

Smiling Instead of Smoking: Development of a Positive Psychology Smoking Cessation Smartphone App for Non-daily Smokers

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Abstract

Purpose The usefulness of mobile technology in supporting smoking cessation has been demonstrated, but little is known about how smartphone apps could best be leveraged. The purpose of this paper is to describe the program of research that led to the creation of a smoking cessation app for non-daily smokers, so as to stimulate further ideas to create “smart” smartphone apps to support health behavior change.

Method Literature reviews to evaluate the appropriateness of the proposed app, content analyses of existing apps, and smoking cessation sessions with non-daily smokers ($n = 38$) to inform the design of the app.

Results The literature reviews showed that (1) smoking cessation apps are sought after by smokers, (2) positive affect plays an important role in smoking cessation, (3) short, self-administered exercises consistently bring about enduring positive affect enhancements, and (4) low treatment-seeking rates of non-daily smokers despite high motivation to quit indicate a need for novel smoking cessation support. Directed content analyses of existing apps indicated that tailoring, two-way interactions, and proactive features are under-utilized in existing apps, despite the popularity of such features.

Conventional content analyses of audio-recorded session tapes suggested that difficulty in quitting was generally linked to specific, readily identifiable occasions, and that social support was considered important but not consistently sought out. **Conclusion** The “Smiling Instead of Smoking” (SIS) app is an Android app that is designed to act as a behavioral, in-the-pocket coach to enhance quitting success in non-daily smokers. It provides proactive, tailored behavioral coaching, interactive tools (e.g., enlisting social support), daily positive psychology exercises, and smoking self-monitoring.

Keywords Smoking cessation · Smartphone app · Non-daily smoking · mHealth · Ecological momentary assessment · Positive psychology

Introduction

Current evidence has demonstrated the usefulness of mobile technology in supporting smoking cessation [1]. At present, this evidence is limited to text-messaging programs. Smartphones apps, however, offer more sophisticated tools for interacting with participants, including intuitive user interfaces and greater functionality. In this paper, we describe the development of a smartphone app to support smoking cessation for non-daily smokers. As a guiding framework, we describe this process within the intervention mapping [2] (IM) framework, so as to enable ready comparison between the steps we took in this development process and the process recommended by the gold standard of IM.

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Methods and Results

Intervention Mapping (IM) Phase 1: Needs Assessment

Methods

At the start of the treatment development process, we established a team of two researchers (B. Hoepfner and S. Hoepfner) to follow-up on an idea we developed based on our experience working with college student daily smokers and a presentation we saw on a novel intervention for smoking cessation (i.e., positive psychotherapy). Namely, the presentation was on a study, where 66 daily smokers received six weekly sessions of counseling (2 weeks before and 4 weeks after a targeted quit date) and 8 weeks of nicotine replacement therapy (NRT). Participants receiving positive psychotherapy for smoking (PPT-S) had significantly higher odds of abstinence (adjusted odds ratio (AOR) = 2.75; 95% CI = 1.02, 7.42; $p = .046$) across follow-ups (8, 16, and 26 weeks) compared to those randomized to standard treatment [3]. We thought this intervention would be a great fit for a new target population—non-daily smokers. We then conducted a literature review to assess the need for a new intervention, in which we examined the available evidence to determine if an intervention was necessary and useful for non-daily smokers, if existing intervention methods were sufficient for non-daily smokers, and to what degree positive psychotherapy might be a useful intervention approach for this target population.

Results

Literature review—Why Non-daily Smoking Matters

Non-daily smoking is an increasingly prevalent smoking pattern. Currently, 22% of all adult smokers smoke on a non-daily basis [4], which constitutes a 30% increase in prevalence in less than two decades [5]. This pattern of smoking is particularly prevalent among young adult (18–24 years of age) [6] smokers, 60–70% of whom smoke non-daily [7, 8]. Formerly believed to be a transient smoking pattern among smokers attempting to quit [9–11], newer research, including our own, indicates that non-daily smoking can be sustained for at least 1 to 2 years [12–14], if not indefinitely [15, 16].

