Psychology of Sport & Exercise 41 (2019) 162–171

Contents lists available at ScienceDirect

Psychology of Sport & Exercise

journal homepage: www.elsevier.com/locate/psychsport

Registered Report

Formative work in the development of a physical activity smartphone app targeted for patients with alcohol use disorders

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ARTICLE INFO

Keywords:
Alcohol use disorders
Physical activity
Exercise
Smartphone app
Usability studies

ABSTRACT

Objectives: Alcohol use disorders (AUDs) are associated with significant physical and mental health concerns. Interventions focused on increasing physical activity (PA) in this population may improve overall physical and mental health associated with AUDs. Given how ubiquitous smartphones have become, PA apps may be a feasible, acceptable, and potentially scalable approach to integrating PA in alcohol recovery. To date, there are no PA apps targeted specifically for this population.

Design: The current study describes 2 formative phases in the development of Fit&Sober, a theory-informed smartphone app designed to increase PA in patients with alcohol dependence.

Methods: Phase 1 consisted of questionnaires and focus groups (3 groups with total N = 23) conducted with patients in current AUD treatment regarding their preferences and feedback on the proposed app design and components. Phase 2 consisted of individual usability sessions (N = 10) conducted with a different set of patients with AUD, in which feedback was provided on the look, usability, and functionality of the Fit&Sober app prototype.

Results: Phase 1 evaluated key components of a physical activity app designed especially for increasing PA in early recovery and refined app features such as the logo, graphical display of data, and specific physical activity-relevant affect words to be used in the app. Phase 2 usability studies provided support for usability, attractiveness, and potential usefulness in the target population.

Conclusions: Through the iterative 2-phase process, a prototype of the Fit&Sober app was created and readied for pilot testing in patients with AUD.

1. Introduction

Alcohol Use Disorders (AUDs) are a significant and costly public health problem (Sacks, Gonzales, Bouchery, Tomedi, & Brewer, 2015). The lifetime prevalence rate for an AUD is 30.3% among adults in the U.S. and 8.5% have an AUD in the past 12 months (Hasin, Stinson, Ogburn, & Grant, 2007). AUDs are the third leading preventable cause of death in the U.S. (Mokdad, Marks, Stroup, & Gerberding, 2004). Individuals with AUDs, particularly those with more severe dependence, can experience significant medical comorbidities (Rehm, Gmel, Sempos, & Trevisan, 2003), struggle with concomitant psychological and cognitive dysfunction, and are at high risk for relapse following treatment (Anton et al., 2006; Xie, McHugo, Fox, & Drake, 2005). Therefore, adjunctive treatment efforts to improve physical and mental health and drinking outcomes are critically needed.

Though relatively unexplored, there have been a number of studies examining physical activity (PA) as one such intervention approach among individuals with AUD (Hallgren, Vancampfort, Giesen, Lundin, & Stubbs, 2017). While studies in the general population show a positive correlation between alcohol consumption and physical activity levels (Conroy et al., 2015), this association is not evident at higher levels of problem alcohol use, particularly alcohol dependence (Lisha, Sussman, Fapa, & Leventhal, 2013). While epidemiological data on the rates of physical inactivity among individuals with AUD are lacking, in

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https://doi.org/10.1016/j.psychsport.2018.02.007
Received 15 October 2017; Received in revised form 13 February 2018; Accepted 14 February 2018
Available online 19 February 2018
1469-0292/

samples of patients receiving outpatient addiction treatment (a number of whom had alcohol use problems), most patients (e.g., over 70%) were NOT regularly engaging in physical activity (Abrantes et al., 2011; Weinstock, Barry, & Petry, 2008). In addition to improved physical health, it has been proposed that targeting physical activity in patients with AUDs may lead to decreases in depressive symptoms, improved coping, better cognitive functioning, sleep improvements, and decreased alcohol cravings (Abrantes, Matsko, Wolfe, & Brown, 2013), which, in turn, could decrease relapse risk as well.

To date, physical activity interventions in patients with AUDs have shown improvements in cardiorespiratory fitness (Brown et al., 2014; Ermalinski, Hanson, Lubin, Thornby, & Nahormek, 1997; Sinyor, Brown, Rostant, & Seraganian, 1982), psychological functioning (Abrantes et al., 2017; Brown et al., 2014; Palmer, Vacc, & Epstein, 1988; Roessler et al., 2013), and, to a lesser degree, drinking outcomes (Brown et al., 2014; Sinyor et al., 1982) have been observed for patients who exercised. However, many of these studies were conducted in the context of inpatient/residential alcohol treatment programs, interventions were fairly brief (e.g., 4–6 weeks), corresponding to the length of inpatient stays and often supervised, occurring 3–5x per week. Among the few exercise intervention studies conducted with outpatients with AUDs (Abrantes et al., 2017; Brown et al., 2014, 2009; Roessler et al., 2013) the most benefits in terms of drinking outcomes, cardiorespiratory fitness, and improved depression were from participants who adhered to the intervention.

