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## TIMEVARYING PREDICTORS OF SMOKING CESSATION AMONG INDIVIDUALS IN TREATMENT FOR ALCOHOL ABUSE AND DEPENDENCE: FINDINGS FROM PROJECT MATCH

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### Abstract

**Aims**—Individuals in treatment for alcohol use disorders are more likely to die from cigarette use than from alcohol consumption. Advanced statistical methodologies that increase study power and clinical relevance have been advocated to examine the timevarying nature of substance use relapse and abstinence, including drinking and smoking. The purpose of this investigation was to examine timevarying factors that are associated with smoking cessation among smokers in the general population, including alcohol use, self-efficacy, and depression, to determine if they were also related to smoking cessation during and after treatment for alcohol use disorders.

**Methods**—Data were garnered from Project MATCH, a longitudinal prospective study of the efficacy of three behavioural treatments for alcohol use disorders. Timevarying covariate analyses were conducted to examine future smoking cessation.

**Results**—Results showed that greater self-efficacy regarding resisting temptations to drink and lower levels of depression were independently associated with increased likelihood of stopping smoking. In contrast, drinks per drinking day and confidence regarding not drinking did not demonstrate such associations.

**Conclusions**—Clinical implications of these findings suggest that interventions to help alcoholics in recovery avoid temptations to drink, as well as decrease depression, may be warranted. By using advanced statistical techniques, these results can help clinicians and organizations working with smokers in treatment for alcohol use disorders to make informed decisions regarding how best to use limited resources.

### INTRODUCTION

Studies have suggested that between 60 and 95% of individuals with alcohol use disorders smoke cigarettes, with many tending to be heavy smokers (Burling and Ziff, 1988; Batel *et al.*, 1995; Toneatto *et al.*, 1995). Likewise, smokers are typically heavier drinkers than nonsmokers (Batel *et al.*, 1995; Marks *et al.*, 1997). Although interventions for alcohol problems encourages patients to stop drinking, cigarette use is often not addressed, and smokers are likely to continue smoking during and after treatment. There is mounting evidence that smokers with alcohol use disorders have worse health outcomes than individuals who do not smoke, including greater likelihood of cardiovascular disease and cancer (USDHHS, 1982;

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Burling *et al.*, 1996, 2001; Hurt *et al.*, 1996; John and Hanke, 2002). In fact, smoking is more likely to kill patients in recovery than the alcohol abuse and dependence for which they are seeking treatment (Hurt *et al.*, 1996).

Tobacco dependence treatment has proven to be efficacious in samples of problem drinkers in recovery, although low quit rates suggest that strong interventions are needed (Joseph *et al.*, 1993; Irving *et al.*, 1994; Bobo *et al.*, 1998; Burling *et al.*, 2001). Yet despite high rates of cigarette use and associated morbidity and mortality, clinicians are often reluctant to advise their patients to quit smoking (Hahn *et al.*, 1999; Gil and Bennett, 2000). The majority of such smokers, however, are interested in stopping (Irving *et al.*, 1994; Zullino *et al.*, 2000). Moreover, contrary to popular belief, clinical studies indicate that continued cigarette use may jeopardize sobriety, whereas smoking cessation may enhance abstinence attempts (Joseph *et al.*, 1993; Toneatto *et al.*, 1995).

Certain psychological and clinical factors have been associated with increased likelihood of smoking cessation among smokers in the general population and those with alcohol use disorders in recovery specifically. These include drinking severity (Collins *et al.*, 1993; Tritto *et al.*, 2001; Tsuang *et al.*, 2001), self-efficacy (Stretcher *et al.*, 1986; Bobo *et al.*, 1996) and depression (Kohn *et al.*, 2003).

