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IS SELF-EFFICACY FOR SMOKING ABSTINENCE A CAUSE OF, OR A REFLECTION ON, SMOKING BEHAVIOR CHANGE?

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Abstract

Social learning theory considers self-efficacy as a causal factor in behavior change. However, in line with behavioral theory, recent clinical research suggests that self-efficacy ratings may reflect, rather than cause, behavior change. To test these two disparate views, self-efficacy was related to actual smoking abstinence on the next day (i.e. self-efficacy causes change), and abstinence status over one day was tested as a predictor of rated self-efficacy for being quit the next day (i.e. reflects change). All data were from two very similar cross-over studies evaluating the short-term effects of both placebo versus medication, nicotine patch (n=209) or varenicline (n=123), on smoking abstinence during week-long practice quit attempts. Placebo versus active medication periods were separated by an ad lib smoking washout, and analyses controlled for prior day's abstinence or self-efficacy values. Results were very consistent between studies in showing essentially bi-directional associations: daily self-efficacy predicted next day's abstinence, and current day's abstinence status predicted self-efficacy for not smoking the next day. However, secondary factors differentially predicted abstinence and, to a lesser extent, self-efficacy between these two medication studies. These data provide some support for both social learning and behavioral theories of smoking behavior change, although self-efficacy may only briefly predict subsequent short periods of abstinence as assessed in these studies. Nonetheless, because self-efficacy has long been assumed to cause behavior change, including smoking cessation, the notion of self-efficacy as a reflection of recent smoking behavior change in these studies warrants greater attention in clinical research on smoking cessation treatment.

Keywords

smoking cessation; self-efficacy; smoking behavior; abstinence; nicotine dependence; behavior change

Self-efficacy, or confidence in being able to change a behavior of interest, is viewed in social learning theory as a causal factor in behavior change. Bandura (1977) proposed self-efficacy as a unifying construct within social learning theory to explain how various psychological interventions succeed in helping patients change maladaptive behavior. He suggested that, regardless of the content of those interventions, they are effective because they increase self-efficacy for making the desired behavior change. Increasing self-efficacy

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to abstain from drug use has been a primary focus of counseling treatments for drug dependence over the past 30 years, including cigarette smoking (Niaura, 2000).

Seemingly consistent with social learning theory (i.e. self-efficacy theory), greater self-efficacy for not smoking assessed just after the quit date has been shown to predict subsequent quit status at later follow-up (see review by Ockene, Emmons, Mermelstein, Perkins, Bonollo, & Hollis, 2000). However, this association may be misleading, and the causal role of self-efficacy in smoking cessation has been called into question. Gwaltney and colleagues (Gwaltney, Metrik, Kahler, & Shiffman, 2009) conducted a meta-analysis of clinical studies relating self-efficacy ratings, either before or after the quit date, with subsequent quit status. They found that self-efficacy assessed before the quit date was less strongly related to quit status than self-efficacy assessed after the quit date. Moreover, self-efficacy was only weakly associated with subsequent quit status unless smoking behavior at the time of the self-efficacy rating was controlled. The authors concluded that self-efficacy ratings after the quit date were substantially affected by very recent success or failure in abstaining, which itself predicts subsequent quit status, and so were a reflection of recent smoking behavior rather than a determinant of future smoking behavior.

Similarly, other research has shown that self-efficacy to not smoke decreases markedly after a lapse, suggesting that self-efficacy is very responsive to recent smoking behavior (Van Zundert, Engels, Ferguson, & Shiffman, 2010). As Gwaltney et al. (2009) pointed out, finding that self-efficacy reflects, rather than causes, change in smoking behavior would have very important implications for counseling interventions for smoking cessation and, perhaps, other drug dependence. Specifically, efforts to directly increase self-efficacy prior to quitting (e.g. Hendricks, Delucchi, & Hall, 2010) likely would not help the patient if self-efficacy is primarily a reflection of recent behavior and not causal of future behavior. Consistent with this notion, Wong and colleagues (Wong, Anthony, Sigmon, Mongeon, Badger, & Higgins, 2004) found in cocaine-dependent outpatients that initial self-reported “confidence” in quitting (similar to self-efficacy) predicted later confidence but not later abstinence from cocaine, while initial quitting success did predict both later abstinence as well as later confidence.

