindMax and the naturalistic trial.

We observed low communality (less than .2) for the items "intimate partner" and "friend" at Day 30 in both the two-factor and three-factor solutions (Tables 4.2 and 4.3). Essentially, these items shared less than 20% of variance in common with the other items in their factor ("parent" and "other relative"), which is problematic. While these items clearly conceptually fall under the label *personal sources*, statistically (in our data) this was not the case. As these items have acceptable communality (more than .2) at the other two time points, this may be just a unique characteristic of our Day 30 responses. It is possible that age plays a role (with younger participants being less likely to have close intimate partners and more likely to seek help from their parents and other family members); however, as mean age is similar across time points (Table 4.1), this may not be

the case in our data. Further research, with larger samples, more assessment items, and a wider variety of demographic and wellbeing data may give further insights.

Another limitation is that one of our identified factors, *health professionals*, only has two items, which is not ideal. In this case, we were limited by the low number of items originally administered in our primary study. Further research should incorporate more GHSQ items, including the ones we originally excluded ("teacher", "youth worker", and "pastor/priest", as well as other [allied] health professionals [such as nurses and counsellors] and distal sources [such as colleagues and supervisors]; including those specified in the "Other" free text responses). When the research question includes Internet-based sources (increasingly likely, given the increasing dominance of the Internet, particularly to new generations), it will also be important to distinguish between the authority of sources (e.g. websites maintained by mental health services vs. personal or community-maintained websites), as well as the type of sources (e.g. websites vs. forums vs. chatbots vs. online strangers).

Finally, our items only assessed *intentions* to seek help for personal or emotional problems, and as such our results cannot be fully generalised to actual help-seeking behaviour (Rickwood and Braithwaite 1994). Similarly, those asking more directly about intentions to seek help for mental health problems would most likely obtain different results. With reference to previous research suggesting that suicidal thoughts and the social withdrawal associated with common mental health problems such as depression and anxiety discourage help-seeking (Rickwood, Deane and Wilson 2007), it is likely that even if participants do endorse seeking help for mental health problems, actual help-seeking behaviour will be observed at a lower rate.

4.5.3. Conclusion

This study was a secondary analysis of help-seeking, wellbeing, and resilience data originally collected for a longitudinal evaluation trial, with the aim of exploring young people's conceptualisation of help-seeking in the Internet age and its possible links with gender, age, wellbeing, and resilience. Factor analyses and regression analyses were conducted on GHSQ data

at three time points. Our results suggest that help-seeking sources can be broadly divided into three types: personal sources, health professionals, and distal sources (including Internet-based sources). Mental wellbeing (as measured by the WEMWBS) was a significant predictor of help-seeking intentions for all types of sources. While gender and relatedness significantly predicted intentions to seek help from both personal and distal sources (in opposite directions), they did not significantly predict intentions to seek help from health professionals. Our findings are suggestive of a shift in how young people conceptualise help-seeking for personal or emotional problems and build upon current literature demonstrating the importance of distal social sources (such as work or school) and Internet-based sources for mental health help-seeking.

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4.7. Appendix A

GHSQ items: 1) intimate partner; 2) friend; 3) parent; 4) other relative; 5) mental health professional; 6) doctor/GP; 7) phone helpline; 8) someone online, who you don't know personally; 9) MindMax; 10) other.

Table 4.9. Polychoric correlation matrix of Day 1 GHSQ items

Item number	1	2	3	4	5	6	7	8	9	10
1	1									
2	.360	1								
3	.277	.333	1							
4	.236	.217	.486	1						
5	.064	.029	.169	.193	1					
6	.028	.060	.213	.351	.541	1				
7	.093	.081	.231	.248	.643	.575	1			
8	-.020	-.068	.072	.222	.335	.483	.422	1		
9	-.027	-.031	.150	.268	.440	.573	.559	.553	1	
10	.009	-.021	.056	.311	.304	.568	.444	.508	.520	1

Table 4.10. Polychoric correlation matrix of Day 30 GHSQ

Item number	1	2	3	4	5	6	7	8	9	10
1	1									
2	.285	1								
3	.195	.191	1							
4	.188	.153	.510	1						
5	.067	.112	.218	.345	1					
6	.003	.013	.159	.458	.574	1				
7	.121	.056	.276	.463	.707	.639	1			
8	.000	.018	.022	.344	.470	.562	.508	1		
9	.026	-.011	.184	.406	.427	.619	.495	.673	1	
10	-.016	.049	.105	.320	.348	.576	.435	.563	.558	1

Table 4.11. Polychoric correlation matrix of Day 60 GHSQ

Item number	1	2	3	4	5	6	7	8	9	10
1	1									
2	.396	1								
3	.293	.243	1							
4	.301	.196	.450	1						
5	.158	.153	.205	.265	1					
6	.062	.167	.151	.396	.444	1				
7	.141	.114	.197	.280	.567	.531	1			
8	.062	.060	.088	.281	.287	.479	.436	1		
9	.093	.035	.182	.384	.286	.551	.435	.718	1	
10	.077	.029	.025	.313	.173	.389	.260	.490	.527	1

4.8. Appendix B

Table 4.12. Mean (SD) wellbeing and resilience scores at Day 1

Gender	Flourishing [1]	CD-RISC10 [2]	WEMWBS [3]	Life satisfaction [4]
Male (*n*=224)	42.26 (7.55)	27.37 (6.56)	49.04 (9.31)	2.14 (.897)
Female (*n*=291)	41.54 (7.77)	25.10 (7.50)	45.74 (10.14)	2.20 (.767)
Sample range	17–56	0–40	19–70	1–4
Scale range	7–56	0–40	14–70	1–4

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Chapter 5: Gamification for improving mental health and wellbeing

Cheng, V.W.S., Davenport, T., Johnson, D., Vella, K., & Hickie, I.B. (in press). Gamification in Apps and Technologies for Improving Mental Health and Well-Being: A Systematic Review. *JMIR Mental Health*.

5.1. Abstract

Background: There is little research on the application of gamification to mental health and well-being. Furthermore, usage of gamification-related terminology is inconsistent. Current applications of gamification for health and well-being have also been critiqued for adopting a behaviorist approach that relies on positive reinforcement and extrinsic motivators.

Objective: This study aimed to analyze current applications of gamification for mental health and well-being by answering 3 research questions (RQs). RQ1: which gamification elements are most commonly applied to apps and technologies for improving mental health and well-being? RQ2: which mental health and well-being domains are most commonly targeted by these gamified apps and technologies? RQ3: what reasons do researchers give for applying gamification to these apps and technologies? A systematic review of the literature was conducted to answer these questions.

Methods: We searched ACM Digital Library, CINAHL, Cochrane Library, EMBASE, IEEE Explore, JMIR, MEDLINE, PsycINFO, PubMed, ScienceDirect, Scopus, and Web of Science for qualifying papers published between the years 2013 and 2018. To answer RQ1 and RQ2, papers were coded for gamification elements and mental health and well-being domains according to existing taxonomies in the game studies and medical literature. During the coding process, it was necessary to adapt our coding frame and revise these taxonomies. Thematic analysis was conducted to answer RQ3.

Results: The search and screening process identified 70 qualifying papers that collectively reported on 50 apps and technologies. The most commonly observed gamification elements were *levels or progress feedback*, *points or scoring*, *rewards or prizes*, *narrative or theme*, *personalization*, and *customization*; the least commonly observed elements were *artificial assistance*, *unlockable content*, *social cooperation*, *exploratory or open-world approach*, *artificial challenge*, and *randomness*. The most commonly observed mental health and well-being domains were anxiety disorders and well-being, whereas the least commonly observed domains were conduct disorder

and bipolar disorders. Researchers' justification for applying gamification to improving mental health and well-being was coded in 59% (41/70) of the papers and was broadly divided into 2 themes: (1) promoting engagement and (2) enhancing an intervention's intended effects.

Conclusions: Our findings suggest that the current application of gamification to apps and technologies for improving mental health and well-being does not align with the trend of positive reinforcement critiqued in the greater health and well-being literature. We also observed overlap between the most commonly used gamification techniques and existing behavior change frameworks. Results also suggest that the application of gamification is not driven by health behavior change theory, and that many researchers may treat gamification as a *black box* without consideration for its underlying mechanisms. We call for the inclusion of more comprehensive and explicit descriptions of how gamification is applied and the standardization of applied games terminology within and across fields.

5.2. Introduction

5.2.1. Conceptualizing Gamification

Gamification is the application of gameful elements for nongame purposes. Although the term has, on occasion, been used interchangeably [1] with the closely related concept of *serious games* (video games developed for a primary purpose other than player enjoyment [2]), both concepts are examples of *applied games*, which involve the implementation of "design concepts and qualities from the game world" [3]. Despite being a relatively new example of applied games, gamification has received considerable interest from the health research community for its potential to increase engagement with health interventions and motivate behavior change [4-8]. However, it should not be assumed that any intervention automatically incorporating gamification will have increased engagement [4]. Even the commonly cited ability of gamification to provide fun and engaging experiences cannot be taken for granted, as fun does not necessarily translate to increased motivation to engage [9]. Nonetheless, proponents of gamification point to its potential cost-effectiveness, accessibility, and flexibility, as well as the increasing worldwide

popularity of video games and the potential of gamification to increase intrinsic motivation [6,10,11], as reasons to apply it to health and well-being.

Multiple definitions have been proposed for the term *gamification*, including the "use of game design elements in non-game contexts" by Deterding et al [12], and "a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation" by Huotari and Hamari [13]. They each provide a guiding framework through which to conceptualize it, with different definitions fitting different usage and research contexts. For example, Huotari and Hamari's definition of gamification emphasizes how it can be used to enhance existing services, such as mental health and well-being interventions, and the mechanisms through which they work. It is a useful way to conceptualize gamification when *implementing* it for mental health and well-being purposes and is arguably more compatible with the general goals of health research.

On the other hand, the definition by Deterding et al is more useful for operationalizing gamification. By emphasizing the contrast between playfulness (*paidia*) and gamefulness (*ludus*), Deterding et al categorize gamification as games-based in part form, comparable but distinct to serious games (games-based in whole form) and playful design (play-based in part form), and the conceptual opposite to toys (play-based in whole form). This definition also prioritizes game design elements, implying a taxonomical approach useful for piecing out the individual elements of gamification and operationalizing the various ways it can be applied. This makes this definition useful for *studying* gamification.

5.2.2. Gamification for Health and Well-Being

Recent reviews find that gamification is most commonly applied to physical fitness interventions and to motivate health behaviors for managing chronic illnesses, and although gamified mental health and well-being interventions exist, they are less common [6,7]. This may be due to the inappropriateness of applying common gameful elements (points, rewards, achievements, social comparison, and competition) to mental health, especially in circumstances where users could

potentially be in distress [14,15]. According to self-determination theory, humans are intrinsically motivated to satisfy their basic psychological needs of autonomy, competence, and relatedness [16]. As subjective enjoyment of video games has been empirically linked to the satisfaction of these constructs [17], gamification should, in theory, also be compatible with increasing intrinsic motivation. However, many instances of gamification for general health and well-being rely on positive reinforcement and extrinsic motivators [6], an approach that has been criticized [18,19]. There may be an understandable reluctance in the community to extend what is perceived to be a behaviorist implementation of gamification [20] to mental health and well-being domains.

Admittedly, by definition, it is more straightforward to influence intervention users' extrinsic motivation than their intrinsic motivation. However, organismic integration theory (OIT) posits that there are low-autonomy and high-autonomy variants of extrinsic motivators [16], with low-autonomy variants having the most harmful effect on intrinsic motivation [9]. The ideal implementation of gamification would, therefore, harness intrinsic motivation and the types of extrinsic motivation that are most likely to be internalized, such as identified or integrated regulation [16]. Previous research in the health field has expanded on properties of video games that may be more compatible with intrinsic motivation, such as narrative, fantasy, and interactivity [21-23]. These properties may also be associated with improved emotional intelligence and regulation [24].

Recent reviews also report a lack of explicit linkage between the theory and application of gamification [1,25]. Although gamification elements have been theoretically matched to behavior change techniques [4,26], this has not translated to theory-driven gamification [22]. Furthermore, even when behavior change theory is referenced, its implementation may not be as comprehensive as it could be [22]. Although most calls for gamification and its application for health and well-being (including mental health and well-being) invoke motivational reasons [4-7,27,28], *motivation* is only 1 driver of health behavior change. According to the behavior change

wheel by Michie et al, the other 2 are *capability* and *opportunity*, and it is these drivers that gamification may be missing its potential to support [22].

5.2.3. Operationalizing Gamification

It is difficult to review past gamification research when the word *gamification* means slightly different things across papers. For example, in the review of health and fitness mobile phone apps by Lister et al [22], *gamification* is used to cover the concepts of leaderboards, levels, digital rewards, tangible prizes, competitions, and social pressure but not avatars or "narrative context" (as Lister et al consider them "game elements"). However, Johnson et al use *gamification* to describe all these elements in their review [6]. Similarly, although Brown et al incorporate both narrative and avatars in their gamification element *Story/theme* [30], both Johnson et al and Lister et al separate these features into 2 elements. In another example, Sardi et al combine *feedback/rewards* into 1 game mechanic [7], whereas other reviews consider these features separately [6,22,25,30]. In addition, few reviews define their gamification elements. This makes comparison of findings across reviews difficult without in-depth examination of individual review methodology.

The term *game* is notoriously difficult to define [31], which may contribute to why definitions of *gamification* vary considerably. Although games have always been present in culture in varying forms [32], the current bidirectional trend of games influencing culture and vice versa (the *ludification of culture* and the *cultivation of ludus* [33]; gamification being a clear example of the latter) may explain the increasing interest shown by researchers in technologies and components that are not inherently game-like but are culturally associated with video games, such as virtual reality, augmented reality, and avatars [1]. Although the fuzzy boundaries of the term *gamification* point to the enthusiasm people from varying fields have for adopting it and may encourage creativity in games (and gamification) research [31], they also represent a clear challenge for the study of gamification.

In their recent review, Seaborn and Fels recommend that the intentional use of gamification be a key indicator of whether an app or technology can be defined as containing gamification or not [1]. This accounts for the fact that certain elements of gamification, such as social comparison and progress feedback, are also present in other behavior change frameworks such as persuasive systems design [34] and prevents false positives from being identified. It also corresponds with Huotari and Hamari's definition of gamification as enhancing a basic service provided by the app or technology [13] (in this case, improving mental health and well-being).

5.2.4. Study Aims

Previous systematic reviews on gamification in health and well-being (including mental health and well-being) have narrowed foci (eg, on evaluation [6] and adherence [30]), resulting in a somewhat incomplete picture of the implementation of gamification for mental health and well-being across the fields of medicine, psychology, computer science, and other related fields. In addition, it has been 4 years since the most recent comprehensive database search [7] was conducted. This study, therefore, aims to conduct an updated systematic review of the application of gamification in apps and technologies for improving mental health and well-being, with a focus on breadth, and using a more in-depth taxonomy of gamification elements. To ensure maximum relevance given rapidly changing technology, only studies from the past 5 years were considered. This review aimed to answer the following research questions (RQs):

- RQ1. Which gamification elements are most commonly applied to apps and technologies for improving mental health and well-being?
- RQ2. Which mental health and well-being domains are most commonly targeted by these gamified apps and technologies?
- RQ3. What reasons do researchers give for applying gamification to apps and technologies for improving mental health and well-being?

