‘A circuit breaker’ – Interrupting the alcohol autopilot: A qualitative exploration of participants’ experiences of a personalised mHealth approach bias modification intervention for alcohol use

G.L. Bolt*, H. Piercy, A. Barnett, V. Manning

* Monash Addiction Research Centre, Eastern Health Clinical School, Monash University, Melbourne, Australia
b Turning Point, Eastern Health, Melbourne, Australia

ARTICLE INFO
Keywords:
mHealth
Qualitative analysis
Approach bias modification
Alcohol
Intervention
Neuropsychology

ABSTRACT
Objective: There is a need for low-cost, wide-reaching interventions to enhance accessibility of support for people with hazardous alcohol consumption. We assessed participant experiences of using a novel, personalised mHealth intervention offering approach bias modification (ApBM) for alcohol use in a community sample drinking at harmful levels to enable a deeper understanding of the end user and engagement.

Methods: Eighteen semi-structured telephone interviews were conducted with adults in the community drinking at harmful/hazardous levels. A reflexive thematic analysis approach was used and data analysis followed iterative categorisation.

Results: Engagement/Motivation and Clinical Value were overarching themes. The useable, accessible, customisable design described by participants enabled training to be readily integrated into routines, enhancing autonomy and self-efficacy beliefs, and facilitating engagement/motivation. Where autonomy or perceived self-efficacy were threatened by a rigid training schedule or lack of clarity/reminders, engagement was reduced. Training increased awareness of drinking behaviours, and encouraged participants to consider alternate goal-directed behaviours with feedback suggesting training may function as a ‘circuit breaker’, increasing time between alcohol craving and seeking, and enabling reflective processing, at least in the short term.

Conclusions: This novel smartphone intervention for alcohol use may be a useful, accessible, ‘just in time’ adjunctive support tool for non-treatment seekers, meeting an important gap in the field. Findings have implications for the implementation of subsequent digital interventions, suggesting participants may stand to gain more from an intervention which enables autonomy and improves self-efficacy beliefs. Theoretically, findings speak to the role of inferential processing in behaviour change, but further research is needed to clearly elucidate ApBM training mechanisms. Practical recommendations for subsequent app iterations are suggested, along with additional opportunities worthy of consideration for future initiatives.

1. Introduction

Alcohol is a leading cause of preventable morbidity and mortality worldwide (Griswold, 2018), with 283 million people meeting DSM-5 criteria for an alcohol use disorder (AUD) during their lifetime (WHO, 2018). With alcohol use accounting for 5.5% of disease burden and injury globally (Lim et al., 2012), and alcohol accounting for the majority of treatment presentations to addiction services (AIHW, 2021) which likely represent only the tip of the iceberg (Ritter, Chalmers, & Gomez, 2019), there is a need for low-cost, wide-reaching solutions.

Accumulating evidence suggests that approach bias modification (ApBM) may be an effective adjunctive intervention for hazardous alcohol use (Eberl et al., 2013; Rinck, Wiers, Becker, & Lindenmeyer, 2018; Salemink, Rinck, Becker, Wiers, & Lindenmeyer, 2021; Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011). ApBM is a computerised cognitive training intervention which aims to re-train implicit alcohol ‘approach biases’ associated with heavy drinking (Bechara, 2005; Field, Kiernan, Eastwood, & Child, 2008; Piercy, Manning, & Staigher, 2021; Wiers et al., 2011) by having participants repeatedly ‘avoid’ alcohol-related images and ‘approach’ non-alcohol related images (Wiers,
Rinck, Dicu, & van den Wildenberg, 2009). Although findings from earlier systematic reviews were mixed (Cristea, Kok, & Cuypers, 2016; Kackoschke, Kemps, & Tiggesmann, 2017), these reviews have been criticised for pooling experimental lab studies and clinical trials in the same analysis (Wiers, Boffo, & Field, 2018a). Subsequent systematic reviews and meta-analyses have suggested there are small, albeit unreliable, beneficial effects of ApBM as an adjunctive intervention for alcohol use in clinical samples who are motivated to change in the medium-to-long term (Batschelet, Stein, Tschuemperlin, Soravia, & Moggli, 2019; Boffo et al., 2019). There have also been further randomised controlled trials conducted since this time showing positive effects (Manning et al., 2021; Salemink et al., 2021), however the strength of the effect has not been recently evaluated. Whether improvements are due to ApBM targeting dysfunctional responses to appetitive cues in the environment or other non-specific components of training paradigms remains to be seen (Boffo et al., 2019), and there are current theoretical debates pertaining to whether an associative or inferential process underpins behaviour change (Wiers, Van Desel, & Kopet, 2020).

With approximately 90% of Australians owning a smartphone (Deloitte, 2019), mobile health (mHealth) provides a platform to widely disseminate evidence-based interventions such as ApBM (Colbert, Thornton, & Richmond, 2020). Smartphone delivery may allow the large proportion of non-treatment seekers with alcohol problems to access a ‘just in time’ intervention during periods of heightened craving (Colbert et al., 2020). Unlike traditional forms of ApBM which use generic training stimuli, mHealth allows for stimuli personalisation, with scope to incorporate behavioural substitution (e.g. targeted, meaningful values/goals to replace drinking) and ‘gamification’ (e.g. feedback, point scoring systems), which may enhance personal engagement, motivation, and overall therapeutic benefit (Kaner et al., 2017; Laurens et al., 2020; Lumsden, Edwards, Lawrence, Coyle, & Munafo, 2016). Completion of ApBM training in naturalistic environments may also enhance transfer of training effects (Norman, 2009). To date, limited research has demonstrated that smartphone delivered ApBM is feasible and acceptable, and the effectiveness of training on drinking outcomes has been mixed (Crane, Garnett, Michie, West, & Brown, 2018; Laurens et al., 2020; Manning et al., 2021).

Our group recently developed a novel, personalised alcohol ApBM application (‘app’) (Manning et al., 2021), with the inclusion of personally relevant antecedents (i.e. alcohol-related stimuli) and consequences (i.e. physical, social, financial benefits of reduction/cessation of alcohol use) within the ApBM mHealth training, which are thought to encourage participants to make goal-relevant behavioural choices (i.e. swipe away or towards, respectively), aligning with Wiers and colleagues’ ABC theoretical framework (Wiers et al., 2020). In an open-label trial, 1309 community-based adults completed a median of five training sessions across four weeks (Manning et al., 2021). The study demonstrated good feasibility, acceptability and significant reductions in alcohol consumption, craving, and dependence. Whilst pilot data is promising, results are yet to be validated in a randomised controlled trial, and further research is needed to understand participant experiences of mobile-delivered ApBM, to inform its future development and implementation. Indeed, there is a dearth of qualitative research examining subjective experiences of ApBM and mHealth interventions for alcohol use generally, with recent systematic reviews highlighting this as a priority for future work (Kazemi et al., 2017; Staiger, O’Donnell, Liknaitzky, Bush, & Milward, 2020).