Non-daily smoking poses substantial health risks [17, 18] and is a recognized public health issue [19]. It poses significant carcinogenic exposure (i.e., 40–50% of that seen in daily smokers) [20] and has been linked to increased total and cardiovascular mortality among men [21]. Indeed, the risk for cardiovascular disease has been found to be nearly equal to that of daily smoking, given a highly non-linear dose-response relationship between tobacco exposure and cardiovascular mortality [22].

From a health disparities perspective, it should be noted that non-daily smoking is disproportionately higher among

ethnic minority groups [9, 10, 23–25]. Thus, to ensure equitable smoking cessation support, it is imperative that effective smoking cessation interventions be developed for non-daily smokers.

Literature review—The Need for Novel Smoking Cessation Support for Non-daily Smokers

Non-daily smokers are motivated to quit smoking. Indeed, epidemiological evidence demonstrates that compared to daily smokers, non-daily smokers have greater current intentions to quit smoking [10, 26, 27] and more recent and planned cessation efforts [27–30] than daily smokers. The fact that non-daily smokers regularly abstain from smoking from day-to-day suggests that they should have relatively little trouble with quitting, but recent evidence demonstrates that most non-daily smokers (up to 82%) fail in their quit attempts [31]. Together, the high motivation to quit coupled with a high failure rate demonstrates the need for smoking cessation support for non-daily smokers.

Juxtaposed with this need is the absence of validated treatments for non-daily smokers. Existing treatments and theoretical models of cigarette smoking assume daily smoking [32–34]. Such models posit that smoking is primarily driven by nicotine dependence, where smokers smoke in order to maintain nicotine levels above a certain level [35, 36]. Non-daily smokers, however, do not smoke continuously, and thus are not maintaining a specific level of nicotine. Moreover, cross-sectional, naturalistic, and laboratory studies have shown that non-daily smokers differ from daily smokers on numerous important dimensions related to smoking cessation, including lower levels of dependence [37, 38], higher levels of self-control [39, 40], superior smoking-related error processing on neurocognitive tasks [41], and lower sensation-seeking impulses [42]. Their smoking motives are also quite different. Compared to daily smokers, non-daily smokers tend to smoke to enhance social experiences rather than to ameliorate negative affect [7, 43–45] and tend to emphasize motives associated with acute, situational smoking (e.g., cue exposure, positive reinforcement) rather than dependence-related motives (e.g., tolerance, withdrawal symptoms, automaticity) [46–48]. These data demonstrate convincingly that non-daily smoking functions quite differently from daily smoking. Finally, existing treatments fail to appeal to non-daily smokers. Non-daily smokers are less likely than heavier smokers to seek or receive traditional treatment [26, 27, 49, 50].

Literature review—Enhancing Positive Affect States to Support Smoking Cessation in Non-daily Smokers

Positive affect enhancement is an empirically sound yet under-utilized treatment target. Unquestioningly, mood plays a central role in smoking, and mood-focused smoking cessation treatments have been developed and were found to be

effective in randomized controlled trials [51–57]. Typically, however, mood-focused interventions have focused on smokers with depression or depressive symptoms, and have largely targeted negative affect. Positive affect, however, is psychometrically distinct from negative affect [58] with different neural underpinnings [59] and psychosocial correlates [58]. It also plays an important role in smoking cessation. Reductions in positive affect have been linked to increased temptation to smoke [60], and data from laboratory cue presentations indicate that exposure to positive affect cues reduces craving in both daily and non-daily smokers [61]. During smoking cessation, positive affect has been shown to decrease in the weeks leading up to the quit day [62], which is problematic, as decreases in positive affect on the quit day are associated with a greater risk for smoking relapse [63, 64]. In our own research with adolescent smokers who reported low nicotine dependence, we found that momentary positive affect was strongly positively linked to momentary self-efficacy to abstain from smoking, both in the days leading up to and following a quit attempt [65], highlighting the importance of positive affect throughout the process of smoking cessation. Further, positive affect states have been shown to decrease defensive processing of self-relevant health information [66], thereby making smokers more receptive to smoking cessation recommendations. Moreover, according to the broaden-and-build theory [67], the experience of positive emotions broadens people's momentary thought-action repertoires, which will allow non-daily smokers to come up with and act upon smoking alternatives. Together, these findings strongly suggest a positive impact of maintained and/or increased positive affect on smoking outcomes, as outlined in Figs. 1, 2, 3, 4, and 5.