5.3. Methods

5.3.1. Search Strategy and Screening Process

A pilot search was conducted in March 2018 to assess the feasibility of this study. This search was replicated on November 21, 2018, by 1 author (VWSC), who searched the databases ACM Digital Library, CINAHL, Cochrane Library, EMBASE, IEEE Explore, JMIR, MEDLINE, PsycINFO, PubMed, ScienceDirect, Scopus, and Web of Science with the following search string: (gamif* OR gameful* OR "game-based") AND ("mental health" OR "wellbeing" OR "well-being" OR "mental illness" OR "mental disorder"). This string was adjusted to match each database's requirements. All citations were screened according to the following 5 steps:

1. Initial search: All citations were downloaded to a citation manager (Endnote X8) library file.
2. Probable inclusion: A preliminary screen was performed according to the inclusion criteria.
3. Prune duplicates: All remaining references were collated into 1 group, and duplicates were removed.
4. Definite inclusion: All remaining references were stringently assessed against inclusion criteria.
5. Additional literature: Additional literature was extracted from reference lists of review papers identified in the initial search (step 1), the reference lists of citations from step 4 (eg, for other papers reporting on the same app or technology), and the pilot search. Those that satisfied the inclusion criteria were added to the final dataset.

5.3.2. Inclusion Criteria

Identified citations had to satisfy the following main inclusion criteria to qualify for inclusion:

1. Be published between the years 2013 and 2018.

2. Describe an app or technology related to the improvement of mental health and well-being outcomes (including secondary outcomes).
3. Define their app or technology as being *gamification*, *gamefulness*, or *game-based.*
4. Be in the English language.
5. Not be labeled a serious game.

The search string was kept general to create a wide search net; however, there are limitations to this approach, which are discussed later in this paper. Apps or technologies that were labeled as *serious games* were not included, as serious games are complete games and, therefore, fall outside the scope of this review. Some citations identified in the initial search appeared to use the terms *gamification* and *serious game* interchangeably, pointing to the inconsistent use of terminology observed by previous reviews of gamification [1]. These citations were individually discussed by 2 authors (VWSC and KV), with reference to Huotari and Hamari's definition of gamification ("a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation") [13], until agreement was reached on whether to include or exclude them from the final dataset. Specifically, we considered apps or technologies that appeared to be complete games specifically developed for their purpose as serious games and excluded them from the dataset as a result.

The search also identified many primarily physical health interventions. They were included if assessing an aspect of mental health and well-being as a research outcome (whether primary or secondary).

5.3.3. Coding Process

Due to its breadth, we used the taxonomy of gameful elements by Tondello et al [35] as a foundation for answering RQ1. Similarly, we used the mental and substance use disorders categories from the Global Burden of Disease study [36] as a starting point for answering RQ2. For RQ3, we coded reasons whenever they appeared in the body of the papers in our dataset. The

dataset was coded with QSR International's NVivo 11, a computer-assisted qualitative data analysis software.

Using the above-identified frameworks as a starting base, 2 authors (VWSC and KV) read and re-read the first 10% of papers to assess the preliminary coding frame and identify any further emergent codes. Both authors also independently coded the first 10% of papers based on the preliminary coding frame. Discrepancies between coders were discussed and resolved, and the coding frame was updated with more precise definitions for each gamification element. This process was repeated on the next 10% of papers until sufficient interrater agreement (κ=0.758) was reached.

The coding process was not straightforward because of an overlap in terminology. This was particularly the case for RQ1. For example, although the term *levels* is commonly used to refer to advancing progress, as in *leveling up*, it is also used to refer to new, more difficult environments [1]. Similarly, we observed *points* being used as both progress markers (experience points) and currency. This necessitated significant revisions between the preliminary and final coding frames. Furthermore, although certain categories of gameful elements identified by Tondello et al [35] were well represented in our dataset (eg, *customization*), others were almost nonexistent (eg, *altruism*). To maintain a balance between simplicity and detail, we collapsed less used gameful element categories into 1 code (eg, collapsing all of Tondello et al's *assistance* elements into our gamification element *artificial assistance*) while keeping other, more used gameful elements separate (eg, maintaining the distinction between *social competition*, *social networking*, *social cooperation*, and *social comparison*). Similar gameful elements that were commonly observed together (such as *levels and progression* and *progress feedback*; or *narrative or story* and *theme*) were also grouped together and precisely defined in our coding frame. Our final coding frame containing 18 gamification elements and 17 mental health and well-being domains is presented in Multimedia Appendix 1 (Chapter 5.7).

One author (VWSC) then applied this coding frame to the entire dataset, including returning to earlier coded papers and recoding when necessary. Data extracts from each new paper were compared with the previously coded data extracts for all relevant codes, and against the coding frame, to ensure consistency.

5.3.4. Thematic Analysis of Research Question 3 Codes

One author (VWSC) collated and thematically analyzed [37] all data extracts pertaining to RQ3. As mentioned previously, coded data extracts were compared against each other multiple times during coding rounds, and across multiple rounds, to refine the coding frame, ensure consistency, and further delineate the concepts covered by each code.

As RQ3 investigates researchers' motivations, coding was done using an interpretivist approach, with the aim of staying relatively close to the dataset, that is, the article text was prioritized over the coder's higher-level interpretations. This was done to prevent the coder from imposing additional meaning that the authors of the original papers may not have intended [38]. For example, although the codes *Increase engagement with intervention* and *Increase motivation to use* may appear to cover similar concepts (although not identical [9]), they were coded separately, as we observed multiple instances of those particular wordings. All RQ3 codes and example quotes are also presented in the final coding frame in Multimedia Appendix 1 (Chapter 5.7).

5.4. Results

5.4.1. Search Strategy and Screening Process

Figure 5.1 shows a summary of the search and screening process.

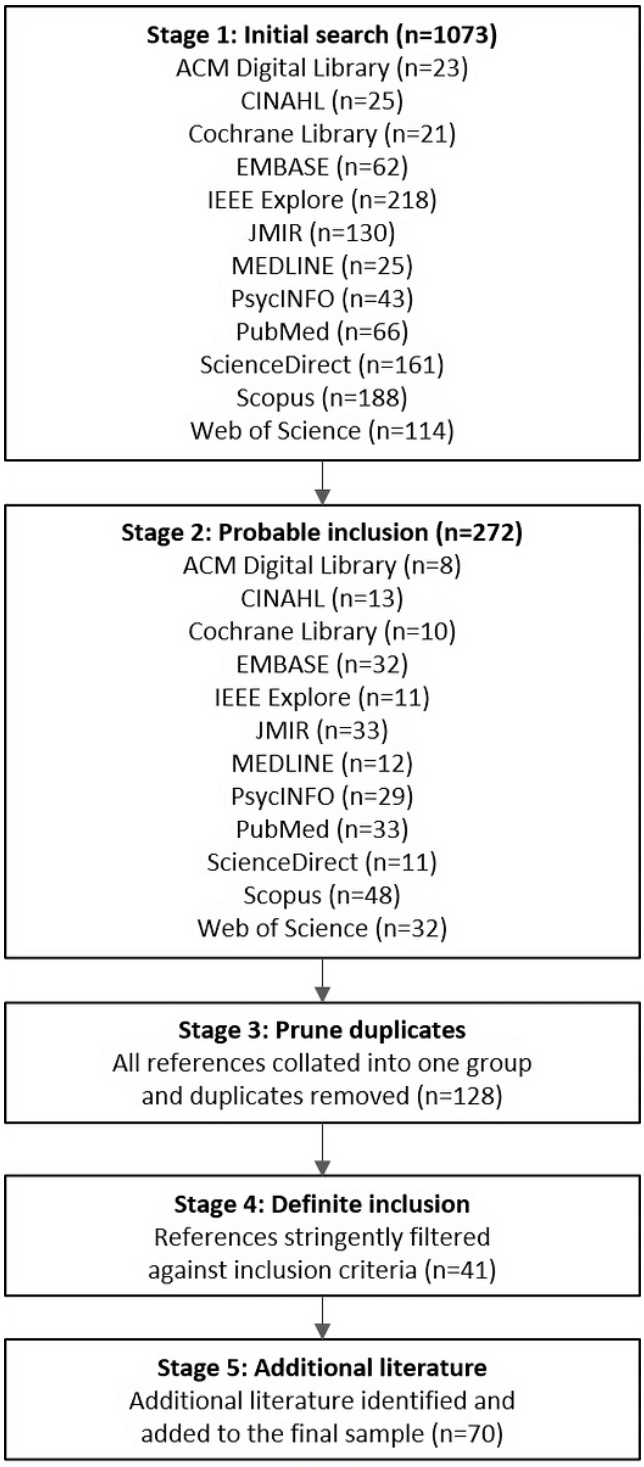

Figure 5.1. Flowchart of papers identified by the search and screening process.

At the end of the screening process, 70 qualifying papers were identified, collectively reporting on 50 apps and technologies. Multimedia Appendix 2 (Chapter 5.8) presents a summary of each app or technology, including description, mental health and well-being domain(s), and gamification elements.

5.4.2. Research Question 1. Gamification Elements

Figure 5.2 shows the number of apps and technologies in the dataset that contain the specified gamification elements.

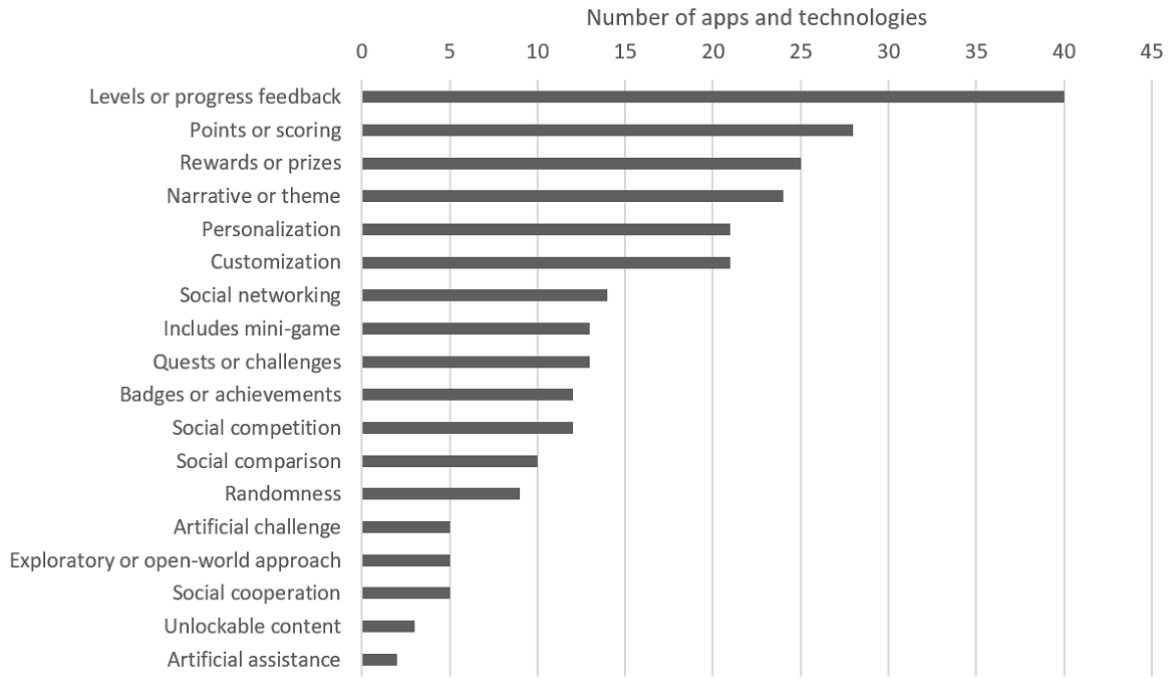

Figure 5.2. Number of apps and technologies containing the specified gamification elements.

Of the 18 gamification elements, the most commonly coded were *levels or progress feedback* (40/50, 80%), *points or scoring* (28/50, 56%), *rewards or prizes* (25/50, 50%), *narrative or theme* (24/50, 48%), *personalization* (21/50, 44%), and *customization* (21/50, 44%). The least commonly coded elements were *artificial assistance* (2/50, 4%), *unlockable content* (3/50, 6%), *social cooperation* (5/50, 10%), *exploratory or open-world approach* (5/50, 10%), *artificial challenge* (5/50, 10%), and *randomness* (9/50, 18%).

Figure 5.3 shows the distribution of the number of gamification elements coded in 1 app or technology, with the mode and median value being 5.

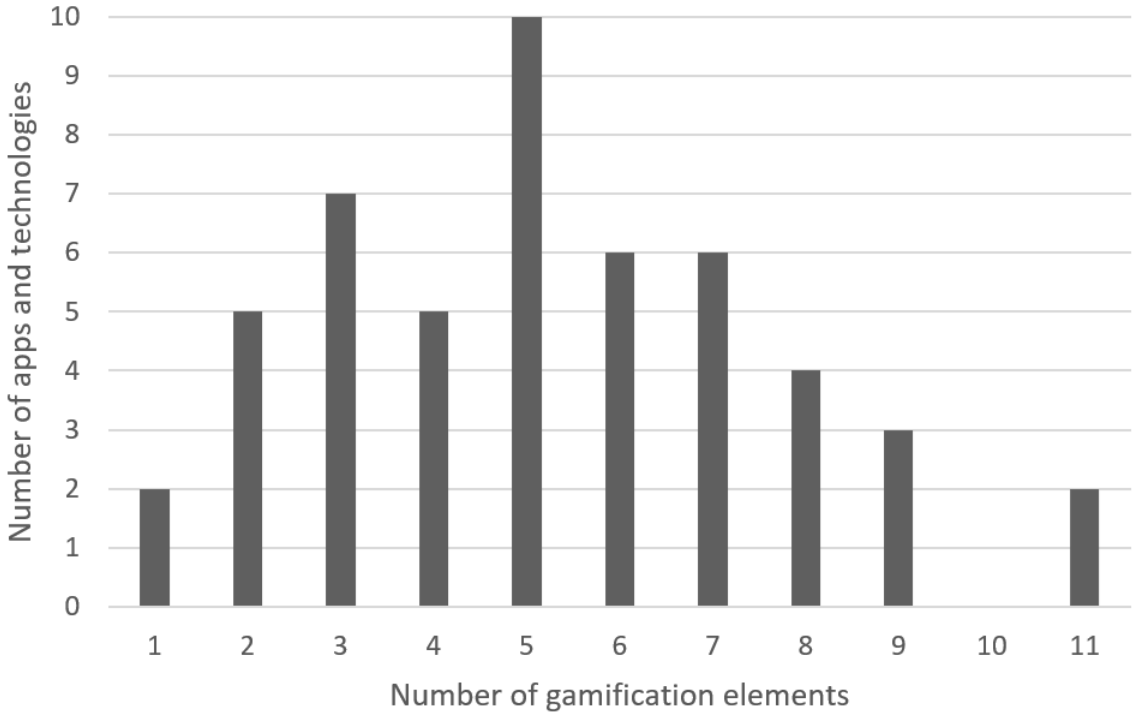

Figure 5.3. Number of gamification elements coded in each app or technology.

5.4.3. Research Question 2. Mental Health and Well-Being Domains Targeted by Gamification

Figure 5.4 shows the count of mental health and well-being domains that were represented in the dataset. (The count does not sum to 50, as some apps or technologies targeted multiple mental health and well-being domains.)