### Drinking severity

The synergism between drinking and smoking can be accounted for by several genetic, physiological, and environmental factors. Both animal and human studies suggest that common genes may influence the prevalence of cross-addictions between alcohol and tobacco (True *et al.*, 1999; Tritto *et al.*, 2001; Heath *et al.*, 2002). Nicotine and other substances also appear to share common physiological reinforcing mechanisms and show additive effects on tolerance and sensitization (Collins *et al.*, 1993; Soderpalm *et al.*, 2000). Smoking may lessen some of the physiological and cognitive effects resulting from alcohol over-consumption or alcohol withdrawal (Tong *et al.*, 1974; Lyon *et al.*, 1975; Leigh *et al.*, 1977; Perkins, 1996; Prendergast *et al.*, 2000). In addition, drinking may trigger smoking urges, and smoking elicit drinking cravings, because of the conditioning mechanisms whereby alcohol is often paired with smoking (e.g. at parties) (Burling *et al.*, 1997; Ellingstad *et al.*, 1997; Palfai *et al.*, 2000; Tsuang *et al.*, 2001; Sayette, 2002). In sum, these results suggest that the high smoking rate among drinkers is related to a constellation of factors that work synergistically.

### Self-efficacy

Bandura (1977) describes self-efficacy as a person's perceived ability to perform on a task as a mediator of performance on future tasks. There is clear evidence that self-efficacy in a specific domain is related to increased likelihood of the desired outcome in that domain. Self-efficacy regarding alcohol abstinence has been shown to be a consistent predictor of sobriety. Data from Project MATCH indicated that baseline Temptation and Confidence Alcohol Abstinence Self-Efficacy scores predicted percent of days abstinent and drinks per drinking day for outpatients for up to 3 years post-treatment (DiClemente *et al.*, 2001). Likewise, self-efficacy regarding stopping smoking has been a consistent predictor of successful smoking cessation for smokers in the general population (DiClemente *et al.*, 1985; Stretcher *et al.*, 1986; Grove, 1993; Meland *et al.*, 1999). Whether self-efficacy regarding alcohol use among smokers in recovery translates to quitting smoking is unclear. In addition, if self-efficacy does translate from one domain to another, whether this self-efficacy is due to inner resources around one's confidence not to drink, or to external manipulation of the environment to reduce behavioural risk of relapse, warrants empirical examination.

## Depression

A compelling body of research has reported that depressed individuals, including both those in the general population and those with alcohol use disorders specifically, are more likely to smoke, less likely to quit, tend to experience more, and more severe, withdrawal symptoms, and are more likely to relapse to cigarette use than non depressed persons (Covey *et al.*, 1990, 1993; Hughes, 1992; Pomerleau *et al.*, 1997; Hitsman *et al.*, 2002). In addition, there seems to be a reciprocal relationship between cigarette use and affective disorders, such that smoking increases the risk of depression (Almeida and Pfaff, 2005).

## Smoking cessation during treatment for alcohol use disorders

Our own research, based on data from Project MATCH, showed that, of the 1307 participants who smoked at any point during the study, 12.5% quit during or after treatment (Friend and Pagano, 2005a). Approximately half of those who stopped smoking retained their non smoking status for 6 months or longer. In addition, individuals who stopped smoking were less likely to relapse to alcohol use than individuals who continued smoking. These findings suggest that there may be factors associated with quitting drinking that are associated with smoking cessation.

## Timevarying analyses in addictions research

Addictive behaviours involve the interplay of psychological, physiological, and environmental factors such as mood, stress, social relationships, and craving, all of which may fluctuate over days, hours, or even minutes. Cross-sectional analyses of the relationships between these timevarying factors cannot adequately capture how these variables influence each other or impact drinking outcomes specifically (Stout and Papandonatos, 2003). Furthermore, analyses that compare only two timepoints cannot reveal when symptoms begin to elevate and subside in relation to a stressful event. Given the limited resources of organizations treating individuals with alcohol use disorders, use of methodologies that mirror real world situations and that can yield clinically meaningful results is vitally needed in the current cost containment realities of a managed care environment.

Our use of timevarying analyses in other studies has allowed us to draw more accurate conclusions from complex, longitudinal data. In an investigation of associations between psychosocial functioning and stress, Pagano *et al.* (2004) used mixed model analyses to show that Global Assessment of Functioning scores declined in the month following a stressful event and gradually increased to previous levels 6 months after the event. Similarly, in a longitudinal study of the relationship between body dysmorphic disorder and helping behaviours, Pagano *et al.* (2007) used proportional hazard regression analyses to demonstrate that increases in helping behaviours predicted subsequent remission from both body dysmorphic disorder and substance use disorders.

