



The development of a smartphone app to enhance post-traumatic stress disorder treatment in high-risk workers

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Abstract

Objective: Post-traumatic stress disorder (PTSD) is highly prevalent in certain populations. However, evidence indicates that many individuals do not respond to treatment. Digital supports hold promise for increasing service provision and engagement but there is a lack of evidence on blended care options and still less research guiding the development of such tools. This study details the development and overarching framework used to build a smartphone app to support PTSD treatment.

Methods: The app was developed in line with the Integrate, Design, Assess, and Share (IDEAS) framework for the development of digital health interventions and involved clinicians (n=3), frontline worker clients (n=5) and trauma-exposed frontline workers (n=19). Integrated iterative rounds of testing were conducted via in-depth interviews, surveys, prototype testing and workshops, alongside app and content development.

Results: Clinicians and frontline workers both expressed a clear preference for the app to augment but not replace face-to-face therapy, with the aim of increasing between-session support, and facilitating homework completion. Content was adapted for app delivery from manualised therapy (trauma-focused cognitive behavioural therapy (CBT)). Prototype versions of the app were well received, with both clinicians and clients reporting the app was easy to use, understandable, appropriate and highly recommendable. System Usability Scale (SUS) scores were on average in the excellent range (82/100).

Conclusions: This is one of the first studies to document the development of a blended care app designed specifically to augment clinical care for PTSD, and the first within a frontline worker population. Through a systematic framework with active end user consultation, a highly usable app was built to undergo subsequent evaluation.

Keywords

mHealth, eHealth, PTSD, smartphone app, digital intervention, blended care

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Introduction

Post-traumatic stress disorder (PTSD) is common, with an estimated cross-national lifetime prevalence of 3.9%,¹ while rates in many high-income countries far exceed this.^{2,3} Many others experience significant symptoms but do not meet the diagnostic criteria, termed partial, subclinical or subthreshold PTSD.⁴ Individuals in high-risk occupations including frontline workers and emergency service personnel show significantly higher rates of PTSD.^{5,6} In addition, PTSD is associated with high rates of suicidality and

comorbidity and substantial disease burden for individuals, families and communities.^{7–10}

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There is convergent evidence that effective treatments for PTSD exist, with most international guidelines recommending trauma-focused psychotherapies as the frontline treatment for PTSD.^{11–14} Despite the agreement about the relative superiority of trauma-focused psychotherapy, relatively few individuals receive this treatment¹⁵ and between half and one-third of PTSD patients do not optimally respond, continuing to display persistent PTSD symptoms.^{16–18} Although many attempts have been made to increase treatment response in PTSD, these have tended to focus on augmentation of extinction and inhibitory learning via brain stimulation devices and novel psychopharmacological treatments, and they have to date yielded only modest gains.¹⁹ Another approach that has been used with success is the provision of mnemonic strategies to augment the gains made in psychotherapy, which compensates for patients not remembering and also not rehearsing strategies learnt in therapy sessions.²⁰ The utility of addressing treatment non-response with this approach is underscored by studies that have shown that this strategy can improve clinical outcomes in people with treatment-resistant depression.^{21,22}

Smartphone applications (apps) can improve accessibility and delivery of effective interventions for a range of mental health conditions including PTSD.^{23–25} As a result there are a growing number of PTSD-related smartphone apps available, however, the majority of these tools are stand-alone, self-help apps that have not been subject to any evaluation or regulation.²⁶ In a literature review of mobile health apps for PTSD, Rodriguez Paras et al.²⁵ found 45 publicly available PTSD-specific apps and stated that there was minimal effort and transparency made regarding the development, usability and validation of this plethora of apps. In addition, few apps were designed to be integrated with clinical PTSD treatment. Similarly, a recent app store review found 69 apps focused on this area but concluded that at present these are failing to fulfil their potential, PTSD-affected individuals and health care providers have great difficulties identifying high-quality apps, and most apps lack any scientific evidence of their effectiveness.²⁶

Early reviews of effectiveness trials of eHealth interventions for PTSD indicate these digital programmes hold promise, with significant improvements in PTSD symptoms independent of the comparison condition, the type of cognitive behavioural therapy-based intervention or the level of guidance provided.²⁷ However, there is good evidence that those PTSD interventions that are not trauma-focused may only have short-term benefits.¹² Research also consistently demonstrates that very few people sustain the use of such self-guided interventions^{28–32} and the high-risk nature of PTSD, especially trauma-focused treatment, makes interventions without therapist guidance subject to safety concerns. Furthermore, Wickersham et al.³³ cast doubt on the ability of self-managed interventions delivered

via smartphone apps to have the same effect as those found in earlier reviews (predominantly online delivery). This was further supported by Goreis et al.,³⁴ who concluded that professional human support is needed for a significant impact on symptomatology³⁵ but that smartphone apps have the potential to enrich traditional therapy protocols.

Currently, there is a lack of research on treatments that bring together the advantages of both approaches in the field of PTSD treatment by combining traditional face-to-face therapy and app-based interventions.³⁴ There is even less literature available to systematically guide the development of these tools. Where these programmes exist there is a consistent failure to actively engage clinicians in development and implementation,³⁶ and as such, real-world uptake is often low.³⁷ Similarly, there has also been an absence of end users included in the development of app-based interventions, despite the fact that a user-centred design process is critical for engagement.³⁸ Although app-based support may not be appropriate for all users, surveys have shown high-risk workers (e.g. emergency service workers, a group in consistent need of PTSD treatment) may be willing to use mental health apps,³⁹ but little is known about the specific needs and preferences of high-risk workers and clinical service users undergoing PTSD treatment. There is therefore a need to work with relevant stakeholders including frontline workers, clinicians/healthcare professionals and technical experts in digital mental health, to inform the development of app-based interventions suitable for these groups.^{40,41}

This study aims to systematically detail the development process used to build a smartphone app that supports face-to-face clinical treatment for PTSD, incorporating novel perspectives on user and clinician preferences for app-supported treatment for frontline workers routinely exposed to traumatic incidents. The app is ultimately intended to improve treatment outcomes by facilitating increased engagement in therapy.

Methods

Overview

Development of effective digital interventions is an iterative process requiring many stages and a multidisciplinary team. The current intervention (referred to from this point onwards as *Support Base*) was designed using the Integrate, Design, Assess, and Share (IDEAS) framework.⁴² This framework was established to guide the development of digital health interventions, employing behavioural theory, design thinking, user-centred design, rigorous evaluation and dissemination throughout. This framework was selected as appropriate over competing models due to its digital focus and integration of theory, design, evaluation and extension of digital interventions beyond facilitating care to incorporate behavioural

modification (in this case engagement in behavioural exercises). The 10 phases of IDEAS are as follows: (1) empathise with target users; (2) specify target behaviour; (3) ground in behavioural theory; (4) ideate implementation strategies; (5) prototype potential products; (6) gather user feedback; (7) build a minimum viable product (MVP); (8) pilot test to assess potential efficacy and usability; (9) evaluate efficacy in an RCT; (10) share intervention and findings. This article reports on the initial seven phases (Figure 1), prior to the more formalised testing and dissemination phases. As the framework was specifically developed with a focus on behaviour change interventions (and the treatment of PTSD requires more than just behaviour change), phase 3 was augmented to encompass not only behavioural theory, but all relevant theories. Figure 1 also shows the specific steps taken at each phase.

It should be noted that the present study was informed by a series of co-design workshops with first responder agencies. These workshops informed the decision to augment in-person therapy in this way. These workshops were not, however, part of the research study described here. This study received ethical approval from the University of New South Wales (UNSW) Human Research Ethics Committee (HC210011). Study activities took place from March to August 2021. Participants received an information statement and consent form detailing the procedures at each phase of the research. They were required to return a signed consent form to the researchers via hard copy or email before participating in the interviews or workshops and via electronic submission for online surveys.

Empathise with users

This study was part of a larger programme of research focused on high-risk workforces (specifically emergency service workers, corrections officers and community

welfare workers) who were regularly exposed to trauma as part of their working life. Consequently, these occupational groups were our demographic of interest throughout. As the aim of *Support Base* was to enhance clinical treatment for PTSD, clients experiencing PTSD and clinicians with experience treating this client group were the two key stakeholders in this research. We sought to derive initial interview and survey data from both these groups.