The notion that self-efficacy may reflect, rather than cause, behavior change has been posited ever since Bandura first proposed the concept of self-efficacy (e.g. Borkovec, 1978). Yet, very little research has directly challenged social-learning theory claims that self-efficacy has a causal role in behavior change. In an important and novel analysis, Romanowich, Mintz, and Lamb (2009) reasoned that, if self-efficacy causes behavior change, as proposed by social-learning theory, then it should be more strongly related to future behavior than past behavior. However, the opposite should be true if self-efficacy reflects behavior change, an explanation consistent with behavioral theory. The authors related carbon monoxide (CO) readings, indicative of recent smoking, to self-efficacy assessed one month apart, before and at the end of a program of monetary reinforcement for smoking reduction. CO predicted post-program self-efficacy, while pre-program self-efficacy did not predict subsequent level of CO, suggesting that self-efficacy only reflected, and did not cause, a reduction in recent smoking behavior. However, unknown is whether these results would generalize to smokers trying to quit and not just cut down, those not receiving a monetary reinforcement incentive for behavior change, and during assessment of near-term self-efficacy ratings over a shorter duration of smoking change.

The current analyses followed up this earlier work by relating daily ratings of self-efficacy to daily abstinence (verified by CO) during week-long practice quit attempts, to determine whether self-efficacy more strongly predicted subsequent abstinence or vice versa. We used data from two cross-over studies of the short-term effects of placebo versus medication,

nicotine patch (n=209) or varenicline (n=123), on brief smoking abstinence. We were also interested in the possibility that self-efficacy had different associations with abstinence as functions of immediate interest in quitting permanently and of reinforcement for daily abstinence. Therefore, subjects included those who were, and those who were not, interested in quitting permanently soon after the completion of the study. Also, all subjects were randomized to monetary reinforcement for abstinence (\$12 per quit day) versus no reinforcement for abstinence, with the same condition in effect for both the placebo and medication phases.

METHODS

The two studies from which these data were derived were approved by the University of Pittsburgh Institutional Review Board. The focus of the two original studies was to examine factors that moderate short-term treatment response to active (versus placebo) smoking cessation medications, nicotine patch in Study 1 and varenicline in Study 2. Except for the medication of interest, most procedures were the same between studies. (See Perkins, Lerman, Stitzer, Fonte, Briski, Scott, and Chengappa [2008] and Perkins, Lerman, Fonte, Mercincavage, Stitzer, Chengappa, and Jain [2010] for more details on rationale and methods of each study).

Participant recruitment and characteristics

The studies were described in advertisements as evaluations of the short-term effects of the medication of interest (nicotine patch, varenicline) on a brief practice quit smoking attempt. Eligible subjects were required to smoke at least 10 cigarettes per day for at least 1 year, provide a CO reading of at least 10 ppm, and to not currently be attempting to quit permanently. The main objective of both studies was to compare medication effects (patch, varenicline) on ability to fully quit smoking for one week between those who did and those who did not want to quit permanently soon (i.e. at end of study). Half of all participants received monetary reinforcement for each day quit (\$12/day) and the other half received no such reinforcement. Current quit interest was assessed by asking participants at least twice whether or not they intended to quit in the next 1-2 months, 4 months, 6 months, or 1 year (responses both times had to be reliable). Those stating an intention to quit permanently at the end of the study, i.e. within the next 1 (patch) or 2 months (varenicline), were considered “high” in current quit interest, while those stating they had no intention of quitting within the next 6 months were “low” in quit interest. Both of these groups were included for study. (Those who wanted to quit between 2 and 6 months were excluded from participation, while those interested in quitting immediately were referred to treatment programs elsewhere and also excluded). For study purposes, regardless of degree of quit interest, all subjects were required to agree to try hard to quit for one week during each medication phase as part of a “practice” quit attempt (see Experimental Protocol below).