## Purpose of this paper

The purpose of this paper is twofold. First, we examine timevarying predictors of smoking cessation, including drinking severity, self-efficacy, and depression, during and after treatment for alcohol use disorders. Our choice of predictors was based in part on the selection of variables that have been shown to be associated with stopping smoking among smokers in the general population. Second, we highlight the use of advanced statistical methodologies, specifically timevarying analyses, to further our understanding of the factors associated with smoking cessation among individuals with alcohol problems who are in recovery. Project MATCH data was ideal for this purpose because of the large sample size ( $N = 1726$ ), frequency of follow-ups (every 90 days), and prospective data collection. We hypothesized that the following would be positively associated with increased likelihood of quitting smoking: (i) fewer drinks per

drinking day; (ii) higher Alcohol Abstinence Self-Efficacy Confidence scores; (iii) lower Alcohol Abstinence Self-Efficacy Temptation scores; and (iv) lower Beck Depression Inventory scores.

## PARTICIPANTS AND METHODS

Our study was based on Project MATCH, a longitudinal investigation of the efficacies of three different behavioural interventions for individuals with alcohol use disorders that were each delivered over the course of 12 weeks (NIAAA, 2001). No tobacco dependence treatment was offered. Data on timevarying predictor variables were available at baseline and every 3 months for the first 15 months of the project.

Project MATCH included 1726 patients with alcohol abuse and dependence in outpatient treatment and aftercare. Participants in outpatient treatment were recruited directly from the community or outpatient centres. Participants from aftercare were enrolled from intensive inpatient or day-hospital programs. Inclusion criteria included participation in either current outpatient treatment or 3 months prior to aftercare and a DSM-III-R diagnosis of alcohol abuse or dependence. Exclusion criteria included current DSM-III-R diagnosis of sedative/hypnotic drug, stimulant, cocaine, or opiate dependence; intravenous drug use during the previous 6 months; current danger to self or others; symptoms of acute psychosis; and/or severe organic impairment. Participants provided informed consent, in accordance with the standards of the Committee on Human Experimentation with the Helsinki Declaration of 1975 (Project MATCH Research Group, 1993).

## MEASURES

### Dependent variable

**Cigarette use**—Cigarette use and smoking cessation were measured using the Form 90-I, developed specifically for Project MATCH (Project MATCH Research Group, 1993). Questions regarding cigarette use included (i) ever cigarette use (yes/no), (ii) number of lifetime weeks of use, and (iii) number of cigarettes smoked per day in the current period (preceding 90 days), which was used to determine whether a participant was a current smoker. A participant with a score of '0' was designated as a current nonsmoker, and a participant with any other score was classified as a current smoker.

### Timevarying variables

**Drinking severity**—Drinking severity was assessed using percent of drinks per drinking day, as measured by the Timeline Follow-Back (TimeLine Follow-Back; Sobell and Sobell, 1992). The TimeLine Follow-Back is a calendar-assisted daily drinking estimation method that provides a comprehensive assessment of a person's drinking over a designated period (in this investigation, 90 days). It has demonstrated adequate psychometric properties in a variety of patient samples (NIAAA, 1995).

**Self-efficacy**—Self-efficacy regarding alcohol abstinence was assessed with the Alcohol Abstinence Self-Efficacy Scale (DiClemente *et al.*, 1994). The Alcohol Abstinence Self-Efficacy, based on Marlatt's cognitive-behavioural model of relapse (1980) is an easily used, psychometrically sound, 20-item self-report measure designed to assess Bandura's construct of self-efficacy applied to alcohol abstinence. Subjects rate their vulnerability to drink (Temptation Subscale) and confidence to abstain from alcohol (Confidence Subscale) across 20 different high-risk situations on a 5-point Likert scale. For each subscale, a summary score is created that reflects the average score across the 20 high-risk situations. Scores range from 1 to 5, with lower Temptation Subscale scores reflecting lower levels of perceived temptation

to drink, and higher Confidence Subscale scores reflecting higher levels of perceived confidence to abstain from alcohol. The correlation between the Temptation and Confidence Subscales was  $-0.41$ , suggesting that these subscales measured related but distinct constructs.