Qualitative is important when evaluating novel mHealth interventions, as it can enable a deeper understanding of the end-user (i.e. engagement, satisfaction, and retention), and facilitate exploration of potential mediators of behaviour change, which can ultimately enhance development of behavioural interventions for alcohol (Dick et al., 2020; Rozental, Forström, Tangen, & Carlbring, 2015; Staiger et al., 2020). For example, in a co-design mixed-methods study, one study found young adults with hazardous alcohol use were optimistic as to the value and effectiveness of a hybrid ApBM online intervention as an adjunctive alcohol treatment (Prior et al., 2020). The qualitative co-design element allowed participants to be “experts of their experiences” (Prior et al., 2020, p2294), recommending program adaptations for future ApBM iterations. Since ApBM is a relatively new approach and personalised delivery via smartphone is entirely novel, it is important to illuminate how the end-user understands and engages with it. This study therefore aims to understand experiences of a personalised smartphone-delivered ApBM app in a community sample drinking at harmful/hazardous levels, including the mechanisms through which training is perceived to impact alcohol cravings and drinking behaviour.

2. Methods

2.1. Design

Qualitative data was collected as part of a broader study exploring the app’s feasibility, acceptability, and preliminary effectiveness amongst Australians in the community drinking at hazardous levels. Detailed methodology can be found elsewhere (Manning et al., 2021). The current study used a reflexive thematic analysis (TA) approach, underpinned by critical realist epistemology (Braun & Clarke, 2019). The flexible and recursive nature of reflexive TA (Braun & Clarke, 2019) was considered appropriate to examine participants’ experiences of a smartphone delivered ApBM intervention, whilst recognising the dynamic interplay between researchers and participants. The Monash University Human Research Ethics Committee approved study conduct (# 21393).

2.2. Participants

Participants were recruited to the parent trial if they were adults (i.e. 18+ years) who met inclusion criteria (i.e. hazardous alcohol use, as indicated by AUDIT scores of 8 or more, with a desire to reduce or cease drinking, and with access to an Android or Apple iOS smartphone with an Australian phone number, updated within the past year). Recruitment was Australia-wide, using online/social media and radio advertising across a six-month period (August 2020 – Feb 2021). Those who completed the open-label pilot post-training assessment and consented to being contacted within three months (n = 277) were invited to participate in interviews. Due to time constraints, a subset of eligible participants (n = 131) were linked to the Qualtrics signup page.

Participants’ ages ranged from 28 to 75 years (M = 54.94, SD = 11.84), and 61% identified as female. Those who completed semi-structured interviews were slightly older than the average age of those who completed the parent trial (Mage = 47), but gender ratios were broadly consistent. They were living in a range of urban, regional, and remote locations across Australia, broadly consistent with Australia’s population distribution. Relative to the parent trial, there was slightly greater representation of individuals residing in New South Wales and Northern Territory, with those in Queensland, Tasmania, and Victoria slightly under-represented, and equivalent rates of people within Australian Capital Territory and Western Australia. 83% of participants were not currently in treatment for alcohol despite mean baseline AUDIT scores being indicative of likely dependence (i.e., ≥20), with the overall rates of risky drinking similar to the parent study. All participants endorsed a high degree of baseline motivation and readiness to change (see Table 1).

Questioning the usefulness of ‘data saturation’ to justify sample size in reflexive TA (Braun & Clarke, 2021b), the authors made an iterative interpretative judgement that there was sufficient ‘information power’ to address study aims after eighteen interviews (Fig. 1) (Malterud, Siersma, & Guassora, 2016). When determining ‘information power’, we considered diversity of experience, quality of dialogue, transferability to the broader parent study, and when similar ideas were arising, with earlier work suggesting little new information is generated after interviews with 20 or so individuals (Malterud et al., 2016; Vasileiou, 2021).
2.3. The intervention

Participants downloaded the app and completed training twice-weekly for four weeks. Twelve personalised images formed training stimuli (six alcoholic beverages, six goals/motivations for reducing drinking). Participants were instructed to repeatedly swipe portrait-oriented framed images upwards (i.e. away from themselves) to simulate an ‘avoidance’ movement, and swipe landscape-oriented framed images towards themselves, stimulating an ‘approach’ movement (Fig. 2). A detailed description of the intervention is outlined elsewhere (Manning et al., 2021) and in the Australian New Zealand Clinical Trials Registry (ACTRN12620000638932).

2.4. Data collection

Participants completed a telephone-based semi-structured interview, receiving a $20 eVoucher for participation. Semi-structured interviews were scheduled recursively between 1.5 and 4 months post-training completion, \( M(SD) = 77.69(21.44) \) days, with informed consent and interviews audio-recorded via telephone. The interview schedule was developed collaboratively, and pilot tested, informed by discussion and the authors’ engagement with extant literature. Audio-recorded interviews ranged from 15 to 32 min in duration and were conducted by researchers HP (\( n = 8 \)) and AB (\( n = 4 \)), and clinician-researcher, GB (\( n = 6 \)). Upon interview completion, researchers reflected upon interview content, making preliminary notes and observations.

