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Testing a Self-Determination Theory Intervention for Motivating Tobacco Cessation: Supporting Autonomy and Competence in a Clinical Trial

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A longitudinal randomized trial tested the self-determination theory (SDT) intervention and process model of health behavior change for tobacco cessation ($N = 1006$). Adult smokers were recruited for a study of smokers' health and were assigned to intensive treatment or community care. Participants were relatively poor and undereducated. Intervention patients perceived greater autonomy support and reported greater autonomous and competence motivations than did control patients. They also reported greater medication use and significantly greater abstinence. Structural equation modeling analyses confirmed the SDT process model in which perceived autonomy support led to increases in autonomous and competence motivations, which in turn led to greater cessation. The causal role of autonomy support in the internalization of autonomous motivation, perceived competence, and smoking cessation was supported.

Keywords: tobacco dependence treatment, autonomous motivation, perceived competence, self-determination theory, adherence

Results from the Lung Health Study (Murray, Connett, Rand, Pan, & Anthonisen, 2002) indicate that 21% of smokers who received intensive tobacco-dependence treatment had maintained abstinence 11 years later compared with 6% who received community care. However, little is known about what factors predict abstinence. The Public Health Service's tobacco-dependence guidelines (Fiore et al., 2000) suggest that supports for autonomy and self-efficacy may be important, but the guidelines offer little empirical support for these process variables. In 1999, the National Institutes of Health (NIH) funded 15 studies of behavior change, referred to as the Behavior Change Consortium (BCC), to link theories of behavior change with important health outcomes (Ory, Jordan, & Bazzarre, 2002). The current study, which is part of the BCC, was a randomized trial conducted to test a self-determination theory (SDT) intervention for tobacco cessation and for dietary change among the subset of patients with elevated cholesterol (Williams, Minicucci, et al., 2002). This article is limited to the tobacco treatment outcomes.

Research on SDT (Deci & Ryan, 1985; Sheldon, Williams, & Joiner, 2003) has indicated that autonomous and competence motivations are associated with change in tobacco use for adolescents (Williams, Cox, Kouides, & Deci, 1999) and long-term tobacco abstinence for adults (Curry, Wagner, & Grathaus, 1991; Williams, Gagné, Ryan, & Deci, 2002). However, no randomized trial has provided an intervention that has increased patients' perceptions of autonomy support, autonomous motivation, and the intended behavioral outcome. Central to SDT are the concepts of autonomous motivation and perceived competence. People are autonomously motivated when they experience volition and choice while behaving. When stopping smoking, patients would be autonomous if they freely chose to stop because they were personally committed to improving their health and the quality and length of their life. People are autonomous in using medications if they freely choose to take a medication they believe may help them reach a valued health goal. People perceive themselves to be competent when they feel able to attain important health outcomes. The construct of perceived competence is similar to that of self-efficacy (Bandura, 1997). We used the perceived competence scale because it was developed with the other measures used in the SDT process model and it is short (four items). Studies indicate that when people are more autonomously motivated they feel more competent to attain relevant health outcomes (Williams, Freedman, & Deci, 1998; Williams, McGregor, Zeldman, Freedman, & Deci, 2004). This is consistent with SDT because autonomy concerns the experience of initiating behaviors that prompt people to feel more competent in

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attaining outcomes. SDT predicts that people will be most effective in stopping smoking when they feel autonomous and competent for doing so.

According to SDT, when practitioners are autonomy supportive, patients will be more likely to become autonomously motivated and to perceive themselves as competent for cessation. *Autonomy support* refers to practitioners' eliciting and acknowledging patients' perspectives, supporting their initiatives, offering choice about treatment options, and providing relevant information, while minimizing pressure and control. Studies have shown that autonomy support by health care practitioners affects patient motivation and health behaviors, including smoking abstinence (Williams, Cox, et al., 1999), weight loss (Williams, Grow, Freedman, Ryan, & Deci, 1996), and medication adherence (Williams, Rodin, Ryan, Grolnick, & Deci, 1998). The present trial examined whether an intervention focused on practitioners' bringing patients to a place of informed choice about whether or not to smoke, and leaving the decision to the patients, would lead to greater perceptions of autonomy (i.e., volition) and competence, and in turn to greater tobacco abstinence.

