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A Novel Training Approach to Activate Alternative Behaviors for Smoking in Depressed Smokers

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The current research developed and tested a novel training strategy to alter the implicit associations between alternative behaviors to smoking and negative affect, and explored its effects on depressive symptoms and on smoking behavior as part of a quit attempt. Using a joystick, participants identified as smokers with depressive symptoms were trained to approach alternative behaviors to smoking in the context of negative affect. Specifically, in the experimental condition, participants were trained to avoid smoking-related targets and to approach alternative activities. In the control condition, participants pushed and pulled an equal amount of smoking and alternative activity-related targets. Compared with the participants in the control condition, those in the experimental condition showed an increase in the accessibility of the alternative activity relative to smoking and a decrease in depressive symptoms. Smoking outcomes did not differ significantly across the 2 conditions. Taken together these results indicate that the value of alternative behaviors to smoking can be modified in the lab without participants' conscious intentions with implications for depressive symptomatology. Future research is required to explore the impact of such training on smoking outcomes.

Public Health Significance
This study contributes to the understanding of the complex relationships between smoking and negative affect. It provides insights into how this association might be modified by introducing alternative behaviors to reduce depressive symptoms and smoking.

Keywords: negative affect, smoking, implicit associations

Tobacco smoking is one of the leading causes of morbidity and mortality in the United States. It is robustly linked to many forms of cancer, chronic lung and cardiovascular disease, and decreased longevity and it imposes enormous public health and financial costs on the nation (U.S. Department of Health and Human Services, 2012). Despite the well-known health risks of tobacco use, a significant percentage of the population initiates smoking on an annual basis and quit rates have slowed among adults (U.S. Department of Health and Human Services, 2014).

One potential explanation for the limited success in reducing tobacco use may be its instrumentality to alleviate stress and negative affect (e.g., Conklin & Perkins, 2005; Shiffman & Waters, 2004). Although negative affect appears to be related to smoking in general, individuals with depressive symptomatology

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may be particularly susceptible to smoking persistence (e.g., Weinberger, Mazure, Morlett, & McKee, 2013). Despite the heterogeneity of depressive symptoms (i.e., negative affect, somatic features, anhedonia, and interpersonal disturbance), lower positive affect predicts lower odds of abstinence above and beyond the other depressive symptoms (Leventhal, Ramsey, Brown, LaChance, & Kahler, 2008; Leventhal & Zvolensky, 2015). This suggests that lower positive affect smokers might be more likely to relapse to raise hedonic tone through smoking. Thus, smoking may come to dominate the repertoire of behaviors that individuals may engage in to cope with negative affect and obtaining rewards and may be perpetuated despite an individual's intention to quit.

These notions are very much in line with research in motivation and self-regulation. Accordingly, people's behavior is driven by their attempts to avoid negative outcomes and/or attain desirable end states, or goals (Kruglanski et al., 2002). Behaviors that are routinely selected and performed to achieve a particular goal become strongly associated with the goal (e.g., Ouellette & Wood, 1998). As a consequence, spontaneous activation of the goal (e.g., regulation of negative affect) by environmental or internal cues may lead to the automatic activation and enactment of behaviors perceived to be most effective for goal attainment (e.g., smoking; e.g., Aarts & Dijksterhuis, & de Vries, 2001; Bargh & Huang, 2009; Kopetz, Collado, & Lejuez, 2015; Kopetz, Lejuez, Wiers, & Kruglanski, 2013).

The association between a behavior and the goal that it fulfills is diminished if alternative behaviors that serve the same goal are active (Kruglanski, Pierro, & Sheveland, 2011). As a consequence, the effectiveness of a smoking cessation intervention depends on its capacity to increase the accessibility of alternative behaviors to smoking during cessation. Indeed, treatment strategies such as Behavioral Activation (BA; Jacobson et al., 1996; Lejuez, Hopko, Acierno, Daughters, & Pagoto, 2011) increase engagement in rewarding daily activities, and simultaneously reduce negative affect and improve smoking cessation outcomes (MacPherson et al., 2010).

Although BA strategies have shown promising results in smoking cessation, its success depends on the individual's capacity to adhere to the treatment, monitor and record daily activities, and focus on abstinence-related activities, all of which require self-control. However, despite individuals' voluntary intentions to remain abstinent, engagement in drug seeking and use behaviors is often perpetuated through relatively automatic processes triggered by drug-related cues in the environment (Stacy & Wiers, 2010; Tiffany, 1990) coupled with relatively weak controlled processes (Bechara, 2005). Given the difficulty of voluntary processes in controlling substance use behavior, interventions that provide alternative activities to smoking in a relatively easy, automatic manner may permit smokers to overcome this difficulty and may therefore facilitate abstinence.

Current Research

In line with these lines of work, the current research developed and tested a computerized training designed to increase the associations between alternative behaviors to smoking and negative affect. The aim of the study was to obtain proof of concept for the notion that accessibility of alternative rewarding activities may decrease the accessibility of smoking in the context of negative affect. Additionally, the study also aimed to explore the effects of the training on depressive symptoms and smoking behavior following a quit attempt.

The training combines the principles of BA and self-regulation and takes advantage of previous work on implicit cognition in addiction. Specifically, it identifies alternative behaviors to smoking (ideographically) and uses a modified Approach Bias Modification procedure (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011) to train smokers with elevated depressive symptoms to respond to negative affect by approaching these self-identified rewarding activities and by avoiding smoking. We postulate that this should increase the accessibility of these activities and therefore the likelihood that the person engages in them when negative affect is experienced. Furthermore, because engagement in one activity decreases the accessibility and the value of other activities, engagement in these alternative behaviors should automatically detract from smoking and, therefore, facilitate abstinence.