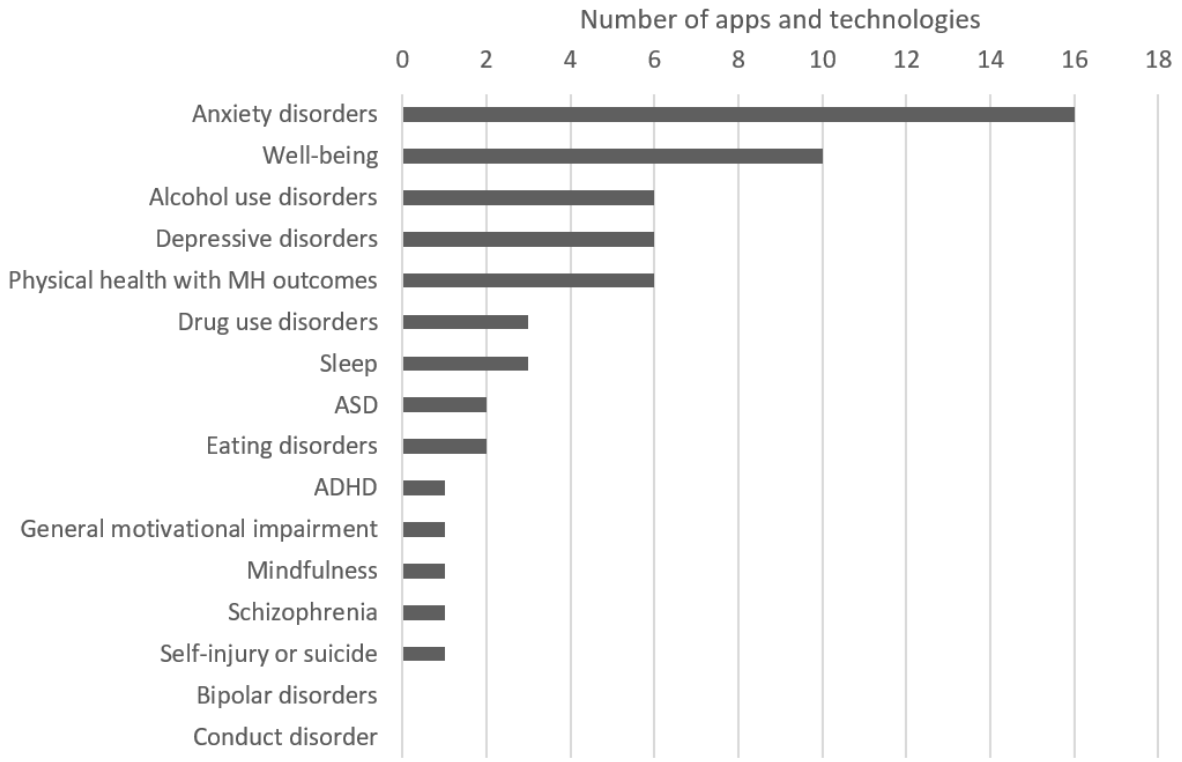

Figure 5.4. Number of apps and technologies targeting the specified mental health and well-being domains. ASD: autism spectrum disorders; ADHD: attention-deficit/hyperactivity disorder; MH: mental health.

Of the 17 mental health and well-being domains, the most commonly coded were anxiety disorders (16/50; 32%), well-being (10/50, 20%), alcohol use disorders (6/50, 12%), depressive disorders (6/50, 12%), and physical health with mental health and well-being outcomes (5/50, 12%). The least commonly coded were conduct disorder (0/50, 0%), bipolar disorders (0/50, 0%), self-injury or suicide (1/50, 2%), schizophrenia (1/50, 2%), mindfulness (1/50, 2%), general motivational impairment, (1/50, 2%), and attention-deficit/hyperactivity disorder (1/50, 2%).

5.4.4. Research Question 3. Reasons for Applying Gamification to Improving Mental Health and Well-Being

We found justification for applying gamification to improving mental health and well-being in 41 of the 70 papers (59%) in the dataset. Figure 5.5 shows the organization of themes, subthemes, and codes, with themes in ovals, subthemes in rounded rectangles, and codes in rectangles.

Example quotes for each code are presented in the coding frame in Multimedia Appendix 1 (Chapter 5.7).

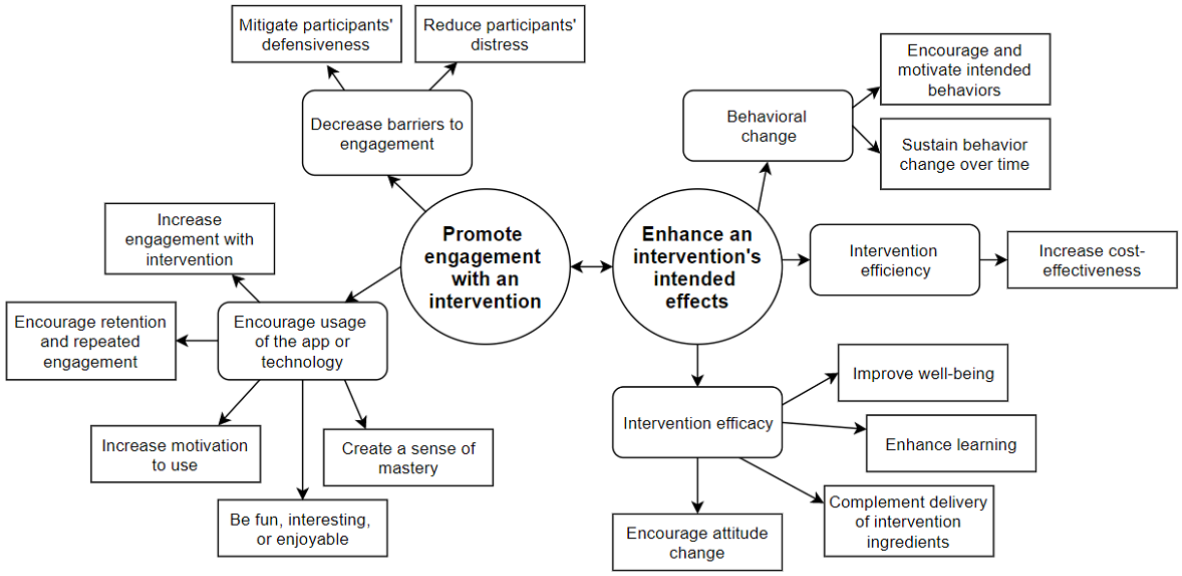

Figure 5.5. Thematic diagram showing themes, subthemes, and codes.

The codes were sorted into 5 main subthemes, which were further sorted into 2 main themes: (1) *promoting engagement with an intervention* and (2) *enhancing an intervention's intended effects*.

Of the 5 subthemes, 2 fell under the first theme (promoting engagement): (1) *encouraging usage of their app or technology* and (2) *decreasing barriers to engagement*. The former was the most commonly cited reason for using gamification and was coded in 31 of the 41 papers (76%), whereas the latter was much less prevalent (6/41 papers, 15%).

The remaining 3 subthemes fell under the second theme (enhance an intervention's intended effects): (1) *behavior change*, (2) *intervention efficiency*, and (3) *intervention efficacy*. Of these subthemes, *behavior change* was the most commonly coded (14/41 papers, 32%), followed by *intervention efficacy* (12/41 papers, 29%) and *intervention efficiency* (2/41 papers, 5%).

5.5. Discussion

5.5.1. Summary

The search and screening process identified 70 qualifying papers that collectively reported on 50 apps and technologies. Of the 18 gamification elements in our coding frame, the most commonly coded gamification elements were *levels or progress feedback*, *points or scoring*, *rewards or prizes*, *narrative or theme*, *personalization*, and *customization*, whereas the least commonly coded were *artificial assistance*, *unlockable content*, *social cooperation*, *exploratory or open-world approach*, *artificial challenge*, and *randomness*. The mode count of gamification elements coded in the included apps and technologies was 5.

Of the 17 mental health and well-being domains in our coding frame, the most commonly coded were anxiety disorders and well-being, whereas the least commonly coded were conduct disorder, bipolar disorders, self-injury or suicide, schizophrenia, mindfulness, general motivational impairment, and attention-deficit/hyperactivity disorder.

Finally, researchers' justification for applying gamification to apps and technologies for improving mental health and well-being was coded in 59% (41/70) papers. In these 41 papers, we identified 2 main themes: (1) *promoting engagement with an intervention* and (2) *enhancing an intervention's intended effects*.

5.5.2. Research Question 1. Gamification Elements

We observed *levels or progress feedback* in a vast majority (40/50, 80%) of the apps and technologies that aim to support the improvement of mental health and well-being in our dataset, making it the most commonly applied gamification element. This is consistent with previous reviews of both the academic literature [7] and stress management apps in the Google Play Store [25] and is unsurprising, as in addition to being easy to implement, progress feedback is a key behavior change technique [4,26]. The near-ubiquitousness of this element may also point at the influence personal informatics has had on health technology [6].

Many critics of gamification point to the inadequacy of the *points, badges, and leaderboards* approach [39] in targeting intrinsic motivation and creating satisfying user experiences [6,18]. But although these elements were present in the apps and technologies in our dataset, only *points or scoring* was in the top 5. This contradicts earlier findings that points are used rarely for mental health and well-being [30] and may be due to the difference in inclusion criteria between both reviews. Alternatively, it could be due to developments in the field of health gamification, with recent mental health and well-being apps and technologies drawing on learnings from early adopter health fields such as physical activity and chronic illness. Meanwhile, *badges or achievements* were observed in 12/50 (24%) apps and technologies. We did not code leaderboards as a specific gamification element, instead including it into our broader gamification element *social competition*, which we observed in 12/50 (24%) apps and technologies. These results suggest that in mental health and well-being domains, points, badges, and leaderboards are far from dominant and that alternative models of gamification are being applied.

Previous research has outlined the potential of progress feedback, points, and rewards to promote behavior change [40,41]; however, their effectiveness is unclear [42] and may depend on how these elements are designed to fit the basic intrinsic and extrinsic motivational processes underlying the app or technology [6,9]. On the other hand, evidence for the potential of *personalization* and *customization* (conceptually similar to the term *tailoring* commonly used in health behavior change literature) is more promising [8,43]. Tailoring offers users increased levels of autonomy, which, according to OIT, would contribute to increased likelihood of internalized motivation and well-being [16]. Ultimately, however, more research is required to establish whether these improvements persist in the long term or merely result from novelty effects [4].

Of the 50 apps and technologies in our dataset, the mode count of gamification elements was 5 (10 apps and technologies, 20%), with the distribution shaped similar to a bell curve with mild positive skew (Figure 5.3). Our observed mode is much greater than the mode of 1 element

identified in previous reviews of Web-based mental health interventions whose evaluation also assessed adherence [30] and stress management apps in the Google Play Store [25]. This finding aligns with recent research showing that a greater diversity of types of rewards in a game led to greater presence, enjoyment, and effort [44]. The fact that our study's coding frame contains more gamification elements than the study by Brown et al [30] may contribute to this difference; however, as Hoffmann et al's study [25] coded for 17 gamification techniques, this may not be the only reason. Furthermore, the increased range (1-11) of gamification elements observed in our sample of apps and technologies for improving mental health and well-being suggests that researchers may be growing more comfortable with applying a range of gamification elements for mental health and well-being [30]. Previous calls for the inclusion of more gamification elements in health and well-being interventions [22] may have also contributed to this increase.

Most of the more frequently observed gamification elements in our dataset, namely progress feedback, points, rewards, personalization, badges, quests, and varying social features, overlap with those in other behavior change frameworks [4,26]. Notably, in persuasive systems design, these features are named self-monitoring, praise, rewards, tailoring, recognition, goal setting, normative influence, cooperation, competition, and social comparison [34]. These overlapping elements make up the bulk of our observations in our dataset, with the exception of *social cooperation*, which we observed infrequently in our dataset (5/50, 10%), *includes mini-game* (13/50, 26%), and *narrative or theme*, which is not found in other behavior change frameworks but was one of the most commonly observed gamification elements in our dataset (24/50, 48%). In its current state, the application of gamification to improving mental health and well-being seems difficult to distinguish from approaches stemming from other behavior change frameworks such as persuasive systems design.

So what distinguishes gamification from these approaches? What added value does gamification offer compared with other behavior change frameworks and techniques? The answer may lie in the gamification elements we observed less frequently in our dataset: *randomness*, *artificial*

challenge, *exploratory or open-world approach*, *social cooperation*, *unlockable content*, and *artificial assistance*. Although elements such as *artificial challenge* and *artificial assistance* are likely underutilized because of their usefulness only in certain contexts (eg, dynamic difficulty adjustment to create a state of flow during attentional bias modification training (ABMT) [45] or providing facial identification cues in an attention training intervention for children on the autism spectrum [46]), other elements such as *randomness*, *exploratory or open-world approach*, and *social cooperation* may be more complementary to mental health and well-being in general.

Randomness, which is one of the key types of play and games according to Caillois [32], can be implemented via a random reinforcement schedule, for example, to facilitate learning [47]. However, more integral to this gamification element is the anticipation of not knowing exactly what to expect, for example, by offering intervention participants missions that have been randomly drawn from a larger pool of missions [48] and the sense of excitement that comes with it. Similarly, designing mental health and well-being interventions to accommodate an *exploratory or open-world approach* complements the flexibility of contemporary internet experiences and may even be expected by intervention participants [27]. However, it may be challenging to apply this to therapeutic approaches whose structures may be more rigid, such as cognitive behavioral therapy. A possible solution in cases similar to these could be to make all modules immediately accessible but indicate a recommended module order [14]. In this way, the user's autonomy is not thwarted [16], and they are empowered with the knowledge of how to navigate the intervention in a way that can benefit them most.

Despite the clearly demonstrated benefits of social connectedness on well-being [49], *social cooperation* is underutilized in mental health and well-being interventions, particularly in comparison with other social elements such as *comparison* and *competition*. Social cooperation represents a positive way of interacting with others that does not explicitly place value on all involved parties (as it would through competition or comparison) and is a way to satisfy our innate need for relatedness and promote well-being [16]. Despite this, the only instances of social

cooperation we observed in our dataset were in physical activity and well-being interventions, with the majority in the form of cooperation nested within competition (cooperating with team members to compete against other teams). As this approach is still competitive at its core, it may be incompatible with many mental health and well-being domains [14,15]. Most instances of social support we observed in our dataset were instead in the form of *social networking*, where users of an app or technology could interact with and affirm each other through posts, private messages, and gifts. It may be useful to draw inspiration from cooperative mechanics from commercial video games to identify how best to apply social cooperation to improving mental health and well-being in more task- and domain-compatible ways. For example, in Massively Multiplayer Online games or video games such as *Snipperclips* [50], players can work together to achieve a system-defined goal (effectively players vs system). Applied to an ABMT intervention, a system-defined social cooperation goal could be having all members of a team complete a stage a certain number of times or collectively achieve a certain score. Designers of mental health and well-being interventions can also consider integrating real-time location data into their functionality (eg, an app aimed at decreasing levels of social anxiety challenges its users to call a gym and provides the phone number of a nearby gym [51]). A recent example of a successful app with this functionality is *Pokémon GO* [52], which encourages its users to make meaningful connections with physical locations and people [53].

5.5.3. Research Question 2. Mental Health and Well-Being Domains Targeted by Gamification

Anxiety disorders was the most commonly targeted mental health and well-being domain in our dataset (16 apps and technologies, 32%), followed by well-being (10 apps and technologies, 20%). Of note is the fact that no gamified apps and technologies targeting bipolar disorders and conduct disorder were identified in this review. (We did, however, exclude 1 intervention aimed at preventing substance abuse and relationship violence for being a serious game [54].) As these

domains, particularly bipolar disorders, have significant associated global burden of disease [36], this may be a research gap worth targeting.

Overall, there is a greater level of diversity in mental health and well-being domains compared with that in previous reviews of the literature [6,7,30]. However, more work remains to be done not only in designing engaging and efficacious gamified mental health and well-being interventions but also in evaluating their effectiveness. The slow pace of clinical research is directly at odds with the fast pace of technological change, frequently rendering interventions obsolete in the time taken to establish their efficacy. For this reason, nontraditional development and evaluation methods such as agile development and rapid prototyping may be more suitable for gamified mental health and well-being interventions [27]. However, care must be taken to ensure that no harm, particularly from the application of gamification [1,55], is caused to intervention testers during these stages of development and testing.