However, as is the case in the general population (Hallal et al., 2012), adherence to PA among individuals with AUDs has been a challenge (Hallgren et al., 2017). Therefore, while this early work demonstrates an interest among patients with AUDs for increasing physical activity in early recovery and has produced promising findings with respect to fitness and depression as well as drinking outcomes, a great deal still needs to be done to address existing gaps in the literature and advance this important research area. For example, little, if any, attention has been given to understanding potential mechanisms through theoretical frameworks. Further, with few exceptions (e.g., (Weinstock, Capizzi, Weber, Pescatello, & Petry, 2014)) little attention was given to physical activity preferences of patients when developing exercise programs; rather, prescribed exercise regimens were utilized. Importantly, the use of technology to help support early intervention effects and increase motivation has been nonexistent in trials to date.

Utilizing technology (e.g., activity monitors and smartphones) to support these physical activity interventions has numerous advantages. For example, while self-monitoring of activity behaviors is one of the most effective strategies for increasing PA (Michie, Abraham, Whittington, McAteer, & Gupta, 2009), it is often burdensome for individuals, leading to poor adherence. Activity monitors and smartphone apps may help to facilitate self-monitoring because they are easy and convenient (i.e., people usually have their phones with them) (Kirwan et al., 2013). These technologies also allow self-monitoring to occur in a manner that is efficient, interactive, and tailored in content (Ritterband, Thorndike, Cox, Kovatchev, & Gonder-Frederick, 2009). An additional advantage of activity monitors and smartphone apps is increased precision of objectively determined physical activity levels (Graham & Hipp, 2014). With more precise information on PA, users are able to determine whether they are exercising at a level consistent with their goals. In turn, accurate PA measurements collected from these devices can be utilized to produce individualized feedback on progress toward goal achievement. Another advantage of utilizing technology to deliver PA interventions, particularly relevant to a patient population with AUDs, is the lack of expertise and formal education in delivering such interventions by mental health and addiction treatment providers (McEntee & Halgin, 1996; Phongsavan, Merom, Bauman, & Wagner, 2007). While most providers believe in the benefits of PA, their lack of knowledge in how to engage patients in increasing their levels of physical activity contributes to low rates of direct PA recommendations (Phongsavan et al., 2007). Therefore, smartphone technology could enable the delivery of evidence-based interventions without the costly, time-consuming approaches to training clinicians (Litvin, Abrantes, & Brown, 2013).

The number of commercially available smartphone physical activity apps has grown exponentially over the last decade. However, only a small number have been empirically tested and none have been examined among patients with AUDs. A meta-analysis of smartphone-based PA interventions found a significant overall mean moderate effect size of $g = .54$ for increased PA (Fanning, Mullen, & McAuley, 2012) despite the lack of theory-based PA strategies (Cowan et al., 2013; Direito et al., 2014; Middelweerd, Mollee, van der Wal, Brug, & Te Velde, 2014). For example, in a recent content analysis of 127 PA apps, an instrument designed to evaluate the theoretical content of PA interventions was used to code the various strategies in each app and determined that existing PA apps only included minimal theoretical content (Cowan et al., 2013). While most existing PA apps do include goal-setting, self-monitoring, and feedback, other important theory-based strategies have been missing – such as time management, relapse prevention, stress management, identifying barriers, and social supports (Cowan et al., 2013; Middelweerd, Mollee, van der Wal, Brug, & Velde, 2014). This is a significant limitation because, the more theory-based strategies (e.g., self-monitoring plus feedback vs. self-monitoring only), the greater the usage rates of PA apps (Bort-Roig, Gilson, Puig-Ribera, Contreras, & Trost, 2014) and the more effective they are at increasing PA in general (Foster, Richards, Thorogood, & Hillsdon, 2013; Noar & Mehrotra, 2011; Webb, Joseph, Yardley, & Michie, 2010).

Therefore, a physical activity app that is informed by theory and targeted for patients with AUDs may ultimately result in the better rates of sustained, long-term engagement in PA. We selected two of the more commonly employed theories in PA intervention to guide the development of a novel app: Fit&Sober. Specifically, we utilized Social Cognitive Theory (SCT; Bandura, 1998) and Self-Determination Theory (SDT; Ryan & Deci, 2000). SCT posits that PA will increase when self-efficacy (belief that one can do a behavior) and positive outcome expectancies (belief that good things will occur as a result of doing that behavior) are increased. Key PA intervention components that are effective in increasing PA and are consistent with SCT include: providing education on benefits of PA, self-monitoring, goal-setting, personalized feedback, skill-building through practice, and problem-solving barriers (Ashford, Edmunds, & French, 2010; Bird et al., 2013; Olander et al., 2013; Williams & French, 2011). Whereas the key concept of SCT is self-efficacy, SDT is a theory of motivation. According to SDT, what drives motivation – perceived locus of causality (PLOC) – comes from either external (e.g., outside the self) or internal sources (the self initiates and maintains behavior). There are 2 overarching types of motivation: intrinsic (doing something for its own sake and for the pleasure it provides) and extrinsic (doing something to achieve a specific outcome). While both external and internal motivation can lead to PA initiation, SDT posits that it is internalized, self-determined motivation (achieved through increases in autonomy, competence, and relatedness) that will lead to long-term adherence to PA (Teixeira, Carraca, Markland, Silva, & Ryan, 2012). Therefore strategies that can connect PA to intrinsic, value-based goals (e.g., maintaining sobriety) may be important to maintain long-term PA in patients with AUDs.