Participants were very similar in the two studies. In study 1, on effects of nicotine patch (N=209), mean $\pm$ SE characteristics were: age of 30.8 ± 0.8 , daily smoking rate of 17.1 ± 0.4 cigarettes, smoking history of 14.0 ± 0.8 yrs, and Fagerstrom Test of Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) score of 4.7 ± 0.1 , indicating moderate dependence. Men comprised 51.0% of the sample. In study 2, on effects of varenicline (N=124), mean $\pm$ SE characteristics were: age of 32.1 ± 1.0 yrs, daily smoking rate of 16.3 ± 0.5 cigarettes, smoking history of 13.2 ± 1.0 yrs, and FTND score of 4.6 ± 0.1 . Men comprised 43.5% of the sample. In both studies, there were no differences in smoking characteristics or dependence due to level of quit interest (n=81 high versus n=128 low in study 1; n=57 high versus n=67 low in study 2). One participant in the varenicline study had missing data for self-efficacy and so was excluded from analyses, leaving an n of 123 in that study.

Medication and placebo

In study 1, NicoDerm CQ (21 mg) and placebo patches matched in size and appearance were obtained from 1-800-patches (Salt Lake City UT), a company that provided patches for clinical research. Patches were applied every morning (Mon-Fri) during the quit weeks of study 1. In study 2, varenicline and placebo tablets matched in size and appearance were obtained from the manufacturer, Pfizer Inc. (New York NY). The varenicline dose run-up regimen was 0.5 mg qd for 3 days followed by 0.5 mg b.i.d. for 4 days during the week before trying to quit, then the full dose of 1.0 mg b.i.d. during the quit week. The same number of placebo tablets was taken during the “run-up” week and quit week of the placebo condition.

Self-efficacy measure

Self-efficacy for not smoking the next day was assessed with a single item, “I am confident I will not smoke at all tomorrow”, rated on a 0 to 100 scale (anchored by “not at all” and “extremely”, respectively). We did not use other measures of self-efficacy (e.g. the Confidence Questionnaire, Baer & Lichtenstein 1988) because they tend to ask about efficacy for abstaining over much longer durations or often far in the future. We devised this one-item measure to capture the short time frame of the smoking behavior being related to the self-efficacy measure (i.e. the next day), although our exploratory analyses also assessed these variables over the week-long quit attempt (see end of Results). Note also that single item self-efficacy measures may have equal or superior predictive validity for smoking behavior, compared to multi-item measures (Gwaltney et al. 2009). Finally, we did not assess self-efficacy during the week before the quit attempt so we could standardize the day-long duration between self-efficacy and quit smoking behavior (and vice versa). Also, subjects in Study 2 were engaged in the varenicline (or placebo) dose run-up period that week, which would interfere with assessment of self-efficacy in the week prior to the practice quit week.

Experimental protocol

During the in-person screening session prior to entering either study, all subjects provided written informed consent for participation after the nature and consequences of the study were explained. The design of each cross-over study was a mix of one within-subjects factor, medication (21 mg nicotine patch or varenicline 1.0 mg b.i.d.) versus placebo, and two separate between-subjects factors: 1) current quit interest (high/low; i.e. desire to quit permanently after the end of the study) and 2) monetary reinforcement for abstinence (\$12/day, no reinforcement). Those entered into the study were randomized to either the abstinence reinforcement or the no reinforcement condition, stratified by high/low quit interest and sex.

Study participation for each subject was 4 weeks in study 1, with two 2-week phases, and 6 weeks in study 2, with two 3-week phases. The first week of each phase involved ad lib smoking with no medication (baseline), and the last week of each phase involved the practice quit attempt while on medication or placebo. (The two extra weeks in study 2 were for the dose run-up week of each phase, varenicline or placebo, after baseline but prior to the quit week while on the full medication dose. Subjects smoked ad lib during this dose run-up week, which was not needed for study 1, on the patch.) Regardless of current level of quit interest, all subjects agreed in writing that they would try hard to quit during the week of the practice quit attempt at the end of each phase. Cross-over to the second phase began following completion of the first phase, starting with the baseline week of ad lib smoking and no medication. Subjects who were abstinent at the end of the first phase had to resume smoking at the start of the second phase (“washout” period), so that we could fairly test the effects of the other medication condition on ability to quit. (No participants failed to resume

smoking.) Order of medication and placebo between phases was counter-balanced between subjects within each quit interest subgroup.