Participants identified as smokers with depressive symptoms were trained across four sessions in two conditions. Negative affect was induced in both conditions. Subsequently, in the experimental condition, participants used a joystick and were trained to avoid (push away) smoking-related targets and to approach (push toward) alternative rewarding activities that were ideographically selected during a baseline assessment. In the control condition, participants pushed and pulled an equal amount of smoking and alternative activity-related targets. The effects of the training were assessed on (a) the implicit association between negative affect and smoking versus the alternative activity and (b) smoking outcomes and depressive symptoms at 1-month follow up after a quit attempt.

Method

Participants

Participants ($n = 66$) were recruited to participate on a study on smoking and negative affect through online and newspaper advertisements in the greater metropolitan area of a large U.S. city. There was no provision of behavioral or pharmacological treatment in this study. There were 467 callers who were assessed for preliminary eligibility through phone screening. Of those screened, 306 were ineligible based on in initial inclusion criteria. Specifically, participants were excluded from the study if they did not meet the following initial inclusion criteria: (a) 18–65 years of age, (b) a regular smoker for at least 1 year, (c) daily cigarette smokers of (≥5 cigarettes per day), (d) have a desire to quit smoking (≥5 on a 10-point scale of desire to quit) and, (e) have elevated depressive symptoms (≥10 on Beck's Depression Inventory-II, BDI-II; Beck, Steer, & Brown, 1996). Additionally, participants were excluded if they met diagnostic criteria for a: (f), current mood episode (major depressive or manic), (g) current substance/alcohol dependence, and/or (h) current psychosis as assessed with the screening modules from the Structured Clinical Interview for *Diagnostic and Statistical Manual for Mental Disease-Fourth Edition* (*DSM–IV*, Non-Patient Version [SCID-NP]; First, Spitzer, Gibbon, & Williams, 2002).

Of the remaining 161 initially eligible participants, 122 showed for their baseline appointments resulting in 94 eligible participants who continued to meet study inclusion criteria described above. Of these, six participants withdrew before attending any experimental session. Of the remaining 88 individuals, 41 were randomized to the control condition, and 47 to the experimental condition. Nine participants (4 from the control condition, 5 from the experimental condition) were withdrew or attended fewer than minimum required of the training sessions. This decision was made in line with the extant literature employing Cognitive Bias Modification procedures with substance using populations similar to the one used in the current study to assure an adequate dose of training and to avoid potential extinction of training that may occur with missed sessions (e.g., Lindgren et al., 2015). An adequate dose of training was defined as completing at least 3 (75%) of the 4 sessions of training. Subsequently an additional 12 participants were excluded at the data analytic stage for inadequate performance on the behavioral measures (higher number of errors on the assessment of accessibility of alternative activity vs. smoking or inattentiveness during the mood induction procedure) resulting in a final sample of 66 participants. Thus, the final sample comprised 66 cigarette smokers who were allocated into experimental ($n = 35$) or control ($n = 31$) conditions (see Figure 1 for participant flow).

Procedure

The procedure and all the materials of the study were approved by the University of Maryland Human Research Ethics Committee. Participants were provided information about the study and asked to sign an informed consent.

Baseline procedure. Callers who met initial eligibility criteria were invited to the laboratory for a baseline appointment. In addition to the previously described eligibility requirements, reading ability was confirmed. Participants were also screened to ensure they were physically able to complete the computerized tasks. Participants provided demographic information such as age, sex, marital status, and level of education. Current depressive symptoms were measured using the BDI-II (Beck et al., 1996). Further, the Timeline Follow Back (TLFB; Brown et al., 1998) was used to record cigarette use, number of smoke days (at baseline, training sessions, and follow up) and cigarette smoking quit attempts (at follow up). Carbon monoxide (CO) verification of current smoking at >9 ppm was also assessed.

In addition to establishing eligibility criteria, the baseline assessment was used to determine potential rewarding activities as alternative to smoking in alleviating negative affect. Eligible participants completed a modified Pleasant Events Schedule (PES),