The purpose of this study was to conduct formative work essential to developing a theoretically-informed smartphone physical activity app (Fit&Sober) targeted for patients with AUDs in early recovery. Two phases of this work will be presented. Phase 1 consisted of questionnaires and focus groups conducted with patients in current AUD treatment regarding their preferences and feedback on the proposed app design and components. Upon completion of Phase 1 and review of results from each component of the focus group sessions, in collaboration with the software designer, the team finalized decisions regarding the prototype of the Fit&Sober app that was to be subsequently tested in Phase 2. Phase 2 consisted of usability sessions conducted with a different set of patients with AUD, where feedback was provided on

the look, usability, and functionality of the Fit&Sober app prototype.

2. Phase 1 method

2.1. Participants and procedures

Prior to conducting the study, all study procedures and methods were approved by the Butler Hospital Institutional Review Board. Patients currently receiving intensive outpatient treatment for an AUD at Butler Hospital's Alcohol and Drug Partial Hospitalization program (ADP) were recruited to participate in a brief focus group interview to discuss the development of a physical activity app for individuals with AUDs. Patients at ADP attend the program from Monday through Friday, 9:00am-3:30pm for 5–10 days. The program includes group therapy, individual therapy with a licensed mental health worker, medication management with an attending psychiatrist, and aftercare planning. Previous research in ADP demonstrates that patients who attend ADP for alcohol treatment are heavy, problematic drinkers, reporting 60 drinks consumed per typical week and report negative consequences well above the cut-off for problematic use (Blevins, Abrantes, Kurth, Gordon, & Stein, 2017). Additionally, patients at ADP report elevations in anxiety and depression, and most meet diagnostic criteria for a mood or anxiety disorder.

During one of their treatment groups, an announcement was made about participating in a focus group involving the development of a physical activity app for patients with AUDs. If participants did not have a conflict (e.g., an appointment with their counselor or physician) at the scheduled focus group time, they were invited to attend. Interested individuals, irrespective of current PA levels, were screened and clinical charts verified to ensure that they had a primary diagnosis of AUD (as this was a program that included both alcohol and drug dependent patients). Participation in the focus group session included completing questionnaires and discussing responses to several open-ended questions in a group format. A total of 3 focus groups, with independent samples of patients, were conducted over the course of several months. Focus group sessions were performed while patients were still enrolled in the ADP program during the scheduled lunchtime break, so as not to disrupt scheduled treatment program's clinical appointments and therapy groups. At the beginning of each session, informed consent was obtained for each participant. Then, participants were given a questionnaire packet and were allotted 15 min to complete it. Following questionnaire completion, participants engaged in a 30-min group discussion led by 2 researchers (1st and 2nd authors), acting as the group facilitators. At the end of discussion, group facilitators summarized the discussion to the group by highlighting major themes, allowing participants to clarify or add to discussion, as needed.

The focus group interview protocol was revised in an iterative fashion: design components (i.e., aesthetics, User Interface, logos, and graphical presentations of data) were refined based on initial focus group feedback and subsequently evaluated in the next focus group. Each group session lasted one hour or less and participants were compensated $25 for their time. All focus group sessions were audio recorded and transcribed verbatim. Participant responses were reviewed by two raters, who independently summarized major themes regarding the proposed app, as expressed in the various components of the group interview, including questionnaire responses, written transcriptions of the 3 focus group sessions, and written notes recorded by group facilitators.

2.2. Measures

2.2.1. Descriptive characteristics

In addition to demographic characteristics, participants were asked to report on whether or not they owned a smartphone and their current level of physical activity. Physical activity was measured by average duration of weekly physical activity, consistent with the exercise as a "vital sign" literature (Coleman et al., 2012). Participants were asked: 1) Over the last 3 months, on average how many days per week did you exercise? and 2) On those days, on average how many minutes/day did you exercise? Participants were also asked to rate their perceived exertion during exercise (RPE; (Borg, 1970)) on a scale of 6–20: 6 = no exertion at all, 9 = very light, 11 = light, 13 = somewhat hard, 15 = hard, 19 = extremely hard, and 20 = maximal exertion. According to the current literature, moderate-to-vigorous physical activity (MVPA) corresponds to RPE ratings of 12 and above (Ritchie, 2012). For individuals rating their physical activity at an RPE of 12 and above, minutes/day was multiplied by days/week of physical activity to create a variable representing total MVPA per week.

2.2.2. Evaluation of logo design

Recent approaches to evaluating app design have included an aesthetic design component that includes icons and logo design (Arellano, Bochinski, Elias, Houser, & Head, 2012; Stoyanov et al., 2015). Since the initial interaction with the app will be with the logo, we decided to elicit feedback from participants on various designs. Participants in focus groups 1 and 2 evaluated 6 app logos, that were created by a professional graphic designer, on a scale of 1 (don't like it) to 10 (love it). Participants in the final group session, focus group 3, evaluated 9 logos, that included enhanced versions based on feedback obtained from focus groups 1 and 2. Logos varied by colors, fonts, the inclusion of a bodily figure walking/running, image of sneakers, and whether or not the word "sober" was overtly used in the app logo. As an example of the variety of logos participants rated, See Fig. 1 (Logos A, B, C).

2.2.3. Evaluation of data visualization for the acute effects of PA

Consistent with SCT and SDT, bringing awareness to the proximal mood-enhancing, urge-reducing acute effects of PA could help increase motivation for PA (Ekkekakis, Hargreaves, & Parfitt, 2013). To do so, participants rated their preference for 2 different types of data visualization for capturing the acute effects of PA (see Fig. 2 for these images). Participants also answered questions related to their level of understanding of each type of data display. In order to determine which

Fig. 1. Examples of Fit&Sober Logo options provided to participants. Logo A was chosen by participants.