The relations among autonomy support, autonomous motivation, and perceived competence as predictors of health outcomes form the basis of the SDT process model of behavior change. Theoretically, the SDT process model represents a process of change called *internalization*, through which people take in and integrate the motivations and competencies for changing a particular behavior or goal. Internalization is expected to be the active process of change in all human beings no matter what treatments (or nontreatments) they encounter. We hypothesized that the intervention would be more likely to facilitate patients' internalizing autonomous and competence motivations to stop smoking because it would enhance the level of autonomy support experienced by intervention patients as compared with community care patients. However, we also predicted that, when people experienced autonomy support, their autonomous motivation and perceived competence would increase accordingly regardless of which condition they are in because internalization is theorized to be a proactive change process for all people. Thus, the relations among the primary motivation variables are expected to be comparable regardless of the level of any of the variables. For example, the magnitude of the relation between autonomous motivation and perceived competence is expected to be stable regardless of level of autonomous motivation experienced. Further, it is expected that, as autonomy support, autonomous motivation, and perceived competence increased as a system, behavior change would be more likely to occur.

On the basis of this, we hypothesized that the intensive intervention condition relative to the community care condition would result in (a) greater perceived autonomy support, (b) greater internalization of autonomous motivation for stopping smoking and for taking cessation medications, (c) greater development of perceived competence for quitting, (d) greater use of medications for stopping smoking, and (e) greater abstinence rates at 6 months. In addition, we hypothesized that (f) the predictive relations among the motivation variables of the SDT process model would be equivalent across the two conditions and that (g) changes in the network of motivation variables would predict both greater use of medications and greater abstinence.

Although SDT has been developed separately from social learning theory (SLT; Bandura, 1997) and stages of change (SOC; Prochaska, DiClemente, & Norcross, 1992), there are similarities among some of the constructs used in these theories (e.g., self-efficacy is similar to perceived competence). However, because change in SDT is hypothesized to occur as a function of internalization of autonomous and competence motivations, and change in SLT and SOC is hypothesized to occur through other mechanisms (e.g., increasing outcome expectancies), interventions based on the three theories tend to be constructed differently to motivate change. SDT assumes that internalization is the process of change for all humans, and that humans are inherently motivated to internalize the regulation of behaviors that allow them to grow and be healthy. Patients' perceptions of autonomy and competence are expected to increase when the patients are supported in making an informed choice for themselves about whether or not to continue a behavior or to start taking a medication. Therefore, the intervention designed for this study establishes an autonomy-supportive climate in the same way for all smokers, no matter their stage of change or their expectancies of efficacy.

Method

Study Design and Conditions

The study design, recruitment, and detailed description of the intervention were reported elsewhere (Williams, Minicucci, et al., 2002). In brief, people who smoked five or more cigarettes per day, were 18 years of age or older, read and spoke English, had no history of a psychotic illness (depression and anxiety were allowed), had a life expectancy of 18 months, and planned to live in the greater Rochester, NY, area for 18 months were recruited through newspaper ads and signs in physician offices to participate in a study about "smokers' health." Intention to quit was not required, as we wanted to work with a general population of smokers, and 52% of the participants indicated that they were not ready to try quitting when they entered the study, before contact with the counselors. The participants were relatively poor, with average incomes more than $10,000 below that of the average for the county. They were also undereducated, with 11% of the sample over 24 years of age having graduated from college, compared with 33% for the county.

Parking passes were given to participants, and they were paid $30 after completing the 6-month questionnaire. (The honoraria were prorated if participants withdrew from the study before completing it.) Participants were stratified according to their cholesterol levels (National Institutes of Health, National Heart, Lung, and Blood Institute, 1997) and were randomly assigned to either community care (30% of the sample) or to the intensive intervention (70% of the sample). This ratio was used because intensive interventions were expected to have greater effect on cessation than community care, and we would minimize the number in community care while still allowing for a test of mediation. All community care patients will be offered intensive treatment once they finish the study.