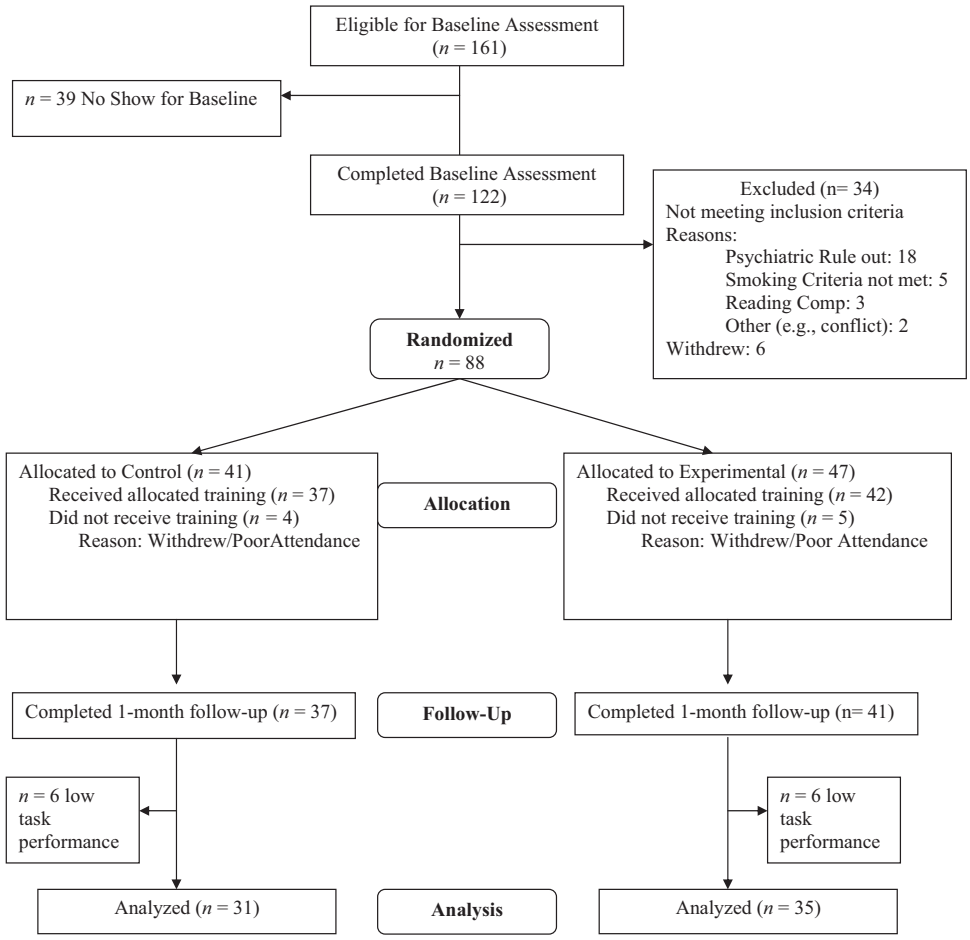

Figure 1. Participants flow.

which consisted of 136 activities stratified by life area (*family*, *social*, *work*, *relationships*, *education*, and *free time*) (Lewinsohn, 1974).

Specifically, they were asked to rate each activity in terms of importance, enjoyment, how often they currently engage in this activity, and how much they would like to engage in the activity in the next month on a 10 point scale (1 = *not at all*, 10 = *very much*). After the participants filled out the PES, they were asked to mark 10 activities that they found most important. Trained research assistants reviewed the activity ratings with each participant and identified corresponding short phrases (≤25 characters including spaces) that personalized the activity (e.g., "play with my child"). Three activities were selected that represented different life areas (e.g., *family*, *social*, and *free-time*). Emphasis was placed on identifying activities that participants found enjoyable and rewarding, in which they had not been engaging recently, but that they would like to engage in within the next month.

Training procedure. Participants were scheduled to complete four training sessions within an 8–12 day period (see Wiers et al., 2011 for a similar procedure), with a quit attempt at Session 4 (end of training) and a subsequent 30-day follow up session. Given that the study aimed to alter the implicit associations between negative affect and smoking versus alternative activities and to explore the effect of this modifications on participants' smoking behavior, the quit attempt was introduced at the end of the training to make sure that participants' conscious attempts did not interfere with the training. In all but two cases, participants completed four sessions. In the other two cases, participants completed three of the four sessions.

All training sessions were completed in the same laboratory room utilizing the same laptop, computer monitor, mouse, keyboard, and joystick. In the beginning of each session, participants' exhaled carbon monoxide levels were obtained (coVita piCO + Smoklyzer, Bedfont Scientific Limited, United Kingdom) and cigarette smoking data since the last session was collected. Cigarette craving was also assessed using the Questionnaire of Smoking Urges-Brief (QSU-Brief; Tiffany & Drobes, 1991). QSU-Brief is a 10-item measure of cigarette craving, which assesses both positive (*All I want right now is a cigarette*) and negative (*Smoking would make me less depressed*) craving symptoms on a scale from 0 (*strongly disagree*) to 100 (*strongly agree*) in 10-point increments.

Following these initial assessments, participants completed a computerized session, which consisted of: (a) induction of negative affect; (b) approach training procedure; and (c) assessment of accessibility of smoking and of the alternative activity.

Induction of negative affect. To induce negative affect, participants were exposed to a modified version of Conklin and Perkins's (2005) negative mood induction procedure. Specifically, they were exposed to three sets of 36 pictures (total of 108 pictures) with negative content drawn from the International Affective Picture Series (IAPS; Lang, Bradley, & Cuthbert, 2008; see Conklin & Perkins, 2005 for procedure). Each picture was presented for 10 s. Images were randomly assigned into each block and block order was randomized across participants. To ensure attentiveness, participants took a brief 5-item quiz on the content of each block. Specifically they were presented with labels corresponding to the content of the slides from the preceding block and were instructed to select all the labels that corresponded to slides that were just presented. The procedure was shown to effectively induce negative affect, to increase craving and to facilitate smoking behavior (as evidenced by latency to light a cigarette and number of puffs) among smokers (Conklin & Perkins, 2005). This presumably happens because presentation of pictures with negative content induces an aversive state and, therefore, activates the goal of regulating negative affect. The extent to which smoking represents a means to this goal, induction of negative affect will facilitate engagement in this behavior. It is noteworthy that the relationship between negative affect and smoking is unidirectional (i.e., from goals to means) and of motivational nature rather than bidirectional based simply on conditioning principles. In other words, induction of negative affect increases the accessibility of behaviors (i.e., smoking) presumed to reduce such state. Furthermore, it increases (rather than decreases) the valence of smoking (Kirchner & Sayette, 2007).

To assess changes in affect pre- and postmanipulation participants completed the momentary version of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). PANAS is a 20-item questionnaire that assesses both positive and negative affect on a 5-point scale with higher scores indicating greater positive or negative affect with respect to the item content.