2.5. Data analysis

Interview audio recordings were de-identified and transcribed verbatim by an external transcription company. TA was informed by the six-phase process outlined by Braun and Clarke (2006). Data analysis followed iterative categorisation (Neale, 2016), which involved a recursive process between data familiarisation, generating, reviewing, defining codes and themes, and report production. To ensure initial data familiarisation and immersion, interviews were read several times and initial codes generated using paper-pencil methods. Transcripts were

---

**Table 1**

| Variable                              | % / M(SD)  |
|---------------------------------------|------------|
| Geographic region                     |            |
| Major cities of Australia             | 61.11%     |
| Inner regional Australia              | 16.67%     |
| Outer regional Australia              | 16.67%     |
| Remote Australia                      | 5.56%      |
| State                                 |            |
| ACT                                   | 5.56%      |
| NSW                                   | 38.89%     |
| NT                                    | 16.67%     |
| QLD                                   | 11.11%     |
| VIC                                   | 16.67%     |
| WA                                    | 11.11%     |
| Smartphone Device                     |            |
| Apple                                 | 61.11%     |
| Android                               | 38.89%     |
| Baseline AUDIT scores                 |            |
| M(SD) = 20.94 (8.21), Range = 9–33   |            |
| Baseline Readiness to change          |            |
| Readiness (/10)                       | M(SD) = 8.61 (1.24), Range = 7–10 |
| Importance (/10)                      | M(SD) = 9.39 (1.99), Range = 7–10 |
| Confidence (/10)                      | M(SD) = 5.94 (1.62), Range = 4–10 |
| Baseline cravings (CEQ)               |            |
| Intensity                             | M(SD) = 5.20 (2.19), Range = 1.33–8.67 |
| Imagery                               | M(SD) = 3.54 (2.47), Range = 0–9.50 |
| Intrusiveness                         | M(SD) = 3.94 (2.48), Range = 0–8.67 |
| Total                                 | M(SD) = 4.16 (2.03), Range = 0.50–8.90 |
| Baseline alcohol dependence (SDS)     |            |
| M(SD) = 7.28 (2.82), Range = 2–12    |            |
| App sessions completed                |            |
| M(SD) = 10 (2.91), Range = 6–15      |            |

---

Barnett, Thorpe, & Young, 2018).

---

**Fig. 1.** Recruitment Diagram.
then imported into NVivo database management program, systematically reviewed line-by-line, with a combination of deductive, inductive, semantic (e.g. ‘ease of use’), and latent (e.g. ‘drinking identity’) codes applied (Braun & Clarke, 2021a). Raw coding files were subsequently exported into Microsoft Word for further analysis, which involved summarising, reviewing, and re-grouping key points to identify patterns, associations, and broader concepts within the data (Neale, 2016). Themes (i.e. patterns of codes within and across the dataset with shared meaning, addressing the research question) (Braun & Clarke, 2021a) were inductively generated by GB and amended through collaborative team discussion and reflection. Rigour was enhanced through processes of comprehensiveness and data crystallisation (i.e. viewing qualitative feedback through different theoretical lenses and researcher perspectives) (Richardson & St Pierre, 2005; Varpio, Ajjawi, Monrouxe, O’Brien, & Rees, 2017). Recognising analysis does not occur within an ‘epistemological vacuum’, analysis and theme generation had potential to be impacted by researchers’ backgrounds in addiction, cognitive neuroscience, and neuropsychology. This study is reported in line with the COREQ consolidated criteria for qualitative research (Tong, Sainsbury, & Craig, 2007), where theoretically applicable, and as guided by the 20-item tool described by Braun and Clarke (2021a).

3. Results

Thematic analysis yielded two overarching themes, (1) Engagement & Motivation, and (2) Clinical Value (Fig. 3).

3.1. Engagement & motivation

A range of intrinsic, extrinsic, and app-related factors impacted participants’ motivation to engage with, and complete, training. Key subthemes ‘autonomy/control’ and ‘perceived knowledge/self-efficacy’ functioned as both facilitators and barriers to engagement.

3.1.1. Autonomy & control

It was in the context of either trying to maintain, or regain, control over drinking behaviour that participants chose to engage with mHealth ApBM: “Alcohol has been very much part of my life but I don’t want it to control my life anymore” (P04). On a background of longstanding alcohol consumption, it was common for participants to describe precipitating personal stressors or ‘rock bottom’ crisis events (e.g. arguments, forensic engagement, hospitalisations) prompting app interest. Other factors included a desire to improve general health, or interest in novel treatment approaches. Motivation to reduce alcohol consumption and engage with the training also changed according to broader contextual factors, for example waning across the festive period (i.e. Christmas, New Years). Participants suggested training engagement was enhanced where the end-user was motivated to change drinking behaviour: “I...
takes the person at the other end of the app, the user, to actually want to [change], and not just do it for the fun of it[...]” (P07).

An intervention that enabled autonomy was integral to the pursuit of regaining control over alcohol behaviours, with user engagement enhanced where participants felt they were able to choose when and how they engaged with training. A flexible training program that could be readily integrated into an existing routine was important, with participants typically completing training at either the beginning or end of the day. Those who completed ApBM training in the morning saw it as a helpful way to set up the day, often using ‘habit stacking’ to pair training with other routine activities (e.g. morning coffee). They recognised this time of day was less likely to trigger late afternoon cravings, whilst allowing for reflection of drinking consequences. In contrast, others preferred to complete the training as a wind down routine after work, or during the “witching hours” (P04) when the greatest urge to drink alcohol arose. Mobile-delivered ApBM was thought to be an innovative helpful way to set up the day, often using ‘habit stacking’ engagement with, a range of treatment and supports which both training. Participants reflected on their previous knowledge of, and successfully reduce their alcohol consumption and navigate mHealth programs. Some had used other mHealth interventions, these largely monitored alcohol consumption or targeted other lifestyle-related factors. Relative to non-smartphone delivered interventions, mHealth was considered advantageous in that it was interactive, quick, convenient, and accessible: “I always have my phone with me so I thought an app on the phone would be a good thing to try” (P13); “[...] I was able just to squeeze it into my commute” (P16). mHealth was also seen as a useful platform to support content personalisation, which further increased user autonomy and engagement. Using customised images “[...],tailored to the things in your life [...]” (P16) was considered “critical” (P13) and “[...] an important element of the whole app” (P05). Where participants used the suggested in-app images to form stimuli (rather than their own images), this was frequently due to lack of awareness and/or suitable content in their photo-library. Nonetheless, training stimuli was still considered personally relevant.

Where training undermined end-users’ autonomy, this negatively impacted app engagement. For example, there were several design features that participants perceived as rigid and lacking flexibility. Greater flexibility with respect to changing image stimuli throughout the training was recommended. Participants also expressed strong and aversive responses towards the in-built lockout feature which prevented repeat training within a 24-hour period. Many described feeling “frustrated”, “angry”, and “disappointed” at their lack of control over training availability, noting this made it challenging to integrate the training program into a pre-existing routine (P01; P03; P04; P06): “[...] it was driving me rather than me driving it in terms of timeframes and that really bothered me[...]” (P03). The lockout feature was especially problematic where individuals were seeking additional support during times of heightened stress or craving but were unable to access mHealth training: “[...] I knew that it had helped me, and I’m waiting to use it and then saw that I had to wait another few hours before I could use it. That’s a bit like having to wait for opening hours for a counsellor or something! It’s more like, you need it now!” (P06).