Participants came to the clinic 3 days during each baseline week and, in study 2, during each dose run-up week (e.g. Mon, Wed, Fri). All were seen on all 5 weekdays (Mon-Fri) during each practice quit attempt week. Abstinence was assessed daily by self-report of no smoking at all over the prior 24 hrs and expired-air carbon monoxide (CO) < 5 ppm. We used a CO cutoff that was lower than that typically used in clinical trials (8 ppm) to ensure complete abstinence over the prior 24 hrs (see Javors, Hatch, & Lamb, 2005; Raiff, Faix, Turturici, & Dallery, 2010). Because of this stringent daily measure of abstinence, we could not analyze cessation on Mondays of the quit week in analyses since the patch in Study 1 was first applied only that morning, too recently (< 12 hrs) to result in CO-verified abstinence by the Monday session. Assessed daily during each practice quit week was self-efficacy for not smoking at all the next day. Other details have been reported elsewhere (Perkins et al. 2008; Perkins et al. 2010).

Data Analyses

In both studies, transition models were used to examine if self efficacy predicted the likelihood of not smoking the following day. This model examined self efficacy's ability to predict next day abstinence while controlling for the previous days' abstinence status. The dichotomous measure of abstinence (yes/no) was used, rather than amount of smoking (e.g. CO level), because the self-efficacy measure asked about confidence in not smoking at all (i.e. dichotomous) rather than in ability to simply cut down (i.e. continuous). A transition model was also used to examine if daily abstinence status predicted (same day) rating of self efficacy to not smoke the following day while controlling for previous days' self efficacy. Both models treated subjects as a random effect with random intercepts.

Both sets of analyses began with a full model that controlled for medication condition, quit interest (stated desire to quit permanently at study end), monetary reinforcement for abstinence, self-reported cigarettes per day (CPD), age, and FTND. Since CPD, age, and FTND were only entered into the model as potential covariates and not primary predictors of interest, they were removed from the model if nonsignificant at $p > .10$ and did not confound the primary effect of interest. Also, primary effects of interest were crossed with each design variable to assess potential interactions. Nonsignificant interactions were dropped from final models. All model assumptions were checked and verified. Analyses were performed using SAS version 9.2 (SAS Institute Inc., Cary, NC).

RESULTS

Daily abstinence rates and means for self-efficacy for not smoking the next day are shown for the practice quit weeks in the nicotine patch and varenicline studies in Figure 1. Results of primary analyses were very consistent between studies in showing that the association between self-efficacy and abstinence was essentially bi-directional.

Does self-efficacy predict abstinence?

As shown in Table 1, daily self-efficacy predicted next day's abstinence in both studies. For every 10-point increase in self-efficacy, the log odds of next day abstinence increased by 0.287 (Odds Ratio: 1.33) in the patch study and by 0.262 (Odds Ratio: 1.29) for all subjects in the varenicline study. The other factors significantly predicting abstinence in the patch study model were previous days' abstinence status, fewer cigarettes per day, reinforcement for abstinence, and medication (i.e. the nicotine patch condition). Other factors predicting abstinence in the varenicline study model were previous days' abstinence status, abstinence

reinforcement, higher quit interest, and medication. Additionally, as reported in the original outcome paper (Perkins et al. 2010), the period effect and the period x medication interaction were also significant, indicating that varenicline's influence on abstinence depended on medication order (i.e. drug first or placebo first). None of these factors affected the association of self-efficacy with abstinence in either study and so are not discussed further.

Does abstinence predict self-efficacy?

Similar to our finding that self-efficacy rating predicted next day smoking abstinence, current day's smoking abstinence status predicted self-efficacy for ability to quit the next day, in both the patch and varenicline studies, as shown in Table 2. This was true despite controlling for prior (previous days') self-efficacy values via the transition models. These associations of abstinence with later self-efficacy were as strong as those of self-efficacy with later abstinence (compare with Table 1). However, the other factors in the patch study significantly predicting self-efficacy to not smoke were medication and monetary reinforcement. No other factors were significant in the varenicline study, and quit interest was not related in either study (Table 2).