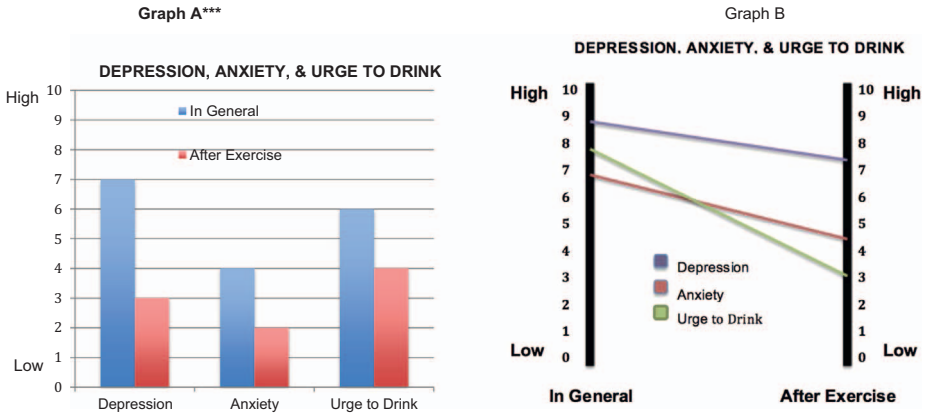

Fig. 2. Examples of mood graph data visualization options. Graph A was chosen by participants.

Table 1
Physical activity affect-related words.

Affect Word	Mean (SD)
Depressed	−2.57 (1.62)
Stressed	−2.63 (1.30)
Urges to Drink	−1.75 (1.28)
Anxious	−1.63 (2.77)
Craving for Alcohol	−1.00 (3.46)
Peaceful	1.00 (2.83)
Tired	1.13 (2.90)
Fatigue	1.25 (2.38)
Calm	1.63 (2.20)
Terrific	1.63 (3.07)
Great	1.75 (2.82)
Good	2.13 (3.00)
Happy	2.13 (3.00)
Strong	2.14 (3.49)
Positive	2.13 (3.04)
Relaxed	2.25 (1.83)
Refreshed	2.88 (2.23)
Enthusiastic	3.13 (1.55)
Energetic	3.13 (1.55)

acute effects were most relevant to this population, participants rated 19 affect-related words (e.g., depressed, stressed, energetic). These words were selected by review of existing affect measures utilized in the physical activity literature (including the Exercise-Induced Feeling Inventory (Gauvin & Rejeski, 1993); The Physical Activity Affect Scale (Lox, Jackson, Tuholski, Wasley, & Treasure, 2000); The Subjective Exercise Experience Scale (McAuley & Courneya, 1994)). Participants were asked to rate the extent to which they expected each affect-related word to change after engaging in physical activity from a scale of −5 (decreases very much) to 5 (increases very much). See Table 1 for a list of the words presented.

2.2.4. Evaluation of PA app components

Participants were presented with a list of 17 app components and asked to rate how important it would be to include that component in an app on a scale of 0 (not important) to 10 (extremely important). Each app component was theoretically-informed by SCT and SDT and specific to an AUD population. Through app features that provide education, display progress toward PA goals, display feedback (e.g., changes in mood with exercise), and encourage social support, increases in key constructs known to influence PA engagement, such as self-efficacy and internal motivation, are expected to occur. These, in turn, would theoretically lead to long-term PA engagement. See Table 2 for a list of the app components that were rated.

2.2.5. Open-ended focus group discussion questions

Group facilitators asked participants a series of open-ended questions related to engaging in PA during early recovery and using an app to help increase PA. See Box 1 for a list of questions.

3. Phase 1 results

3.1. Sample characteristics

A total of 3 focus groups were conducted (Group 1 n = 7, Group 2 n = 8, Group 3 n = 8, Total N = 23). The sample was 43% female and had a mean age of 39.00 years (SD = 12.16). All participants were Caucasian. Most (80%) owned a smartphone. Only 5 participants (21.7%) self-reported exercising at or above the public health recommendations (150 min of MVPA per week).

3.2. Logo preferences

Participants rated the various logos moderately positive (mean score ranging from 3.75 to 7.07). Participants reported a strong preference for NOT including the word “sober” overtly in the app logo, motivated by privacy concerns (e.g., if someone else were to scan the icons on their phone). Of the various logo options presented, the preferred logo was Logo A (Fig. 1), which displays the initials “F” and “S” within the image, yet without overtly spelling the words “Fit” and “Sober”.

3.3. Graphical data display

Participants were presented with several different graphical presentations of data in bar graph and line graph form and asked three questions to determine their level of understanding of the data presented in each display: (1) “Which of the following is highest in general: anxiety, depression, urge to drink?”; (2) “What happens to this person's anxiety level AFTER exercise: it stays the same, it increases, it decreases?”; (3) and “Which of these factors changed the most AFTER exercise: anxiety, depression, urge to drink?” Participants, on average, answered correctly at a similar rate when presented with bar graphs (mean correct = 74.67%, SD = 32.32) and line graphs (mean correct = 73.96%, SD = 33.87). Participants also rated the understandability of graphs (“How difficult was this graph to understand?) on a scale of 1 (not at all) to 10 (very difficult). On average, they rated the bar graphs (M = 2.34, SD = 1.82) as being easier to understand than the line graphs (M = 2.57, SD = 1.57).