3.1.2. Perceived knowledge & self-efficacy

User engagement and motivation was enhanced where participants perceived themselves as having the skills/knowledge required to successfully reduce their alcohol consumption and navigate mHealth training. Participants reflected on their previous knowledge of, and engagement with, a range of treatment and supports which both consciously (e.g. Dry July, AA, Smart Recovery) and subconsciously (e.g. hypnotherapy) targeted addictive behaviour. It was against this background that participants described a curiosity to explore novel therapeutic tools and treatment options targeting alcohol use.

The overall usability of the mHealth application impacted perceived self-efficacy and engagement. The consensus was that the program was “easy to use”, “simple” and “straightforward” such that “anyone could use it” (P01-03; P07-08; P11-14; P17-18). For the most part, users responded positively to the app flow and design, describing it as “[...],quite seamless” (P04) and “[...],very professional” (P08). The training concept “made sense” (P13) and was considered efficient and engaging. The swiping mechanism was intuitive, with the swiping symbolism of ‘pushing away’ bad habits and ‘moving towards’ goals/values resonating with participants: “[...] I liked that aspect of towards me, love, kindness, my family, that sort of stuff towards my heart [...]and the other idea is, you know, swatting a fly. Just sort of move it away [...] I don’t need it[...],closing the fridge door” (P13). There were mixed views with respect to the gamification elements, with some noting increased motivation to train, whereas others struggling to appreciate added value (“[...] didn’t seem to serve a purpose[...]”, P10) or indicating speed-accuracy trade-off: “I tried to be the speed king, and of course, I flunked badly” (P07). It was suggested that within-app game-like elements may be most effective when related to the skillset being trained, and more appealing for younger generations. Some participants discussed minor technical issues, particularly where there was poor internet connection, which negatively impacted engagement. Despite this, the overall quality and usability of the app enhanced perceived self-efficacy and contributed to a mostly positive user experience.

Users also highlighted the importance of having clear, simple instructions and a training rationale to maximise perceived self-efficacy and engagement. The in-app video-explanation was well-received and enhanced understanding for some, but others sought greater clarity in relation to scientific underpinnings and/or depth of instructions. Poor knowledge and understanding of the nature of the training had potential to threaten perceived self-efficacy and reliability of user-engagement. For example, responding to an irrelevant-feature (i.e., swiping according to picture orientation, as opposed to content) was a common source of confusion, which impacted performance accuracy, although participants were generally able to master response requirements through trial and error. Nonetheless, some wondered whether this irrelevant-feature design was sufficient for image content to be cognitively processed and re-trained: “[...] as I progressed I actually started to swipe up or down based upon viewing just the left hand corner of the frame[...], I was in fact ignoring the image deliberately” (P08). Similarly, many struggled to understand the purpose of incongruent trials (i.e., occasionally swiping an alcohol image towards themselves). A variety of explanations were attributed in an attempt to allay poor understanding of this design feature, ranging from superficial (e.g. reflected a ‘glitch’, designed to increase concentration), through to deeper and more interpretive (e.g. 90:10 stimuli-presentation ratio is designed to symbolise a goal of alcohol reduction as opposed to abstinence): “[...] I think I understand the reason for it[...] is to get me to think that little bit more, and it’s okay to have a wine, and it’s okay to push my family away when they annoy me” (P13).

Where participants perceived themselves to be lacking skills required to successfully use the app, this negatively impacted engagement. For some, reliability and consistency of app engagement reduced where demand was placed on the end-user’s memory function (i.e. providing weekly reports on alcohol consumption and remembering to complete training), “I wouldn’t be able to tell you what I drank last Monday because I’m not sure what I did last Monday[...] not because I’m in an alcohol haze, but because I’m so busy and I work and I can’t remember” (P16). The inclusion of a daily drinks tally to support memory function was recommended. Although some participants felt in-app automatic reminders were useful in ensuring training consistency, others described prospective memory failure (i.e., forgetting to complete the training ‘in the moment’) due to infrequency and unpredictable timing of notifications: “If it’s not in your face then you’re kind of caught out by all the other noise and have to actually really remember to get on with it, or do it as soon as you get the message, and that’s not always possible [...] more reminders would be helpful without pestering” (P09).

3.2. Clinical value

Many participants described increased awareness of alcohol triggers
and drinking behaviour throughout the training: “[…]I was making a conscious effort to think about my intake. If I wasn’t doing the app, I would just be doing what I did” (P10); “[…]it means you’re very aware […]each time I pick up a drink I should be saying ‘do I need this or don’t I?’” (P17). Awareness appeared to be enhanced through two key processes: routine engagement with an intervention serving as a reminder, alongside the self-monitoring of alcohol intake shedding light on quantity of consumption. Increased awareness was seen to be one component of subsequent behaviour change: “[…]I think one of the steps forward in cutting back is being aware” (P10); “I think it actually builds your own confidence and knowledge as well at the same time as behaviour” (P14).

Whilst the changes in thinking patterns and near-transfer effects of training were recognised, with some participants commenting on improved task performance over time (e.g. higher scores), there were mixed opinions as to whether training generalised to changes in alcohol craving or behaviour: “[…]I’m not sure that I could say that beyond the actual task that I was clearer headed[[…].]I just realised I had to concentrate in the exercise and I don’t know if that translated beyond that” (P09). Few described being triggered by alcohol stimuli, particularly where training was targeted to drink preference and completed in the afternoon. Others felt that the training had either no clear impact upon cravings, or that it assisted in “[…]calming surface urges” (P06). With respect to alcohol consumption, some participants described a significant reduction, noting that they were “[…]drinking a lot more” (P03) prior to completing the training (“I’ve cut down my consumption by 90 percent!” P13), and even going so far as to avoid completing the training where they wanted to have a drink. In contrast, others described no changes to alcohol consumption, with a degree of hesitancy to comment on effectiveness until further research was conducted. Many described at least a subtle change in their approach, for example reducing the number of drinks consumed in one sitting, no longer storing alcohol at home, or introducing alcohol-free days.