Enhancing positive affect with brief, self-administered exercises is feasible. While positive affect interventions to improve smoking cessation outcomes are largely absent from the addiction literature, an entire sub-discipline of psychology, coined positive psychology [68], is dedicated to understanding and

enhancing the frequency and intensity of positive affect states. This research has led to the creation of positive psychology exercises that are designed to enhance positive states. A recent meta-analysis, spanning 51 positive psychology interventions and a total sample size of 4266 participants found that these positive psychology exercises have consistently led to improvements in overall well-being ($r = 0.29$) and reductions in depression ($r = -0.31$) [69]. These effects are impressive, given that many of these interventions were very brief, self-administered positive activities rather than clinician-administered treatments [69].

IM Phase 2—Program Objectives

Methods

Next, given the clear need for smoking cessation support for non-daily smokers and the promise of a positive psychology approach for this population, we consulted with the expert in this area to see how this treatment approach might be optimized, and explored the idea of delivering this treatment via smartphone technology.

Results

Expert Consultation In discussing his treatment development work with us, Dr. Kahler noted that the positive effect of his positive psychotherapy intervention [3] was achieved despite sub-optimal completion rates of the daily positive psychology exercises, where participants reported forgetting assignments or cramming exercise completion right before treatment sessions. Importantly, the value of completing these exercises was demonstrated by the trial, where a greater use of PPT-S strategies during the initial 8 weeks of quitting was associated with a less steep decline in smoking abstinence rates over time (OR 2.64, 95% CI 1.06, 6.56, $p = .04$). Consequently, these results suggest that improving exercise

Fig. 1 Treatment mechanism

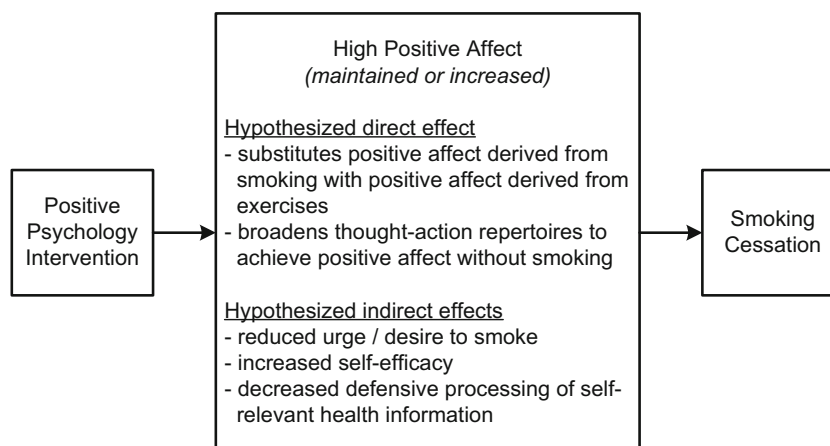
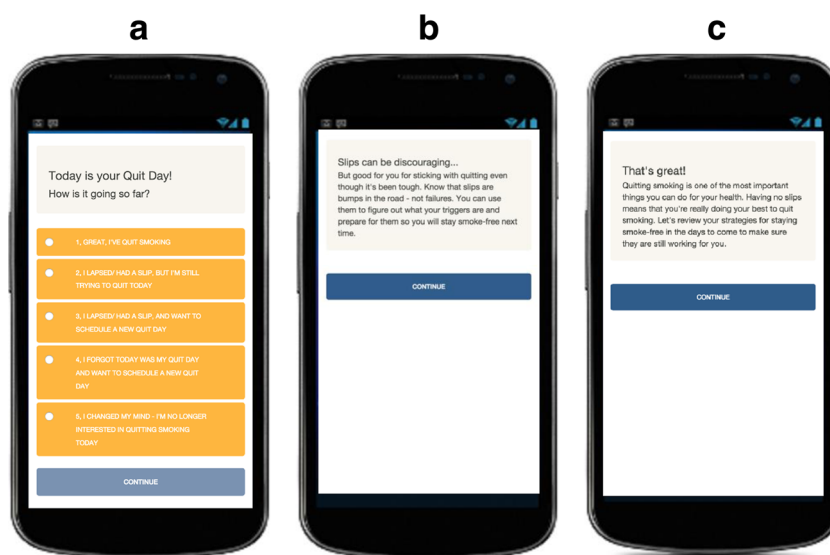