3.4. Affect ratings

Table 1 presents results regarding participant ratings of the relevance of various affect words related to acute bouts of PA. Results

Table 2
Theory-informed app components and ratings.

Components	Theory	Mean (SD)
Able to give me specific advice if I feel an urge to drink.	SE, BB, C, SDM	9.24 (1.18)
Able to keep track of how many days I have been sober.	SE, C, G	8.75 (2.45)
Able to show me how my mood changes with exercise.	SE, C, K	8.52 (1.69)
Able to show me how my cravings/urges for alcohol changes with exercise.	SE, C, K	8.29 (2.33)
Sends me notifications to get up and be active if I am spending too much time sitting.	BB, SE	8.19 (2.58)
Able to see my progress toward achieving my exercise goal.	G, K, C	8.14 (2.08)
Allows me to enter my zip code so that it can help me find a local exercise option (e.g., bike path) near me.	BB, K, C, A	7.86 (2.59)
Able to identify my social supports for sobriety.	SE, R	7.86 (2.62)
Provides me with motivational quotes every day.	SE, C, POE	7.84 (2.71)
Provides resources and ideas for ways I can be more physically active.	K, BB	7.76 (3.05)
Able to track steps/day of walking or exercise.	G, K, C	7.20 (2.69)
Able to send my primary care physician a brief report of progress toward sobriety (e.g., day sober).	R, SDM	7.19 (2.46)
Able to track number of minutes/day of exercise.	G, K, C	7.10 (2.69)
Allows me to set my own exercise goals.	A, G	7.05 (2.42)
Able to identify my values and the reasons I am increasing my physical activity.	POE, SDM, A	6.86 (2.61)
Able to identify my social supports for exercise (e.g., someone to exercise with me)	R, A, SDM	6.19 (3.31)
Able to send my primary care physician a brief report of my progress toward exercise goals (e.g., average steps/day).	R, SDM	5.90 (2.72)

Note: SCT Constructs: K = Knowledge/Awareness; G = Goal-setting; BB = Benefits and Barriers; SE = Self-Efficacy; POE = Positive Outcome Expectancies. SDT Constructs: A = Autonomy, C = Competency, R = Relatedness, SDM = Self-determined Motivation.

Box 1
Focus Group Questions.

1. What do you think about increasing physical activity during early recovery?
2. In what way do you think it might be helpful?
3. What do you think about using a smartphone app to help you increase your physical activity?
4. Have you used a physical activity app before? What was that experience like?
5. What would you like to see be a part of a physical activity app that was tailored specifically for individuals like yourself who are in early recovery from alcohol?
6. What did you think of the logos you rated? Did you have any specific reaction to having the word “Sober” in the logo?
7. What did you think of the mood graphs you rated? Did you find one type of graph easier to understand than another?
8. What do you think will be important for us to consider including in the development of the app to increase app usage by future participants?
9. What impressions did you have on the versions of the dashboard? Too much information? Are there other features/information you felt were missing from the Dashboard?

revealed that participants believed that increases in “energetic” (+3.13) and “enthusiastic” (+3.13), would occur after physical activity as well as decreases in “depression” (−2.57), “stress” (−2.63) and “urges to drink” (−1.75).

3.5. App component ratings

Table 2 lists participant mean ratings for each app component. Participants rated several sobriety-related components as the most important: the ability to receive specific advice when experiencing an urge to drink and the ability to keep track of sobriety. They also rated several physical-activity components highly: the ability to see how mood and urges change with exercise, receiving notifications when sedentary, and seeing progress towards physical activity goal achievement.

3.6. Major themes from focus group discussions

Overall, there was high enthusiasm for the Fit&Sober app concept during the focus group discussions. Most participants indicated a desire to increase their physical activity during the early recovery period and indicated that the idea of using an app specifically for alcohol dependent patients was very appealing. Several common themes that arose during the focus groups directly influenced the development of the app prototype. First, participants found the aspects of the app that targeted recovery important to emphasize. As such, we included the following features as part of the app, in order to address this specific interest: a counter showing the number of days sober, ability to search for local AA meetings by connecting to the AA website directly from the Fit&Sober app, and identifying specific recovery supports (e.g., sponsor, doctor). Second, not all participants appreciated the proposed feature of the app that would send a monthly progress report to their treatment providers. Therefore, we elected to make this feature of the app optional and one they could decide to implement on their own from the app. Lastly, there

was interest to provide some "gamification" to the app – in order to help increase engagement with the app. In response to this suggestion, we added a "points system" that was based on different levels of engagement with the app. More specifically, points would be awarded on a weekly basis for updating PA goals, inputting mood after exercise, displaying mood graphs, as well as with engaging with other parts of the app (e.g., updating reasons for exercising). Accumulation of points would lead the user to move up from one level to another (e.g., from novice to warrior). We note that levels are based on engagement with the app, rather than the user's actual PA.