Due to the sensitive nature of the topic and the potential for individuals to know one another personally via their employer, individual interviews were preferred over the use of focus groups in the initial development phases for both clinicians and frontline workers. These interviews were supplemented by a brief questionnaire.

Participants. Participants were recruited within Australia. Clinicians were recruited via the UNSW Traumatic Stress Clinic (TSC), a service specialising in PTSD treatment with a focus on emergency services and other frontline workers. Eligible clinicians were provided an expression of interest form via email. Potential participants then indicated their interest in participating by contacting the research team directly via email/phone. Eligibility criteria were as follows: (1) Aged 18 years or older, (2) currently working as a clinician providing mental health interventions, including experience delivering treatment for PTSD and (3) currently residing in Australia.

To recruit the frontline worker cohort for this study, an expression of interest was circulated to eligible current and previous TSC clients. Potential participants indicated their interest in participating by contacting the research team directly via email/phone, or by asking that their treating clinician provide their contact details to the research team on their behalf. Potential participants were then screened over the phone. Eligibility criteria were as

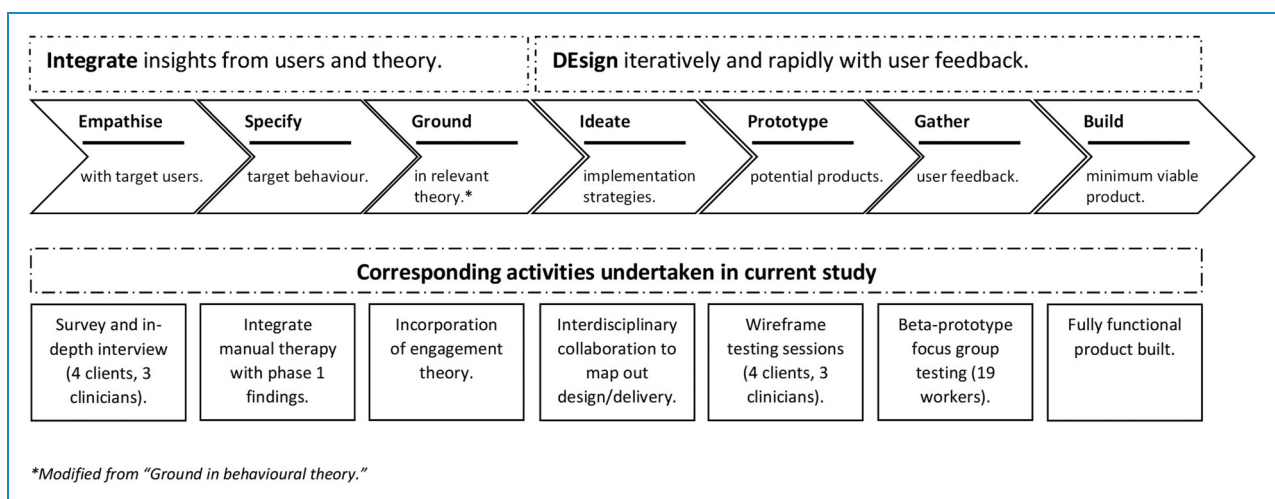


Figure 1. The Integrate, Design, Assess, and Share (IDEAS) framework⁴²; assess and share stages are omitted.

follows: (1) Aged 18 years or older, (2) currently or previously working in a frontline industry (e.g. fire and rescue, police, ambulance, corrective services, community services) and (3) currently being treated or previously treated for PTSD/trauma-related mental health condition by a health professional (e.g. psychologist, psychiatrist).

Procedure. Once participants were screened as eligible, they were provided with the consent form and participant information sheet, a link to the online survey (delivered via Qualtrics) and a scheduled time for the interview. They were asked to complete the survey prior to the interview. Interviews (1 hour) were conducted online via Zoom, with the exception of one clinician interview which was conducted in person for participant convenience. Frontline workers ($n = 4$) who participated in interviews were reimbursed for their participation by means of a \$50 gift voucher. Clinicians ($n = 3$) undertook the study within paid work time, therefore received no reimbursement. The clinician interviews were conducted by two researchers (MD and DC). Frontline worker interviews were led by a digital service designer, with assistance from a user experience designer and a researcher (DC). All interviews were recorded.

Interview and survey questions. The content for the interviews is presented in Table 1. The supplementary frontline worker survey included questions pertaining to demographic factors (age, gender, occupation and work status), help-seeking behaviour, smartphone use, app preferences and treatment homework completion. The supplementary clinician survey included questions pertaining to

demographic factors (age, gender, occupation and work status), work-related factors (years of experience, employer and predominant presentations seen), blended care/digital mental healthcare (previous use, beliefs, perceived helpfulness of blended and stand-alone interventions and likelihood of use with clients), app preferences and critical aspects of treatment to integrate. Where relevant, survey items were measured using a 5-point Likert scale from ‘not at all useful’ to ‘extremely useful’, ‘extremely unlikely’ to ‘extremely likely’ or ‘not at all important’ to ‘extremely important’.

Specify target behaviour

The behavioural goals the app sought to enhance or generate were driven primarily by the evidence-based manualised treatment delivered at the TSC.⁴³ The 12-session manual of trauma-focused cognitive behavioural therapy (CBT) included psychoeducation, imaginal and in vivo exposure, cognitive restructuring and relapse prevention. The core manual was supplemented with an additional skills manual (including content on anger, depression, sleep, panic, distressing emotions, negative thoughts, guilt and shame, problem drinking and substance use and pain management) which was used where appropriate and where time permitted.

The manualised therapy content was then combined with the insights gathered from users in the initial phase to define both the critical purpose of the app in relation to the treatment and the outcomes on which it could be assessed. By distilling the needs of the differing stakeholders, we sought to determine where the app would hold greatest

Table 1. Breakdown of interview sessions.

Frontline workers		Clinicians	
Background	<ul style="list-style-type: none"> • Daily life • Mental health maintaining behaviour • Familiarity with/use of tech 	Current experience	<ul style="list-style-type: none"> • Completion and dropout • Barriers • Potential for smartphone app support
Mental health app	<ul style="list-style-type: none"> • Goals/motivations for use • Pain points/barriers • Desired features/content • Potential for use in therapy 	Homework	<ul style="list-style-type: none"> • Aspects of completion • Barriers • Opportunities
Homework	<ul style="list-style-type: none"> • Current experience • Motivations • Pain points • Needs, opportunities 	Clinical content	<ul style="list-style-type: none"> • Delivery of current manualised therapy • Critical learnings from each session
Open discussion		Features	<ul style="list-style-type: none"> • Video content • Grounding techniques • Critical elements • Open and locked content • Sharing of content (with therapist)

benefit and focus on the scope of idea generation that was to come.

Ground in relevant theory

In order to ground the content of the app in appropriate theory and enhance delivery of the clinical content, a diverse team was assembled. This included mental health experts, user experience experts, digital learning design and delivery specialists and IT developers. The intention within this phase was to incorporate behavioural strategies to improve app usage and programme adherence.

As trauma-focused CBT entails active engagement with the avoided stimuli to achieve habituation and desensitisation, in turn leading to reduced anxiety, motivation for change is largely driven by outcome motivators (those that focus on the eventual outcomes of behaviour change, in this case reduced avoidance/reexperiencing, improving functioning, etc.). By contrast, process motivators (which make the process of behaviour change itself more engaging and intrinsically rewarding) tend to be more effective in initiating and sustaining behaviour changes.⁴⁴ As outcome motivators rely on delayed reinforcement and are difficult to achieve and maintain, we sought to instil, where possible, process motivators to enhance app engagement.

Ideate implementation strategies

A team of mental health experts (academics, research officers, psychologists and psychiatrists) worked with the manualised treatment content and the data collected in the initial study phases to translate the original content into app-appropriate screens in an accessible, simplified format. This took place over a series of sessions within the research team and with external experts. Five overlapping stages were used (Appendix 1 in Supplementary Material). These were as follows: (1) Iterative brainstorming of features and journey mapping; (2) Drafting of prioritised content and flow; (3) Engaging with Digital Learning experts for content delivery; (4) Collaborating with user experience experts and designers; (5) Consulting with IT developers.