Approach training procedure. After mood induction, participants completed a modified approach bias modification procedure (Wiers et al., 2011) designed to increase the association between negative affect and alternative rewarding activities while decreasing the association between negative affect and smoking. Specifically, on the computer screen, participants were presented with images tilted three degrees to the right or to the left (Cousijn, Goudriaan, & Wiers, 2011). The images depicted active (e.g., a cigarette being held between two fingers) and passive (e.g., cigarette in an ashtray) smoking, participants' own alternative activities generated during baseline (e.g., a parent playing with a child), or a neutral picture (e.g., a notepad). Because of the idiosyncratic nature of images, we also added phrases corresponding to these activities. Phrases were placed on a black background to create an image. All images (pictures and phrases) were standardized to approximately 330 × 240 and pixels and were not compressed (e.g., .bmp) to ensure accurate timing of presentation. Using a joystick, participants were instructed to either pull the joystick toward themselves (approach) or push away from themselves (avoid) depending on the orientation of the image. The push/pull action corresponded to a zooming function, which simulated approach and avoid actions.

In the first session, participants were instructed to push the joystick away from themselves (avoid) if the image was tilted to the right and pull the joystick toward themselves (approach) if the image was tilted to the left. The instructions were reversed for the second session. This block set was repeated in Session 3 and Session 4, resulting in two presentations of each left/right push/pull orientation.

Before start of the actual training, 10 practice trials were conducted. Research assistants were present during the E1 practice phase only to offer assistance. The first four images included the text "Push" or "Pull" to establish directionality, while the final six were blank. An incorrect response would elicit a red "X," and the stimuli would be repeated until a correct response was logged. The task itself contained a total of 200 stimuli (evenly split between

image and phrase) were presented of which 80 represented smoking, 80 represented participants' own alternative activities, and 40 represented a neutral activity. Stimuli were randomly presented and selected from 50 smoking images, 15 smoking phrases, 40 neutral images, 21 neutral words, 15 alternate activity images, and 3 alternate activity phrases.

Unbeknownst to the participants, in the experimental condition, they would always avoid (push away) smoking-related images and approach (pull toward) the images related to the alternative activity. Participants in the control condition approached and avoided smoking and the alternate activities equally. In both conditions, neutral images were approached and avoided equally. The approximate length of the training procedure was 7.5 min.

It is noteworthy that although both smoking and alternative activities were presented to the same extent during the procedure, in the experimental condition, they were associated with different behavioral tendencies: approach for alternative activities versus avoid for smoking. Given that the training occurred in the context of negative affect, the procedure should presumably change the extent to which the participants perceive the behaviors as effective in reducing negative affect. Although one could argue that the procedure may result in the alternative activities being perceived as negative, there is evidence suggesting that the behaviors perceived as effective in satisfying one's goals or needs are in fact perceived more positively (Brendl, Markman, & Messner, 2003; Fishbach, Shah, & Kruglanski, 2004). Therefore, we reasoned that this training procedure, in the context of negative affect, would increase the accessibility of alternative rewarding activities as effective means to regulate negative affect without resulting in the decrease in the valence of these activities.

Accessibility of smoking versus alternative activity. The strength of the association between negative affect and smoking versus the alternative activities was assessed using a modified sequential lexical-decision task (see Kopetz, Faber, Fishbach, & Kruglanski, 2011). During this task, participants were primed with one of the IAPS pictures used to induce negative affect. The picture was immediately followed by a target phrase representing an activity (smoking vs. alternative activity) or a nonactivity. Participants were asked to decide as fast as possible whether the target presented on the screen represented an activity or not for a total of 150 trials. On 50 of these trials, the target represented participants' own alternative activities (e.g., "Ride Bike"). Another 50 targets represented smoking activities (e.g., "Smoke Menthol"). Neutral activities (e.g., "Use Notepad") and nonactivities (e.g., "Blue Couch") were presented on 25 trials each.

At the beginning of each trial, a fixation point ("+") appeared in the center of the screen for 500 ms to indicate to participants where to focus their attention. The fixation point was then replaced by a randomly selected negative IAPS picture for 20 ms, forward and backward masked to ensure that it did not reach the threshold of conscious awareness (Bargh & Chartrand, 2000). After 220 ms the mask was replaced by the target representing an activity or a nonactivity. Participants were instructed to determine whether the target represented an activity (by pressing the "Z" key on the keyboard) or nonactivity (by pressing the "/" key). There was a 720 ms interval between the onset of the prime and the target, which defines the stimulus onset asynchrony or SOA (Neely, 1977).

The current procedure was based on the notion that goal-relevant knowledge should be more accessible upon the activation of a particular goal (Aarts et al., 2001; Ferguson, Hassin, & Bargh, 2007; Sherman, Rose, Koch, Presson, & Chassin, 2003). As Ferguson et al. (2007) noted, "the current goals of a perceiver provide limitations and constraints on the types of knowledge accessible in memory and this drives perceiver's attention toward certain elements within the environment" (p. 22). Accordingly, inducing negative affect should render the behaviors associated with alleviating negative affect more accessible. The stronger the association (between negative affect and alternative activities vs. smoking) the shorter the reaction time (RT) to the targets of interest (alternative activity vs. smoking) should be.

At the end of the fourth training session participants were given a copy of "Clearing the Air" (National Cancer Institute, 2008), a smoking cessation strategy guide, and reminded that they would make their quit smoking attempt at midnight after the final session.

Follow-up procedure. Participants were scheduled to return 30 days after their final experimental session for a follow-up session. During the follow-up appointment, participants' level of exhaled Carbon Monoxide and depressive symptoms were assessed. Research assistants administered the TLFB to assess cigarette use and cigarette smoking quit attempts since the final experimental session.