Fig. 2 Screenshots illustrating tailored behavioral counseling feedback. **a** Quit day check-in. **b** Feedback when lapsed. **c** Feedback when abstinent



completion rates may further augment the positive effects of the positive psychology-based treatment approach to smoking cessation. Based on these findings, we chose a smartphone

app approach to deliver treatment, as it can encourage daily exercise completion noninvasively and in a timely manner.

Literature Review—Using Smartphone Technology to Deliver Treatment Treatment delivery via a smartphone app has many advantages; chief among them is its formidable reach. Currently, 64% of American adults own a smartphone, a near-doubling in prevalence since 2011 (35%) [70]. Smartphone ownership is particularly high among smokers motivated to quit smoking (80%), the vast majority of whom (94%) are familiar with downloading and using apps [71].

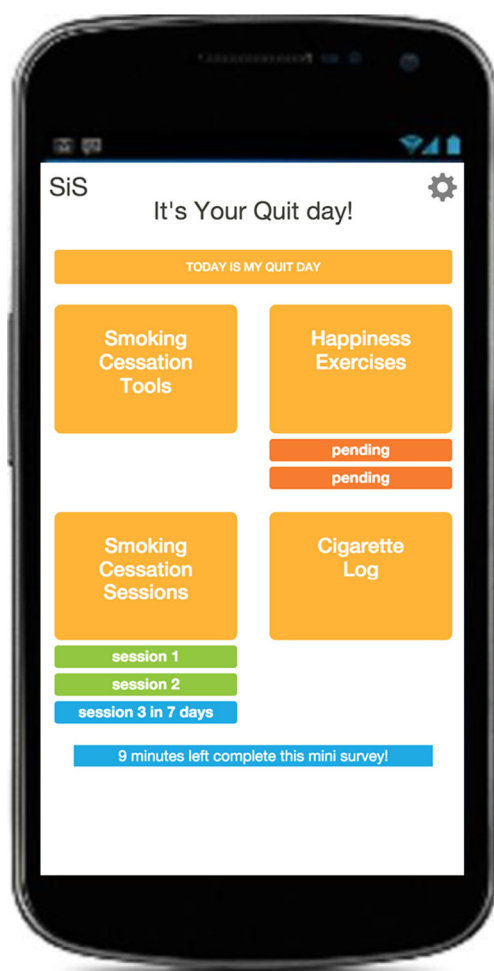


Fig. 3 Screenshot of the Home-Screen

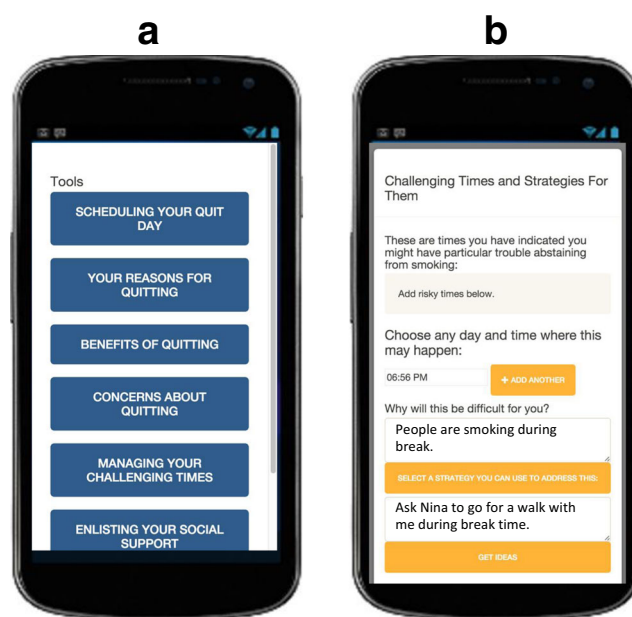


Fig. 4 Screenshots illustrating interactive tools. **a** Choosing a tool. **b** Inputting information into the “Managing Your Challenging Times” tool

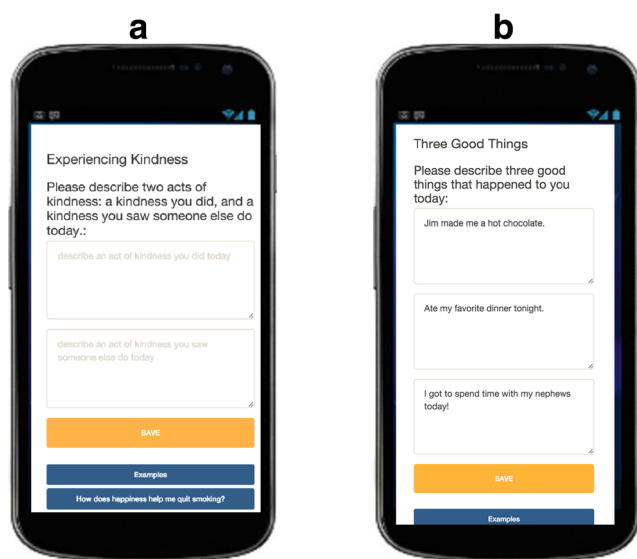


Fig. 5 Screenshots illustrating positive psychology exercises. **a** Experiencing kindness. **b** 3 Good things

To date, there are no published studies testing the effectiveness of smartphone apps for smoking cessation [72, 73], despite the demonstrated usefulness of mobile technology in smoking cessation [1]. Moreover, currently available smartphone apps generally do not take advantage of the capacity for sophisticated functionality. Instead, existing apps are generally limited to providing simple, stand-alone tools (e.g., calendars, calculators) and rarely adhere to established guidelines for smoking cessation [74–76]. Nevertheless, smoking cessation smartphone apps are a tool proactively sought out by smokers (many smoking cessation apps have more than 10,000 downloads, with some exceeding 500,000 downloads), which strongly suggests that treatment delivery via smartphone app is feasible and likely to be impactful.