Prototype potential products

Based on output from the initial phases, app user journeys were mapped out, through digital wireframes. This allowed for the construction of a functional prototype for testing (Appendix 1 in Supplementary Material). Participants then provided feedback on features and suggested improvements.

Participants. Wireframe prototype testing sessions were conducted with the same clinicians ($n = 3$; 1 hour each) and several frontline workers ($n = 4$; 1.5 hours each), three of whom had been previously interviewed.

Procedure. All sessions were conducted online via Zoom. This format was chosen for several reasons: due to COVID-19 restrictions, for participant convenience and to facilitate sharing of on-screen wireframes and recording of sessions. Participants were guided through a range of core app features in the prototype and asked for their general feedback as well as clarification on expected behaviour/interaction with the app (Appendix 2 in Supplementary Material). A ‘think-aloud’ method was employed in which participants were asked to vocalise their thinking process as they directed the researcher to work through a series of tasks within the prototype.^{45,46} For clinicians, this was based on expected client behaviours and clinical requirements, while for workers this was based on personal preferences and consideration of their prior experiences of treatment. They were prompted with relevant questions as they progressed, while being encouraged to comment and provide verbal feedback. Frontline workers who participated in these sessions were reimbursed for their participation by means of a \$75 gift voucher. Again, clinicians undertook the study within paid work time and received no reimbursement. The testing sessions were led by a user experience designer, with assistance from a second designer and a researcher (DC). All sessions were recorded.

Gather user feedback

Following wireframe prototype testing, feedback was incorporated into the development of a more complete beta prototype. This prototype was tested with frontline workers within focus group workshops to explore interest, potential barriers to use, appropriateness of content and language and areas for improvement.

Participants. Participants were recruited from a state-wide department in Australia comprising corrective and welfare service workers, with high rates of occupational trauma exposure. All frontline workers were eligible to participate, regardless of PTSD diagnosis or treatment experience, in order to enrich the data collected regarding the non-clinical aspects of the app (e.g. language, engagement and acceptability), to more accurately simulate treatment-naïve patients who had not previously encountered therapy concepts, and to avoid potential confidentiality issues arising from the workshop format. The partner organisation promoted workshop sessions by posting recruitment flyers/advertisements in the workplace and/or online (e.g. via social media channels, email newsletters).

Procedure. Five 1-hour workshops to provide feedback on the beta prototype were conducted ($n = 19$). Workshops ranged in size from three to five participants. All workshops were held online via Microsoft Teams and were led by a user experience designer, with assistance from a researcher

(DC). At the request of the partner organisation, workshops were not recorded. Participants viewed demonstrations of the app prototype and were asked a series of open-ended questions to stimulate group discussion about app features and content, usability and suitability for frontline workers (Appendix 2 in Supplementary Material). At the end of each workshop, participants were asked to respond individually to an anonymous online survey delivered via Qualtrics and to quantitatively assess their impressions of the app.

Workshop and survey questions. The prototype app features and content/functions presented to workshop participants for discussion are shown in Table 2. The online survey included three questions assessing: (1) understanding of app content; (2) suitability of language for frontline workers; and (3) likelihood of recommending the app to others. Items were measured using a 5-point Likert scale from ‘strongly disagree’ to ‘strongly agree’. The survey also included an adapted version of the System Usability Scale (SUS).⁴⁷ The SUS consists of 10 usability questions measured on a 5-point Likert scale from ‘strongly disagree’ to ‘strongly agree’. Each item is scored from 0 to 4. The total score ranges from 0 to 40; for ease of interpretation, this is then converted to a score out of 100 by multiplying by 2.5.⁴⁸ For the purpose of this study two questions were

removed (‘I found the system very cumbersome to use’ and ‘I felt very confident using the system’) as these questions depend on direct user interaction with the app, which did not occur within the workshop prototype demonstrations. The remaining eight items resulted in a total score ranging from 0 to 32; this was converted to a score out of 100 using a factor of 3.125.

Build a MVP

Based on the prototype testing, app wireframes were further refined and all app components were developed using an agile software development model.⁴⁹ The build of the app took place via the creation of ‘user stories’ within Jira software.⁵⁰ Daily meetings were held to provide updates on app development progress, while fortnightly refinement sessions were used to organise user stories for each upcoming ‘sprint’ (a 2-week time block during which all development and review efforts were focused on a predefined set of tasks). Fortnightly testing of the latest app build occurred within TestFlight mode (a testing environment for smartphone apps) at the end of each sprint. Comprehensive end-to-end testing occurred upon build completion to ensure optimal functioning, check for bugs, confirm system compatibility, etc. This phase culminated in the MVP.

Table 2. Workshop discussion topics.

App feature	Included content/functions
Onboarding	<ul style="list-style-type: none"> • App login • Create app PIN • Welcome screens • Set goals
Home screen and main app sections	<ul style="list-style-type: none"> • Sessions • Skills • Profile • Get help
Create app session	<ul style="list-style-type: none"> • Set session timeframe • Select session activities • Create activity reminders
Interactive skills activity (<i>Thought challenging</i>)	<ul style="list-style-type: none"> • Activity overview • Text entry responses • Emotion ratings (slider response) • Identify thinking patterns (multiple choice selection) • Review and reflect on activity • Activity summary page
Grounding skills activity (<i>Attention trainer</i>)	<ul style="list-style-type: none"> • Activity overview • Attention trainer animation
Complete app session	<ul style="list-style-type: none"> • Session activity list • Send session summary to therapist

Analysis

This study used a mixed methods approach to data collection and analysis, combining surveys, interviews and workshop data. For the qualitative portions of the study (interviews, workshops and open-ended survey responses) discussion themes and topics were determined *a priori* based on the aims of the study and targeted stage of the IDEAS framework. These themes/topic areas were guided by the facilitator/interviewer and, in the case of the interviews, followed the sections of the guided interview script. Transcripts/recordings were reviewed by two members of the research team independently in order to identify, label and group together key points. Each researcher independently sorted responses by theme/topic area, consistent with the guided interview script. Discrepancies were discussed and resolved by consensus. These techniques were drawn from previous research used to develop digital interventions.⁵¹

Results

Empathise with target users

Clinician surveys. All clinicians (n = 3) were clinical psychologists (3–15 years of clinical experience) identifying as female, with current or previous experience in delivering PTSD treatment at the TSC. The most common presentations seen in their current clients were anxiety, PTSD and depression. Two clinicians had previous experience with online mental health interventions, but this was limited. Both stated they would be ‘somewhat likely’ to incorporate an app as a treatment support tool, while the other clinician was ‘neither likely nor unlikely’. All clinicians viewed online interventions as more helpful when delivered with clinician support or alongside treatment compared to stand-alone programmes without clinician support.

The clinicians identified the following features of an app designed to support treatment as either ‘very’ or ‘extremely’ useful: skills practice to consolidate session content, distress management techniques, homework exercises, delivery of progress reports to clinician and facilitation of information transfer between clinician and client. Delivery of progress reports to the client was seen as having variable utility, ranging from ‘slightly’ to ‘extremely’ useful. The clinicians viewed app-based delivery of existing session content as less (‘slightly’ to ‘very’) useful.

Clinician interviews. Several key findings emerged from the clinician interviews. Although frontline workers tend to be highly engaged in treatment and have high completion rates, this can be impacted by barriers to completing treatment, in particular: (1) Inflexibility of manualised treatment programmes; (2) Lack of motivation or unwillingness to engage in treatment; (3) Life circumstances such as lack of

time and family responsibilities; and (4) Avoidance, especially in the context of dealing with memories of traumatic events.