Finally, research assistants provided a funneled debriefing procedure, in which participants were asked their thoughts on the purpose of the study, purpose of experimental tasks, pattern of words presented during the lexical-decision task, ability to identify the IAPS pictures presented during the lexical-decision task, and any connection between the tasks. If participants provided an answer to any question, follow up questions were asked about when the participant became aware of a purpose/connection, and how the participant explained the connection/purpose. Two participants suspected that the purpose of the study was to "associate important things with not smoking and negative things with smoking," and "change behavior in regard to smoking . . . try to change your emotions;" however, neither participant was able to decipher the true intention of the task structure.

Results

Preliminary Analyses

Participants' demographic and baseline characteristics are presented in Table 1. Training conditions did not differ significantly on baseline characteristics. Initial analyses were conducted to ensure that the negative mood induction had the intended effects on participants' self-reported affect. First, across sessions and regardless of condition, participants had over 80% correct answers on the quiz taken to ensure attentiveness during the mood induction. Second, across sessions and regardless of condition, the mood induction resulted in a significant decrease in positive affect as well as a significant increase in negative affect. The results are presented in Table 2.

Separate analyses were conducted to test the effect of the training procedure on (a) accessibility of smoking versus alternative activity in the context of negative affect, (b) depressive symptoms, and (c) smoking outcomes. The 1-month follow-up rate was

Table 1
Participants' Demographic and Baseline Characteristics

Variable	Experimental (n = 35)	Control (n = 31)
1. Age (*M* (*SD*))	44.86 (13.18)	46.19 (14.26)
2. Ethnicity: Black (%)	62.9	67.7
White	28.6	25.8
Other	8.5	6.5
3. Gender: Female (%)	45.7	32.3
4. BL CPSD (*M* (*SD*))	11.51 (5.04)	14.27 (7.13)
5. Cigarette type: Menthol (%)	75%	80%
6. Desire to quit (*M* (*SD*))	8.43 (1.60)	8.48 (1.67)
7. BL BDI (*M* (*SD*))	14.03 (8.11)	12.72 (7.12)

Note. Training conditions did not differ significantly on baseline characteristics ($p < .05$). BL = baseline; CPSD = number of cigarettes per smoking day; BDI = Beck's Depression Inventory.

98.7% for the final analyzed sample (n = 66) and 88.6% when considering all originally randomized.

Sex has been identified as an important factor associated with successful smoking cessation. Specifically, an extensive body of literature indicates that women tend to have lower likelihood of achieving abstinence (e.g., Smith, Bessette, Weinberger, Sheffer, & McKee, 2016). Although sex differences in smoking cessation and abstinence rates are reported systematically, the reasons for such differences are less well understood. Women report that they are more likely to smoke in response to negative affect or stress (e.g., Fidler & West, 2009) and depressive symptoms have been demonstrated to be more strongly related to smoking maintenance and relapse for women as compared with men (Husky, Mazure, Paliwal, & McKee, 2008; Nakajima & al'Absi, 2012). Other studies however, do not find evidence for mediating role of affect in smoking cessation among women. Given the relevance of sex for both depressing symptomatology and smoking outcomes, we included this variable in all our analyses.

Accessibility of Smoking Versus Alternative Activity

The effect of the training procedure on the change in cognitive accessibility of smoking versus alternative activity in the context of negative affect was determined by analyzing participants' RT to smoking versus alternative activity related targets presented during the lexical decision.

Participants with greater than 30% missing data (four participants) over the experimental sessions were excluded from the analysis (cf., Wiers et al., 2011). Because the latency of incorrect responses would be difficult to interpret in terms of accessibility strength, only correct responses were used in our analyses (Fazio, 1990). The rate of wrong responses in this sample was 5%. Furthermore, latency responses less than 200 ms (< .01%) or greater than 2,000 ms (4.8%) were treated as outliers and coded as missing data. Missing data were replaced by the series mean for the analyses.

To minimize the skewedness of the data, the median RT was calculated for each category of targets (smoking vs. alternative activities vs. neutral activities, cf., MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Schoenmakers, de Bruin, Lux, Goertz, Van Kerkhof, & Wiers, 2010). Faster RTs indicate higher accessibility of the targets.

Craving, CO-level, and the number of cigarettes per day were not related to participants' RT to either smoking or alternative activities in any of the sessions. Although a significant relationship between the accessibility of the cognitive concepts associated with smoking versus alternative activities and self-report and behavioral outcomes would have strengthened our confidence regarding the relevance of the findings, the lack of such relationship is not uncommon in the literature (e.g., Wiers et al., 2011). Furthermore, participants did not differ in their general RT to neutral activities as a function of experimental condition in any of the training session (Session 1: M = 985.61, SE = 30.42 vs. M = 1030.96, SE = 31.82; Session 4: M = 870.73, SE = 34.12 vs. M = 889.41, SE = 35.68) that suggests that any difference between groups cannot be attributed to individual difference in general latency.