4. Phase 2 methods

4.1. Participants and procedures

Patients who were receiving treatment for AUD in an Alcohol and Drug Partial Hospitalization program (ADP) were recruited to participate in 1-hour long sessions where they evaluated the usability of various features of the Fit&Sober app prototype. A PhD-level research psychologist performed all usability studies. Small samples of 5 individuals are typical for usability studies and have been shown to identify at least 85% of usability problems when developing other technologies (Nielsen, 1993), thus we recruited in increments of 5 until 2 consecutive increments reported usability scores above the cut-off (see below). Similar to Phase 1, sessions were performed onsite at ADP during the lunchtime break, so as not to disrupt regularly scheduled activities in the program. Ten single-participant sessions were completed. At each session, following informed consent, participants were introduced to the Fit&Sober app prototype (see Fig. 3) on a study smartphone and given 5 min to explore features on their own. Participants were then given a set of predetermined tasks to complete while using the app (e.g., entering a mood or craving rating, the activities locator to find local PA resources; See Table 3 for list of tasks). Consistent with a mixed-method approach to testing usability (Jansky & Huang, 2009), participants were audiotaped completing each task while "thinking out loud" such that they verbalized their actions, thoughts, and perceptions of the app (Kirwan et al., 2013). Each task was timed. Participants also completed a questionnaire packet to further evaluate the individual's perception of the app and provided feedback on design, usability, and app components. Participants were compensated $25 for their time. All methods and procedures were approved by Butler Hospital's Institutional Review Board.

4.2. Measures

Participants completed the 10-item, highly reliable (Bangor, Kortum, & Miller, 2008), widely used System Usability Scale (SUS; Brooke, 1996) at the end of the usability session. The range of scores on the SUS is 0–100 and scores 70 and above indicate good usability and satisfaction (Bangor, Kortum, & Miller, 2009). We also evaluated the attractiveness and detail of 8 design features on the app on a scale of 1 (very unattractive/not detailed at all) to 5 (very attractive/very detailed). Participants were asked the ideal number of pop-up notifications that they would receive every day (several per day, 1 per day, several per week, 1 per week, none). Participants were then asked to rate usefulness of the proposed app components on a scale of 1 (not useful at all) to 5 (very useful). Lastly, participants were asked whether or not they would choose to download the app for use on their phone, and also whether or not they would recommend the app to a friend (yes/no). In addition to providing numeric ratings detailed above, participants were given an opportunity to provide additional open-ended feedback on usability, design, content, features to add or remove, and particular likes/dislikes.

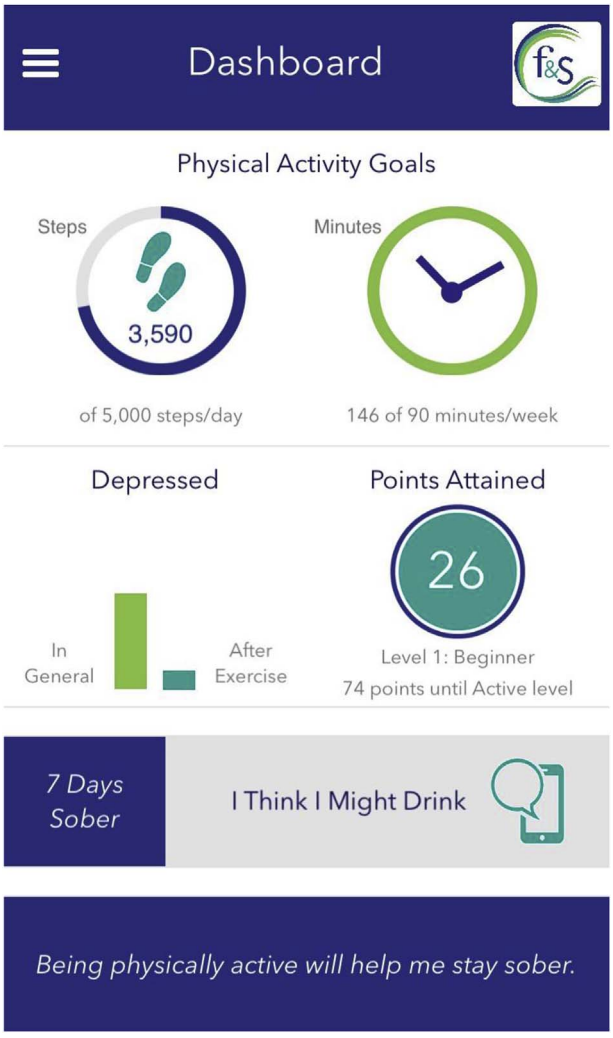

Fig. 3. Fit&Sober dashboard.

5. Phase 2 Results

5.1. Sample characteristics

Ten individuals (50% female) participated in the usability study. The mean age of participants was 38.00 years (SD = 14.63) and all reported being Caucasian. All participants owned a smartphone.

5.2. Usability scores

SUS scores for the first 5 participants (mean = 81.00, SD = 20.66) and second 5 participants (mean = 81.50, SD = 8.94) were above recommended cut-offs of 70. The total mean score was 81.25 (SD = 15.01).

Participants reported the following ratings (on a 1–5 scale) on attractiveness and detail scales: colors in the app (mean = 3.40, SD = .97), fonts (mean = 4.00, SD = .67), layout (mean = 3.80, SD = .79), professional appearance (mean = 4.50, SD = .53), suitability of design (mean = 4.50, SD = .53), overall look (mean = 3.90, SD = .88), overall design (mean = 4.20, SD = .79), and content detail (mean = 4.20, SD = .42). They reported the following ratings on the usefulness scales: physical activity options section (mean = 4.70, SD = .48), sobriety resources section (mean = 4.50, SD = .85), and other app content to help increase physical activity (mean = 4.30, SD = .48).