Table 3 outlines the main areas clinicians believed the app would be most useful. Although they did not feel an app would be useful within sessions themselves, there was a consistent belief that an app would be a powerful tool for clients between sessions, in a variety of ways: ‘It could really help in terms of consistency and accountability, with sending people reminders to complete tasks or reflect on what happened in the previous session between appointments. I think that could help maintain motivation to stay engaged’ (P1); ‘For monitoring, tracking, and sharing of information, very helpful’ (P2); ‘There’s very little contact between the clinician and the client between sessions so this would be a way to bridge that gap ... a lot of the change occurs between sessions, but they’re not necessarily getting that input outside of the formal session time’ (P3). They also discussed the advantages of this means of ‘homework’ completion over the existing paper-based workbook: ‘It’s portable, it’s unobtrusive, you can get reminders, the game-like features can make it a bit more fun, a bit more light-hearted, it’s not as text-heavy’ (P1); ‘I really think it’s just about how much easier it would be and more discreet to be able to do all of this on an app rather than this big book’ (P3). Finally, they highlighted important elements to include in the app itself (Table 3).

Frontline worker/client surveys. The frontline worker survey participants (n = 4) were on average 50 years of age (range: 42–56) and all lived in New South Wales, Australia. Participants had between 6 and 40 years of experience in an emergency service or frontline role. Two identified as male and two identified as female. Two were employed full time, one was on extended work leave for health reasons and one was currently unemployed. Three participants were currently being treated for PTSD, while one had received PTSD treatment previously. All except one had also received treatment for depression or anxiety, either currently or previously. All stated that they used a mobile phone for several hours a day and used apps on a regular basis, either for work or personal reasons.

All participants owned a smartphone and used it at least a few times a day. Two participants had previously used a wellbeing app and continued to do so at least once a month. Notably, those who had previously used these apps reported they were only somewhat likely to try a wellbeing app developed for frontline workers, while those who had no experience with wellbeing apps were extremely likely to use one (provided it was easy to use and private). While most (n = 3) believed it would be extremely important for such an app to be entirely separate from their employer, two participants also felt employer involvement would be useful for the promotion of the app only.

Table 3. Frontline worker and clinician reflections on a smartphone adjunct to therapy.

	Frontline workers	Clinicians
Potential utility of an app within treatment	<ul style="list-style-type: none"> • Receive immediate support when struggling • Complement therapy sessions • Reinforce usefulness of content and encourage user progress • For reference and staying on track after treatment • Targeted specifically to emergency service/frontline workers • Should not be too time-consuming or include excessive information • Provide a sense of understanding and reassurance 	<ul style="list-style-type: none"> • Consistency and accountability, for example, prompt reflection and task completion • Easily share information with therapist • Ability to consolidate learning and rationale behind treatment (e.g. via educational videos) • Potential to incorporate mood monitoring • Simple checklist of homework tasks to complete between sessions • Provide additional motivation and encouragement throughout treatment
Advantages of an app over existing workbook	<ul style="list-style-type: none"> • Ease of typing (or using voice-to-text function) instead of hand-writing • Portability and discretion when completing tasks • Usefulness of automated reminders • Potential to show user progress and improve motivation • Ease of tracking responses over time and keeping completed tasks in one place • Ability to easily share information with therapist and/or partner • Increased accessibility and convenience • Streamlined presentation of information • Reduced paper consumption 	<ul style="list-style-type: none"> • Less text-heavy compared to a workbook • Discreet and unobtrusive • Can utilise automated prompts/reminders (increase habit forming) • Potential for gamification and lighter tone than a workbook • Streamlined 'one-stop shop' to record information, summarise session content, monitor progress and complete activities • Form a 'bridge' for therapist and client between formal session times • Portable and convenient to use
Preferred app features and activities	<ul style="list-style-type: none"> • Mindfulness/breathing/grounding exercises • Psychoeducation • Goal setting and tracking • Voice recording • Tracking mood, exercise, diet, alcohol consumption and sleep 	<ul style="list-style-type: none"> • Grounding exercises, breathing, mindfulness and relaxation audio recordings • Psychoeducation (especially content that can be shared with friends/family to help facilitate support and understanding) • Thought monitoring and cognitive components (with prompting) • In vivo exposure, with ability to schedule times for behavioural experiments • Imaginal exposure, with in-app voice recording • Ability for clinician to customise app content/features according to the needs of the client

Three participants reported they would prefer to seek mental health treatment in person (i.e. with a counsellor, psychologist or other health professionals), while one preferred a combination of digital and in-person treatment. No one reported a preference for digital treatment in isolation. If an app was included as part of treatment, all stated they would prefer to use it daily in small amounts (from 5 to 20 minutes per day) rather than one longer session per week. Participants were likely to use the app across a range of contexts including at work, on days off, and only when distressed or if they felt like

they needed it. The most useful features/content cited for inclusion in an app were videos explaining treatment concepts, skills to manage distress, audio tracks for relaxation/mindfulness/breathing and a mood/symptom tracker.

Most (n = 3) participants said they had always completed the homework assigned during their mental health treatment. Reasons for non-completion included concentration issues and feeling distressed or uncomfortable, while indicating completion could be aided by reducing text content and increasing content appeal. Half reported they would prefer

to complete session homework in an app (with reasons including easier access, less likelihood of losing it and better engagement); the other half preferred a paper-based workbook (with reasons predominantly related to the written format aiding thinking and memory retention).

Frontline worker/client interviews. Individual 1-hour interviews were conducted online via Zoom with the four survey participants. The interviews allowed for more in-depth discussion around the use of apps to support mental health, as well as preferred features and content in an app designed to support therapy. All participants indicated they would be likely to use an app to support their mental health. The main reasons provided for engaging with an app were to receive immediate support when struggling, for reference and staying on track after completing treatment, and to complement therapy sessions (but importantly, not as a substitute for treatment or diagnosis): ‘It’s not the substitute for a psychologist, it’s all that background support and information’ (P1); ‘A place to check back in and it gives maybe some guidance when you’re a bit stuck and you can’t just quickly go and find somebody to necessarily talk to or relate to’ (P2). Perhaps unsurprisingly, they wanted an app to be simple, easy to use and relevant to their needs: ‘It’s got to be easy to use ... Simple navigation is pretty important’ (P1); ‘If it’s relevant and doesn’t take a heap of time is a massive thing for me’ (P2); ‘You want something fairly simple and something that satisfies the anxiety or the driver that has made you go to it’ (P3); ‘An app that shows an understanding of what emergency services workers go through ... That we’re here to help, you’re not alone’ (P4).

The main areas frontline workers believed the app would be useful to support treatment are presented in Table 3. Regarding completion of homework tasks, all participants indicated they were interested in using an app instead of or in conjunction with the paper-based workbook. Participants identified several advantages of using an app (Table 3). In terms of specific app features and content, most interviewees wanted an app that could act as a ‘one-stop shop’ solution for managing their mental health: ‘A sort of one-stop shop where you can go on the app “Oh look, I’m having a bit of difficulty with this,” find it, read it or it gives you a link to a podcast or something like that’ (P1). Participants thought that much of the existing treatment workbook content could be easily adapted into an app format and that the app could not only facilitate homework completion, but also incorporate a range of additional features (Table 3). However, it was noted that excessive information would be a hindrance: ‘A lot of apps throw out so much information ... so for me that actually loses me rather than captures me, because I get overwhelmed very quickly with too much information’ (P4). A sense of agency was also seen as important, with participants expressing the view that they would want choice over which tasks

to complete: ‘For me a choice is always good ... so if there’s varying types of homework, just have options’ (P4).

All respondents were generally supportive of being able to share their app progress with a therapist, although one participant suggested they would want control over what information would be shared: ‘If it was just for your therapist’s eyes, you’d want to be saying who can see it and where it’s used’ (P2). Two participants mentioned the importance of being able to share therapy content with their partner, to enable them to be informed and facilitate support and accountability during treatment: ‘I used to give her the workbook and say “Here’s the chapter I’ve done today,” and she used to read that and then go “Oh yeah, okay, now I get it, now I understand it”’ (P1); ‘It helps you have an understanding for each other, it helps them be more patient with you, and I think that’s really important when you’re going through treatment’ (P4). Two participants explicitly mentioned concerns about privacy of information: ‘I would like to know that there is a level of security ... where the information is going, how is it being stored and all that would be important to me’ (P2); ‘It absolutely needs to address the trust stuff, because there’s a lot of distrust with technology now’ (P3). Technical issues were also raised as a potential concern that could impact usability and motivation to use an app: ‘If it was me using the app there would be a level of anxiety or stress attached, and frustrations with getting into an app would potentially compound the anxiety’ (P2).