IM Phase 3—Theoretical Methods and Practical Strategies

Methods

To inform the specific content of the app, we took two steps. First, we conducted a content analysis of currently existing smartphone apps for smoking cessation to examine what worked. Second, we conducted a pilot study in non-daily smokers to identify needs in smoking cessation support.

Results

Content Analysis We used a directed content analysis approach [77] to describe the nature of currently existing, publicly available Android smoking cessation apps, as downloaded from Google Play between 10/1/13–5/31/2014

[76]. Dimensions we specifically coded were the degree to which smartphone apps adhered to national clinical practice guidelines (i.e., delivering the 5As, “ask,” “advise,” “assess,” “assist,” and “arrange follow-up”), and to what degree they used “smart” features—two-way interactions, proactive reaching out, and tailoring of health messages. In line with previous studies [74, 75], our results indicated that currently available smartphone apps largely provide simplistic tools (e.g., calculators, trackers) and continue to fall short of adhering to national clinical practice guidelines. Extending the evidence, we found that higher levels of tailoring in addressing the 5As and the use of two-way interactions, proactive alerts, and responsiveness to quit status were related to both app popularity (i.e., number of downloads) and user-rated quality. These results suggest that smokers looking for smoking cessation support via a smartphone app are open to more sophisticated, proactive smartphone apps that coach them through a quit attempt. Based on this finding, we designed our smartphone app to adhere to the 5As, to use tailoring extensively, and to proactively check-in and provide feedback to participants at multiple points during their quit attempt.