The majority of participants (70%) indicated that the ideal number

Table 3
Usability tasks.

1. Imagine that it is Monday morning and you successfully completed your step count goal for the previous week. You realize that you want to challenge yourself by increasing your step count goal. Please increase the step count from 5000 per day to 5500 per day.
2. You also notice on Monday morning that you exceeded your minutes per week activity goal, so you want to challenge yourself to engage in more PA this week. Please increase your minutes/week PA goal from 90 min/week to 100 min/week.
3. You have an hour to spare before a doctor's appointment and are close to Butler Hospital. Find a local activity that you can engage in while you're waiting for your doctor's appointment.
4. You notice that you entered your sobriety date as the day you entered ADP, but remember that you had a few days sober before you started the program. Please enter your sobriety date as June 26, 2017.
5. You find out that an old friend is in the AA program and has been sober for two years. You already had their phone number listed in your phone, and now realized that they could be supportive in your recovery. Please add "Old Friend" to your sober support list.
6. You get some tough news from a friend and notice that you start having cravings for alcohol. You need some options of what to do to cope with the cravings so that you don't relapse. What options does the app suggest?
7. You remember that you had a really high step count day last week but don't remember what day. Where do you go on the app to find details of the steps you took in the previous week?
8. You took a walk last Saturday that was beautiful and scenic, but you're not sure that you have time today to take the same route. You decide to check your minutes per week of exercise over the last week to see how many minutes of PA you had last Saturday. Where do you go on the app?
9. You realize that your mood has been changing over time as a result of engaging in exercise. You want to see a detailed graph of your mood. Where can you find the graphs of depression, stress, urge to drink, enthusiasm, and energy?
10. You are proud of the progress you've made and you want to show your psychiatrist details of how much you've been engaging in PA. How would you send your psychiatrist a progress report?
11. You haven't filled in your mood ratings for a while and the app reminds you to do so. Where would you go to fill in your ratings?
12. You are excited to level up in the point system on the app. Where do you go to see details about points earned and points until next level?
13. You notice that the app isn't acting right. What would you do if something goes wrong with the app?
14. Your motivations for PA have changed over time. Please delete the other motivations and add these new ones: you now want to be physically active to be healthier, because you have a health condition caused by not being active, and because being physically active will decrease your depression.
15. You notice that you're stuck in the same routine for physical activity and you're interested in trying out something new. Find two new things to do in RI for exercise that you wouldn't normally engage in.
16. You just finished exercising and you want to document how you feel. Where would you go to input your mood ratings on the app?

of notification messages would be one per day. Two participants (20%) indicated that they would like to receive several messages per day from the app, while one participant (10%) indicated that they would prefer several messages per week. Most participants (80%) reported that they would personally choose to download the app so that they could use it on their phone and all participants (100%) reported that they would recommend the app to a friend. Results from timed task trials indicated that participants had relatively little difficulty completing the tasks, spending an average of 9.63 s on each task (SD = 5.96).

6. Conclusions

The current study describes 2 formative phases - including input from our target population and focused usability studies with app prototype - in the development of a physical activity smartphone app targeted for patients with alcohol dependence. Phase 1 consisted of eliciting feedback from patients with alcohol dependence regarding key components of a physical activity app designed especially for increasing PA in early recovery. In addition, feedback from patients was also elicited on specific features of the app such as the logo, graphical display of data, and specific physical activity-relevant affect words to be used in the app. After each of 3 focus group interviews, the Fit&Sober app prototype was iteratively refined, incorporating patient feedback. After Phase 1, through individual usability studies, the prototype of the Fit&Sober app was evaluated in Phase 2 for ease of use, attractiveness and potential usefulness in the target population.

The formative phases described in this study are consistent with the principles of Agile Software Development (ASD; Cockburn, 2006). ASD is increasingly utilized in the development of mHealth applications (van Mierlo et al., 2014), including work led by the Centers for Disease Control (Savel et al., 2013). Unlike the sequential, and inflexible approaches of earlier software development styles, ASD is broadly focused on being incremental, iterative, rapid, and responsive in the context of interdisciplinary collaborations (Cockburn & Highsmith, 2001), resulting in the investigative team having frequent communication with the app developer during the creating of the Fit&Sober app prototype.

Rather than utilize an existing PA app, this formative work was necessary to develop an app for a specific population, in order to increase the likelihood of long-term sustained physical activity. It has been argued that most individuals have been socialized to exercise for health-enhancing, weight loss, and appearance goals (Segar, Eccles, Peck, & Richardson, 2007). Yet, less than half of the population meets the recommended guidelines of physical activity and adherence to PA continues to be a significant public health challenge. SCT and SDT may help to explain why these goals have not been effective in resulting in long-term, sustained physical activity. From the perspective of SCT, these are distal goals and less likely to influence current behavior. And, according to SDT, these goals are externally motivated rather than internally motivated. Indeed, it has been argued that to sustain exercise, personally meaningful goals (rather than cultural or societally driven expectations of exercise) are necessary (Segar, Eccles, & Richardson, 2011). Patients with AUDs in early recovery have unique intrinsic sobriety-related goals and motivations that, if identified, highlighted, and integrated with their PA goals, could lead to greater early use of exercise as well as long-term adherence to physical activity.