Specify target behaviour

The central behavioural component of PTSD treatment is to reduce the experiential avoidance behaviours engaged with in an attempt to suppress unpleasant emotions, thoughts, memories and bodily sensations, related to a prior trauma.⁵² Based on the initial co-design phase, the role the app could play in supporting this treatment in achieving this end was primarily through the following means: (1) Between-session task completion; (2) Grounding exercise delivery; (3) Learning reinforcement; (4) Thought identification and challenging activities; (5) In vivo exposure and facilitating behavioural experiments; (6) Guiding imaginal exposure tasks; (7) Housing a coping plan for relapse prevention.

Ground in relevant theory

The manualised approach used for the treatment of PTSD incorporates constructs from Bandura’s Social Cognitive Theory (SCT),⁵³ cognitive behavioural theory,⁵⁴ and extinction theory.⁵² The treatment manual utilised by the clinicians in the TSC has undergone significant evaluation,^{55,56} based on theory grounded in exposure-based cognitive behaviour therapy for PTSD.⁵⁷ The manual incorporates a number of elements with specific focus on

Table 4. Behavioural strategies employed to enhance engagement.

Behavioural strategy	Description	Implementation
Choice/control	Provide objective and perceived choice and control over one's environment and actions	Balance guided session content with ability to autonomously complete certain content
Competence	Provide immediate, frequent, clear, constructive, encouraging positive feedback following success	Affirmations and encouragers following activity completion
Context	Embed intervention into real/imaginary contexts with stories/characters.	Video content providing relevant examples
Curiosity	Provide sensory (colour, taste, sound) and cognitive (mystery) curiosity and surprise	Enhanced visual design through specific design team and cohesive design strategy
Growth mindset	Cultivate belief that behaviours are malleable with effort	Explanations of outcomes pre-activity. App tone (within language and visuals) focused on growth
Personalisation	Personalise intervention using an individual's name and personally relevant content	Ability to include personal goals for treatment, tailored sessions created with therapist
Pride	Cultivate pride and a sense of accomplishment	Affirmations and encouragers following activity completion
Teamwork	Facilitate cooperation and teamwork among individuals, groups, or teams	Framing of the programme to be completed with therapist

cognitive restructuring, in vivo exposure tasks and prolonged imaginal exposure. This latter procedure is based on the premise that engagement of trauma memories overcomes avoidance of trauma reminders through habituation and facilitates mastery of associated distress.⁵⁸ To maximise engagement within the app, specific behavioural strategies to enhance process motivation were incorporated.⁴² The specifics of these strategies and their implementation within the app are based on available evidence, collaborative discussion among the multidisciplinary team and the results of phase 1 of the study. These are presented in Table 4.

Ideate implementation strategies

This phase involved a process of brainstorming within the multidisciplinary team and culminated with a complete set of wireframes and a testable prototype of the app. Screenshots of the prototype app are presented in Figure 2. The draft flow began with: (1) Onboarding; (2) Goal setting; (3) Session creation; and (4) Selection from three forms of content (psychoeducational videos, interactive skills and grounding skills). In consultation with digital learning experts, specific content was tailored for app delivery. Each activity began with an overview page (explaining purpose and description of the activity) and an accompanying summary section (housing all completed

content). Different options for implementation of content were designed for testing. These included the addition of a Reactions and Triggers activity, the locking or unlocking of content in line with face-to-face sessions, options for voice recording, options for summary sharing and the location – and flow through – of various content within the app.

Prototype potential products

Clinician testing. Clinicians were presented with app wireframes for five specific app features: (1) Creating a session; (2) *Imaginal Reliving* activity; (3) *Reactions and Triggers* activity; (4) Session summary; and (5) Coping plan. Overall, clinicians were enthusiastic and supportive about this content being presented in the digital form: ‘Something to structure and keep it in one place looks really useful ... Something like this fills the gap’ (P1); ‘Makes it more accessible’ (P3). The main benefits mentioned were the ability to set reminders/notifications to complete homework tasks, and portability and accessibility of an app: ‘Can include reminders within the app, it’s transportable, people can access it in real time’ (P2); ‘Portability of it is going to be very helpful ... Easier to see and monitor how they going, rather than the physical workbook being carried around’ (P3). Clinicians also identified specific improvements that could be made. In creating a session, clarification was required around the use of the term

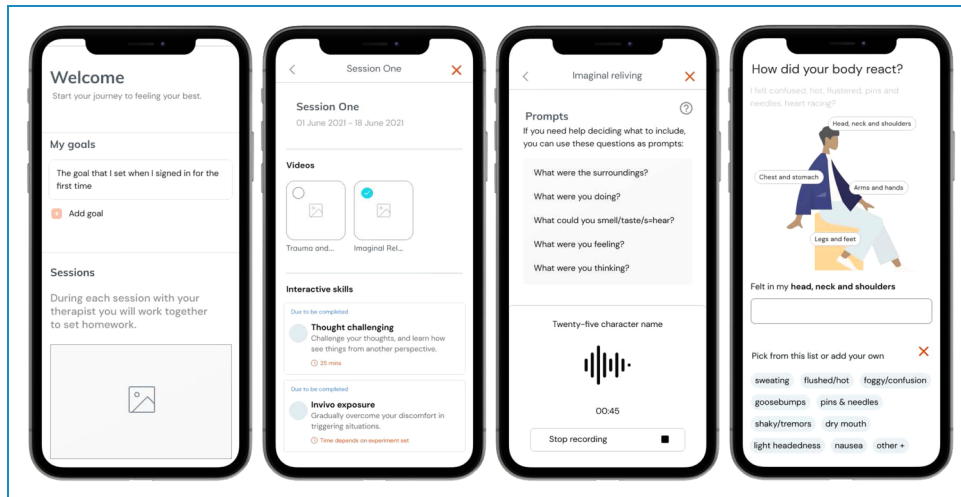


Figure 2. Screenshots of app prototype.

‘sessions’ within the app: ‘Does a “session” mean homework session or a face-to-face therapy session?’ (P1). To avoid confusion with clinical treatment sessions, it was suggested that this term could be changed to ‘practise’, ‘tasks’ or ‘homework’. Clinicians also recommended making it clearer that session homework within the app is always set with guidance from the therapist.

For the *Imaginal Reliving* activity, recommendations included: stating that voice recording is optional (reliving often involves sensitive information, and some frontline workers may want to skip this activity if they think recording is compulsory); clarifying that ‘they should only be reliving the memories they have already brought up in sessions with their therapist’ (P2); and changing the reliving prompts to ‘remind them to stay in present tense’ (P3).

Clinicians felt that the *Reactions and Triggers* activity could be a useful tool at the start of therapy, although one expressed concern that some users might feel a sense of failure if they were unable to identify the triggers for their trauma reactions: ‘Not sure how this will help. Could be harmful in a sense, as they may not have a “trigger” ... Could feel like they fail by not being able to complete it’ (P3). As there was mixed feedback on the potential benefits of this activity, it was subsequently deemed a low-priority app feature and was not included in the MVP app version.

Regarding the session summary, clinicians thought it would be useful to include both a list of activities and specific responses entered within activities: ‘Good to have completed details of each activity so you can check the client is doing the activities correctly’ (P2). While sending a homework summary to the therapist was seen as important, it became clear that the specific functionality for this would need to be defined in detail (e.g. sending via email directly to clinician, to general clinic email address or allowing client to generate and send this manually).

Clinicians were also concerned that they might not have time to review the client’s completed activities prior to the next treatment session: ‘Realistically I wouldn’t look at it in a busy back-to-back day’ (P1).

The coping plan was seen as an important feature to help clients prevent a potential relapse after completing therapy, thus it was suggested that it should be easily accessible within the app: ‘Is there a way to make it appear on the home screen?’ (P2); ‘I would want to get straight to what will help me cope right now’ (P3). Based on this feedback, the completed coping plan was placed on the home screen in the MVP app version.