5.5.4. Research Question 3. Reasons for Applying Gamification to Improving Mental Health and Well-Being

5.5.4.1. Theme 1: Promoting Engagement With an Intervention

Encouraging usage of the app or technology was the dominant reason for applying gamification, appearing in 31 of the 41 (76%) papers that provided a reason for using gamification. Gamification was purported to improve multiple aspects of engagement, including fun and enjoyableness, and create a sense of mastery. This would encourage both first contact and repeated contact with the app or technology, concepts that are analogous to engagement and retention. However, further research is needed to learn how gamification enhances engagement [4] and whether it may be more effective at establishing initial engagement or ongoing use.

Gamification was also said to be a tool to *decrease barriers to engaging* with an intervention, both in terms of mitigating participants' defensiveness and reducing participants' distress. This was much less used, appearing in 6 (15%) papers. The mental health and well-being domains

represented were also limited, with mitigating participants' defensiveness mentioned only by authors of interventions targeting alcohol use and anxiety disorders [56-59] and reducing participants' distress exclusively mentioned by authors of interventions targeting phobia [60,61]. Interestingly, despite significant societal levels of stigma against mental health problems, these reasons were not cited for any other mental health and well-being domain.

5.5.4.2. Theme 2: Enhancing an Intervention's Intended Effects

Most of the data extracts under this theme related to *behavior change* (14 papers, 32%). Specifically, researchers aimed to use gamification to encourage intended behaviors and sustain behavior change over time. This was unsurprising, given the focus of these apps and technologies on improving mental health and well-being through behavior change, possibly in response to academic calls for action [4,5]. The ability of gamification to support behavior change is also somewhat supported by existing research [41,62,63], although further research is required on whether, and how for long, these effects persist [4].

Other aims related to *intervention efficacy* were also mentioned, including encouraging attitude change, enhancing learning, improving well-being, and using gamification elements to complement the delivery of intervention ingredients (eg, by presenting an ABMT task as a game of snap [64]). As mentioned previously, more research is needed to establish the extent of the effects gamification may have on supporting these goals.

Finally, although this was only mentioned in 2 (5%) papers, gamification was touted as a way to potentially increase the cost-effectiveness of interventions either by attracting users to participate without using material incentives or by making the feedback and reward loop interesting enough so that the intervention attracted new users and incentivized the existing users to continually generate new content, creating a closed loop [58]. This specific intervention design was for a personalized normative feedback intervention targeting problematic levels of alcohol consumption and may, therefore, be impractical for many mental health and well-being domains requiring trained moderators and therapists. However, designers of more self-directed

initiatives such as preventive or well-being interventions (particularly those that rely on social comparison) may find this a useful model.

5.5.4.3. Overall

Of 41 papers, 13 (32%) explicitly linked gamification to motivation to use the app or technology. This points to the origins of gamification as being defined as a motivational affordance and the way it was initially introduced to electronic health and mobile health as a tool to increase engagement and motivate behavior change [4-6]. However, in the context of behavior change theory, motivation is only 1 driver of behavior change, with the other 2 being capability and opportunity [29]. The focus on motivation, seemingly at the expense of capability and opportunity [22], represents lost potential.

Some gamification elements are particularly compatible with capability and opportunity. For example, according to Lister et al, capability can be promoted via *self-monitoring*, and opportunity by providing *cues to action* and *peer pressure* [22]. The gamification equivalent to these techniques would be *levels or progress feedback*, *personalization*, and social mechanics (whether *competition*, *cooperation*, *networking*, or *comparison*) respectively. As an example, a mental health and well-being app or technology might identify certain times of day when users are engaged in particular activities or have free time and time notifications accordingly (*personalization*).

Finally, although the above sections provide insights into what the writers of some papers in our dataset intended to achieve with gamification, it is important to note that reasoning behind the decision to implement gamification was only provided in 41 of 70 (59%) of papers. This may be indicative of a lack of consideration of the mechanisms through which gamification may influence behavior change in a large portion of mental health and well-being–related research. Furthermore, this may indicate that the lack of linkage between the theory and application of gamification observed in the greater literature [1,25] is also present, to a degree, in mental health and well-being. In other words, some applications of gamification to apps and technologies for improving mental health and well-being may be treating gamification as a *black box*, which is

clearly problematic. With reference to Huotari and Hamari's definition of gamification [13], designers of mental health and well-being interventions may find it helpful to identify the key attitude and behavior change mechanisms and processes through which they intend the intervention to work and how these interact with established evidence-based techniques in their field. Once these core *services* (or *intervention principles* [65]) are identified, gamification can then be applied in various ways to enhance these services. This would result in a more targeted, theory-driven, evidence-based application of gamification to improving mental health and well-being.

5.5.5. Study Limitations

This study aimed to systematically review literature published from 2013 to 2018 to identify any and all instances of the application of gamification to apps and technologies for improving mental health and well-being. Furthermore, this review had a broad focus, including sources that are traditionally excluded in systematic reviews such as conference papers and conceptual papers. This was done to ensure as much accuracy as possible in describing the current state of the gamification of health and well-being. However, there are some limitations to this study's methodology that must be acknowledged to fully contextualize our results.

First, there is a possibility that some qualifying papers were not identified by the search. Although a wide variety of keywords were used to capture as many results as possible, this may particularly be the case for more specialist papers that may only discuss their specific mental illness and not include the phrases *mental health*, *wellbeing*, *well-being*, *mental illness*, or *mental disorder*. Furthermore, interventions were frequently described as *gamification* when they were actually (as judged by the authors) serious games. Although those studies were excluded, the initial search would not have captured any interventions that were the other way around—gamified interventions that were labeled *serious games*. The search process would also have failed to identify apps or technologies that the academic literature does not report and explicitly link to gamification, including many commercially developed apps or technologies. The results of this

review are, therefore, not fully generalizable to commercially developed apps and technologies for improving mental health and well-being.

It is also likely that not all gamification elements in an intervention were able to be coded, as researchers may not have fully described their apps and technologies in the papers. It is also possible that the gamification elements described in papers may have been removed from the app or technology in subsequent software updates. Furthermore, in some studies, as in best practice, gameful design was so embedded within the intervention that the gamification elements could not be separated from the active ingredients of the intervention. Alternatively, and on the other extreme, in some cases, the only mention of gamification was a blanket statement that it had been applied, making it difficult to judge which elements these statements referred to. For these reasons, *all* features of an intervention were evaluated against the coding frame and coded. In doing so, coding detail was also kept consistent between studies that only evaluated 1 version of an intervention and studies that evaluated a control version against a gamified version (of which there were not many). As the health gamification field matures, there is a need for the inclusion of more detail when describing the implementation of gamification and more consistent use of applied games terminology within and across fields.

As certain intervention paradigms can be used for multiple contexts (eg, ABMT), the range of mental health and well-being domains we observed is also likely to be an underestimate of the range of domains, both within mental health and well-being and across all aspects of health and well-being, to which gamification can potentially be applied. Similarly, as the focus of this review was the *improvement* of mental health and well-being, apps and technologies that used gamification for other mental health and well-being–related purposes such as measurement were excluded from the review.

Finally, as the primary aim of this review is to provide a record of all reported gamified apps and technologies for improving mental health and well-being within the past 5 years (2013-2018), we did not collect any information on the included apps or technologies' efficacy or effectiveness

on any evaluation metric. However, given that a previous review has identified the relative lack, and low level of quality, of evidence for the effectiveness of gamification for health and well-being [6], this analysis may be premature. Furthermore, although this review investigates individual gamification elements, we acknowledge and argue that gamification is best implemented and evaluated holistically, as implied by Huotari and Hamari's definition of gamification [13]. Instead of evaluating individual gamification elements, a more practical and informative approach may be to evaluate individual (gamified) intervention principles [65].

5.5.6. Conclusion and Future Directions

This paper reports the results of a systematic review on all applications of gamification to improving mental health and well-being reported in the literature in the past 5 years (2013-2018). A total of 12 databases and journals were searched for qualifying papers, and from the search results, we identified 50 qualifying apps and technologies. Results suggest that gamification is being applied to a greater range of mental health and well-being domains compared with previous reviews and that a greater diversity of gamification elements is being used. Our results also suggest that in the context of improving mental health and well-being, gamification is not being implemented in the behaviorist fashion focusing mostly on positive reinforcement that has been observed and criticized in the wider literature [19]. Importantly, however, our results are only reflective of gamified apps and technologies reported within the academic literature. Future research can conduct a review of commercially developed gamified apps and technologies for improving mental health and well-being and compare and contrast findings with those derived from the academic literature. Similar reviews can also be conducted for serious games and commercial games (potentially including both video games and non-digital games) with mental health themes.

This review also found that certain gamification elements, such as *randomness*, *artificial challenge*, *artificial assistance*, *exploratory or open-world approaches*, and *social cooperation*, are underutilized for the improvement of mental health and well-being and that further research

(ideally with rapid prototyping methods such as agile development [27]) is needed to identify how best these elements can be applied to improving mental health and well-being, if at all. There is also a need to consider and evaluate how gamification may promote a wider variety of drivers for health behavior change. Although current applications of gamification in improving mental health and well-being are primarily for improving motivation (to engage with the intervention or change behavior), future applications should consider how gamification can serve other behavior change drivers such as capability and opportunity [22,29]. It is also important to evaluate whether gamification may lead to unintentional, harmful effects, and in what circumstances this may occur [1,55]. For example, what would be the effects and ethical implications of using randomness in a substance use disorder intervention, given that they both involve dopamine?

Finally, most researchers in health technology probably share the fundamental goal of developing interventions that enable and empower the greatest improvement in health and well-being for the greatest number of people in the target population. To achieve this, there is an urgent need to describe the implementation of gamification to health interventions in more explicit and precise detail and to standardize applied games terminology (including *gamification*, *serious games*, and other types of applied games) within and across fields. It may also be fruitful to take a step back from the single-minded focus on engagement that has been characteristic in academic literature on the gamification of health and well-being until now [6,30], and consider more broadly how gamification can enhance the basic functionality of a mental health and well-being intervention. Identifying a mental health and well-being intervention's goals and intentionally designing gamification to support them in novel and pragmatic ways may be the best way to achieve rapid progress in this field.

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5.5.8. Conflicts of Interest

IBH was an inaugural Commissioner on Australia's National Mental Health Commission (2012-2018). He is the Co-Director, Health and Policy at the Brain and Mind Centre (BMC), University of Sydney. The BMC operates an early intervention youth services at Camperdown under contract to *headspace*. Professor Hickie has previously led community-based and pharmaceutical industry-supported (Wyeth, Eli Lily, Servier, Pfizer, AstraZeneca) projects focused on the identification and better management of anxiety and depression. He was a member of the Medical Advisory Panel for Medibank Private until October 2017, a Board Member of Psychosis Australia Trust, and a member of Veterans Mental Health Clinical Reference group. He is the Chief Scientific Advisor to, and an equity shareholder in, Innowell. Innowell has been formed by the University of Sydney and PwC to deliver the Aus $30 million Australian government–funded *Project Synergy*. Project Synergy is a 3-year program for the transformation of mental health services through the use of innovative technologies. None of the other authors declare any conflicts of interest.

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5.7. Multimedia Appendix 1

Coding frame: RQ1 (gamification elements)

Gameful element	Definition
Artificial assistance	Assistance imposed or facilitated by the system, within the system experience. Doesn't include things like allowing repeats, but includes things like decreasing difficulty of completing tasks.
Artificial challenge	Have difficulty imposed by the system (for example, via limited lives, increased speed, or time pressure).
Badges or achievements	Being awarded permanent visual recognition, for example via badges, certificates and achievements, by the system in response to accomplishing meaningful goals inside the system.
Customization	Being able to customize avatars and other types of representation (of the self or of the player character), or other aspects of the user experience, either freely or through spending in-game currency or real currency.
Exploratory or open-world approach	User is free to explore the system at their leisure and access to system components or modules is not restricted.
Includes mini-game	A smaller game is included in the app or technology but it remains a sub-component (i.e. app or technology is not a serious game).
Levels or progress feedback	User is given an indication of their progress in a task and in the overall content of the system, and how far they have to go to succeed in or finish the task and reach the next milestone.
Narrative or theme	The system adopts a certain theme or premise and presents itself faithfully according to that premise (e.g. a CBT program may be presented on a game board; results may be presented on a spinning wheel), and may or may not include an underlying storyline.
Personalization	The system learns about you either by asking you directly or by analyzing your behavior in the system, and adapts what and how it presents to you to suit you (e.g. adaptive difficulty, using real-time location data). As opposed to 'Customization', this is driven by the system.
Points or scoring	The user gains points for completing tasks, which can be either static or scale based on their performance.
Quests or challenges	Users are invited to complete specific tasks in exchange for rewards.
Randomness	Having the result of a certain aspect of the system (quests, tasks, etc.) be determined by chance, either partially or entirely. Includes scripted events (i.e. the appearance of chance).
Rewards or prizes	Receiving rewards or prizes by completing specific tasks or goals, or by reaching certain milestones.
Social comparison	The system allows users to see other users' actions, and to show off their own achievements, progress and/or status to other users.
Social competition	Users are placed in implied (via leaderboard) or direct competition with each other.
Social cooperation	Working together with other users, for example as part of a team, to achieve a goal.
Social networking	System or app allows users to make connections with each other, perhaps facilitating this by matching similar users, and to express or act upon these connections, for example via gifting, or communicating via comments, messages, stickers, etc.
Unlockable content	Unlocking additional content (outside of the main game or intervention) after reaching certain milestones, achieving a significant goal, or exploring different paths, etc.