Exploratory analyses

These results suggested bidirectional influences between self-efficacy and smoking abstinence, rather than one factor being exclusively predictive of the other as would be expected by self-efficacy theory versus behavioral theory. However, our findings could be a function of the intentionally short time frame for each assessment (i.e. one day). In exploratory analyses, we wanted to see if self-efficacy on Monday predicted week-long smoking abstinence, and if smoking abstinence on Monday (despite brief use of the patch in study 1) could influence self-efficacy to not smoke the rest of the week, rather than just on the next day. (This additional item, asked as part of the self-efficacy assessment, was worded, "I am determined to go without smoking the rest of the week".) As with the primary analyses above, the relationship between self-efficacy and abstinence was essentially bi-directional. Assessed on Monday, self-efficacy to not smoke the rest of the week predicted subsequent abstinence the rest of the week in both the patch and varenicline studies (coefficients of 0.037 and 0.053, t's of 3.08 and 2.82, respectively, both $p < .01$). Moreover, abstinence on Monday strongly predicted rating of self-efficacy to not smoke the rest of the week, in both the patch and varenicline studies (coefficients of 12.481 and 15.205, t's of 3.45, $p < 0.005$, and 4.10, $p < 0.001$, respectively). The similarity of this association of first day's abstinence with subsequent self-efficacy to stay quit over the rest of the week was very consistent, even though mean $\pm$ SE abstinence rates on Monday were only 18.4 $\pm$ 1.9% in the patch study (due to very recent patch application that first day of the quit week), versus 32.9 $\pm$ 3.0% in the varenicline study.

DISCUSSION

Recent clinical research involving smokers attempting to quit permanently or cut down has suggested that ratings of self-efficacy for change in smoking behavior are more strongly influenced by, rather than a cause of, smoking behavior (Gwaltney, et al., 2009; Romanowich, et al., 2009). Those findings tend to conflict with social learning (self-efficacy) theory, which proposes that self-efficacy for changing a behavior causes subsequent behavior change and largely ignores the reverse association, behavioral influences on self-efficacy (Bandura, 1977). However, our results in both studies indicate strong bi-directional associations between self-efficacy ratings and smoking behavior. Self-efficacy predicted next day smoking abstinence as clearly as current day abstinence predicted (same day rated) self-efficacy for not smoking the next day, even after controlling

for previous day's values for abstinence or self-efficacy. The consistency of those results stand in contrast with the limited or variable effects between studies of secondary factors on smoking abstinence (Table 1) or, in particular, on ratings of self-efficacy (Table 2). For example, quit interest (wanting to permanently quit at study end) predicted abstinence only with varenicline and not patch, but it had no association with self-efficacy in either study. Thus, our findings perhaps lend support to both self-efficacy as a causal factor in behavior change, as posited by social learning theory, and the notion that self-efficacy can reflect recent behavior change, as behavioral theory would suggest (Romanowich et al., 2009). Yet, given widespread acceptance of self-efficacy as a cause of behavior change (e.g., Niaura, 2000; Ockene et al., 2000), our finding of the reverse association, that abstinence strongly predicts self-efficacy for ability to later change smoking, supports the need for greater consideration of the often overlooked behavioral explanation of self-efficacy in clinical studies of behavior change.

Our finding that self-efficacy predicted abstinence as strongly as abstinence predicted self-efficacy is somewhat contrary to a few of the recent smoking studies using different procedures to address directionality of self-efficacy and smoking change (Gwaltney et al. 2009; Romanowich et al. 2009). This latter research involved clinical studies of self-efficacy for making a permanent change assessed weeks before the follow-up assessment of smoking behavior. Both of our studies, however, involved smokers asked to quit temporarily who rated self-efficacy for not smoking on the next day (or, exploratory only, for the rest of the practice quit week). We examined a short interval between self-efficacy rating and smoking behavior so we could relate them in close temporal proximity and limit potential intervening (and unmeasured) factors that might distort the relationship. Moreover, for study design reasons (see Methods, Self-efficacy measure), we only assessed self-efficacy on or after the quit day, rather than before trying to quit, and Gwaltney et al. (2009) and Romanowich et al. (2009) both showed that self-efficacy poorly relates to future abstinence when assessed well prior to the quit day than after initial quitting. Our results also may be somewhat different from Wong et al. (2004), who found in cocaine users that abstinence predicted later self-efficacy for remaining abstinent from cocaine, while initial self-efficacy did not predict subsequent success with remaining abstinent.