Pilot Study We conducted a pilot study with 38 young adult non-daily smokers interested in quitting smoking and asked them to make a quit attempt. To support their quit attempt and to document the process of smoking cessation, participants engaged in three brief behavioral counseling sessions—1 week prior to the quit day, on the quit day, and 1 week after the quit day. Using audio-recordings of the three intervention sessions, we conducted a conventional content analysis [77], utilizing independent raters, to explore themes that emerged as non-daily smokers undertook a quit attempt. All participants set a quit day, thereby confirming that the concept of a quit day has relevance even in non-daily smokers. Indeed, our participants clarified that they were making intentional, purposeful attempts to quit smoking on their quit day, rather than simply not smoking as per their typical smoking pattern. When discussing barriers to success in their quit attempt, participants most commonly expressed concerns about their ability to abstain when around others who smoke, including friends, family members, and strangers (62%). These social situations included those involving alcohol for 33% of participants. Other anticipated barriers included negative affect regulation (38%). Rarely mentioned were worries about relapsing due to habitual smoking (12%, e.g., after class, when driving), low motivation (12%, e.g., desire to smoke, having “just one”) or stimuli-prompted smoking (5%, e.g., having cigarettes around). In discussing these barriers with non-daily smokers, we noticed that participants oftentimes were thinking of specific occasions in which they typically smoked. Given that these smokers were non-daily smokers, who smoked on average 6–7 (median) cigarettes per week, it made intuitive sense that they would be able to anticipate the circumstances of

these specific smoking occasions. In fact, systematic coding of behavioral counseling, audio-tapes revealed that nearly all of the participants (97%) identified specific challenging times that would hinder their ability to remain abstinent. Excitingly, in discussing these specific challenging times with research staff, most participants (87%) were able to generate strategies to mitigate chances of relapse at these times. Some participants generated these strategies in session while others discussed ideas they had previously developed on their own. Either way, the resulting strategies were personally relevant, specific ways in which participants thought they might avoid cigarettes after their quit day. This finding suggested a possible feature for our app: helping non-daily smokers remember their own strategies in the “heat” of the moment.

The discussed barriers also suggested another feature. Given that social situations were the most commonly mentioned barrier to staying smoke free in our sample and the importance of social support in smoking cessation, we wondered how our non-daily smokers felt about social support. In our audio-tape review, we found that many participants (84%) felt that social support would be helpful during their quit attempt, despite the fact that several of them were actively hiding their smoking from important people in their lives (e.g., younger family members, parents, colleagues). While perceived as helpful, only 57% of participants actually enlisted social support. Part of the difficulty in enlisting social support was that participants at times were unsure about what to ask for or failed to realize that different people may be helpful in different ways (e.g., telling a coach about the chosen quit day may help them feel more accountable and telling friends may reduce the times they are offered cigarettes). Thus, this finding suggested that it might be helpful if the app provided some ideas for what kind of social support to ask for and helped users identify and enlist one or more people who could provide social support for their quit attempt.