The community's accepted standard of care was selected as the comparison group because it would not be ethical to intentionally undermine patient autonomy with a controlling condition. Thus, the main questions addressed in this study are what happens to patients' autonomous motivation and perceived competence and to their subsequent health behaviors (taking medications and stopping smoking) if they are provided with greater autonomy support than is provided in the community.

Community care condition. Participants randomized to community care received the Public Health Service (PHS) booklet *You Can Stop Smoking* (PHS, 2000), a photocopy of the results of their cholesterol tests, and a list of active smoking cessation programs (phone numbers and costs) in the Rochester area. They were advised to make an appointment with

their own physician to discuss their cholesterol results and smoking, and they were encouraged to enroll in a smoking cessation program.

Intensive intervention condition. Participants in the intervention condition were given the same recommendations and materials given to those in community care and were asked to meet with study counselors four times in the subsequent 6 months. The first meeting was in person. The subsequent meetings were also encouraged to be in person, but phone follow-up was allowed if the participants so chose. Additional in-person or phone contacts with a counselor were allowed if initiated by the patients, and patients were told that they could schedule a meeting with a study physician for a medication consultation if they chose to do so. After completing baseline questionnaires (approximately 50 min), the participants had their first meeting with a health counselor (50 min).

After the first visit, the patient met with the counselor for 20-min follow-up visits. Counselors had been trained to support the participants in making a clear and autonomous decision about whether or not to make a quit attempt. The participants' smoking history and attitudes were explored, including why they liked smoking, their past quit attempts, and what health risks they perceived from smoking. Counselors asked briefly about participants' life strivings and about how smoking either helped or hindered their attainment. Participants' 10-year risk for developing cardiovascular disease was reviewed with them (Grundy, Pasternak, Greenland, Smith, & Fuster, 1999), and they were informed that quitting smoking would cut that risk by 50% within 12 months (U.S. Department of Health and Human Services, 1990).

After summarizing and acknowledging any reactions from the patients, counselors asked whether or not the patients wanted to stop smoking. If they were not ready to stop, they were asked to return in 1 to 2 months to discuss smoking further. If they said they wanted to stop smoking, counselors moved on to support their perceived competence for quitting by establishing a cessation plan according to Public Health Service (PHS) guidelines (Fiore et al., 2000). Specifically, counselors discussed setting a quit date in the next 30 days, informed the patients about the expected time course of withdrawal, and discussed the medications recommended to reduce withdrawal symptoms. Follow-up was planned for the 1st week after cessation. Patients were also asked if they wanted to discuss their smoking and medication use with a study physician or with their own physician.

In all parts of the interview, counselors focused on understanding the patients' perspectives and emotional responses. Follow-up visits for those who had not wanted to quit involved counselors' reviewing the participants' values and initiating a discussion about any further thoughts on whether to try quitting. At any time the patients said they wanted to quit, counselors pursued supporting competence and making a quit plan. Follow-up visits for those who wanted to quit focused on reviewing and acknowledging any quit attempts, reframing failed attempts as short successes and asking if they wanted to quit again, asking about any negative medication effects, and reviewing standard relapse prevention according to the PHS guidelines (Fiore et al., 2000).

Procedure and Time Line

Baseline assessments. At baseline, all participants completed questionnaires assessing demographic information, medical history, smoking history, and intention to quit smoking in the next 30 days. They also had their blood pressure measured. In addition, participants completed the Fagerstrom Addiction Severity Scale (FAS; Fagerstrom & Schneider, 1989), the Treatment Self-Regulation Questionnaire (TSRQ) for autonomous motivation (Williams, Gagné, et al., 2002), and the Perceived Competence Scale for Cessation (PCSC; Williams, Gagné, et al., 2002).

1-month assessment. One month after baseline, participants were mailed a follow-up questionnaire packet. Three attempts were made to phone participants who did not return questionnaires in 2 weeks, and a second questionnaire was mailed if needed. The 1-month packet assessed smoking status and intention to quit smoking, as well as the TSRQ and the PCSC. The packet also included the Health Care Climate Questionnaire (HCCQ; Williams, Grow, et al., 1996) to assess patients' perceptions of the health care practitioner's autonomy support regarding tobacco use.