For many, the app functioned as a ‘circuit breaker’ in the cycle of problematic alcohol consumption. Participants described the ApBM training as a meditative diversionary tool; a stopgap distracting from ‘unhelpful thoughts’ and ultimately increasing the time between alcohol craving and seeking: “[…]it would work immediately in calming the moment, sort of like a circuit breaker[…]in that it forced you to pause and concentrate on something else for probably just the right amount of time[…]it was enough time to refraze, to reset, a bit like a meditation task[…]” (P06); “I find moments now where I really stop and think before I go to the fridge[…]it was a bit of a circuit breaker in my thinking pattern[…]that was a really positive sign that something shifted or something’s changed” (P12). With delayed alcohol seeking, participants were more readily able to reflect upon their consumption. Increased time for evaluative processing not only enabled participants to consider the impact of their drinking, it also allowed for greater consideration of “healthier alternatives” (P01), enhancing scope to reflect on intrinsic goals or motivations: “It’s about training your brain, it’s about[…]making conscious positive decisions, because for me, what would happen is I would drink and I would make bad decisions[…]there’s an app that helps you train your brain to give you the opportunity to make more conscious positive decisions for you” (P04). Reflective processes were further strengthened by the inclusion of personalisation, positive training stimuli, which, in effect, created vivid imagery to highlight a range of alternative behaviours that might “replace” alcohol consumption: “[…]training reminded [me] that yes, you can just go and […]do some meditation to relax rather than having a glass of wine[…]you can go for a walk[…]rather than reach for a glass of wine[…]” (P01). Behavioural substitution components of the training were seen as integral to a shift in thinking patterns: “Maybe it’s seeing images of things that are bad for you and being able to dismiss them with a swipe, whereas to see things that you like to do and swipe down and effectively take possession of, that’s the influence that I think has some fundamental benefit” (P08); “[…]you do start to have a second thought of what about holiday, cash, money, family […]so it probably does start to change your thinking in that regard[…]things that I’d like to replace my drinking with” (P02). Others felt a strengthening of their connection to content of their ‘approach’ images: “Definitely those images in my mind started popping up a lot more and thinking about the things that mean a lot to me[…]setting positive goals and moving towards a happier, healthier place” (P03). Beyond changes to thinking at a conscious level, several participants also felt the repetitive ‘drill and practice’ aspects of the training subconsciously “desensitised” them to alcohol cues in their environment: “[…]that constant repetition of seeing something that you don’t like, or that you’re triggered by that you want, that you don’t want to want[…]made it easier to see drinks in real life and I wasn’t triggered by it, so I could see other people drinking[…]and not be triggered by them” (P11); “The brain training is basically[…]a repetitive series of mental actions that you finally learn and reprogram some of your habitual thinking” (P16). Conversely some participants were unsure whether training effects could be directly attributed to the training program, or whether change arose due to other factors such as pre-existing ‘commitment to stop [drinking]’ (P11) or “placebo effects” (P18).

Participants also reflected on other individual and training-related factors that had potential to impact training effectiveness. Whilst training effects were reported to persist longer-term for a couple of people, effects largely dissipated upon training completion. Thus, participants wondered whether the training dose was sufficient to maintain durable behaviour change (“I would have loved to keep going with it[…]at the time it did [improve ability to resist alcohol cues], it sort of faded away” (P07); “I also wondered whether it’s really dependable on you doing this rigorously [over] more than just five or whatever weeks it was, and therefore is that enough time to maintain it?” (P09); “[…]it seems to have worn off a bit, which I don’t know why that is, but anyway[…]” (P18). Those who requested additional training had largely exceeded the minimum recommended dose (i.e. twice weekly for four weeks, totalling eight sessions), completing up to 15 sessions of training. There were also differing opinions about the appropriateness, likelihood of engagement, and utility of mHealth ApBM with certain age groups. mHealth apps were suggested to be especially suitable to younger adults due to their increased familiarity with technology and gamification. Whilst there was recognition that older adulthood in particular brought unique challenges for increased consumption (e.g. retirement, loneliness, boredom), there were questions as to the appeal, suitability, and effectiveness of mHealth technological interventions in “somebody post 50” years and older (P06). Some also raised doubts on whether the same mechanisms of behaviour change would hold across the lifespan. Overall, however, there was a consensus that this novel ApBM mHealth intervention would be best used as an adjunct to other therapeutic tools rather than as a standalone intervention. Participants noted that “[…]drinking disorder is a complex problem, so[…]it needs a complex solution” (P11), and that this intervention therefore may best function as a “tool in the toolkit” (P16). Finally, specific practical adaptations for subsequent app iterations were suggested (Table 2).

4. Discussion

This is the first study to characterise participants’ experiences of using a personalised, novel mHealth ApBM intervention targeting harmful/hazardous alcohol use. Qualitative analysis enabled a deeper understanding of factors that may contribute to end-user engagement and satisfaction, informing future app-iterations as guided by co-design principles. The findings offer nuanced insights into the implementation and impact of a novel cognitive intervention and suggest that mHealth ApBM is an acceptable approach to addressing alcohol issues in those who are motivated to change, complementing existing international literature on ApBM as a supportive tool for alcohol use (Ebehi et al., 2013; Rinck et al., 2018; Salesnik et al., 2021; Wiers, Gladwin, Hofmann, Salesnik, & Ridderinkhof, 2013). Themes have potential transferability for subsequent mHealth designs and are likely to be relevant to the implementation of ApBM in clinical and community-based settings more broadly.

In accord with previous literature (Prior et al., 2020), analyses
Table 2
Practical suggestions for the future development of mHealth applications.

| Category | Suggestions for future development |
|----------|-----------------------------------|
| Technical Issues | Address bugs/glitches, Increase font size |
| App Design | Remove lockout feature, Enhance clarity of instructions, particularly re: irrelevant feature response and incongruent trials, Change timeline follow-back alcohol reporting to facilitate recall and/or include drinks counter, Increase frequency/consistency of in-app reminders, Increase flexibility over picture selection, Increased clarity re: ability to upload own pictures, Deliver training over a longer period to consolidate learning +/- consider booster sessions, Alter gamification to increase task relevance +/- include peer accountability, Include FAQ’s to support perceived self-efficacy of the end-user |
| Scope for future research | Explore task relevant versus irrelevant design, Explore feasibility, acceptability & preliminary efficacy of training in older adults, Explore length of training & inclusion of booster sessions on outcome, Qualitative research to further elucidate behaviour-change mechanisms, Randomised control design to determine clinical efficacy |