IM Phase 4—Program Development

Methods

In IM Phase 4, we designed the actual intervention and worked with our software development partners to create the smartphone app. In line with emerging recommendations for the development of smartphone health apps [78], we involved a multidisciplinary team in the development process and designed our app for interactivity through tailored content. Disciplines represented by our team and/or through consultation were smoking cessation, mobile technology, health communications, online tools for health behavior change in general and smoking cessation in particular, statistics, ecological momentary assessment, and positive psychology. We also involved our research assistants in this process, who had direct experience in working with non-daily smokers undergoing a

quit attempt, and who, as young adults themselves, use Smartphones extensively. In developing Version 1.0, we relied on national guidelines for smoking cessation treatment [79] and National Cancer Institute (NCI)-sponsored self-help materials (i.e., “Clearing the Air”: <http://smokefree.gov/sites/default/files/pdf/clearing-the-air-accessible.pdf>) to inform the content of the behavioral counseling app-delivered sessions. We drafted logic-branched content in REDCap, a free, secure, web-based application designed to support data capture for research studies, and asked three clinical psychologists with expertise in smoking cessation to review it. We then edited the content based on their feedback to tailor to non-daily smokers, and asked our software development team to design the app based on this content and tailored information flow.

Results

SiS is an Android app that acts as a behavioral, in-the-pocket, coach that uses positive psychology exercises to enhance quitting success in non-daily smokers. It provides support in four overall approaches: (1) proactive, tailored behavioral coaching, (2) interactive tools, (3) daily positive psychology exercises, and (4) smoking self-monitoring.

Tailored Behavioral Counseling Sessions Logic-branched, tailored behavioral counseling is delivered upon installing the app (pre-quit), with follow-ups on the quit day and 1-week post-quit. These sessions guide users through the app’s interactive tools, follow federal guidelines for treating tobacco use [80], and are grounded in well-established behavioral intervention methods [81].

Interactive Tools Seven tools are available to customize the users’ quit attempt and to provide support: (1) scheduling the quit day; this date will trigger Sessions 2 and 3 and *motivational messages* (e.g., banner displaying days until the quit day, congratulatory messages for achieving milestones), (2) entering personal reasons for quitting smoking; these reasons will be displayed as part of *just-in-time reminders* to boost motivation during challenging times, (3) reviewing benefits of quitting, via a logic-branched library, (4) addressing concerns about smoking, also via a logic-branched library, (5) identifying challenging times (e.g., Thursdays at 10:00 p.m.), and designating strategies to navigate them. Pop-up boxes provide suggestions and examples. Once a challenging time is saved, users receive a reminder at that time, consisting of one of their personal reasons to remain smoke-free, and their chosen strategy to navigate this time safely, (6) identifying social support; pop-up boxes provide ideas for ways in which people can support the quit attempt, and (7) combating sabotaging thoughts, via a logic-branched library.

Positive Psychology Exercises Participants complete one positive psychology exercise per day, as chosen by the app at random. These exercises have been adapted for Smartphone-use from exercises shown to be effective in enhancing positive affect [82–84]: (1) *Three Good Things*—Participants enter text describing three good things that happened to them that day, (2) *Savoring*—Participants enter text describing two experiences they savored, (3) *Experiencing Kindness*—Participants describe an act of kindness they performed and one they witnessed. All entries are logged in the app and can be reviewed by participants at any time.

Self-Monitoring Smoking Users click a button to time-stamp cigarette use, resulting in a log that can be reviewed at any time in graphical format.

IM Phases 5 and 6—Development of Implementation Plan and Program Evaluation

Methods

This phase is currently in progress, and consists of two efforts. First, we are currently readying SiS for free world-wide distribution via GooglePlay. Prior to making it available on GooglePlay, however, we are requesting institutional review board approval to create a data repository for this app, so that we will be able to conduct user analytics analyses on the data users generate by using the app. These crowd-sourcing data will inform further app development efforts. Second, we are currently seeking funding for structured pilot tests of this app, in which we plan to employ an iterative process of gathering feedback from the end-users (i.e., non-daily smokers), reviewing data in an expert panel, implementing suggested changes, and then conducting a randomized trial to test the effectiveness of the app to support smoking cessation.