On average, clinicians provided the following ratings for the app: 4.70/5.00 (ranging from ‘Agree’ to ‘Strongly agree’) for understanding of app content; 4.30/5.00 (ranging from ‘Agree’ to ‘Strongly agree’) for ease of use; 4.70/5.00 (ranging from ‘Agree’ to ‘Strongly agree’) for recommending the app to clients.

Frontline worker/client testing. The participants were familiar with the existing TSC workbook content, having all recently used it at the clinic. Having to repeat activities using photocopied paper and the fact that there was not a convenient way to track progress in one place were cited as inconveniences with the existing workbook: ‘You’d photocopy or add pages into the book, but it’s a lot easier to add it to the app’ (P1); ‘If you did that multiple times and you wanted to see how things might change as you progress, you’ve got to go back through bits of paper ... there’s nothing in one space to track your progress’ (P2). Having something to refer to outside of treatment sessions, however, was useful.

Participants were shown a range of app features: (1) Onboarding; (2) Home screen; (3) Creating a session; (4) Session summary; (5) *Thought Challenging* activity; (6)

In Vivo Exposure activity; and (7) *Imaginal Reliving* activity.

All participants found onboarding simple. They understood the app login and passcode creation procedures. They appreciated this layer of security and most said they would be likely to use the passcode feature: 'Personally I like that level of security, that your information is not necessarily going to fall into the wrong hands' (P2). All were happy with the wording of the app introduction screens, with one participant noting they particularly liked the encouraging tone of the welcome message: 'It's good, because it is a journey, and that's something that I've learned. And if you start using this and you don't know that it's a journey you'll soon find out' (P4). Participants highlighted the importance of goal setting at the start of treatment; several suggested adding examples or prompts to aid the user in focusing on their goals, as this can be difficult when beginning therapy. Although one preferred goal setting to be compulsory during onboarding, another stated that they would like the option to skip this until further along in the therapy process: 'I would probably skip this until I've had time to think on it ... but I would come back to it, definitely' (P4).

The participants approved of the clean and straightforward home screen layout: 'It's nicely segmented so that it's easy to read' (P4). One participant commented that they liked the ability to add additional goals from the home screen. In contrast to the clinician testing, most ($n = 3$) participants commented that the term 'sessions' made sense within the app and interpreted this as directly related to therapy sessions, adding that the description explaining the sessions concept ('During each session with your therapist you will work together to set homework') helped to provide context for the user. This was preferred over other terms such as 'practise', 'tasks' or 'homework'. Based on this user feedback, the term 'sessions' was retained for the MVP app version.

In general, there was some confusion about creating a session (i.e. setting homework tasks). Participants were unsure whether the psychoeducation videos could be watched at the time of adding to a session or not. All four wanted to click the videos immediately to watch them, assuming that the video tiles were functional rather than simply being added to the session at this point. Once videos were added to the session, it became clearer to participants that they were intended to be viewed later as homework: 'Once I'd gone through the videos, I understood quite easily what we were doing' (P3). Participants reported that the activity descriptions were clear, with the right amount of text to describe each task and prepare the user: 'The heading is very clear and then there's a very short, precise rundown under each one as to what exactly it is and how long it goes for, which I really like' (P4); 'It's a short and succinct explanation of the skill ... I like

that they've set out steps of what we'll be doing' (P3). The ability to set activity reminders was seen as extremely useful; participants appreciated the flexible choice of reminder frequency and stated they would want the option of reminders for all activity skills tasks: 'Setting frequency, that's good' (P2); 'It's making that very clear how often I have to do it ... When you've got multiple different activities you need to complete, you can easily forget how often you're meant to be doing them, so that's actually really good' (P4); 'There's some homework tasks that you're going to want to do every day, like the breathing techniques ... Some of the other tasks might be three times a week, or once a week, or once a month ... You actually probably need to have the flexibility to set different reminders for each task' (P1). One participant said they would not want reminders to be too intrusive, while another said they would be unlikely to use them: 'I would prefer to do without them, but I can see why people would need prompting to do it' (P3).

Two participants pointed out that the session summary (showing selected activities for that session) would benefit from having an editing function in case the user wanted to remove or select additional activity skills after creating a session. While two participants stated they would prefer to share their session summary/homework with their therapist directly via the app, most were also comfortable with using email to perform this function. There were no specific objections to sharing of this data as it was mentioned electronic sharing of data had been already taking place (especially as a result of COVID-19-imposed telehealth): 'I did most of my treatment through COVID, so everything was online through Zoom meetings and that sort of stuff, and I was having to hold my book up to the camera ... and [the therapist] would take a screenshot of that, or I'd email it' (P1).

Regarding specific activities within the app, participants completed most tasks with ease, reported that the content made sense, and demonstrated an understanding of how to use interactive elements such as keypad text entry, slider bar ratings and audio recording. The language used in the app was well received and acknowledged as being warm and supportive: 'I think the language is encouraging and reads in a supportive way' (P2). One participant noted that the lighter tone made the activities feel 'less "homeworky"' (P4). They also commented approvingly on the simplicity of the app layout and ease of navigation through activities. Participants explicitly mentioned that two of the activities (*Thought Challenging* and *Imaginal Reliving*) would be easier to complete in the presented app format compared to the existing workbook.

There was positive feedback on various elements used across the activities: introductory information designed to prepare the user for each task and explain its potential benefits (seen as particularly useful for emergency workers, who are accustomed to following procedures); prompts

and examples to aid user responses; and storing of detailed activity summaries (e.g. to compare thoughts/feelings before and after activities or to review at a later time to see their progress or avert relapse). Several participants liked the use of visuals in the ‘Body Mapping’ (Figure 2) section of *Thought Challenging* and believed this would help them to locate different feelings in specific areas of the body: ‘I really like that ... It’s good to have examples to sort of help understand what is going on within yourself’ (P3); ‘If you were to ask me how my body reacts, I would probably just say “tense” ... but that triggers me to say “Okay, well, how did I specifically feel in those areas?”’ (P4). Participants especially appreciated the in-app referral to grounding activities at the end of potentially distressing activities, noting that this acknowledged the difficulty of the therapeutic process and that grounding was helpful to reduce distress in the moment: ‘I think that’s really cool, identifying and recognising that it is hard, and how you can with grounding activities get yourself back to functioning again’ (P2).

Several suggestions were made to improve the user experience of specific components: provide clearer guidance and instructions on some *Thought Challenging* screens; use a drag and drop function instead of arrows to reorder answers in the behavioural experiments ladder of the *In Vivo Exposure* activity; provide more detailed instructions and additional prompts on the *Imaginal Reliving* recording screen, as well as clarifying that recording the reliving session is not compulsory (two participants indicated they were ambivalent about or would be unlikely to use the recording function).

Gather user feedback

Workshop participants (n = 19) were recruited predominantly from within Corrective Services (79%). No demographics were collected during this phase to maximise confidentiality. Several key findings emerged from these workshops.

In general, participants found onboarding (app login, passcode creation, introduction screens and goal setting) straightforward and understandable. However, some participants indicated that more detailed instructions would be useful, such as a user guide or ‘Frequently Asked Questions’ section.

Participants were guided through the creation of app sessions. Reminders were seen as useful in completing homework tasks, although it was equally important to make these optional, as some participants expressed the opinion that reminders could be triggering or demotivating if they were not able to do the task at the selected time. There was also potential for the client to feel overloaded or a sense of failure if they did not complete all the set activities in a session. The export session summary function for downloading or sharing with the therapist was generally

seen as positive, provided the client could choose whether to send their information to the therapist (confidentiality and privacy were of particular importance here). Based on workshop feedback, it was determined that the MVP app version would include activity reminders and the export session summary as optional functions controlled by the user.

Participants were shown a complex activity example (*Thought Challenging*) which included various interactive functions including keypad text entry, slider bar ratings, multiple choice questions and an activity summary. Workshop feedback consistently indicated that participants understood the activity purpose and content. Several individuals noted that they liked the recurring banner at top of screen (designed to remind the user of the chosen thought being challenged in the activity), as well as prompts to help answer questions.