Coding frame: RQ2 (mental health and well-being domains)

Alcohol use disorders
Anxiety disorders
Attention-deficit/hyperactivity disorders
Autistic spectrum disorders
Bipolar disorders
Conduct disorder
Depressive disorders
Drug use disorders
Eating disorders
General motivational impairment
Mindfulness
Physical health with mental health and well-being outcomes
Schizophrenia
Self-injury or suicide
Sleep
Well-being

Coding frame: RQ3 (reasons for applying gamification to improving mental health and well-being)

Theme	Subtheme	Code	Example quote
Promote engagement with an intervention	Decrease barriers to engagement	Mitigate participants' defensiveness	"It was anticipated that providing feedback in the context of a game, which was not explicitly focused on alcohol, might improve efficacy among heavier drinkers by reducing defensive reactions to the intervention content." [1]
		Reduce participants' distress	"In the context of [virtual reality exposure therapy], which can be highly distressing for patients, gamification may reduce the negative experiences of treatment." [2]
	Encourage usage	Be fun, interesting, or enjoyable	"The rehabilitation games were designed to combine a variety of rehabilitation exercises with gaming elements, thus making the otherwise monotonous practice more competitive, motivating, interesting and enjoyable." [3]
		Create a sense of mastery	"Digital coins and badges give the users a sense of accomplishment […]" [4]
		Encourage retention and repeated engagement	"The design of this mindfulness project exercises several common game mechanics to maintain user interest over time, without attempting to distract them during mindfulness meditation." [5]
		Increase engagement with intervention	"The Wellbeing Game uses gamification to encourage engaging in the Five Ways to Wellbeing through." [6]
		Increase motivation to use	"Similar to the ARET system, the VRET system will also follow a gamification approach to motivate the patient during her/his therapy by feeding back the actual achievements but also the progress that is already accomplished." [7]
Enhance an intervention's intended effects	Behavior change	Encourage and motivate intended behaviors	"In this paper we explore how a gamified digital behaviour change intervention can be adapted to encourage people of different personality types to engage in simple acts of kindness." [8]
		Sustain behavior change over time	"Gamification also can be useful for clients with initiation impairments due to frontal lobe deficits by acting as an adaptive aid to prompt behavior and develop habits and routines." [9]
	Intervention efficacy	Complement delivery of intervention ingredients	"Because the ultimate goal of PNF interventions is to induce behavior change by helping participants learn facts about the true prevalence of various behaviors among their peers, CampusGANDR was designed to reward participants for accurate perceptions of peers' behaviors using a system of points." [10]
		Encourage attitude change	"[…] the present study explored the effects of gamification on […] creating positive attitudes towards sleeping and waking up at optimal times." [11]

		Enhance learning	"To enhance learning and motivation, the program calibrated the difficulty level between each round, depending on the participant's performance." [12]
		Improve well-being	"Through gamification, many benefits, such as the commitment of users to participate in various activities and sharing of experiences that have potential well-being effects on the users may be reached." [13]
	Intervention efficiency	Increase cost-effectiveness	"Delivering a brief alcohol intervention within the context of a gamified app allows the intervention to be disguised as something fun and interesting, which may reduce or even eliminate the need to provide compensation in order to attract and retain participants." [10]

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5.8. Multimedia Appendix 2

Intervention	Description	Mental health domain	Gamification elements
0Phobia [1]	Self-directed virtual reality (VR) exposure therapy mobile app for acrophobia used with cardboard VR goggles. The gamified component involves acting as a theatre employee who is tasked to spot objects from various heights.	Anxiety disorders	Narrative or theme
Active Team [2]	A physical activity intervention delivered through a mobile app aiming to encourage users to undertake physical activity. The social gamified component includes gifting, leaderboards, and challenges.	Physical health with mental health and well-being outcomes	Customization Levels or progress feedback Quests or challenges Social competition Social networking
Agoraphobia Free [3]	Mobile app delivering interactive game-based cognitive behavioral therapy, tailored specifically towards agoraphobia and panic. The app takes the premise of the user guiding a virtual character through therapy sessions and instructs the user to apply the learned techniques to their own situation.	Anxiety disorders	Narrative or theme
Beat the Street [4-7]	A community intervention where individuals and teams compete to tap at as many radio-frequency identification (RFID) scanners as possible. These scanners are stylized as 'Beat Boxes' and are positioned all over a town or city. Participants are assigned to teams and teams compete to score the most points. A few individual participants are also randomly chosen to receive prizes every week.	Physical health with mental health and well-being outcomes	Games of chance Levels or progress feedback Narrative or theme Points or scoring Rewards or prizes Social comparison Social competition Social cooperation Social networking
BoosterBuddy [8]	A mental health tracking mobile app that aims to motivate users to perform self-management and behavioral activation tasks through the premise of completing quests to wake up their 'buddy'. Through using the app, users unlock options to aesthetically customize their buddy.	General motivational impairment	Customization Levels or progress feedback Narrative or theme Personalization Points or scoring Quests or challenges Rewards or prizes Unlockable content
BRANCH [9]	An electronic screening and brief intervention mobile app containing a drink diary, goal-setting functions, information and	Alcohol use disorders	Customization Personalization Points or scoring

	resources on reducing drinking, and normative drinking feedback. The app is enhanced by social features and a point-based system.		Social competition Social networking
CampusGANDR [10, 11]	A personalized normative feedback intervention aimed at reducing alcohol use in undergraduate students. It is presented as a social game where users are ostensibly matched with other Facebook users of the same age and gender and can compare their behavior on various aspects of university life.	Alcohol use disorders	Customization Games of chance Levels or progress feedback Narrative or theme Points or scoring Rewards or prizes Social comparison Social competition
Challenger App [12, 13]	A gamified mobile cognitive behavioral therapy app aimed at social anxiety disorder. Users identify skills they want to gain and are assigned challenges to complete, which are personalized to the user. Users can also leave each other anonymous feedback and advice.	Anxiety disorders	Badges or achievements Customization Levels or progress feedback Narrative or theme Personalization Quests or challenges Rewards or prizes Social comparison Social networking
Cheese Ninja Game [14]	A gamified cognitive bias modification training paradigm. The study contained two gamified versions, one with an additional social component and one without. Codes are based on the social gamified version.	Alcohol use disorders	Narrative or theme Personalization Social comparison Social networking
CityBuilder Game [15]	A cognitive bias modification training task (specifically visual probe task; VPT) targeting substance misuse, embedded into a city-building game. Users earn points from completing VPT rounds that they can use between rounds to customize their city and can view and rate the cities of other participants.	Alcohol use disorders Drug use disorders	Customization Levels or progress feedback Points or scoring Social comparison Social networking
Coping with Voices [16, 17]	A computerized cognitive behavioral therapy program aimed at helping users cope with auditory hallucinations.	Schizophrenia	Includes mini-game Social comparison
Crush the Crave [18-20]	An evidence-based mobile app for smoking cessation, aimed at young adult smokers.	Physical health with mental health and well-being outcomes	Badges or achievements Customization Includes mini-game Levels or progress feedback Personalization

			Social competition Social networking
Daily Challenge [21]	An online intervention delivered via a website and email focusing on improving general well-being (physical, emotional, social, etc.) Participants are set an email every day with a daily challenge to complete a small task related to improving their health and well-being.	Well-being	Badges or achievements Customization Levels or progress feedback Points or scoring Quests or challenges Rewards or prizes Social comparison Social cooperation Social networking
DJINNI [22]	A design concept for an exposure therapy system targeting social anxiety disorder that can be delivered through either augmented reality or virtual reality. Participants are encouraged to progress in their treatment through real-time indicators of their progress.	Anxiety disorders	Artificial assistance Levels or progress feedback Personalization Points or scoring Rewards or prizes
Emotiv EEG headset [23]	Virtual reality software providing users natural, relaxing virtual environments (e.g. Angkor Wat) to facilitate mindfulness meditation.	Mindfulness	Levels or progress feedback Points or scoring Unlockable content
Empowered Brain system [24]	A smart glasses-based intervention that aims to improve attention and social communication deficits in children. One module, Face2Face, rewards staring at faces through cartoon images and arrows, and another, Emotion Charades, contains a 2-player emotion identifying game.	Attention-deficit/ hyperactivity disorders Autistic spectrum disorders	Artificial assistance Levels or progress feedback Personalization Points or scoring Rewards or prizes
IMPACT - 'Intrinsically-Motivating Playable Attentional Control Training' [25]	An attentional bias modification paradigm aimed at reducing attention bias for negative stimuli (in this case disgusted human faces). Users are scored based on performance. The system also adapts the task difficulty based on the user's performance.	Anxiety disorders Depressive disorders	Artificial challenge Levels or progress feedback Personalization Points or scoring
IntelliCare suite [26]	A suite of mobile apps that each represent and encourage a different behavioral strategy or skill (e.g. goal setting, sleep hygiene) useful for treating depression and anxiety.	Anxiety disorders Depressive disorders	Badges or achievements Customization Exploratory or open-world approach Levels or progress feedback Personalization

Kindness is Contagious [27-29]	A persuasive intervention aimed at improving subjective well-being. In this 7-day intervention, participants are assigned 'kindness activities' daily that are personalized based on their personality type.	Well-being	Levels or progress feedback Personalization Points or scoring Quests or challenges Rewards or prizes Social competition Social networking
Learn to Quit [30]	A mobile smoking cessation app that delivers acceptance and commitment therapy to its users. It is tailored for people with serious mental illness and delivers its content via modules containing a simple narrative.	Physical health with mental health and well-being outcomes	Badges or achievements Includes mini-game Levels or progress feedback Narrative or theme Personalization Rewards or prizes
MEBook [31, 32]	A multimedia intervention (a learning environment with gaming elements) that aims to deliver social greetings training via video self-modelling to children with autistic spectrum disorders.	Autistic spectrum disorders	Levels or progress feedback Narrative or theme Personalization
MindMax [33-37]	An Australian Football League-themed (AFL) mobile app combining psychoeducational modules that teach behavioral strategies derived from acceptance and commitment therapy and positive psychology, social connection, and gamification and casual video games that aims to promote conversations around well-being in young Australian males and fans of AFL.	Well-being	Customization Exploratory or open-world approach Includes minigame Levels or progress feedback Points or scoring Quests or challenges Rewards or prizes Social comparison Social competition Social cooperation Social networking
MindTrails [38]	A proposed redesign of an existing Web-based anxiety training program that includes gamification.	Anxiety disorders	Levels or progress feedback Points or scoring
MoodMission [39]	A mobile app aimed at all age groups that gives its users "missions" (tasks based on cognitive behavioral therapy strategies) to help them deal with mood- and anxiety-related issues.	Anxiety disorders Depressive disorders	Badges or achievements Games of chance Levels or progress feedback Personalization Quests or challenges

			Rewards or prizes
MOPOrtal/Clans of Oulu [40, 41]	An intervention aiming to encourage physical activity in young Finnish men. In addition to personalized goals, information, and feedback, the intervention contains a location-based mixed-reality game that encourages any kind of activity (physical, social, etc.).	Physical health with mental health and well-being outcomes	Badges or achievements Customization Levels or progress feedback Personalization Rewards or prizes Social networking
Oiva [42]	A mobile app based on acceptance and commitment therapy that teaches skills to manage stress and improve mental wellness.	Well-being	Exploratory or open-world approach Levels or progress feedback Rewards or prizes
REACH App [43]	A mobile app adapting the REACH protocol for childhood anxiety.	Anxiety disorders	Badges or achievements Includes mini-game Levels or progress feedback Narrative or theme Quests or challenges Rewards or prizes Unlockable content
Readysetgoals [44]	A mobile app that supports therapeutic goal setting in the context of treating substance addiction using the metaphor of mountain climbing. Users select activities to do (goals or challenges), wagering points and setting a time limit. Their payoff is determined by the time limit and the difficulty of the task. The more goals users complete, the higher rank they achieve, and the further up the mountain they progress.	Drug use disorders	Artificial challenge Customization Games of chance Levels or progress feedback Narrative or theme Points or scoring Quests or challenges Rewards or prizes
Recovery Record [45]	A mobile app that contains a meal diary, meal reminders, affirmations, rewards, and the functionality to link with clinicians.	Eating disorders	Personalization Rewards or prizes
RehabMaster [46, 47]	A game-based virtual reality rehabilitation program for patients with chronic hemiparetic stroke. It aims to improve health-related quality of life, depression symptoms, and upper extremity function.	Physical health with mental health and well-being outcomes	Customization Includes mini-game Levels or progress feedback Points or scoring Social competition

Shots [15, 48]	A gamified cognitive bias modification of attention task presented as a slot machine. It was emphasized to participants that despite its appearance, it has no gambling elements.	Alcohol use disorders	Levels or progress feedback Narrative or theme Points or scoring Rewards or prizes
SIGMA [49]	An mHealth intervention aimed at overweight young people with maladaptive eating attitudes and behaviors. It contains both an explicit, cognitive-behavioral training component as well as an implicit, attentional bias retraining component.	Eating disorders	Artificial challenge Games of chance Levels or progress feedback Narrative or theme Points or scoring Rewards or prizes Social comparison
Sigrid-Secrets Art Experience [50]	A gamified location-based art experience (geocaching) in Pori, Finland, that aims to promote its users to engage physically and socially with the displayed artworks, contributing to improved well-being.	Well-being	Includes mini-game Narrative or theme Points or scoring Social networking
Sleep Ninja [51]	A mobile app that delivers cognitive behavioral therapy for insomnia to young people. In the app, young people interact with a 'Sleep Ninja', who coaches them through multiple psychoeducational modules to become a 'black belt' in sleep.	Sleep	Customization Exploratory or open-world approach Levels or progress feedback Narrative or theme Personalization
Sleepy Bird [52]	A gamified mobile alarm clock app containing an integrated casual video game. Sleepy Bird rewards participants with 'lives' (i.e. chances to play the casual video game) if they report healthy sleep-wake behaviors.	Sleep Well-being	Artificial challenge Includes mini-game Levels or progress feedback Narrative or theme Personalization Points or scoring Rewards or prizes Social competition
SmartCAT [53]	A multi-platform intervention delivering CBT to children experiencing anxiety that consists of a mobile app and a Web-based, integrated clinician portal. SmartCAT contains multiple modules with mini-games and a reward system including both virtual and real-world rewards (agreed on with their clinician).	Anxiety disorders	Badges or achievements Customization Includes mini-game Levels or progress feedback Personalization

			Points or scoring Rewards or prizes
SOmNI [54]	A mobile app for adolescents that works in conjunction with an activity tracker to increase night-time sleeping hours.	Sleep	Levels or progress feedback Personalization Points or scoring Rewards or prizes Social competition
Stress Free [3]	A mobile app delivering interactive game-based cognitive behavioral therapy (CBT) that targets anxiety and stress in general. A virtual therapist teaches the user generic CBT skills and relaxation techniques.	Anxiety disorders	Includes mini-game Quests or challenges
Superbetter [55, 56]	A multi-platform initiative aiming to gamify resilience and mental health. SuperBetter is made up of a mobile app, a website, and a Web-based forum. Users select well-being-related challenges to complete and are rewarded with points and level-ups when they report completion.	Depressive disorders Well-being	Customization Levels or progress feedback Narrative or theme Points or scoring Quests or challenges Social comparison Social networking
The Wellbeing Game [57]	A free online game that adapts the Five Ways to Wellbeing framework to a game format.	Well-being	Badges or achievements Levels or progress feedback Points or scoring Rewards or prizes Social competition Social cooperation
Therapeutic Evaluative Conditioning [58]	A mobile app that aims to reduce self-aversion and increase aversion to self-injuring behaviors through a short game-like paradigm.	Self-injury or suicide	Artificial challenge Games of chance Points or scoring
This Is Your Life! [59, 60]	A Web-based well-being intervention that uses the metaphor of a professor helping the user journey through various locations towards a flourishing life.	Well-being	Badges or achievements Levels or progress feedback Narrative or theme
Unified Health Gamification [61]	A theory-based, responsive approach enabling application of gamification to multiple facets of health and well-being (physical, social, mental, and cognitive). It aims to allow individual users to participate in a broader social context and interact with people who may have different health interests to their own.	Well-being	Badges or achievements Customization Includes mini-game Levels or progress feedback Personalization Points or scoring

			Quests or challenges Rewards or prizes Social competition Social cooperation Social networking
Unnamed gamified ABMT intervention [62]	A gamified attentional bias modification paradigm presented as a mobile app. This intervention features cartoon imagery (blue sprites hiding in grass; different colored jewels used as performance feedback).	Anxiety disorders	Levels or progress feedback Narrative or theme Points or scoring
Unnamed gamified nightlife intervention [63]	A gamified typical nightlife intervention delivered in quieter areas of clubbing or music events. It aims to increase awareness of risks associated with substance use.	Alcohol use disorders Drug use disorders	Customization Games of chance Includes mini-game Levels or progress feedback Narrative or theme Points or scoring
Unnamed gamified 'snap' ABMT [64]	An attentional bias modification dot probe task presented as a game of snap where players have to identify whether photographs of two human faces making different expressions depict the same person. Participants' performance is presented as a score and they are encouraged to improve their high score.	Anxiety disorders	Games of chance Levels or progress feedback Narrative or theme Points or scoring
Unnamed mobile app to reduce cognitive vulnerability and mild depressive symptoms [65]	A mobile app that delivers rational emotive behavior therapy aimed at addressing users' cognitive vulnerability and mild depressive symptoms. The app displays a slowly decreasing "Energy" level. Users can increase (i.e. maintain) their "Energy" level by reading informative articles and completing set tasks.	Depressive disorders	Customization Levels or progress feedback Narrative or theme Quests or challenges Rewards or prizes
Unnamed truck driving simulator [66, 67]	A virtual reality action-cue exposure therapy aimed at current or former truck drivers with PTSD from work-related accidents. In addition to the exposure therapy, users can also customize their truck.	Anxiety disorders	Customization Exploratory or open-world approach Games of chance Levels or progress feedback Narrative or theme Rewards or prizes
VIMSE/Itsy [68, 69]	A self-directed, gamified, virtual reality exposure therapy application aimed at spider phobia.	Anxiety disorders	Customization Levels or progress feedback Narrative or theme

Woebot [70]	A mobile app containing a text-based conversational agent that delivers CBT microsessions.	Anxiety disorders Depressive disorders	Includes mini-game Personalization

Summary of outcomes relating to gamification and gamification elements

Note: This summary is included only in this thesis (not in the published version of this paper).