**Depression**—Depression was assessed with the Beck Depression Inventory. The Beck Depression Inventory is one of the most widely used self-report instruments for assessing depression severity (Beck *et al.*, 1961). Each of the 21 items is scored on a 4-point Likert scale ranging from 0 (neutral) to 3 (maximum severity). The Beck Depression Inventory has been used for over 25 years to identify depressive symptoms and has been reported to be highly reliable regardless of the population studied (Beck *et al.*, 1988). It has good internal consistency (coefficient alpha = 0.8), adequate construct validity, and successfully differentiates depressed from non-depressed patients. The items are summed to obtain a total score that can range from 0 to 63, with higher total scores indicating more severe depressive symptoms. Thirteen percent of the sample had a total baseline Beck Depression Inventory score of 20 or more, classifying them as showing moderate to severe depression.

**Motivation**—Motivation, one of our static variables, was assessed with the University of Rhode Island Change Assessment (University of Rhode Island Change Assessment; DiClemente and Hughes, 1990). The University of Rhode Island Change Assessment, used to assess motivation for change in Project MATCH (Kadden *et al.*, 2003), is a 32-item self-report measure that includes four subscales measuring four stages of change: precontemplation, contemplation, action, and maintenance. Responses are measured on a 5-point Likert scale ranging from 1 (strong disagreement) to 5 (strong agreement). Each subscale contains eight items, with higher subscale scores indicating that someone is higher on that particular stage of change. The University of Rhode Island Change Assessment has shown adequate psychometric properties among individuals in treatment for alcohol use disorders, differentiating patients on use severity, urges to drink, and other relevant variables (DiClemente and Hughes, 1990).

**Data analysis**—Statistical analyses were conducted using SAS version 8.0 (SAS Institute Inc., 1999), using PROC FREQ, PROC ANOVA, and PROC PHREG. Depending on the type of variables (continuous or discrete), analysis of variance (ANOVA) or chi-square analyses were performed to evaluate demographic and clinical differences between groups. Covariate static predictors included treatment arm (outpatient or aftercare), gender, age, education, race, ethnicity, marital status, Stage of Change as a proxy for motivation, and lifetime history of cigarette use (lifetime weeks of cigarette use). Our dependent variable, smoking cessation, was calculated using the number of cigarettes smoked daily at each assessment timepoint. Timevarying independent variables; including drinks per drinking day, Alcohol Abstinence Self-Efficacy Temptation and Confidence scores, and Beck Depression Inventory scores; were assessed in the preceding visit to examine smoking cessation in the consecutive visit. Proportional hazards regressions were conducted to determine associations between static predictors, measured only at baseline, and timevarying predictors in relation to the likelihood of quitting smoking. We reported all two-tailed tests with significance values greater than 95% ( $P < 0.05$ ).

## RESULTS

### Sample baseline characteristics

Sociodemographic and clinical characteristics of our sample are reported in Table 1. Our final sample consisted of 1193 participants who smoked at baseline and completed the 3-month assessment. There were no significant differences between study participants ( $N = 1193$ ) and participants who smoked at baseline but did not have complete 3-month data ( $N = 52$ ) in gender,

race, age, education, lifetime weeks of cigarette use, percent days abstinent from alcohol use at baseline, or drinks per drinking day at baseline.

### Static and timevarying predictors of smoking cessation

One-hundred and two participants quit smoking over the 15-month investigation. Sixty-seven percent of these individuals stopped smoking in the 6 months following the end of treatment. Additional information regarding the course of smoking cessation in relation to alcohol consumption is detailed elsewhere (Friend and Pagano, 2004, 2005a,b).

The majority of static variables assessed at baseline did not predict smoking cessation over the course of the study, with a few notable exceptions (see Table 2). Participants with a shorter history of cigarette use were significantly more likely to quit smoking than smokers with a longer cigarette use career. In addition, older participants were significantly more likely to stop smoking. Results from analyses of the University of Rhode Island Change Assessment demonstrated that individuals with higher maintenance scores, the most advanced stage of change, were significantly more likely to stop smoking than individuals with lower scores. Significant findings were also found with the action stage of change in the reverse direction, so that increases in action scores were related to decreased likelihood of quitting smoking. Scores on the two lower levels of the stages of change (precontemplation and contemplation) were not significantly associated with stopping smoking.

Results from the timevarying analyses are also presented in Table 2. Alcohol Abstinence Self-Efficacy Temptation and Beck Depression Inventory scores were significantly associated with quitting smoking over the duration of the study. More specifically, for each unit increase in the Temptation score, the likelihood of quitting smoking decreased by an estimated 32%. For each unit increase in Beck Depression Inventory score, the likelihood of quitting smoking decreased by an estimated 4%. In contrast, drinks per drinking day and Alcohol Abstinence Self-Efficacy Confidence scores were not significantly associated with stopping smoking.