suggest that participants generally respond positively to the simplicity and brevity of mHealth ApBM training. Many reflected that the training was intuitive and engaging, which contrasts earlier work criticising traditional ApBM as ‘monotonous’ and ‘boring’ (Beard, Weisberg, & Primack, 2012). It may be that the delivery of training through smartphone enhances engagement and accessibility. The perception of the touch screen/swiping design as ‘intuitive’ suggests mHealth delivery may enable naturalistic arm flexion and extension having discernible effects, associated with positive attitudes/approach and negative attitudes/avoidance, respectively (Cacioppo, Priester, & Bersno, 1993). In keeping with more recent recommendations (Verdejo-Garcia et al., 2019), an intervention that enabled a flexible training schedule and personalisation of content was of great importance to consumers. This allowed participants to utilise principles of ‘habit stacking’, where a new behaviour is stacked on top of a routinised pre-existing behaviour (i.e. ‘habit’) to enable ready-adoptions of new behaviour, with less cognitive effort (Scott, 2017). Additionally, customisable digital media encouraged participants to take a more active role in the intervention process, with changes to drinking awareness and behaviour extending beyond training into the ‘real world’ for some. This supports earlier work (Norman, 2009), and highlights the importance of personalisation to support learning transfer. App engagement also appeared to be impacted by how readily the intervention and broader environment supported participants’ autonomy and perceived self-efficacy. The importance of clear instructions and training rationale was highlighted, in keeping with previous research (Neale, Tompkins, & Strang, 2015) and this may feed into participants’ understanding of threat and coping appraisals, enhancing self-efficacy, and in turn influencing behavioural intentions (Milne, Orbell, & Sheeran, 2002). Indeed, earlier social cognitive models have suggested that increased self-efficacy may predict intentions (Bandura, 1977; Fishbein, 2009; Prochaska & Velicer, 1997; Tolma, Reining, Evans, & Ureda, 2006).

Whilst the concept of motivation within the ApBM field is not novel (Wiers et al., 2018a, 2018b), findings highlight the complex, multifaceted and dynamic nature of motivation and its role in behaviour change. Within the current study, and at the level of the individual, the pursuit of novel therapeutic interventions for hazardous alcohol use fundamentally stemmed from motivation to change behaviour, with all participants concerned about their alcohol consumption, looking to either reduce or abstain from drinking, and endorsing very high ratings with respect to their ‘readiness’ to change at baseline. Although this is in keeping with earlier research in the field (Wiers, Boffo, & Field, 2018b), it raises the question of whether mHealth ApBM training serves to offer additional benefit, over and above participants’ baseline motivation. To some extent, qualitative feedback from this study suggests training at least maintained baseline engagement and motivation to change drinking behaviour, perhaps through increased drinking awareness and self-monitoring, which would support earlier research in this area (Gass et al., 2021). The training process may also serve to mitigate ‘state-based’ lapses (‘slips of action’) in motivation (Dickinson, 1985), momentarily calming or distracting individuals from alcohol-related cravings, thereby interrupting the alcohol ‘autopilot’. This may be especially useful given current analyses suggest there are fluctuations in motivation, even amongst those endorsing a high readiness to change at baseline, with motivation to reduce alcohol consumption waning more noticeably in the afternoons or festive period (i.e. Christmas / New Year). The mobile-delivered aspect of this training lends itself well to these fluctuations, serving as a ‘just in time’ intervention that can be adapted according to personal preference (Perski et al., 2021; Zech, Rotteveel, & van Dijk, 2020).

Over and above the initial motivation to reduce alcohol consumption, personalised ApBM training may also enhance motivation to approach alternative behaviours with positive consequences (e.g. time with family, exercise, saving money, maximising health etc). Findings not only highlight the value of including goal-directed stimuli within the training, they also suggest participants are taking more purposive actions, guided by goals and consequences (i.e. via processes of ‘top-down’ reflection) when it comes to alterations in approach-avoidance behaviours. Although ApBM has traditionally been conceptualised as a ‘bottom up’ implicit method of behavioural intervention, findings in part support Wiers and colleagues’ (2020) more recent ABC model which suggests that ‘inferential processes, rather than associative processes, may underpin behaviour and behaviour change. Nonetheless, qualitative feedback indicates that the degree to which inferential processes can be readily applied may vary according to broader individual and contextual factors, at least in the initial stages of behaviour change, with longer-term behavioural consequences most effectively considered where activating events (i.e. antecedents) are less likely to interfere, and hence cognitive load is minimised. Whether this is because such antecedences lead to an active shift of participants’ short term goals in the moment (e.g. wanting alcohol to relax, connect with friends etc) versus a more implicit dissociation between knowing and doing (i.e. frontal lobe paradox (Newsdell, Lewis, Rodrique-Davies, Heirene, & John, 2022), which can arise in the setting of alcohol-related cognitive impairment (Walsh, 1994) remains to be seen, and future qualitative research could look to explore underlying thought patterns and carer perspectives to tease this apart further. Relatedly, it was also interesting to note participants’ poor understanding of the irrelevant-feature task design, which subsequently had negative effects upon training engagement. This design was selected to enable implicit training (i.e. where participants are not consciously focusing on the outcome), replicating earlier work (Wiers et al., 2011), with incongruent trials thought to increase concentration and engagement. Current findings do not necessarily support these assumptions, and perhaps speak to a broader issue worthy of consideration within the ApBM field. Indeed, there is some suggestion that irrelevant-feature methods of assessing approach bias lead to spurious outcomes, predominantly dictated by data processing methods (Kalveci, 2021). However, literature to date has been relatively quiet with respect to the advantages and disadvantages of relevant (i.e. explicit instructions to swipe accordingly to content) versus irrelevant feature design in relation to ApBM training. Findings also raise questions as to training design; that is, if ApBM is in some way enabling ‘top down’ cognitive processes, then the usefulness of an implicit, irrelevant-feature design is questionable.