For example, the acute benefits of exercise for improving negative affect and decreasing urges and cravings has been compelling in the smoking-exercise literature (Haasova et al., 2014; Roberts, Maddison, Simpson, Bullen, & Prapavessis, 2012). While much less is known about the acute effects of physical activity among individuals with AUDs, there is preliminary evidence, albeit in small uncontrolled studies, for decreases in alcohol cravings immediately after PA (e.g., (Brown, Prince, Minami, & Abrantes, 2016)) and even with brief 10-min bouts of physical activity (Taylor, Oh, & Cullen, 2013; Ussher, Sampuran, Doshi, West, & Drummond, 2004), though these effects can be variable depending on the timing of assessments. As such, there is a need for more research on the acute effects of PA in those with AUDs, including the standardization of when affective/mood assessments are conducted. Yet, if these acute effects are supported, they could be highly relevant for patients in early alcohol recovery given that negative affect and urges/cravings to drink are known to put them at risk for relapse (Abulseoud et al., 2013; Walitzer & Dearing, 2006). Consistent with SCT, if patients with AUDs were to have greater awareness of these immediate benefits of PA on affect and urges, they may be more likely to persist with PA. The self-monitoring + feedback capabilities of smartphone technology could be an ideal approach to help increase the

saliency of these immediate effects for patients with AUDs, and to potentially lead to strategic use of PA "in-the-moment", when alcohol urges arise. Indeed, recent research examining how patients experience smartphone apps for PA found that the process of engaging with the app resulted in a sequential and synergetic process that, in turn, resulted in increased awareness and knowledge of PA, PA goal-setting, feedback, increased confidence in completing PA, and increased investment – or "ownership" – of PA behavior that ultimately transformed patients' relationship with exercise (Casey et al., 2014). Therefore, a smartphone is well-suited to help patients with AUDs make important connections between PA and sobriety that could have synergistic benefits on both long-term sustained PA as well as reduced risk for alcohol relapse.

An important next step will be to pilot the Fit&Sober app in order to examine whether this population will use and find such an app helpful for increasing PA during early recovery. While a smartphone app for increasing physical activity has yet to be developed for patients with AUDs, apps focused on alcohol relapse prevention have been developed and successfully implemented with alcoholics (Cohn, Hunter-Reel, Hagman, & Mitchell, 2011). For example, Giroux, Bacon, King, Dulin, and Gonzalez (2014) conducted a qualitative study of the experiences of individuals with AUDs using an app to decrease drinking that included alcohol-specific psychoeducational content, feedback on alcohol patterns, monitoring high-risk situations, assessment of cravings, and stress management. Participants reported that utilizing the app for 6 weeks helped them increase their awareness of alcohol cravings, that they appreciated prompts to self-monitor drinks and cravings, that the graphical display of weekly feedback kept them on track, and found the information about alternate coping strategies for managing psychological stress very helpful (Giroux et al., 2014). Use of the app was very high in the first week (25 times) and continued use was consistent (accessed 5 ×/week) over the course of the 6-week intervention (Dulin, Gonzalez, & Campbell, 2014). These findings are promising and support the notion that patients with AUDs would use a PA smartphone app that includes similar concepts being included in the Fit&Sober app (e.g., self-monitoring of urges/craving) but focused on increasing physical activity.

There are several limitations that merit discussion. First, our samples were small and given the developmental nature of this work, we did not employ rigorous recruitment criteria for our focus group and usability phases. As such, it is possible we experienced recruitment bias and obtained feedback from patients who had favorable attitudes toward smartphone apps and the use of technology, more generally. Additionally, given the nature of focus groups, it is possible that individuals with differing opinions from the majority did not speak up and that the positive views of the app were not reflective of all participants. Further, the focus of this work was on the long-term use of the Fit&Sober app for patients engaged in alcohol treatment. It is possible that this app would not be appealing for non-treatment seeking populations engaged in heavy drinking (e.g., college students). Relatedly, our sample was limited in racial and ethnic representation. Future work could include testing the Fit&Sober app in a broader array of individuals with AUDs.

In conclusion, given the physical and mental health problems as well as risk for relapse among patients with AUDs, future epidemiological studies on the prevalence rates of public health recommendations for PA as well as intervention efforts to increase physical activity in this population could have a significant public health impact. Given the limited prior research on PA among individuals with AUDs, there is a clear need for PA interventions that are scalable and sustainable, resulting in long-term adherence to PA, which is necessary to maintain healthy outcomes and reduce relapse risk. Smartphone apps have shown promising results for increasing physical activity in other populations but have suffered from the lack of theory-based strategies. This study reports on the formative work conducted in the development of a PA app (Fit&Sober) that is guided by the principals of SCT and SDT to help patients in early recovery capitalize on their sobriety goals and integrate them with PA pursuits. Pilot testing of the Fit&Sober app in patients with alcohol dependence is currently underway (NCT02958280).

Acknowledgements

This work was supported by a grant funded by the National Institute on Alcohol Abuse and Alcoholism (NIAAA; R21 AA024295; PI: Ana M. Abrantes, PhD). NIAAA had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

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