A mixed model analysis of variance was conducted to test the effects of training on the change in accessibility of smoking and alternative activities. Specifically, training condition (Experimental vs. Control) and sex (Men vs. Women) represented the between-subjects variable whereas time (Session 1 vs. Session 4) and activity (Smoking vs. Alternative activities) represented the within-subjects variables. There was no main effect of sex ($F(1, 63) = 2.63$, $p = .10$, $\eta^2 = .04$). Furthermore, sex did not interact with the other variables in the model ($F(2, 63) = .70$, $p = .40$, $\eta^2 = .01$). To maximize power and simplify the interpretability of the results, we did not include sex as a variable in the model, but used it as a covariate for subsequent analyses. The analysis revealed a significant three-way interaction between training condition, time, and activity, controlling for sex ($F(1, 64) = 4.63$, $p = .03$, $\eta^2 = .06$). Pairwise comparisons using the Bonferroni correction showed that in the experimental condition, accessibility of alternative activities increased significantly from Session 1 (M = 736.17, SE = 21.83) to Session 4 (M = 681.94, SE = 27.91, $p = .02$) whereas the change in the accessibility of smoking was not significant ($p = .08$). In the control condition, both the accessibility of alternative activities and smoking decreased significantly ($p = .01$ and $p < .01$, respectively). The results are presented in Figure 2.

Depressive Symptoms

A mixed model measure analysis of variance was conducted to test the effects of intervention (Experimental vs. Control) time

Table 2
Mood Induction Attentiveness and Manipulation Check

Session	Affect change *M* (*SD*)	Recall %
Session 1	—	83.14%
Positive affect	−.28 (.57)*	—
Negative affect	.39 (.75)*	—
Session 2	—	85.83%
Positive affect	−.42 (.54)*	—
Negative affect	.21 (.55)*	—
Session 3	—	89.92%
Positive affect	−.32 (.55)*	—
Negative affect	.11 (.60)*	—
Session 4	—	88.05%
Positive affect	−.27 (.53)*	—
Negative affect	.17 (.50)*	—

* $p < .05$.

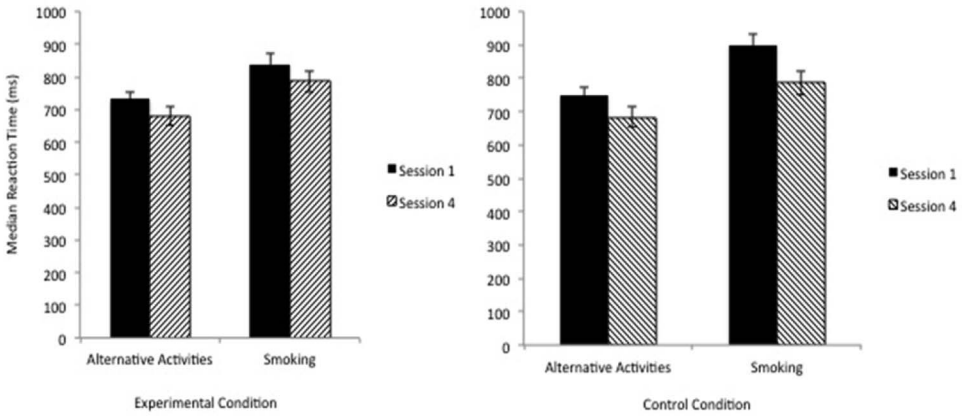

Figure 2. Participants' change in reaction time to alternative activities vs. smoking targets as a function of intervention.

(Baseline vs. One month follow up) and sex (Men vs. Women) on depressive symptoms assessed by BDI. The results revealed a significant main effect of sex ($F(1, 63) = 5.28$, $p < .05$, $\eta^2 = .07$) suggesting that female participants had lower BDI scores ($M = 9.05$, $SE = 1.14$) than male participants ($M = 12.44$, $SE = .92$). However, this effect was not qualified by intervention and time suggesting that the intervention did not differentially affected participants as a function of sex. There was a significant interaction between condition and time ($F(1, 63) = 4.62$, $p < .05$, $\eta^2 = .068$). Simple effects analysis indicated that in the control condition, participants' depressive symptoms did not significantly change between baseline ($M = 11.94$, $SE = 1.41$) and follow up ($M = 9.64$, $SE = 1.21$), $p = .12$. In contrast, in the experimental condition, depressive symptoms decreased significantly between baseline ($M = 14.01$, $SD = 1.29$) and follow up ($M = 7.38$, $SD = 1.10$), $p < .01$.

Smoking Outcomes

To test the effectiveness of the training on smoking behavior, we examined multiple outcomes as recommended by Hughes and colleagues (Hughes et al., 2003). These outcomes included: (a) CO-verified 7-day point prevalence abstinence (i.e., reporting of at least 7 days of abstinence in the week before the 1-month follow-up assessment corroborated by CO ≤8 ppm; SRNT Subcommittee on Biochemical Verification, Benowitz et al., 2002) that is a primary reported outcome in smoking cessation; (b) the percentage of participants who never relapsed (i.e., relapse defined as reported 7 consecutive days of smoking ≥1 cigarette per day) to capture those who did not return to a regular pattern of smoking and; (c) survival to relapse as an indication of duration participants persisted in their quit attempts (Shiffman et al., 2006). Finally, to describe our outcomes more fully, we examined change over time in cigarettes per week for each of the 4 weeks of the follow-up interval. Although smoking reductions are less commonly reported, they may be important short-term markers for longer-term cessation outcomes (Klemperer & Hughes, 2016). These variables are presented in Table 3.

Chi-square difference test indicated no significant differences between the experimental and the control conditions in CO-verified 7-day point prevalence abstinence at the 1-month follow-up (8.6% vs. 9.7%, respectively, $\chi^2(1, N = 66) = .024$, $p = .88$). Furthermore, there were no significant sex differences in CO-verified 7-day point prevalence abstinence at the 1-month follow-up within the experimental condition (12.5% of women vs. 5.3% of men, respectively, $\chi^2(1, N = 35) = .58$, $p = .58$) nor within the control condition (10.0% of women vs. 9.5% of men, respectively, $\chi^2(1, N = 33) = .002$, $p = .97$).