Beyond state-based changes to motivation, delayed alcohol seeking with opportunities for active reflection may in turn lead to more
generalised (i.e. trait-based) changes in motivation and behaviour. Training seemed to enable active reflection and conscious de-valuation of alcohol cues outside of the training period for some, which aligns with more recent theoretical debates within the field (Hogarth & Field, 2020; Wiers et al., 2020). Indeed, our earlier qualitative work found significant reductions in alcohol consumption persisted one-month after training among those who completed follow-up (Manning et al., 2021). This is consistent with the broader literature where durability of effects have been found with ApBM when delivered via a laptop and joystick with patients at 3-months post inpatient withdrawal (Manning et al., 2022) and 12-months when delivered to those in residential treatment (Eberl et al., 2013; Wiers et al., 2011). A multi-factorial design, with inclusion of passive/objective alcohol consumption measures (e.g. skin conductance, BAC) and subjective reports of motivation to change (e.g. readiness rulers) pre/post session should be implemented in future research to tease apart whether changes are due to training effects or other non-specific factors. The durability of mHealth delivered ApBM beyond one month also remains to be seen, with some participants indicating reduced maintenance of effects between 1.5 and 4 months post-training cessation at the time of qualitative interviews. With these participants largely completing the recommended training dose, and up to 15 training sessions, findings highlight that future mHealth ApBM iterations should consider not just the ideal number of sessions to optimise training effects (Boffo et al., 2019; Eberl et al., 2013), but broader factors suggested to impact habit formation, including duration of training, intensity of training and consolidation periods, and schedule of rewards. Additional ‘booster’ sessions may be needed after a period of four weeks to extend immediate gains (Kelly et al., 2014; Nguyen et al., 2019). Future research could also explore whether training effects are optimised with gradual fading of training intensity, and progressively longer periods of behavioural consolidation between sessions. Participants’ recommendation to change training stimuli raises the possibility that rewards (i.e. images of positive goal-directed stimuli) need to be delivered variably to ensure they are impervious to de-valuation over time (Dickinson, 1985). With sufficient dosage and intensity of training, variable rewards, and progressive fading of cues, it may be that what starts out as conscious goal-directed instrumentality, with time, becomes a more habitual action (Dickinson, 1985). That is, training may function as a ‘circuit breaker’ in the cycle of excessive drinking (i.e. state-based changes), interrupting the alcohol ‘autopilot’ and ‘buying time’ prior to consumption to enable greater opportunities for reflexive processing, which for some, may lead to more generalised and longer-term behavioural change.

Conclusions drawn from the present study should be viewed in light of the following limitations. We recognise that findings of consumer experiences may be biased towards those with more positive experiences by virtue of the fact that only those who completed the post-training follow-up (and hence were likely more engaged and motivated) were invited to complete a qualitative interview. Poor retention has been a major challenge in the mHealth field to date (Amagai, Pila, Kaat, Nowinski, & Gershon, 2022; Reis & Zhang, 2020; Torous, Lipschitz, Ng, & Firth, 2020), and whilst we had considered inviting all participants to engage in qualitative interviews at sign-up, we did not want additional requirements for engagement to deter participants from commencing training, as flagged during our initial consumer consultation phase (Manning et al., 2021). In order to capture the full spectrum of facilitators and barriers to mHealth ApBM engagement, experiences of those who dropped out were also explored. Participants within the current study were also drinking at hazardous/harmful levels, and whether outcomes hold for a sample with less significant alcohol consumption remains to be seen. Earlier research suggests ApBM may not be as effective in student samples with less significant alcohol consumption and who are not motivated to change (Wiers et al., 2018b), however it is also possible that less significant alcohol consumption may be cognitively protective (Mende, 2019), thereby enabling individuals to more readily implement inferential processes to facilitate durable behaviour change, even in the face of activating alcohol cues. The harmful levels of alcohol consumption in a non-treatment seeking sample nonetheless aligns with previous literature (Ritter et al., 2019) and exemplifies the need to develop accessible support options for people in the community. Since this study was conducted in Australia, where alcohol cues are ubiquitous, the broader impact of socio-cultural factors on both drinking patterns and scope for behaviour change should also be considered. Qualitative feedback in part speaks to cultural impacts upon alcohol use, namely the challenges of reducing alcohol consumption across the Australian Christmas and New Year period, where alcohol is commonly consumed for social/celebratory purposes. We also recognise that through email communication, participants had potential to be alerted to the clinician-researcher’s role as ‘psychologist’, and it is possible this shifted the participant-researcher relationship, as has been noted previously (Richards & Emslie, 2000). We attempted to divert social desirability responding with the use of neutral, non-leading questioning. Furthermore, due to practical considerations and potential for a further ‘power paradox’ to emerge (Motulsky, 2021), this study did not employ member checking (i.e. respondent validation post-analysis).

The clinical implications of the current study suggest that individuals with hazardous alcohol consumption might stand to gain more from an intervention which enables autonomy and improves self-efficacy beliefs, encouraging active reflection of consequences of alcohol consumption and alternate goal-directed behaviours. Practically speaking, this requires a flexible, adaptable mHealth design with clear explanations and a training rationale which highlights the necessity of repetition and persistence (Beard et al., 2012). Additional strategies to enhance end-user engagement might include use of customisable and intuitive content and incorporating compensatory strategies such as tracking charts, prompts, and reminders to support retrospective and prospective memory function. Overall, this mHealth ApBM intervention is novel and meets an important gap in the field. Findings suggest it holds promise as a useful, accessible support tool for adults in the community drinking at hazardous levels and looking to reduce their alcohol use. Future mHealth design iterations should seek to maximise end-user autonomy and perceived self-efficacy, with a view to enhancing engagement and motivation. Exploration of whether positive training effects are contingent upon continued app use, or whether more persistent trait-based behavioural changes may be facilitated by implementation of ‘booster sessions’, fading of training dosage over time, or a combination of these factors, would be worthwhile. The next step will be to conduct a randomised controlled trial to evaluate the efficacy of training in reducing alcohol use and cravings, as well as exploring the feasibility and acceptability of mHealth ApBM across the lifespan.

Role of Funding Sources
Funding for this study was provided by The Australian Rechabite Foundation (ARF). ARF had no role in the study design, collection, analysis, interpretation, or preparation of this work.

CRediT authorship contribution statement
G.L. Bolt: Conceptualization, Methodology, Investigation, Formal analysis, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration. H. Piercy: Conceptualization, Methodology, Investigation, Formal analysis, Resources, Writing – review & editing, Project administration. A. Barnett: Methodology, Investigation, Formal analysis, Resources, Writing – review & editing. V. Manning: Conceptualization, Methodology, Formal analysis, Resources, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest
The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: VM and HP are Directors and shareholders of Cognitive Training...
Solutions Pty Ltd, which recently began commercialising the ‘SWIPE’ app, which is a later and modified version of the ApBP app used in the published pilot study on which these qualitative findings are based. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data availability
The data that has been used is confidential.

References
AIHW. (2021). Alcohol and other drug treatment services in Australia annual report https://www.aihw.gov.au/reports/alcohol-other-drug-treatment-services/alcohol-other-drug-treatment-services-australia.