A number of other issues and recommendations emerged from the workshops. Some participants suggested that a more personalised tone of voice in the app would help increase user buy-in and accountability. Ease of use was viewed as particularly important, to ensure workers do not feel alienated by the technology or inadequate if they do not understand how to use it. Voice-to-text function was seen as a potentially useful addition to the app, especially for older workers who may not be comfortable typing on their phones. Finally, it was noted that custodial workers would not be able to access app content during work hours, as they cannot carry their personal phone (and hence would not have access to grounding activities or help/support tools in case of distress on the job).

All participants except one responded to the anonymous survey. On average, workers (n = 18) provided the following ratings for the app: 4.56/5.00 (ranging from ‘Agree’ to ‘Strongly agree’) for understanding of app content; 4.50/5.00 (ranging from ‘Neutral’ to ‘Strongly agree’) for language suitable to frontline workers; 4.78/5.00 (ranging from ‘Agree’ to ‘Strongly agree’) for recommending the app to others. The mean SUS score was 81.94/100 (within the ‘Excellent’ range).

Build a MVP

The final content of the planned app is presented in Table 5 with screenshots of the MVP version of the app presented in Figure 3. From the early phases of development, the primary purpose of the app was to facilitate client homework and provide interactive support between sessions. The content was developed in line with the TSC emergency worker manual (covering 12 core sessions) and the outcomes of the prior stages of this development process. In addition to the gold standard content⁴³ derived from the TSC manual, the app also incorporated a range of grounding skills that the manual or clinicians referred to but were not manualised (e.g. mindfulness). The design was

Table 5. Planned content of overall app.

Content type	Included sections
Psychoeducational videos	<ul style="list-style-type: none"> • Trauma and PTSD • Understanding emotions • Thought challenging • Behavioural experiments • Imaginal reliving
Interactive skills (CBT)	<ul style="list-style-type: none"> • Understanding thinking patterns • Thought monitoring • Thought challenging
Interactive skills (In vivo exposure)	<ul style="list-style-type: none"> • Exposure ladder • Behavioural experiments
Interactive skills (Imaginal reliving)	<ul style="list-style-type: none"> • Audio recording^a • Subjective Units of Distress Scale (SUDs) record
Grounding skills	<ul style="list-style-type: none"> • Breath trainer • Attention trainer • Safe space imagery • 'Five things' exercise • Mindfulness exercises
Relapse prevention	<ul style="list-style-type: none"> • Stressful situations • Early warning signs • Coping plan
Other general features	<ul style="list-style-type: none"> • Goal setting for therapy • Crisis support resources • Pincode lock option • Reminders • Mood monitoring^a • Download of completed tasks (for clinician review)

^aNot present in MVP build.

PTSD: post-traumatic stress disorder.

intended to allow for not only the iterative build of skills content around specific presentations and comorbidities (omitted from this build), but also new content to support other treatments offered by the outpatient service. The MVP allowed the treating clinician to work with the client to add homework to the app during each session. Users could then download a summary of their completed tasks to share with their therapist prior to their next session or keep for their own records. The final build of the MVP included optional goal setting within onboarding. The home screen incorporated all elements that were deemed in testing to be most critical for quick access (including goals, current session and coping plan). Optional reminders were included for all activities (videos, interactive skills and grounding skills).

Emergency support tab was included on all navigational app pages. The navigation bar included specific tiles for sessions and skills.

Discussion

This article describes the systematic development of an evidence-based mental health app designed to augment manualised clinical care for PTSD. The intervention was shaped by considerable consultation with end users, clinicians and a multidisciplinary team of designers, user experience experts, digital learning specialists and mental health researchers. The intervention design process utilised the IDEAS framework and resulted in the production of a novel app incorporating psychoeducation, CBT, exposure tasks, grounding and mindfulness exercises. The aim of the build was to include the core components of the programme with flexibility to incorporate new content over time.

The final product reflected comments and feedback from interviews, surveys and workshops with clients (frontline workers experiencing or having experienced PTSD), clinicians at a trauma-focused outpatient clinic and employees from a trauma-exposed high-risk workforce. Based on this feedback the principal aim of the app was to support homework completion and maintain engagement with therapy between face-to-face sessions. Interestingly, homework completion was viewed as a major benefit and important purpose for the app, although the clients within this sample already reported high rates of homework completion. This may indicate these workers' treatment engagement was particularly good and such a tool may in fact have greater utility among clients with poorer overall engagement. This highlights the importance of client involvement in decision-making around blended care.⁵⁹ During the Integrate stage it was apparent that clinicians' main interest in the app was to augment therapy by way of increased engagement, facilitating homework completion and reminders and acting as a bridge between formal sessions. This sentiment was also shared by clients; although there was interest in use of such a tool, few wanted a truly blended approach to care (i.e. a mix of delivery modes, reducing therapist time), instead favouring an app to support face-to-face sessions, but not as a substitute for them. This underscores a central failing of many attempts to deliver blended care⁶⁰ and highlights the importance of a co-design approach to development.⁶¹ Although there are tremendous benefits in terms of resource reduction and sustainability where digital interventions can replace therapist time, considerations around client and clinician needs and motivation is key.⁶² Thus, where these tools may hold greatest potential is through complementing existing treatments in order to optimise time in sessions, streamline (and motivate) between-session behaviour, maximise and accelerate outcomes through reinforced

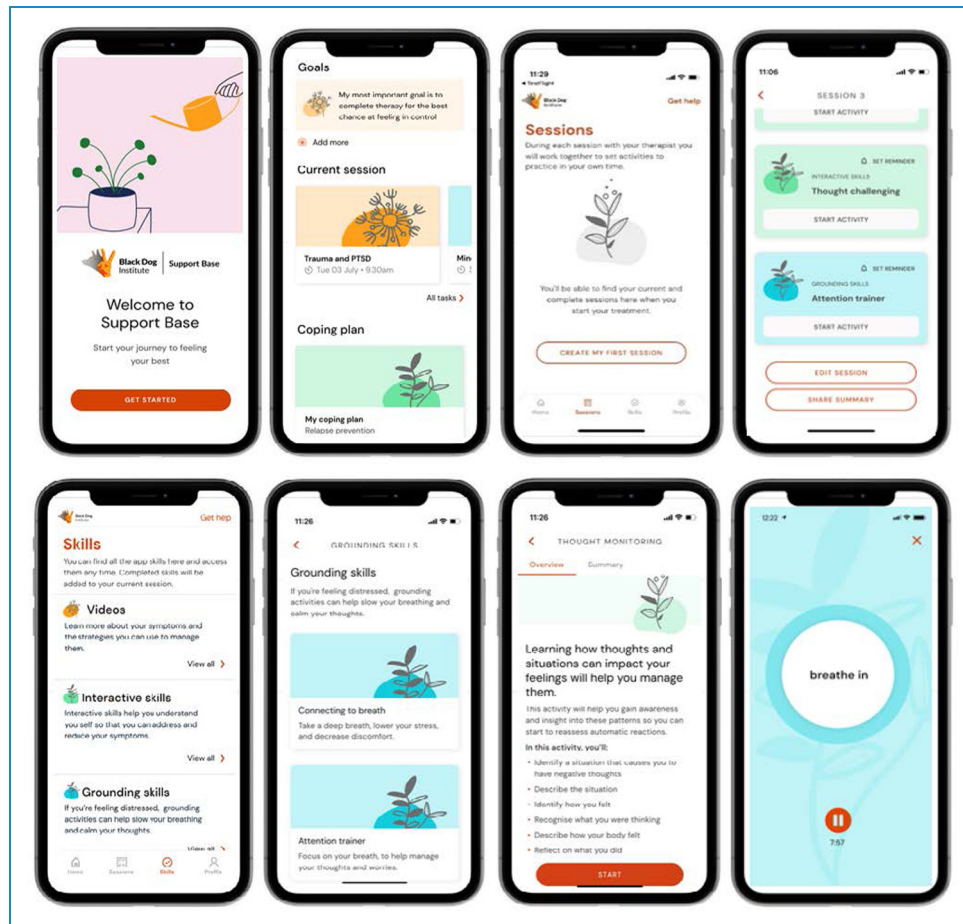


Figure 3. Screenshots of app minimum viable product (MVP).

learning and reduce relapse. The enhanced user confidence, flexibility, scope, personalisation, guidance and accountability that blended care offers compared to purely digital modalities,⁶³ and the scalability, low cost, accessibility and standardisation digital tools offer over traditional care makes a strong case for blended care models. Indeed, there is emerging evidence of lower dropout rates within blended care models compared to treatment as usual.^{64,65} Nevertheless, aspects such as dissatisfaction with the treatment model, weak therapeutic alliance and low motivation are barriers to all forms of treatment and blended care models should consider individual preferences when balancing the benefits of each modality.