Regarding relapse, a Kaplan-Meier survival analysis suggested that participants in the experimental condition took longer to relapse to 7 consecutive days of smoking compared with the control condition ($M = 10.65$, $SD = 12.60$ vs. $M = 5.35$, $SD = 10.29$; Cohen's $d = .46$), although the difference was not statisti-

Table 3
Smoking Outcomes Across Four Weekly Intervals as a Function of Intervention

	Number of cigarettes		Number of smoking days	
	M (*SD*)		*M* (*SD*)	
Weekly intervals	Experimental ($n = 35$)	Control ($n = 31$)	Experimental ($n = 35$)	Control ($n = 31$)
Days 1–7 postquit	29.42 (31.49)	47.12 (40.32)	4.28 (2.75)	5.48 (2.37)
Days 8–14 postquit	35.71 (38.34)	50.12 (43.13)	4.65 (2.49)	5.67 (2.63)
Days 15–21 postquit	34.22 (36.15)	48.38 (43.08)	4.91 (2.58)	5.45 (2.47)
Days 22–28 postquit	33.31 (33.15)	49.51 (47.44)	5.20 (2.54)	5.22 (2.70)

cally significant, $\chi^2(1, N = 66) = 2.29, p = .11$, one-tailed. It was notable that 31.4% ($n = 11$) of participants in the experimental condition compared with 19.1% ($n = 6$) of participants in the control condition never met the relapse criterion during the follow-up interval (see Figure 3). Within each condition, women relapsed more quickly than men although these effects were modest and nonsignificant (experimental condition (women: $M = 8.81$, $SD = 12.48$ vs. men: $M = 12.21$, $SD = 12.83$; Cohen's $d = .27$; $\chi^2(1, N = 35) = .48$, $p = .49$, one-tailed) and control condition (women: $M = 3.30$, $SD = 8.74$ vs. men: $M = 6.33$, $SD = 11.01$; Cohen's $d = .30$; $\chi^2(1, N = 31) = .10$, $p = .75$, one-tailed). There were no notable sex differences in never having met the relapse criterion during the follow-up interval within the experimental condition (25.0% of women vs. 36.8% of men) with somewhat larger differences in the control condition (10.0% of women vs. 19.0% of men), although cell size make the latter difficult to interpret.

With regard to cigarettes per week, repeated measures analyses were conducted with generalized estimating equations (GEEs) with exchangeable correlational structure to test the effect of training and time (across the four intervals post assigned quit day) on this outcome for each week post Session 4, controlling for baseline total cigarettes. After controlling for the effect of total baseline cigarettes smoked on the smoking outcome ($B = .13$, $SE = .02$, $p = .0001$), the difference between the experimental condition and the control condition on cigarettes per week did not reach significance ($B = 5.14$, $SE = 6.38$, $p = .42$), despite that cigarettes per week were generally lower in the experimental condition compared with the control condition. There was not a linear effect of time ($B = .79$, $SE = 1.33$, $p = .55$) suggesting that overall smoking rates were relatively stable across each week of the follow-up period and did not vary across time. Additionally, there was not a significant interaction between the linear effect of time and training condition ($B = -.04$, $SE = .04$, $p = .24$). Sex was not related to cigarettes per week ($B = -4.35$, $SE = 6.59$, $p = .51$), and there was no significant interaction between sex and training condition ($B = -14.95$, $SE = 13.44$, $p = .27$) or between sex and time ($B = 3.16$, $SE = 2.57$, $p = .22$) on this smoking outcome.

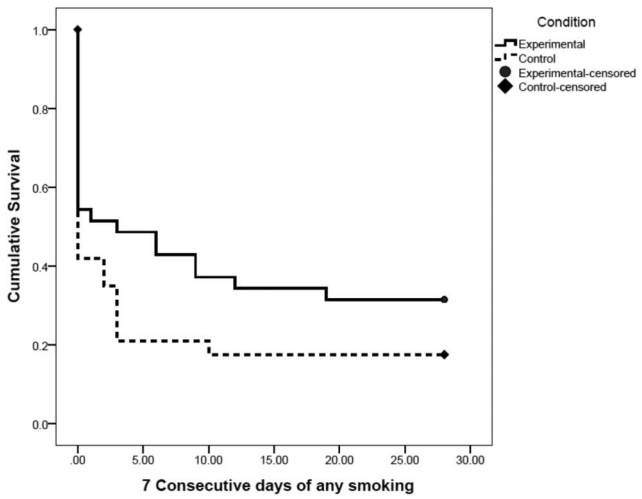

Figure 3. Participants' survival time (number of days to 7 consecutive days of smoking) as a function of training.

Discussion

The current study presents the development and testing of a novel training approach to activate alternative behaviors for smoking cessation in depressed smokers. The training combines the principles of behavioral activation and self-regulation and takes advantage of previous work in implicit cognition in addiction. Specifically, it assumes that maintenance of smoking behavior in individuals with depressive symptoms occurs through a combination of negative and positive reinforcement processes whereby smoking dominates individual's repertoire of behaviors effective in coping with negative affect and obtaining rewards. As a consequence, the current training attempted to increase the accessibility of alternative behaviors to smoking to possibly reduce depressive symptoms and, therefore, facilitate changes in smoking behavior. Given that voluntary control may be difficult during quit attempts, the training aimed to increase the implicit association between negative affect and alternative behaviors while decreasing its association with smoking. Through this procedure, alternative activities to smoking should become accessible in a relatively easy, automatic manner, which might permit smokers to overcome the difficulty of voluntary control of smoking behavior.