Aragami, S., Pila, S., Kaat, A., Nowinski, C., & Gershon, R. (2022). Challenges in everyday functioning of healthy older adults: A systematic review and meta-analysis. Frontiers in psychiatry, 13(9), 218. https://doi.org/10.3389/fpsyt.2021.1007383

Beard, C., Weisberg, R., & Primack, J. (2012). Socially Anxious Primary Care Patient attitudes towards Cognitive Bias Modification (CBM): A Qualitative Study. Qualitative Research in Sport, Exercise and Health, 13(3), 320-329. https://doi.org/10.1080/2159676X.2019.1628806

Braun, V., & Clarke, V. (2021a). One size fits all? What counts as quality practice in reflexive thematic analysis. Journal of Research in Sport, Exercise and Health, 11(4), 589-597. https://doi.org/10.1080/2159676X.2020.1769238

Braun, V., & Clarke, V. (2021b). To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. Qualitative Research in Sport, Exercise and Health, 13(2), 201-216. https://doi.org/10.1080/2159676X.2019.1704846

Caccipollo, T. J., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitude: II. Arm flexion and extension have differential effects on attitudes. Journal of Personality and Social Psychology, 65(1), 3-14. https://doi.org/10.1037/0022-3514.65.1.3

Colbert, S., Thornton, L., & Richmond, R. (2020). Smartphone apps for managing alcohol consumption: A literature review. Addiction Science & Clinical Practice, 15(1).

Crane, D., Garnett, C., Mitchie, S., West, R., & Brown, J. (2018). A smartphone app to reduce excessive alcohol consumption: Identifying the effectiveness of intervention components in a factorial randomised control trial. Scientific Reports, 8(1), 4284-4311. https://doi.org/10.1038/s41598-018-22420-8

Cristea, I. A., Kok, R., & Cuypers, P. (2016). The effectiveness of cognitive bias modification interventions for substance addictions: A meta-analysis. PLoS ONE, 11(9), e0162226. https://doi.org/10.1371/journal.pone.0162226

Deloiux, J. (2019). Mobile Game Survey: The Australian, K. Saleh, E. F. S. Wiers, R. W. (2016). Approach bias modification in alcohol dependence: Do clinical effects replicate and for whom does it work best? Developmental Cognitive Neuroscience, 43, 48-51. https://doi.org/10.1016/j.dcn.2012.11.002

Field, M., Kierman, A., Eastwood, B., & Child, R. (2008). Rapid approach responses to alcohol cues in heavy drinkers. Journal of Behavioural Therapy & Experimental Psychiatry, 39, 209-218. https://doi.org/10.1016/j.jbtep.2007.06.001

Fishbein, M. (2009). An integrative model for behaviour prediction and its application to health promotion. In Emerging theories in health promotion practice and research (pp. 215–234). Jossey-Bass/Wiley. Hoboken.

Gass, J., Funderburk, J., Shepardson, R., Kosiba, J., Rodriguez, L., & Maisto, S. (2021). The use and impact of self-monitoring on substance use outcomes: A descriptive systematic review. Subst Use Misuse, 40(4), 512. https://doi.org/10.1080/10826084.2019.1675858

Griswold, M. G., Gass, J., Funderburk, J., Shepardson, R., Kosiba, J., Rodriguez, L., & Maisto, S. (2021). The use and impact of self-monitoring on substance use outcomes: A descriptive systematic review. Substance Use and Misuse, 40(4), 512. https://doi.org/10.1080/10826084.2019.1675858

Griswold, M. G., Borsari, B., Levine, M. J., Li, S., Lamberson, K. A., & Matta, L. A. (2017). A Randomized Clinical Trial. JAMA Psychiatry, 74(2), 133-140. https://doi.org/10.1001/jamapsychiatry.2016.5888

Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample Size in Qualitative Interview Studies: Guided by Information Power. Qualitative Health Research, 26(13), 1753-1760. https://doi.org/10.1177/1049732316648444

Manning, V., Girafel, J. B., Reynolds, J., Staiger, P., Pierry, H., Bonomo, V., Luhman, D. (2002). Alcohol use in the year following approach bias modification during inpatient withdrawal: Secondary outcomes from a double-blind, multi-site randomised controlled trial. Addiction, 117.

Manning, V., Garfield, J. B. S., Clark, S. G., Andrabii, M. N., & Luhman, D. (2013). A Personalized Digital Approach Bias Modification Smartphone App (“SBM”) to Reduce Alcohol Use: Open-Label Feasibility, Acceptability, and Preliminary Effectiveness Study. JMIR Mhealth Uhealth, 1(2), e13153. https://doi.org/10.2196/mhealth.13153

Mende, M. (2019). Alcohol in the Aging Brain - The interplay between alcohol consumption, cognitive decline, and the cardiovascular system. Frontiers in Neuroscience, 13(713).

Milne, S., Orbell, S., & Sheeran, P. (2002). Combining motivational and volitional interventions to promote exercise participation: Protection motivation theory and implementation intentions. British Journal of Health Psychology, 7, 163-184.

Motulsky, S. (2021). Is member checking the gold standard of quality in qualitative research. Qualitative Research, 8(3), 389-400. https://doi.org/10.1080/14780887.2017.1303556

Neale, J. (2016). Iterative categorization (OC): A systematic technique for analysing qualitative data. Addiction, 111(6), 1096-1106. https://doi.org/10.1111/add.13141

Neale, J., Tompkins, C., & Strang, J. (2015). Qualitative evaluation of a novel contingency management-related intervention for patients receiving supervised injectable opioid treatment. Addiction, 111(9), 1619-1630. https://doi.org/10.1111/add.13141

Parker, A. J., Ebert, E., Naughton, F., Heider, J. J., Brown, J., & Businelle, M. (2021). Technology-mediated just in time adaptive interventions (JITaIs) to reduce harmful substance use: A systematic review. Addictive Behaviors, 117(5), 1220-1241.

Perski, O., Hebert, E., Naughton, F., & Businelle, M. (2021). Technology-mediated just in time adaptive interventions (JITaIs) to reduce harmful substance use: A systematic review. Addictive Behaviors, 117(5), 1220-1241.

Perski, O., Hebert, E., Naughton, F., & Businelle, M. (2021). Technology-mediated just in time adaptive interventions (JITaIs) to reduce harmful substance use: A systematic review. Addictive Behaviors, 117(5), 1220-1241.

Perski, O., Hebert, E., Naughton, F., & Businelle, M. (2021). Technology-mediated just in time adaptive interventions (JITaIs) to reduce harmful substance use: A systematic review. Addictive Behaviors, 117(5), 1220-1241.