The outcomes of the interventions described in the papers included in the review were not included in the main body of this chapter as only a minority of papers reported outcomes. The majority of studies that reported outcomes also have cross-sectional designs and many potential confounding variables; hence, causality cannot be inferred. Furthermore, as is detailed in this chapter and in other parts of this thesis (e.g. Chapter 1.2.5), it may be impractical to isolate game design elements from the intervention they are applied to, which complicates their evaluation, and which may be a reason for the lack of previous research on the effectiveness of applying game design principles to apps and technologies for improving mental health. With these caveats, I summarise the outcomes of the included papers here, where reported.

Of the 70 publications included in the analysis, one was excluded from this summary [31] as it appeared to report the same data as another included publication (similar sample size and study design) [32]. A further publication (Chapter 3) was included as despite being unpublished, it is the subject of this thesis (MindMax) and furthermore reports evaluation of an app/technology already included in this systematic review. Out of the resulting 70 publications, 32 were research papers that evaluated mental health and wellbeing outcomes in either a randomised controlled trial or a pilot evaluation. Collectively, these papers report on 29 interventions targeting 11 domains (anxiety disorders, depressive disorders, wellbeing, self-injury or suicide, sleep, autism spectrum disorders, attention-deficit hyperactivity disorders, alcohol use disorders, drug use disorders, physical health with mental health and wellbeing outcomes, and schizophrenia). Of these 32 papers, 78% (25/32) reported positive outcomes[6] [3-4, 10-11, 13, 16-17, 19, 21, 24-26, 28, 32, 42, 46, 48, 52, 56-58, 61-62, 64, 67, 70], 22% (7/32) reported ambiguous or neutral outcomes (e.g. outcomes not directly related to mental health and wellbeing, such as attitudes towards physical activity) [5-6, 14-15, 25, 41, 48], and none (0/32) reported negative outcomes. Again, we cannot be sure whether these outcomes are due to gamification, other intervention content, or even confounding factors arising during study participation (as discussed in Chapter

[6] Due to the varying designs of the studies (RCT vs. naturalistic trials vs. pilot studies), outcomes were considered positive if general increases in the mental health and wellbeing variable of interest were reported, regardless of whether they outperformed control or treatment-as-usual or not. Included in this count (but not cited in references) is Chapter 3.

3). Furthermore, it is not clear whether gamification can even be isolated from the reviewed interventions at all. Nonetheless, and keeping publication biases in mind, the reported outcomes of gamified apps and technologies for improving mental health and wellbeing are promising.

Also of interest is whether certain gamification elements are perhaps more useful or relevant to certain domains. While correlation analyses were performed to assess relationships between the presence/absence of gamification elements (RQ1) and mental health and wellbeing domains (RQ2), both within and across research questions, we did not include the resulting heatmap in this chapter as it was not informative and could be misleading, for multiple reasons.

First, as there is a general lack of evidence on the effectiveness or efficacy of gamification, conducting correlation analyses on only the apps or technologies demonstrated to be effective (for example) would result in overly low sample sizes. Second, as it is difficult to separate gamification elements from intervention ingredients, significant correlations would not necessarily indicate effective, or even interesting, elements. Furthermore, while we identified correlations between certain elements and mental health domains (e.g. badges and tobacco cessation interventions), a significant correlation is not indicative of the effectiveness of that particular element for that domain. It may equally suggest that this model of intervention has been replicated multiple times and that badges (for example) just happen to be part of the model. Finally, while this review reduces gamification to its individual elements for the sake of operationalisation, gamification should be implemented holistically. A correlational heatmap would implicitly endorse the former approach.

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Chapter 6: Discussion

6.1. Overview

This thesis reports the work done by me as part of my PhD. It is part of the broader MindMax Study, which is a collaboration between The University of Sydney's Brain and Mind Centre, Queensland University of Technology, and the Australian Football League Players' Association (AFLPA; Mitchell et al., 2017). Two PhD projects fall under the MindMax Study: the first (and the subject of this thesis) evaluating the mental health and wellbeing outcomes of using MindMax, and the second investigating usage patterns of, and engagement with, MindMax. While this thesis reports the work I conducted for the first project, where appropriate I also synthesise learnings from the second project and from the broader MindMax Study into this chapter.

6.2. Thesis aims

The aims of this thesis are fourfold:

1. to iteratively co-design and develop a gamified app for mental health and wellbeing,
2. to evaluate the eventuating app, MindMax,
3. to consolidate literature on gamification for mental health and wellbeing, and
4. to synthesise findings into practical guidelines for implementing gamification for mental health and wellbeing.

In this chapter, I first summarise the contributions of this thesis in relation to each thesis aim and state their limitations. I then discuss their collective implications and future directions for study, before concluding this thesis.

6.3. Contributions

6.3.1. Overall

Chapters 2 to 4 of this thesis address the first two aims of this thesis and report on the complete co-design, development, and evaluation process of a gamified mHealth app. Previous research in eHealth and mHealth (specifically Behavioural Intervention Technologies) highlights the importance of detailed documentation of the design and evaluation process (Mohr et al., 2015), including any changes made to the technology being evaluated. Mobile phone apps must change and adapt based on changing software requirements and user expectations to remain usable and relevant. However, juxtaposed against the fast pace of technological advancements in the mobile app and digital games industry is the considerable lag between clinical research and practice (estimated by Green, Ottoson, García, and Hiatt, 2009, to be 17 years). This poses problems for any traditional randomised control trial (RCT) design; hence, more flexible evaluation designs that allow for constant updates to the technology being evaluated have been recommended (Fleming et al., 2017; Mohr et al., 2015). This thesis and related publications from the broader MindMax Study address this issue by providing as much detail as possible on MindMax and its evaluation. Notably, software development detail and screenshots of MindMax are provided at a range of software development stages: from alpha and beta prototypes pre-launch, to five months after launch (all Chapter 2), to one year after launch (Vella et al., 2018).

This thesis and the broader MindMax Study also provide a model (summarised in Figure 6.1) for future research looking to develop and evaluate mHealth apps, whether for mental health and wellbeing or for other health contexts. Specifically, learnings from co-developing MindMax were used to inform the continuing software development of MindMax (reported in Chapter 2). This was made possible by working with the contracted software developers to take advantage of their iterative agile development approach, and by the naturalistic trial design (Chapter 3) that accommodates the continuous change of the product under development throughout the trial period. As a secondary analysis on the longitudinal data collected for evaluation, Chapter 4 also

provides insight into how such data can be rigorously analysed to contribute more broadly to mental health research (in this case on help-seeking intentions). The use of both qualitative and quantitative evaluation methodologies takes advantage of the strengths of each approach, and enables the triangulation of, and a higher level of confidence in, this thesis's findings.

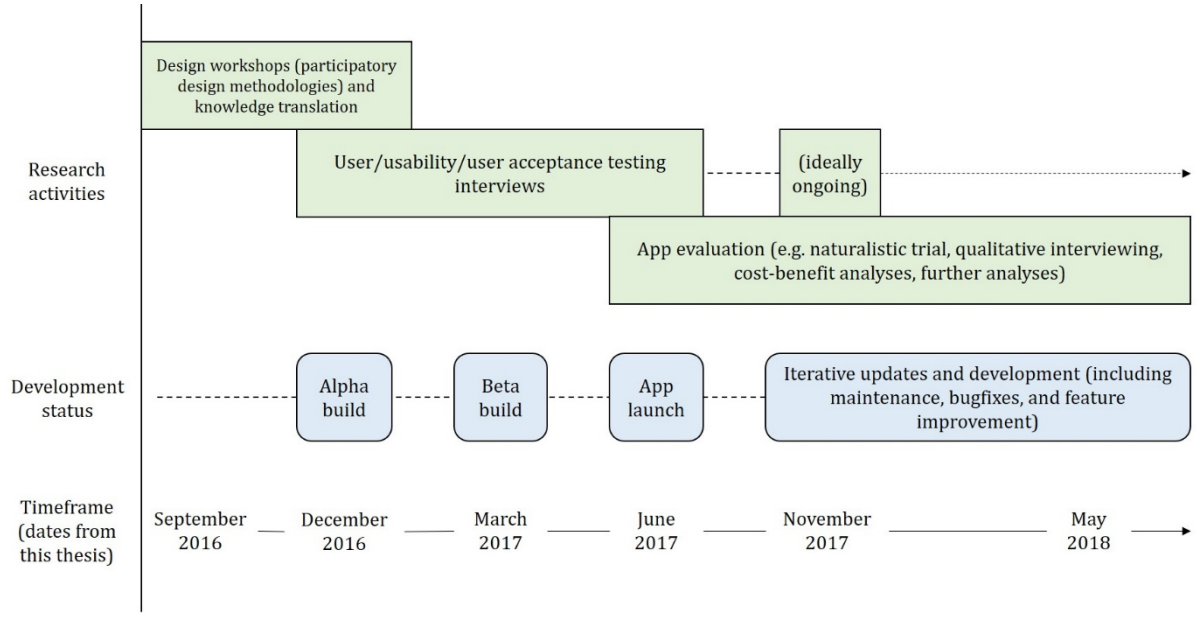

Figure 6.1. Model for developing and evaluating mHealth apps used in this thesis

To address the third aim of this thesis (to consolidate literature on gamification for mental health and wellbeing), Chapter 5 reports on a systematic review of gamified apps and technologies for improving mental health and wellbeing. It also contributes a taxonomy of gamification elements (in the coding frame; Chapter 5.7) drawn from both research in human-computer interaction and from previous reviews of health gamification, that future health gamification research (including mental health and wellbeing) can draw from. While reducing gamification to a series of elements does not accurately reflect the systemic structure of the games that gamification draws its design inspiration from (Chapter 1.2.4; Deterding, 2015), this taxonomy aims to be a resource that will contribute to consistency in terminology in health gamification.

Finally, to address the fourth and final aim of this thesis, the following sections discuss the contributions of this thesis in relation to each thesis aim in more detail, as well as their limitations, and their wider implications. The findings of this thesis are then synthesised into best practice

guidelines for implementing gamification for mental health and wellbeing, reported in Chapter 6.5.4.

6.3.2. Iteratively co-designing and developing MindMax (Aim 1)

Chapter 2 outlines the iterative co-design and development process employed for MindMax. Importantly, its findings show that participants (younger people aged 16 to 35 years) are broadly supportive of applying games to mental health and wellbeing. Previous research shows that using PD at an early stage of development is useful and cost-effective, as it allows target audience-specific issues to be identified before extensive resources are committed to developing the software further (Sockolow et al., 2017). Chapter 2 reports a similar outcome resulting from the PD workshops and UX interviews. It also highlights the value of progress feedback and in personalising UXs (including social experiences) to fit an individual user's needs and preferences.

Importantly, as user testing was conducted at multiple time points and stages of development (two time points before app launch and one time point after app launch), findings fed back into the development process. However, there was a gap between what representative end users wanted and what the contracted software developers could deliver with the available development resources. It may have been helpful to have the software developers take part in the PD workshops alongside the representative end users. However, their presence may also have influenced workshop dynamics, as their expertise in technology development would have placed them in a relatively higher position of authority, potentially undermining the workshop's participatory nature. This dynamic would have to be managed and carefully balanced by workshop facilitators.

6.3.3. Evaluating MindMax: Primary outcomes (Aim 2)

Chapter 3 and Chapter 4 focus on the evaluation of the impact using MindMax may have had on its users; specifically, its wellbeing, resilience, and help-seeking outcomes. Results from the naturalistic, longitudinal evaluation trial (Chapter 3) show that people who were given the

opportunity to use MindMax experienced 30-day and 60-day increases in impersonal help-seeking intentions and sense of connection to MindMax, and 60-day increases in flourishing.

Our observed increases in sense of connection to MindMax were qualified by interactions with other independent variables, namely gender and base wellbeing. The 30-day increase in sense of connection to MindMax was higher in male participants with high base wellbeing than in female participants with both high and low base wellbeing, and not observed at all in male participants with low base wellbeing. In a similar trend, the 60-day increase in sense of connection to MindMax was higher in participants with high base wellbeing than in participants with low base wellbeing. These interaction effects were not robust against corrections for extreme positive skew; however, the main effects described above were present in all sensitivity analyses.

As argued in Chapter 3, while these increases could be due to other factors, they also suggest that exposure to MindMax is broadly helpful. Increases in intentions to seek help from impersonal sources were observed in all groups, including male users with low base wellbeing (Chapter 3). This suggests that MindMax's attempt to appeal to the target audience was successful. We observed a smaller increase in female participants (though between-gender differences were not statistically assessed), suggesting that while creating a universally appealing intervention (e.g. gender-synchronised interventions; Rice, Purcell, & McGorry, 2018) is difficult, it may still be beneficial to non-target users. Chapter 2 reports that our strategy of presenting content in an informal, masculine tone to make MindMax more appealing to younger men also had the effect of making it less appealing to many female participants, potentially reversing its helpfulness for them. While it may be difficult for an intervention to be truly universally appealing, especially given changes in how social groups (e.g. grouped by gender, ethnicity, or culture) define and assert themselves, the primary role of frontline, user-facing tools such as MindMax is to support individuals' health and wellbeing. It is important for such tools to pivot with the times, adapting their messaging alongside it, aiming to effect improvement and, most importantly, to cause no harm.

The usefulness of Internet-based sources, particularly for young men, has been established (Ellis et al., 2012; Ellis et al., 2013). In Chapter 3, I found that the Internet-based sources evaluated in the naturalistic trial (specifically 'MindMax' and 'someone online, who you don't know personally') fall under a larger factor named 'impersonal help-seeking', alongside the sources 'mental health professional', 'doctor/GP', and 'phone helpline'. After 30 days of exposure to MindMax, we observed an increase in intentions to seek help from impersonal help-seeking sources that persisted even at 60 days after baseline (Chapter 3). This suggests a possible pathway where individuals may be encouraged to seek help via continual engagement with Internet-based sources, eventually leading (when required) to identification by, and the required treatment from, mental health professionals.

6.3.4. Evaluating MindMax: Secondary (help-seeking) outcomes (Aim 2)

The grouping of the sources in the factor 'impersonal help-seeking' identified in Chapter 3 suggests a common way in how these sources are perceived. Chapter 4 examines the help-seeking behaviours of our sample in more depth through exploratory factor analysis and related techniques. While the primary analysis (n=313; Chapter 3) excluded many participants due to lack of compliance with the protocol (i.e. not using MindMax), for the secondary analysis this was irrelevant. Hence, Chapter 4 reports results from a much larger sample (n=530). Following the secondary analyses, the 'personal help-seeking' factor identified in Chapter 3 (renamed in Chapter 4 to 'personal sources') remained the same. However, examining fit indices of the two-factor and three-factor solutions on the full sample in Chapter 4 suggested that the 'impersonal help-seeking' factor identified in Chapter 3 should actually be split into two: 'health professionals' and 'distal sources'.