In any case, based on our results, self-efficacy rating may influence subsequent smoking behavior change, as self-efficacy theory proposes, but only when assessed after beginning the quit attempt or if the predicted smoking behavior is very proximal in time to the rating. Factors accounting for when self-efficacy may or may not predict subsequent smoking behavior could be determined if smoking cessation trials frequently assess self-efficacy and smoking before and after the quit date, and assess self-efficacy for abstaining over different time courses (e.g. one day, one week, one month, one year). However, such research should also be designed to determine the conditions under which smoking behavior influences self-efficacy, given the clear evidence for this relationship found here and in prior relevant smoking studies (Gwaltney et al. 2009; Romanowich et al. 2009). For example, a gradual reduction in smoking ahead of a quit date could increase initial success of a quit attempt (Hughes & Carpenter, 2006), partly because such smoking reduction may cause a gradual increase in self-efficacy for being able to quit, at least in the near-term, supporting behavioral theory.

In conclusion, over short durations of attempts to quit, self-efficacy to not smoke predicts next day smoking abstinence, and abstinence predicts same day ratings of self-efficacy to quit the next day. Both self-efficacy theory and behavioral theory of behavior change are generally supported by these results. Clinical research should examine these associations with frequent assessments and over longer periods of time to determine the conditions under which these associations hold. Results of that research may determine when self-efficacy

ratings have predictive validity (and are clinically useful) and when they do not. Such research should also examine whether findings extend to results for attempts to understand abstinence from other drug use (e.g., Wong et al. 2004). Finally, more attention should be paid in clinical research to the underappreciated influence of smoking behavior change on subsequent ratings of self-efficacy.

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Figure 1.

Daily means $\pm$ SE for smoking abstinence (bottom) and for self-efficacy to not smoke the next day (top) during each practice quit week, in the nicotine patch study (N=209, left) and the varenicline study (N=123, right).

Figure 2. Mean $\pm$ SE rating of self-efficacy to not smoke the next day by current day abstinence status, in the nicotine patch study (left) and in the varenicline study (right).

Table 1

Self-efficacy (in bold) and other predictors of next day smoking abstinence for both studies.

Predictor	Nicotine Patch study			Varenicline study		
	coeff	Wald χ^2	p (signif.)	coeff	Wald χ^2	p (signif)
Constant	-2.267	173.81	<.0001	-3.240	118.22	<.0001
Prior Abstinence	2.421	272.25	<.0001	2.623	172.64	<.0001
FTND			ns			ns
Cigs/day	-0.041	7.85	0.005			ns
Reinforcement	0.501	11.90	0.0006	0.403	4.05	0.044
Quit Interest			ns	0.567	8.32	0.003
Period			ns	1.301	19.13	<.0001
Medication	0.298	4.39	0.036	0.621	4.30	0.038
Self-efficacy	0.028	112.16	<.0001	0.026	48.42	<.0001
Period X Medication			ns	-1.171	8.29	0.0001

ns = non-significant

Table 2

Smoking abstinence (in bold) and other predictors of self-efficacy to not smoke the next day for both studies.

Predictor	Nicotine Patch study			Varenicline study		
	coeff	Wald χ^2	p (signif.)	coeff	Wald χ^2	p (signif)
Constant	51.902	1625.35	<.0001	53.568	1588.84	<.0001
Prior Self-efficacy	0.731	1251.76	<.0001	0.819	1367.74	<.0001
Reinforcement	13.898	4.88	0.001			ns
Quit Interest			ns			ns
Period			ns			ns
Medication	3.594	9.98	0.002			ns
Abstinence	11.256	68.23	<.0001	7.909	28.90	<.0001

ns = non-significant