6-month outcomes. Six months after baseline, all participants were mailed a follow-up questionnaire that asked about quit attempts, smoking status, point prevalence, and the use of medications. Participants who reported not smoking via the point prevalence question were instructed to call the study to arrange for a validation test.

Measures

Smoking status, cessation, and medication use. Smoking status and cessation were assessed as follows. The primary measure was biochemically validated 6-month 7-day point prevalence (7-day PP), which is a dichotomous measure. Patients were asked to respond either "yes" or "no" to the following question: "Have you smoked a cigarette, even a puff, in the past 7 days?" For those participants who answered "no," serum cotinine was analyzed to validate the point prevalence report of cessation (Pojer et al., 1984). As recommended (Hughes et al., 2003), we report both the validated and unvalidated 7-day PP. Only those participants who responded "no" to the 7-day PP question and were validated as not smoking via serum cotinine were treated as not smoking.[1] Participants were also asked to report the longest number of days they had not smoked since they began the study and the number of days since their last cigarette. A latent cessation variable for use in the structural equation modeling (SEM) analyses was constructed using validated 7-day PP, longest number of days not smoking, and number of days since last cigarette as indicators. The three indicator variables have been shown to relate to long-term abstinence in previous reports (Dale et al., 2001; Farkas et al., 1996; Williams, Gagné, et al., 2002) and loaded significantly on the 6-month latent cessation variable in this study (βs = .90, .81, and .85, ps $< .01$, respectively).

In addition to assessing "cessation," we measured 6-month "prolonged abstinence" (6-month PA; Hughes et al., 2003), because it has been found to be more stable (Pierce & Gilpin, 2003). Specifically, whereas 6-month cessation was assessed with 7-day PP 6 months after patients began the study, 6-month PA was assessed 6 months after the patients' reported quit dates (Hughes et al., 2003). Finally, we asked the number of serious quit attempts (lasting more than 24 hr) the patients had made since beginning the study.

Participants were also asked if they had used any of the following medications to aid in cessation: nicotine patch, nicotine gum, nicotine nasal spray, nicotine inhaler, or sustained release bupropion. For each medication used, participants reported the type, the dose, and the number of days it was used. From this, two variables were created. First, the numbers of days each medication was used were summed to obtain the number of medication days. The second variable was the number of medications used by the participant. These two variables were significant indicators of the latent medication variable in the SEM analysis (βs = .50 and .50, ps $< .01$).

TSRQ. Ryan and Connell (1989) developed the TSRQ to assess autonomous motivation, and it has been described (Williams, Minicucci, et al., 2002) and validated elsewhere (Williams, Gagné, et al., 2002) Autonomous motivation for cessation and autonomous motivation for taking cessation medication (nicotine replacement or sustained release bupropion) were each assessed using six items at baseline and at 1 month. Participants responded to each item on a 1 (*strongly disagree*) to 7 (*strongly agree*) scale (example item: "The reason I would stop smoking permanently or

[1] Across our intention-to-treat sample of 1,006 participants, 118 answered "no" to the 6-month assessment of the 7-day PP question. Of these 118 participants, 96 (81%) were validated as not smoking by serum cotinine. Of the 22 participants who reported they were not smoking, but were not validated as such, 17 were in the intensive intervention and 5 were in community care. Each of these 22 participants was considered as smoking in the final analysis.

continue not smoking is because I feel that I want to take responsibility for my own health"). Items reflecting autonomous reasons for stopping smoking exhibited good internal consistency at baseline (α = .86) and at 1 month (α = .89), as did those for using medications at baseline (α = .87) and at 1 month (α = .91). A factor analysis was conducted at both baseline and 1 month in which all 12 items from both scales were included. At both time points, autonomous motivation for taking medications and autonomous motivation for cessation loaded cleanly on their respective factors, yielded eigenvalues greater than 1, and had no cross-loadings greater than .25.