Some of the major criticisms of the current paper-based treatment workbook were that it was lengthy and dense. Additionally, the workbook itself did not include (and in some cases referred clients to unspecified tools for) content such as mindfulness or grounding skills. Both clinicians and clients explicitly mentioned the potential for the app to become a ‘one-stop shop’ to house all therapeutic content during and beyond the course of treatment. Furthermore, that reduced text content was a major

advantage if delivered well within an app context. However, this was counterbalanced by some clients highlighting the idea of ‘digital fatigue’ (reduced capacity for reading or writing on a screen) and the rehearsal benefits gained by the physical act of writing. In building the app, digital learning was a central consideration. There is a body of evidence on how to optimise the presentation of information including use of contrast, simplicity of language, number of lines per screen and navigation systems, which was leveraged in the development process.^{66,67} Efforts were made to reduce app shortcomings (e.g. option to use voice-to-text rather than typing, minimal characters per screen, use of visuals) and enhance other aspects which can sometimes be lost in the digital format (e.g. rehearsal via re-presentation of prior inputted text).

Other central themes of motivational enhancement (especially via presenting progress summaries, reminders and encouragement), ease of use and agency (around completion and sharing), were viewed as important to consider. This idea of ‘shared decision making’ around care, especially in terms of blended care for mental health conditions, has been highlighted in recent work in the area.⁶⁸ The

primary concerns about a digital offering related to security/privacy, especially in recording imaginal exposure tasks, data sharing and the potential for technical issues. These concerns are not uncommon across various occupational groups,⁶⁹ and highlights the ongoing need for caution with how eHealth interventions are often realised. It is also important to note that there were varying degrees of interest in the app as a replacement for the current workbook, reiterating the importance of providing client choice. Tailoring of digital components to individual needs (along with combining these offerings with human support) is viewed as central to engagement.⁷⁰ A recent review found the concept of ‘therapeutic persuasiveness’ (i.e. the incorporation of persuasive design/behaviour change principles) to better predict eHealth adherence compared to a range of other constructs.⁷¹ This highlights the importance of the behavioural modification focus of the IDEAS framework and specifically the use of strategies to enhance process motivation in the app itself.

In the design and feedback stage, wireframes and a functioning prototype of the app were developed based on the broad requirements from phases 1 to 3. These components passed through multiple testing rounds exploring app flow, design, content, understanding, preferences and ease of use. Iterative improvements were made between rounds of testing. This resulted in greater ability for both clients and clinicians to tailor and control the app and allowed for prioritisation of features. The final prototype of the app was seen as useful and promising, and received high ratings from clients, clinicians, and trauma-exposed workers. Further feedback was integrated into the MVP of the app which included three broad activity groupings: psychoeducational reflection videos, interactive skills (CBT, exposure and relapse prevention) and grounding exercises (mindfulness, breathing training and attention training). Although the quantitative scores on the scales administered, and the qualitative feedback received throughout can provide useful data regarding aspects of ease of use, understanding and overall user experience, rigorous evaluation is needed to determine an objective measure of engagement. Digital health modalities (particularly apps) often suffer from engagement challenges, especially post-trial.⁷² The role of clinician guidance and support is of considerable importance⁷³ and highlights the importance of clinician involvement and co-design. This is likely to be especially true for frontline workers due to relatively low levels of digital technology adoption among these populations, although there is some evidence of this changing.³⁹

Previous work has emphasised the potential for digital tools in PTSD treatment,²⁷ but highlights the importance of a blended or guided approach to their use.^{33,34} However, few apps have been designed to be integrated with clinical PTSD treatment,²⁵ and fewer still use a clear evidence-based approach, or have been developed in a systematic manner involving end users.³⁶ Collaborating with

end users both improves the range of perspectives included, leading to unique and innovative ideas, and can better match the end product with the need of the audience.⁷⁴ The robust IDEAS framework used to guide the development process employs clearly defined, transparent steps, resulting in an intervention that is theory-driven, evidence-based, needs-focused and replicable. These aspects of the current study are a major strength. Additionally, a multidisciplinary team collaborated to develop and iterate the content and design, maximising not only clinical utility but also user engagement. This was highlighted by the mean SUS score of 81.94 in phase 6 for the prototype, which is considered ‘Excellent’ and places the app in the upper quartile of products tested using this method.⁷⁵

The study was limited to those working or receiving care from one trauma-focused outpatient clinic and one additional frontline trauma-exposed organisation. Although this was a deliberate decision to ensure that the app was designed to meet the needs of this population, the specific focus may impact generalisability of the results beyond the context of trauma-informed CBT and the type of frontline worker populations involved in user testing (emergency/corrective service workers). For example, our findings may be less relevant to members of the general population experiencing PTSD, or to other trauma-exposed frontline workers (e.g. medical staff). It should also be noted that there was a lack of diversity in the clinician sample (all were female and drawn from the same clinic), and this may have limited representativeness of clinician feedback. This sample was, however, representative of the clinicians working within the clinic, while the clinic itself was necessary as a manualised basis from which to develop the app. In addition, the clinicians were generally receptive to the use of a digital tool, which may not be representative of wider interest, however, questioning allowed for clinicians to specifically state how (if at all) such a programme could be beneficial. Furthermore, the small samples involved may not fully represent the preferences of a larger group and caution is required in extrapolating these findings, especially to those with more complex PTSD. However, the clinicians involved had extensive experience with the population of interest and the gold standard manual therapy. As the aim of the study was to outline the practical application of a framework for building such a tool, this method could be replicated by others. Rigorous testing with more representative groups will be required to answer questions about preferences and application of blended approaches to PTSD more broadly.

The data collection format used may have also impacted the findings. COVID-19 protocols (combined with individual preferences) resulted in the use of Zoom/Teams interviews and workshops which may have impacted individuals’ capacity to adequately participate. However, the facilitators had recent and substantial experience tailoring these methods for this format, which allowed for ease of

presentation of content on screen. We also did not seek to conduct a formal thematic analysis on any qualitative data collected. There were several reasons for this decision including scope of study, sample size and nature of questions asked of respondents. Instead, we intended to elicit feedback within specified categories; nevertheless, this may limit specific conclusions. Similarly, researcher perspectives are known to play a role in the interpretation of qualitative data.^{76,77} Exploration of these perspectives was again beyond the scope of the current study but should be acknowledged in considering interpretation.

As this study involved only the ideation and design stages of the IDEAS framework,⁴² further research surrounding the evaluation and implementation of the app is required. Within the evaluation phases, it will be important to consider not only app uptake and use, but also collect data to qualitatively contextualise and understand this use in order to optimise value and knowledge gains. The ultimate aim is integration into existing systems and procedures, and client practice is fundamental to the success of blended approaches to care, with previous attempts often marred by failures in implementation.⁶⁸ Clinicians and clients have been often found to view new digital innovations as valuable but fail to integrate them into daily practice as they do not easily fit their regular activities.⁷⁸ As such, following on from evaluation phases, appropriate training around the use of the tool in practice is vital for optimising widespread use. This may also involve adaptation to different contexts and presentations.

In summary, this study described the iterative, participatory development of a mental health app designed to augment manualised clinical care for PTSD. It is the first known study to systematically detail the development of a PTSD app and one of the few known development papers of digital interventions for blended mental health care. The app itself has the potential to not only improve clinical practice, but also support shared decision-making in blended care. Using such approaches to better integrate in-person care and eHealth interventions, specific benefits of both modalities can be employed. However, the findings also highlight the complexities of developing such models and the importance of shared decision-making and divergence of opinion which are critical considerations for implementation in order to increase engagement and enhance clinical outcomes. This study demonstrates the multiple development phases that are connected by continuous evaluation cycles and active end user consultation and can help guide other researchers in systematically and efficiently developing future interventions.

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