Chapter 4's findings also demonstrate complex links between gender, age, wellbeing, resilience, and help-seeking intentions. In general, participants reported higher intentions to seek help from personal sources than from health professionals or distal sources. However, female participants reported higher intentions to seek help from personal sources than male participants, and male

participants reported higher intentions to seek help from distal sources than female participants. Furthermore, for each of the help-seeking sources, mental wellbeing (as measured by the WEMWBS) influenced help-seeking intentions more than gender and age combined (Tables 4.5–4.7, Chapter 4). Relatedness also contributed more to intentions to seek help from personal and distal sources (albeit in opposite directions) than gender. This shows the importance of not only individual characteristics (levels of wellbeing), but also social connectedness.

While age, resilience, and wellbeing predicted intentions to seek help from health professionals, adjusted R^2 was extremely low (2.5%), suggesting that the impact of these variables is negligible. Conversely, adjusted R^2 was high for personal sources (25%), with wellbeing as the strongest predictor (and relatedness and being female as the other two significant predictors). Of particular interest are the predictors of distal sources. In addition to low resilience, high wellbeing, and greater life satisfaction (matching the patterns observed for the other two categories of help-seeking sources), being male and having low levels of relatedness also positively predicted intentions to seek help from distal sources. Both traits are associated with poorer mental health outcomes (Rice et al., 2018; Vella, Johnson, & Hides, 2013). While adjusted R^2 for distal sources is not large (8.5%), it still represents considerable enough influence that targeting this category of help-seeking sources may be worthwhile, especially on a population scale. Chapter 4's post-hoc finding that participants who expressed intentions to seek help from 'nobody' scored higher, on average, on their distal sources factor score further supports this, as it points to the helpfulness of this category in targeting (or being available to) individuals who are the least willing to seek help. These findings suggest that designers of Internet-based interventions and resources should tailor their content towards such individuals, as these resources will likely be the first port of call for many individuals with low help-seeking intentions.

6.3.5. Consolidating literature on gamification for mental health and wellbeing (Aim 3)

Chapter 5 reports on the results of a systematic literature review on how and why the broader academic community (i.e. within and beyond health research) applies gamification for the improvement of mental health and wellbeing. This review was conducted with reference to previous criticisms of mainstream gamification focusing too much on influencing motivation extrinsically (Robertson, 2010; Sicart, 2014), and being too focused on increasing motivation at the expense of other health behaviour drivers (Lister et al., 2014).

One key finding of Chapter 5 is that the PBL (points, badges, and leaderboards) approach often criticised by game designers and certain parts of academia is not widely implemented for mental health and wellbeing. It also found that many of the most frequently applied gamification elements (levels or progress feedback, points or scoring, rewards or prizes, narrative or theme, personalisation, and customisation) draw their roots from other behaviour change techniques or persuasive technology frameworks (e.g. personal informatics or persuasive systems design). This may be due to academic conservatism; that is, wanting to use only the elements that have been demonstrated in previous research to be effective. This is a reasonable motivation, as gamification is a new field with a sparse, context-specific evidence base. However, this also means that gamification for mental health and wellbeing cannot be easily distinguished from other existing persuasive frameworks. Additionally, previous research aiming to 'deconstruct' gamification (Zuckerman & Gal-Oz, 2014) arbitrarily separates so-termed 'feedback' features from what they term 'gamification' features (social and competitive features), when other researchers consider feedback features to be gamification as well. This is one of many examples of researchers conceptualising gamification differently (more detail is provided in Chapter 1.2.3), and points to how a lack of intentional gamification (Seaborn & Fels, 2015), and a lack of detail of describing gamification, may be counterproductive to advancing the field.

One concerning finding of Chapter 5 is that reasons for applying gamification were only coded in 59% of the articles included in the systematic review. This suggests that the lack of linkage between theory and implementation found in a broader review (Seaborn & Fels, 2015) is also present in gamification for mental health and wellbeing, and further strengthens the case for theory-driven gamification that draws from self-determination theory (Chapter 1.3.2) and sociological and game studies theories on games and play (Chapter 1.3.1). However, Chapter 5 also finds that in general, more gamification elements are being deployed in gamified apps and technologies for improving mental health and wellbeing than in previous reviews, which suggests that understanding of gamification is increasing and that researchers who are developing interventions may be more comfortable with implementing gamification in a more multifaceted way. This has the potential to lead to better outcomes (Johnson et al., 2018). Ultimately, the field appears to be maturing and gamification for mental health and wellbeing seems to be starting to strike its own identity.

6.4. Limitations

As the limitations of the individual studies that make up this thesis are discussed in their respective chapters, this section focuses on the limitations of this thesis as a whole.

First, while one of the aims of this thesis was to co-design and develop an app for mental health and wellbeing, MindMax is a wellbeing intervention aimed at 16-to-35-year-old, predominantly male, Australian AFL fans. Hence, some of the findings of this thesis may not be generalisable to other types of mental health problems (particularly serious mental illnesses). However, a recent finding that self-management apps (MindMax being an example of this) lead to better outcomes in people with serious mental illnesses (Lean et al., 2019) is encouraging. Together with research establishing that games are played by people who place on a wide range of mental health indicators (and that therefore, serious mental illness is not a barrier to acceptability of game-based interventions; Mandryk & Birk, 2017), these findings suggest that gamification and applied

games can be successfully incorporated into interventions targeting serious mental illnesses as well.

The findings of this thesis may also not be fully generalisable to older or younger populations, and those that are not Australian or male. However, one strength of this thesis is that it places more focus on men, a population that has historically been under-studied and underserved by mental health research (Ellis et al., 2014; Rice et al., 2018). Furthermore, this thesis included female participants at all stages of research and contributed further to the literature on gender differences in help-seeking (Chapter 3; Chapter 4) and acceptance of mental health and wellbeing interventions (Chapter 2). However, due to low group sizes it was not possible to include participants who were neither male nor female in the multivariate analyses described in Chapter 3 and Chapter 4. As those of diverse genders are known to experience worse mental health outcomes (Russell & Fish, 2016; Skerrett, Kõlves, & De Leo, 2015), this is a notable limitation of this thesis. Future research could use alternative analysis methods that allow for small sample sizes, such as calculating reliable change indices, to allow for full contribution of this data.

The content of MindMax was also determined before the PD workshops described in Chapter 2 were conducted. This was done for timeline management reasons despite contradicting PD principles recommending that the end user be involved at all stages of design (Hagen et al., 2012). However, this approach proved to be helpful during testing. By allowing PD to inform (co-)development alongside research and other expert contributions (Fleming et al., 2016), we were able to draw on the expertise of researchers (to determine what content would be most helpful to users) and the AFLPA (to determine how best to engage people interested in their brand) before consulting representative end users for their expertise on whether they would find this content useful and how they would prefer to experience this content.

Finally, in the systematic review reported in Chapter 5, and in this thesis generally, I choose to focus on gamification for the direct and indirect improvement of mental health and wellbeing, in order to keep the scope of this thesis manageable. Hence, the findings of this thesis relate most

directly to gamification for this purpose (although MindMax does contain examples of applied games to promote learning, as described in Chapter 2 and Chapter 6.5.1). However, gamification can also be useful for other purposes related to mental health and wellbeing, such as assessment and cognitive training. As gamification is suited towards promoting engagement and re-engagement (discussed in Chapter 6.5.1 and by Vella et al., 2018), it may be especially complementary with cognitive training, which requires sustained practice over multiple training sessions.

6.5. Implications and future directions

6.5.1. Engagement, re-engagement, nuanced engagement, and wellbeing

As reviewed in Chapter 1.2.3, there is a lack of research into whether gamification is effective in increasing engagement. As part of the broader MindMax Study, Vella et al. (2018) investigated the effect of gamification on user engagement and re-engagement with MindMax. Through interviewing organic users and examining usage analytics data of MindMax's organic userbase (numbering over 2,500 users), they found that the games component both attracted users to the app and sustained their interest in it, particularly in between app updates. MindMax's casual games, *Crappy Bird* and *Flick Footy*, also acted as a bridge between various MindMax components, with users moving between the games and the wellbeing modules. As 'footies', MindMax's in-game currency earnable only through engaging with module content and interacting with the community, were required to play the casual games, recreational gameplay of these games acted as a reward, and was effective in supporting the delivery of MindMax's wellbeing components.

Chapter 4 of this thesis finds that participants with higher resilience expressed a lower intention to seek help from health professionals and distal sources (this trend was also present, though nonsignificant, for personal sources; Table 4.5, Chapter 4). It is not surprising that individuals with an increased buffer against threats to their wellbeing would feel less willing to seek help when facing difficulties. However, what would happen to these individuals if their wellbeing levels dropped? Relatedly, Chapter 4 also finds that wellbeing levels positively predict help-

seeking intentions and that, therefore, those with low wellbeing are less likely to want to seek the help they need.

The results of the naturalistic trial (notably conducted on a sample that *did* engage with MindMax during the evaluation period; Chapter 3) show that participants who were given the opportunity to use MindMax freely experienced an improvement in wellbeing (flourishing), help-seeking intentions (for impersonal sources), and sense of connection to MindMax. Taken together, the findings of Chapter 3, Chapter 4, and the research conducted by Vella et al. (2018) suggest a possible pathway through which low-wellbeing individuals can access help. Applying gamification and similar techniques to Internet-based resources can support user engagement and re-engagement, which may in turn support regular check-ins with individuals' mental health and wellbeing, better placing them to receive help when they encounter difficulties. Furthermore, Chapter 3 reports that although we did not observe a 30-day increase in sense of connection to the MindMax community in our male participants with low base wellbeing, by 60 days we did. In addition to suggesting that more sustained intervention is needed for certain subgroups, particularly those with relatively higher levels of need, this also again supports the utility of using gamification to promote engagement and re-engagement with apps and technologies for mental health.

In Chapter 1.2.5, I review existing literature and argue that gamification can support not only engagement and re-engagement, but also more nuanced, deeper engagement with intervention content. Deeper engagement with a mental health intervention has been linked to better outcomes (Donkin et al., 2011). In MindMax, the asteroid tapping mini-game (Figure 2.4, Chapter 2) is an example of applied games being used for such purposes. To win this mini-game, MindMax users must tap a series of small asteroids representing helpful thoughts, while avoiding large, black asteroids that represent unhelpful thoughts as they would grow larger if tapped (therefore blocking the user from seeing and tapping the helpful thoughts). This mini-game was designed to

illustrate the concept of letting unhelpful thoughts pass in a way that requires active user participation, and was well-received by MindMax users (Vella et al., 2018).

As games are artefacts and activities that require active participation (or *play*) to progress, they are a natural complement to the types of activities our user testing participants, and young people more broadly, endorse: those that are actively engaging and practise useful skills (Chapter 2; Ellis et al., 2013). Playing games is also linked both theoretically and empirically to increased wellbeing (Granic et al., 2014; Ryan et al., 2006). Therefore, designing interventions to contain more of these types of activities, and applying gameful design concepts to these activities instead of solely peripherally via progress feedback, points, and rewards (the most commonly applied gamification elements in apps and technologies for improving mental health and wellbeing; Chapter 5), would make mental health and wellbeing interventions more appealing to young people and deliver intervention content in a way that may be more engaging and well-received.

6.5.2. The supportive role of gamified technology

Sicart (2014) argues that technology, particularly gamified technology, should support a person in achieving 'the good life'. Similarly, in their definition of 'gamification' as "a process of enhancing a service with affordances for gameful experiences in order to *support* [a] user's overall value creation [emphasis added]", Huotari and Hamari (2012, p. 20) emphasise the supportive role of gamification. The findings of this thesis, and of the broader MindMax Study, demonstrate the potential of gamified apps and technologies for mental health and wellbeing to act as supportive tools, and suggest three ways in which this support can be provided. Specifically, with reference to Huotari and Hamari's (2012) definition, in order to be effective, gamified technologies should be intentionally implemented to support *users* (people), *value* (evidence-based processes), and the *creation* of this value (user interaction with these evidence-based processes).

Chapter 2 and Chapter 5 show the importance of tailoring UX, which can range from relatively simple (e.g. the system consistently referring to the user with the right name and pronouns after a user inputs them) to more sophisticated tailoring based on user behaviour and preferences.

Chapter 2's findings (from UX testing interviews) suggest that users of mental health and wellbeing apps and technologies highly value a tailored UX, while Chapter 5's findings further show that whether or not these are considered gamification elements, both passive, system-driven tailoring (described in Chapter 5 as 'personalisation') and active, user-driven tailoring (described in Chapter 5 as 'customisation') are among the most commonly implemented elements in gamified apps and technologies for the improvement of mental health and wellbeing. The endorsement of both personalisation and customisation suggests that not only do users of these technologies want technology to support them, they also want to *help* the technology support them.

While personalisation and customisation are not the only ways to achieve this, when designed appropriately they have the potential to be an efficient way to promote a system's and a user's mutual goals, while respecting individual differences between users. Chapter 3 found that users who were given the opportunity to use MindMax at their leisure experienced an increase in intentions to seek help from impersonal sources (such as mental health professionals, phone helplines, and Internet forums). A possible way to facilitate this could be to offer a direct channel within MindMax linking the user to such sources of help. In an extension of these ideals, an app or technology for mental health and wellbeing, whether gamified or not, could monitor user behaviour, previously logged data, or even biomarkers, and display prompts or other information to the user to support them towards making choices that may be more beneficial to their health and wellbeing. As this is sensitive health information, however, it is imperative that appropriate informed consent has been given and that the user knows exactly how their data is being used and protected.

In addition to supporting users on an individual scale, gamification can also support the connection between users. Chapter 5 argues that gamified mental health and wellbeing interventions should avoid competitive mechanics and should instead draw inspiration from cooperative mechanics in contemporary digital games, particularly ones with a heavy focus on

cooperation such as *Journey* (Thatgamecompany, 2012). Importantly, *Journey's* social mechanics almost completely contrast those of many mainstream digital games and typical cases of social gamification. Instead of invoking social status and competition through elements such as badges, levels, leaderboards, and customisable avatars (usually with prestige markers such as special clothing items or accessories), *Journey's* multiplayer mode encourages social cooperation through the way a key game mechanic, energy recharging, is designed.

In *Journey*, an important mechanic is flying, which can only be done when sufficient energy has been accumulated. While this energy naturally builds up over time, proximity with another player increases the speed at which it recharges, decreasing the difficulty of progressing through game levels and creating a natural incentive to play with another player. However, while multiplayer mode can make it easier to solve puzzles (given a sufficiently cooperative play partner), it is not necessary, which preserves player autonomy. Furthermore, multiplayer interaction is limited to moving, jumping, and playing a musical note, and all players are represented by a hooded avatar with no other identifying markers (Figure 6.2). By removing overt markers of difference such as language and gender, this design reflects a more egalitarian philosophy of prioritising current actions over previous achievements, which may align better with the goals of mental health and wellbeing interventions.

Figure 6.2. Screenshot of *Journey*, with two players in multiplayer mode (Martin, 2012)

In addition to supporting people, gamified technologies should be implemented to intentionally support evidence-based processes. Many of the participants of the UX testing interviews reported in Chapter 2 did not actively comment on the applied games system implemented in MindMax beyond the casual video games (*Flick Footy* and *Crappy Bird*), suggesting that this system did not dominate their experience of using MindMax. Similarly, in the broader MindMax Study Vella et al. (2018) found that MindMax users did not appear to spend a disproportionate amount of time on the games and gamification components of MindMax, and that MindMax's applied games system supported user engagement and re-engagement with the wellbeing modules. These findings provide an example of how gamification, and applied games, can be used to support the delivery of an intervention's 'active ingredient'. While this active ingredient can take many forms, such as an intervention principle (Mohr et al., 2015), an app, a technology, or other process, it is important that it has an evidence base showing empirical support for the techniques or mechanisms through which the intervention aims to improve its users' mental health and wellbeing.