## DISCUSSION

Our results showed that some of our hypotheses were confirmed. Consistent with our hypotheses, results indicated that lower Alcohol Abstinence Self-Efficacy Temptation scores and lower Beck Depression Inventory scores were significantly and positively associated with greater likelihood of stopping smoking. In contrast, drinks per drinking day and Alcohol Abstinence Self-Efficacy Confidence scores showed no relation to smoking cessation.

Of the two components of self-efficacy measured, only one, temptation, was significantly associated with smoking cessation, whereas confidence was not. These findings reaffirm that the two Alcohol Abstinence Self-Efficacy subscales represent distinct constructs, which is consistent with Marlatt's heuristic model of relapse (1980). Marlatt's model (1980) conceptualizes relapse as having behavioural and cognitive components. The fact that perceived ability to resist drinking temptation was correlated with increased probability of smoking cessation may be attributable in part to the fact that temptation resides in behavioural adjustment to external stimuli in the environment. In addition, these findings suggest that the ability to resist temptations to drink may translate to parallel capacities in a related but separate domain (tobacco use). In contrast, the reason why perceived self-confidence regarding drinking abstinence was not a predictor of smoking cessation is unclear. It may be because confidence is based on a cognitive internal self-assessment, as opposed to temptation's residing in the external environment. Additional investigations that empirically validate this hypothesis are warranted.

Our findings further indicated that decreases in depression were associated with an increased likelihood of quitting smoking. Individuals whose depression improves in the year following alcohol treatment may be more willing to endure the initial discomfort of cigarette withdrawal compared to those whose depression remains constant or worsens (Covey *et al.*, 1997). Patients should be screened and assessed to determine the level of depressive symptoms and, if they appear to be remitting, interventions to help the individual quit smoking should be introduced.

Contrary to our hypothesis, drinking severity was not significantly related to the probability of quitting smoking. There are several factors that might help to account for this outcome. First, our analyses of the static variable motivation, as assessed by the Stages of Change, indicated that individuals with higher sobriety Maintenance scores were significantly more likely to stop smoking than individuals with lower scores. Significant findings were also noted with the Action Stage of Change but in the opposite direction. Scores on the two lower levels of the Stages of Change Ladder were not significantly associated with stopping smoking. Together, these results suggest that individuals who have successfully decreased their alcohol consumption and are focused on alcohol relapse prevention may be better able to make additional lifestyle modifications, including smoking cessation, than those who are in the process of changing their drinking behaviours or those who are not motivated to address their alcohol consumption. Since participants were roughly evenly distributed across these stages of change, the heterogeneity of the sample in terms of motivation to change drinking behaviours may have masked group differences regarding willingness to change smoking behaviours. Second, the majority of MATCH participants resumed pre-treatment drinking levels 1 year after treatment (Cisler *et al.*, 2005). It is possible then that, if smoking cessation is associated with long-term alcohol abstinence, the lack of relationship between drinking and smoking in this sample is a function of the absence of sobriety maintenance. Third, the tobacco use outcome used in this study was complete smoking cessation, rather than reduction in cigarette consumption levels. In previous work, we have shown that decreases in alcohol consumption are related to reductions in cigarette consumption (Friend and Pagano, 2005b). It is plausible that inclusion of outcomes other than smoking cessation may have yielded different results regarding associations between drinking severity and smoking.

There are several limitations of this study that should be noted. First, we used a conservative approach in determining smoker status (no cigarettes vs one or more cigarettes daily) in order to identify an event of smoking cessation. Second, the number of quit events in the sample limited the number of predictor variables that we could include in our timevarying covariate model. Third, no experimental manipulation was conducted, so our results, while compelling, provide only associations and do not indicate causality. Finally, Project MATCH was not designed to determine which elements are the most important contributors to smoking cessation.