The results showed that the training differentially affected the accessibility of smoking compared with alternative behaviors in the context of negative affect. Specifically, while in the control condition both the accessibility of smoking and of alternative activities increased, in the experimental condition, only the accessibility of alternative activities increased significantly. Increased accessibility of alternative behaviors to smoking may decrease the likelihood of smoking as a way to regulate negative affect (Kruglanski et al., 2011). Indeed, this idea is supported by decision making and behavioral economics models suggesting that substance use is a function of the availability of reinforcing alternatives (Rachlin, 1997; Redish, 2004) as well as the accumulating literature in the tobacco field linking engagement in alternative smoke-free rewarding activities to abstinence in cessation trials (Goelz et al., 2014) and conversely in tobacco escalation and maintenance (e.g., Audrain-McGovern et al., 2011). These current findings add to the literature by suggesting the value of specific behaviors could be successfully altered through laboratory procedures often outside participants' conscious awareness (Zhang, Fishbach, & Kruglanski, 2007).

The training did have a significant impact on participants' depressive symptoms. Participants in the experimental condition showed a significant decline in depressive symptoms between baseline and the 1-month follow-up while there was no change in depressive symptoms for the participants in the control condition. These findings are in line with the principles of behavioral activation, which suggest the beneficial effects of accessible alternative rewarding activities on reducing depressive symptoms (Lejuez et al., 2011). Specifically, BA is designed to target greater contact with valued, environmental sources of reward via systematic efforts to increase engagement of and enjoyment in daily activities. These activities are hypothesized to results in improved depressive symptoms (Lejuez et al., 2011). In the present study we were unable to determine measurable, behavioral changes in actual

activity engagement. However, our findings suggest the possibility that individuals in the experimental condition might have experienced greater accessibility of alternative rewarding activities when experiencing negative affect as a function of the training. It is possible that the training resulted in increased attention to opportunities for engaging in rewarding activities when experiencing negative affective states that may have resulted in depressive symptom reductions. The specific mechanisms by which the experimental condition resulted in depressive symptom reductions requires further investigation.

The effects on the smoking outcomes were generally nonsignificant, although there were some indications of possible effectiveness. The survival analysis indicated that individuals in the experimental condition took longer to relapse compared with the participants in the control condition, but the nonsignificant nature of this finding suggests caution in interpreting these results. Finally, the number of cigarettes smoked across the follow-up period was also lower among participants in the experimental group compared with the control group, but the difference did not reach significance.

The overall lack of sex differences in the findings was notable given the important gender differences that have been identified in smoking cessation (e.g., McKee & Weinberger, 2015). Although women reported lower depressive symptoms than men in this study, the effect did not vary with training condition. The lack of sex differences across smoking cessation outcomes might have been reflective of the general lack of robust smoking outcomes in this study in general. Given the extensive research that has identified sex differences in motivational factors maintaining smoking and driving differences in smoking cessation outcomes (e.g., Perkins, 1996; Smith et al., 2015), future research should attempt to elucidate the role that this variable may play in interventions similar to the one explored here.

Taken together, the results are encouraging particularly with regard to accessibility of alternative activities to smoking and depressive symptoms, but not conclusive with regard to smoking behavior. There are several limitations of the current study that may suggest future research directions to better understand the relationships among these critical variables.

One obvious limitation is the small sample size, which might have limited our ability to detect reliable effects on smoking outcomes. The size of the sample might have also limited our ability to test the indirect effect of the training. It is possible that the training does not have a direct effect on smoking outcomes; rather its effects are mediated through increased accessibility of alternative activities and decreased depressive symptomatology. However, the number of participants recruited for this study does not provide the statistical power to formally test this model. In general, large samples are needed to test the mediating role of implicit processes in clinical effects (e.g., Wiers et al., 2011 vs. Eberl et al., 2013).

Another limitation refers to our ability to determine the extent to which participants engaged in the alternative activities that they were trained to approach. Although such activities might have become more accessible, it is unclear whether the participants actually engaged in these activities. Future research should investigate the extent to which such training actually facilitates engagement in rewarding alternative activities and explore the extent to which such engagement moderates the effects on smoking outcomes.

Finally, although the training was modeled after previous similar procedures (Wiers et al., 2011), it is possible that four training sessions are not sufficient to induce a difference in the accessibility of alternative activities relative to smoking that would systematically promote congruent behavioral choice (e.g., engagement in alternative activities rather than smoking to alleviate negative affect). Indeed, a recent study investigated individual learning curves for the alcohol approach-bias retraining, and found great variability of number of sessions needed, with a median of six sessions (Eberl et al., 2014, see also Eberl et al., 2013).

To conclude, the current research describes the development and testing of a novel training to activate alternative behaviors for smoking cessation for smokers with depressive symptoms. The training approach is theoretically and methodologically innovative. It integrates the principles of basic self-regulation and behavioral activation, and it suggests that accessibility of alternative behaviors to alleviate negative affect may decrease depressive symptoms and the likelihood of smoking as a means to alleviate negative affect. Furthermore, it offers a methodological procedure to increase the accessibility of alternative behaviors by increasing the implicit association between these behaviors and negative affect. By attempting to alter such implicit processes, such procedure may allow smokers to overcome the difficulty of voluntary control in their attempts to limit smoking and/or quit and may, therefore, facilitate abstinence. The results are encouraging but invite future research to address the limitations of the current study and develop more efficient treatment strategies for substance use in general, and smoking in particular.

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