Relatedly, broader research has recommended that gamification be applied intentionally and in a way that is explicitly informed by theory (Seaborn & Fels, 2015). Designing gamified interventions with a focus on satisfying the innate psychological needs specified by SDT can

promote motivation that is relatively more internally regulated, and create conditions favourable for psychological wellbeing (Ryan & Deci, 2000). This can complement self-management interventions, which are a cost-effective, autonomy-promoting method of improving mental health outcomes that are helpful for people with serious mental illness (Lean et al., 2019). Co-designing interventions that promote autonomy with healthcare consumers, particularly people with lived experience of mental illness, can also contribute towards counterbalancing their frequent experiences of unidirectional, paternalistic doctor-patient relationships.

Finally, in tandem with UX design, gamified apps and technologies can support the creation of value, or the direction of user effort towards the abovementioned evidence-based processes. Evaluations of mental health and wellbeing interventions rightly criticise the low levels of usability and intuitiveness in many empirically validated interventions that can lead to high levels of user frustration (T. Chou, Bry, & Comer, 2017). However, frustration, or more specifically effort and challenge, is also important for engagement. I refer specifically to the strategic elicitation of user effort via engaging levels of challenge. While immersion and similar flow-inducing techniques have been cited as an engagement-related advantage of implementing gamification and other game-inspired elements (Baranowski, Buday, Thompson, & Baranowski, 2008), the opposite approach also has its benefits. Tyack and Wyeth (2017) argue that focusing on immersion and flow creates the opposite of what is conducive to human learning: a critical, conscious, reflective mental state. Similarly, participants in the UX interviews conducted for this thesis found activities that required more active participation (e.g. creating, and physically typing, a message to a loved one) more helpful and meaningful than activities requiring less participation and effort (Chapter 2). While one of MindMax's casual games, *Crappy Bird*, was criticised by some users as being unintuitive and difficult, some of its users, both from the UX interviews reported in Chapter 2 and from broader research, also found this high level of challenge motivating (Mitchell, Johnson, Vella, Klarkowski, & Peever, 2018, March, p. 26; Vella et al., 2018). These examples illustrate the ways gamification and applied games can contribute to creating a more multifaceted UX. While intervention designers should focus on improving usability and on making

it easy for a user to navigate the intervention, they can also consider how gamification and applied games can contribute thinking into where, and how, to make activities *harder* and more challenging. As game developers are experts in designing challenges, this seems a natural area about which to consult their expertise. A collaboration between health researchers, game studies academics, and game developers could potentially lead to a novel, engaging, and effective intervention for mental health and wellbeing.

6.5.3. Assess suitability

So far, this thesis has reviewed, evaluated, and presented findings that support how gamification can be applied for the improvement of mental health and wellbeing. In Chapter 5, I contribute a coding frame of 18 gamification elements towards future gamification research. Similarly, in the next section, Chapter 6.5.4, I synthesise the collective findings of this thesis into best practice guidelines for gamifying mental health and wellbeing interventions. However, while this thesis strongly advocates for the application of gamification to mental health and wellbeing interventions and initiatives, this application must still be justified. Before mental health researchers assess how best to apply gamification to their intervention, it is best to assess whether gamification should even be applied at all.

McCallum (2012) makes the point that while games designers can design for player experience, they cannot control it, and that each player is different and may interpret the game in ways the designer may not have intended or predicted. To illustrate this, he gives the example of children deliberately failing so they can watch an entertaining game over screen. While it is the role of the designer and testers to anticipate such unintended outcomes during the game design and development process, this may not be feasible, or appropriate, for all projects. As Chapter 1.4.1 argues, games (and systems in general) depict situations and experiences through abstraction and communicate via procedural rhetoric. Cases where such abstraction is difficult, or otherwise impractical, to perform and test would not be suitable for gamification.

In her talk at the Game Developers Conference, Robertson (2012) describes an example of a situation where applying games was ultimately deemed to be unsuitable. She describes the challenges faced by, and ultimately the failure of, her former studio, Hide&Seek, in tackling an assignment to gamify (Robertson uses the term to mean 'turn into a game') the death of a woman named Joyce Carol Vincent, whose skeleton was discovered in her apartment three years after her death. While the intention was to create an emotional, interactive experience of Vincent's story and the circumstances surrounding her social isolation and death, Robertson and her team faced challenges in depicting the topic respectfully and sensitively (for example, avoiding potentially triggering self-harm impulses), as well as in abstracting the intersecting social forces, such as domestic violence and racism, that contributed to this grisly conclusion. Ultimately, as the story had a definite, tragic, end that could not be translated into a 'win state', they deemed it impossible to depict this story and the complex intertwining factors in a way that would result in what they considered a good quality game. Robertson stresses that while they could make the experience *interactive*, due to its incompatibility with the common themes that characterise games (reviewed in Chapter 1.3.1) they could not make it a game. Intervention designers facing situations like this should be aware of the problems with applying games to these cases and should consider alternate behaviour change strategies and techniques.

6.5.4. Guidelines for implementing gamification for mental health and wellbeing (Aim 4)

This thesis, and the broader MindMax Study, report on the co-design, development, and evaluation process of MindMax. While writeups describing the development and evaluation of other gamified apps and technologies for mental health and wellbeing exist, they rarely report the whole process in such high levels of detail. The work reported in this thesis and the broader MindMax Study therefore have broad implications for gamifying mental health and wellbeing. While I discuss these implications in the previous sections of this chapter, in this section I also

summarise them into five broad guidelines suggesting best practice for designing a gamified mental health and wellbeing intervention (Box 6.1) and expand on the guidelines below.

Box 6.1. Guidelines for implementing gamification for mental health and wellbeing

1. Assess the suitability of implementing gamification and make sure it complements the intervention's aims and processes[a]
2. Implement gamification intentionally at a deeper, systemic level to support users, evidence-based processes, and user engagement with these processes[b]
3. Assess the acceptability of the gamified intervention throughout the design and development process, involving all stakeholders (including but not limited to representative end users, researchers, health professionals, software developers, and game designers)[c]
4. Evaluate the impact of the gamified intervention[d]
5. Provide comprehensive and detailed documentation of the (co-)design, development, and evaluation process, using terminology correctly and consistently[e]

[a]Chapter 6.5.3
[b]Chapter 1.2.2, Chapter 6.5.1
[c]Chapter 1.4.1, Chapter 1.4.2, Chapter 6.5.2
[d]Chapter 1.2.3, Chapter 2, Chapter 6.3.1
[e]Chapter 1.2.3, Chapter 5, Chapter 6.3.5

First, it is important that designers assess the suitability of implementing gamification to the mental health and wellbeing intervention (Chapter 6.5.3). This assessment should concretely operationalise the intended aims of the intervention and consider how gamification can be implemented to support these aims. Furthermore, the purpose(s) of gamification—for example, to promote re-engagement, or to support a deeper level of engagement (both discussed in Chapter 6.5.1)—should be determined.

Second, gamification should ideally be implemented at a deeper, systemic level of the intervention. As gamification shares many similarities with other behaviour change techniques (Chapter 1.2.3), and is frequently mischaracterised (Chapter 1.2.4), this intentional, 'pre-registered' implementation can contribute to more consistency in the study of gamification (Seaborn & Fels, 2015). Gamification should interact with the other components of the intervention to create a

coherent system (Deterding, 2015). Furthermore, gamification should play a supportive role in the intervention (Chapter 6.5.2). Specifically, it should support intervention users' individual differences and preferences via passive and active tailoring, and support (optional) social connection between users via social mechanics. Cooperative social mechanics may align more with the goals of mental health and wellbeing interventions than competitive social mechanics (Chapter 5). The gamified intervention should also be deliberately designed to support the evidence-based theories (e.g. SDT, examples provided in Chapter 1.3.2) and techniques (e.g. the Michie, van Stralen, and West, 2011, behaviour change wheel, examples provided in Chapter 5) that should drive intervention content. Finally, in tandem with UX design, gamification should support user interaction with such content by directing user effort away from noncrucial intervention components (e.g. registering an account). Instead, user effort should be directed towards the evidence-based components, through activities that require active user participation and that provide engaging, interesting levels of challenge. Such activities are endorsed by young people, particularly young men (Chapter 2; Ellis et al., 2013) and naturally complement the ideals of gameful design.

Third, it is important to assess the acceptability of the gamified intervention at multiple stages throughout the design and development process. Early testing of key intervention concepts prevents wasted resources on unsuitable concepts and improves the acceptability of an intervention with its target audience (Chapter 1.4.2). Ideally, PD and related co-design methodologies, that allow all stakeholders to contribute their unique expertise to the design process, should be used. For a gamified mental health and wellbeing intervention, stakeholders would include, but not be limited to: representative intervention users (e.g. with lived experience of mental illness), health professionals, researchers, software developers, game designers, and game players. While it may be useful to provide opportunities for different stakeholder groups to co-design the intervention with each other (e.g. a PD workshop), it is also important to be mindful of the possibility of implicit power dynamics influencing the final outcome (Chapter 6.3.2). It is also important to confirm the acceptability of what the intervention and its gamification system

may be communicating (Chapter 1.4.1), to prevent intervention content and functionality from being misinterpreted and misused (Chapter 6.5.3).

Fourth, the impact of the gamified intervention should be evaluated. Ideally, the intervention should be evaluated across multiple stages of implementation so that early findings can be applied towards improving the intervention (Chapter 2). To accommodate the fast pace of technological change and the complex nature of UX, a wider variety of faster and more flexible methods, such as qualitative data collection and analysis (Chapter 2; Chapter 5), naturalistic evaluation trial designs (Chapter 3), and analysing usage analytics (Vella et al., 2018) should be employed. A mix of methods and data sources also suits different research questions and enables triangulation of findings with increased convergent validity. As there is little research on the long-term effects of gamification (Chapter 1.2.3), this should also be evaluated, if possible.

Finally, the design (ideally co-design), development, and evaluation process should be documented comprehensively. The purpose and functionality of both the intervention and how gamification supports this should be described in detail. Chapter 5 contributes a taxonomy of 18 gamification elements for this purpose (in Chapter 5.7). While gamification should be conceptualised as a system and should not be reduced to its individual elements (Chapter 1.2.4), listing individual gamification elements and using terminology consistently increases clarity and gives researchers (and intervention designers) a more complete, accurate picture of the gamified intervention described. This is particularly relevant for researchers and designers unfamiliar with the study of games and gamification and who are encountering gamification literature for the first time. As games and play are a fundamental cultural force in society (Chapter 1.2.2; Chapter 1.3.1), these researchers and designers would likely have a lay familiarity with games in personal and informal contexts, with the resulting differences in conceptualisation and terminology. In this situation, clear, cohesive literature would go far in increasing the uniformity of different conceptualisations of gamification and in reducing divergent usages of basic, important terms such as ‘serious game’.

6.5.5. Future directions for research

The guidelines above recommend best practice for implementing gamification for mental health and wellbeing. As stated above, a higher level of collaboration with industry, ideally incorporating co-design methodologies, is needed to develop these gamified interventions. However, while the development and potentially even some aspects of the design of these interventions will be outsourced to software developers and other stakeholders, there are contributions that researchers are uniquely positioned to make.

First, it is imperative that the developed interventions be evaluated, not just to determine the effectiveness of interventions and intervention principles, but also to evaluate the suggested best practice guidelines themselves and whether they are useful and complement standard practices of both research and the tech industry. More evaluation will also point to which aspects or types of gamification may be more compatible with certain types of interventions (for example, a certain type of gamification may be particularly compatible with a specific mental health domain or behavioural change mechanism). Furthermore, while gamification (and applied games in general) has been deployed to support care on an individual (usually self-directed) level, it may be productive to determine whether it could do so on a systemic and service-directed level as well.

More research is also needed to determine the best way to study gamification. While conceptualising the study of individual gamification elements (through a taxonomical approach) may be more straightforward, games are a system (Deterding, 2015). Subscribing too closely to the taxonomical approach may therefore have a danger of implying that each individual element has an additive impact, and may not be able to capture the synergistic value of the whole game system. The best way forward in this regard may be to apply mixed methods and document both the individual gamification elements (or features) contained in the intervention, as well as the broader effect or impact of the intervention (potentially through thematically analysing interviews and focus groups, or even using grounded theory approaches). Naturalistic trial

designs are also suitable as they accommodate contemporary software development schedules without necessarily sacrificing research rigour.

The findings of this thesis also suggest that distal sources such as Internet-based apps and technologies (potentially including digital games) are the most preferred port of call for those who are least likely to seek help for their mental health and wellbeing. It may therefore be impactful from a research and healthcare point of view to form partnerships with digital game developers and create campaigns around, and *within*, digital games that normalise help-seeking for mental health problems. There is also promising potential in analysing gameplay data to determine whether it can be linked to mental health outcomes. While this approach would raise large data privacy implications (and would therefore require full informed consent from participants), when performed appropriately (with regards to data cleaning, analysis and interpretation) it could produce findings with considerably increased validity, as data gathered from a person naturalistically playing a game is much more ecologically valid than data gathered from an artificial laboratory task or questionnaire.

Finally, the effect of individual differences (gender, age, etc.) is unclear and has the potential to generate many research questions. For example, is gamification more effective for younger people than it is for older people, and what types of gamification would suit which groups? While young people express a preference for actively engaging tasks (as discussed in Chapter 6.5.2), would this also extend to older people? Furthermore, while challenge is important for engagement (also discussed in Chapter 6.5.2), what would the appropriate level of challenge be, and how does this vary across groups? While narrative and procedural designs have the potential to support learning (as discussed in Chapter 1.4.1), does personality moderate the impact of these features on learning? While games have been a fundamental cultural force since the beginning of history (Caillois, 1958/2001), how universal is their appeal in the context of mental health and wellbeing interventions? The field of gamification research is young, and the field of gamification of mental health and wellbeing is even younger. As gamified mental health technologies represent

the intersection of mental health research, human-computer interaction, and game studies, interdisciplinary collaboration, with human-computer interaction and game studies researchers, will be important in answering these questions.

6.6. Conclusion

This thesis reports on the co-design and systematic evaluation of a gamified app for mental health and wellbeing. Its findings demonstrate the importance of co-design, across the development cycle, in creating mental health and wellbeing interventions that are broadly acceptable to the target end-user population. They also point at the importance of Internet-based resources for mental health and wellbeing, particularly to those who are least likely to seek help. As such, promoting engagement and re-engagement with these resources would increase their ability to reach those who need them the most. Gamification represents one way of achieving this.

Encouragingly, this thesis's findings also suggest that gamification is increasingly being applied in apps and technologies for improving mental health and wellbeing in a deeper and more comprehensive manner than previously observed. However, current applications share similarities with other behavioural change frameworks, such as persuasive systems design. In order for gamification to represent the cultural artefact it draws its principles from, it is important that future implementations harness more fundamental, but under-utilised, types of play and game mechanics, such as randomness, role-playing, and social cooperation. Games scholars have described games as "unproductive" (Caillois, 1958/2001, p. 10) and yet "effort[ful]" (Juul, 2005, p 36; Klabbers, 2006, p. 33). While much discourse has focused on the high levels of engagement games (and digital games) enjoy despite their unproductivity, perhaps the discourse can be swung to focus, instead, on how to direct the effort games inspire from their players to align with the aims of mental health and wellbeing research.

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