Despite these limitations, our study offers a unique contribution to the literature for several reasons, including the use of novel statistical methods for alcohol and smoking research, timevarying covariate analyses, to examine factors related to quitting smoking during and after treatment for alcohol use disorders and how such factors may intertwine over time. Although our investigation cannot establish causality, it adds to the growing number of empirical studies advancing the understanding of how smoking cessation naturally occurs among alcoholics in recovery. Future research is warranted that capitalizes on the methodologies and results of this study to help identify additional clinical characteristics and process mechanisms that are associated with quitting smoking among individuals with alcohol use disorders in recovery.

There are several clinical implications of these results that should be noted. First, these findings suggest that interventions that target only alcohol use may generalize to other maladaptive behaviour, including cigarette use. We anticipate that even more powerful results may have

been realized if tobacco dependence treatment had been offered as part of Project MATCH. Second, our results appear to indicate that strategies to increase behaviour skills related to not smoking may yield more beneficial results than efforts to increase self-confidence regarding relapse. Third, findings from the current investigation suggest that smoking cessation interventions are likely to be more successful among individuals who have been abstinent from alcohol use for a period of time. Project MATCH, however, did not include an intervention that targeted tobacco use. Thus, we can form reasonable hypotheses, but experimental studies are merited to examine these issues. Fourth, our findings also suggest that psychological and pharmaceutical interventions to treat depression among alcoholics in recovery appear warranted to increase the likelihood of successful quit attempts, particularly in light of the risk of increased depressive symptoms during the first two- to four-week period of nicotine withdrawal (West *et al.*, 1987; Pomerleau *et al.*, 2001). Given these individuals' increased vulnerability to cigarette use both because of their alcohol consumption and because of their depression, interventions that target depression are critical. Finally, our study can help clinicians and organizations working with this patient group make informed decisions regarding how to use limited resources. These empirical findings can be applied directly to clinical care to provide what are often limited resources for tobacco dependence treatment to ideal candidates.

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**Table 1**

## Baseline demographic and clinical characteristics

		<b>Total 1193 (100%)</b>
Gender	Male	909 (76%)
	Female	284 (24%)
Race	Caucasian	969 (81%)
	African-American	134 (11%)
	Other	90 (8%)
Marital status	Married	370 (31%)
	Single	823 (69%)
Age (M, SD)		39.12 (10.27)
Education (M, SD)		13.03 (2.03)
Lifetime tobacco use, years (M, SD)		2.96 (1.60)
Drinks per drinking day		17.69 (11.23)
Stages of change (M, SD)		
Precontemplation		13.19 (4.46)
Contemplation		35.68 (3.63)
Action		33.61 (4.06)
Maintenance		30.31 (5.41)
Beck depression inventory (M, SD)		10.44 (8.37)
Self-efficacy temptation (M, SD)		2.92 (0.91)
Self-efficacy confidence (M, SD)		3.07 (0.91)

Table 2

Static and time-varying predictors of smoking cessation

	Parameter Variable	Standard Estimate	Chi-Square Error	Pr> Chisq	Hazard Ratio	Lower	Upper
<i>Static variables, baseline</i>							
	Age	0.04808	16.8960	<0.0001	1.049	1.025	1.074
	Marital status	-0.00817	0.0138	0.9066	0.992	0.865	1.137
	Gender	-0.36412	1.9643	0.1611	0.695	0.418	1.156
	Race	-0.00612	0.04856	0.9101	0.991	0.845	1.121
	Education	0.06151	1.3366	0.2476	1.063	0.958	1.180
	Treatment arm	-0.07103	0.0911	0.7628	0.931	0.587	1.477
	Lifetime weeks of tobacco use	-0.00208	89.1413	<0.0001	0.998	0.997	0.998
	Drinks per drinking day	-0.01081	0.7916	0.3736	0.989	0.966	1.013
	Stages of change						
	Maintenance	0.05873	5.5921	0.0180	1.060	1.010	1.113
	Action	-0.06545	4.4065	0.0358	0.937	0.881	0.996
	Contemplation	-0.05626	2.6331	0.1047	0.945	0.883	1.012
	Precontemplation	-0.02559	0.9362	0.3333	0.975	0.926	1.027
<i>Time-varying variables, follow-up</i>							
	Beck depression inventory	-0.03711	4.0893	0.0432	0.964	0.930	0.999
	Self-efficacy, temptation	-0.38548	6.3233	0.0119	0.680	0.504	0.918
	Self-efficacy, confidence	-0.00385	0.0015	0.9694	0.996	0.818	1.213