Discussion

In this paper, we have used the guiding framework of intervention mapping to describe the development of a smoking cessation smartphone app to support smoking cessation in non-daily smokers. As all things, this process started with a basic idea, namely the idea to leverage the advances made in positive psychology to improve health behaviors. Positive psychology interventions are already starting to be used in medical settings, where this treatment approach is employed to improve physical activity in patients recovering from acute coronary syndrome [85, 86] and in patients with Type 2 diabetes [87]. The field of addiction treatment is only slowly coming to the realization that positive psychology may have something to offer [88]. For smoking cessation, the promise of

this treatment approach appears to be particularly high, given the well-documented importance of mood in smoking, the under-utilized potential of positive affect, and the consistent and impressive effects of self-administered, brief exercises to enhance positive affect. Using a smartphone app to deliver this intervention likewise appears to be a particularly good match, given that the potency of the positive psychology exercises appears to lie in their integration into daily life, an integration that is the key advantage of mobile technology [89]. The true test of this idea, of course, is still forthcoming. We have yet to collect the first data point on anyone using SiS, a moment we are eagerly awaiting.

In fact, data collection for mobile interventions itself represents an exciting new frontier. The reality is that we are now able to communicate much more rapidly and interactively with our target populations than ever before. Currently, the field is still using traditional methods to formally collect pilot data prior to disseminating a proven product. At the same time, however, the dissemination of mobile apps is unlike the dissemination of other interventions in two key ways—The mobile intervention can be made available world-wide with the click of a button, and it can be just as easily updated. Theoretically, that means that we could communicate interactively with our targeted end-users in a truer partnership than has previously been possible. Practically, such an approach falls far outside the familiar domain of the research methods we have been trained in. It will be interesting to see how the field will handle this new challenge. For SiS, we are pursuing a two-pronged approach that will hopefully allow us to embrace the best of both worlds. We are pursuing funding to enable us to conduct systematic structured pilot studies to work closely with specifically recruited non-daily smokers, and we will be exploring options to solicit feedback from a much larger population of non-daily smokers via crowd-sourcing, where we will be exploring blogs, internet forums, and other online methodologies to be in touch with the intended end-users of our app.

Finally, in speaking of new frontiers, we should not lose sight of the fact that currently our technological capabilities to track and communicate with users far outstrip the specificity of our theoretical models to adequately guide and inform mobile health behavioral interventions. The unique opportunity of interactive, mobile interventions lies in their ability to communicate the “right” information at the “right” time, where “right” may be quite different from person to person. Existing models of health behavior change [90–94], as well as more specific models of addiction and relapse [32, 95–100] lack the temporal specificity to guide real-time adaptive interventions. In SiS, we seek to address this challenge by collecting ecological momentary assessment (EMA) [101] data alongside providing the intervention so as to provide the real-time context of our real-time intervention. Whether or not users will be willing to providing this feedback is an open question at the

moment. Encouragingly, however, it should be noted that crowd-sourcing EMA data is in fact possible, as demonstrated convincingly by the Dutch national study “How Nuts Are The Dutch” [102], in which $n = 629$ provided EMA data 3 times per day for 30 days without any remuneration.

In this spirit, we are making our app publically available, and are eagerly awaiting feedback from smokers, clinicians, researchers, and anyone interested in this app. Of special note of interest to researchers is potentially the fact that the app does include functionality to flag users who are using this app as part of a research study. Thus, if you or your colleagues would like to recruit users to try out this app, we would be able to work with you to provide you with their data (given your participants’ consent, of course). Please be in touch if that is something you would like to pursue.

Conclusion

SiS is an Android smartphone app that acts as a behavioral, in-the-pocket coach that uses positive psychology exercises to enhance quitting success in non-daily smokers. We are making it publically available (free of charge) in the hopes of gathering user data and feedback to help us enhance this app.

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Compliance with Ethical Standards

Funding This research was supported by grants from the National Institute on Drug Abuse (K01 DA027097) and the Massachusetts General Hospital Executive Committee on Research (ECOR # 2014A051686).

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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