The means of the six items were calculated for each scale at each time, yielding baseline and 1-month scores for autonomous motivation to quit, and baseline and 1-month scores for autonomous motivation for taking medication. The two scale scores at baseline and the two scores at 1 month were significant indicators of the latent variables of autonomous motivation at baseline and autonomous motivation at 1 month, respectively (βs = .50 and .66, ps $< .01$, at baseline, and .52 and .70, ps $< .01$, at 1 month).

PCSC. Four items assess the degree to which patients feel able to stop smoking successfully. Respondents indicated their agreement with each item on a 1 (*strongly disagree*) to 7 (*strongly agree*) scale (example item: "I feel confident in my ability to stop smoking permanently"). The four items exhibited good internal consistency at baseline (α = .91) and at 1 month (α = .93). The four items were averaged at each time point to form baseline and 1-month perceived competence indices for the analyses of variance (ANOVAs). The four items at each time point were used separately as indicators of the latent variable for perceived competence at baseline and 1 month in the SEM analyses. Each of the indicators loaded significantly on its respective latent variable (βs = .87, .87, .82, and .89, at baseline, and .91, .90, .86, and .94 at 1 month).

HCCQ (Williams, Gagné, et al., 2002; Williams, Grow, et al., 1996). The HCCQ assesses patients' perceptions of the degree to which their providers were autonomy supportive (vs. controlling) in consulting with them regarding their smoking. Patients responded to 15 items on a 1 (*strongly disagree*) to 7 (*strongly agree*) scale (example item: "I feel that my counselor has provided me with choices and options about my smoking"). The mean of the 15 items in the present sample was calculated to create the HCCQ index used in ANOVAs. The scale had good internal consistency (α = .94). The latent variable for autonomy support was created by averaging three mutually exclusive sets of 5 items each from the HCCQ, and each of these was used as an indicator of the latent autonomy-support variable (βs = .87, .95, and .88, ps $< .01$).

Results

Recruitment and Retention

Of the 2,681 individuals screened for eligibility, 1,006 were randomized to condition. Of the 1,006 randomized into the study (292 community care, 714 intensive intervention), 866 were active at 1 month (250 community care, 616 intensive intervention), and 703 were active at 6 months (207 community care, 496 intensive intervention). During the 6 months following randomization, 78 individuals withdrew from the study, 6 died (no deaths were related to the study), and 219 were lost to follow-up at 6 months (see Figure 1).

A comparison of participants active at 1 month with those who dropped out (n = 140) indicated that those who dropped out of the study were less likely to be Caucasian (73.6% vs. 83.2%), $\chi^2(1) = 7.52$, $p < .01$; were more likely to have said they were ready to quit in the next 30 days (55.4% vs. 45.6%), $\chi^2(1) = 4.58$, $p < .05$; reported higher autonomous motivation for quitting smoking at baseline (6.26 vs. 6.05), $t(1002) = 2.16$, $p < .05$; and reported higher perceived competence for quitting at baseline (4.65 vs. 4.31), $t(1002) = 2.30$, $p < .05$. For non-White minorities, there was no difference between those who dropped out of the study and those who stayed in the study on either perceived competence for quitting or autonomous motivation to use medications (all ps $>$ .35). However, minorities who dropped out reported higher, yet nonsignificant, autonomous motivation for quitting smoking at baseline than those who stayed in (6.63 vs. 6.36, Cohen's d = .37), $t(179) = 1.71$, p = .09.

Analytic Overview

Two types of analyses were conducted with these data. First, we conducted an "intention-to-treat" analysis, which included all 1,006 participants. Missing data regarding the motivation variables were replaced by a participant's last known report or, if necessary, by mean replacement. If smoking status or medication-taking information was unavailable at the 6-month follow-up, the participant was considered smoking or not taking medication, respectively.

Second, the SDT process model was tested using an "as treated" subsample of our 1,006 participants. For these 866 participants who were active at 1 month, we required those in the intervention to have completed the intervention (at least four contacts) to be included. If smoking status or information regarding medication use for any of these 866 was not available at the 6-month follow-up, participants were considered to be smoking or not using medications. Multigroup SEM analyses were used to test the SDT process model on this subsample, as it offered the greatest degree of data actually reported by participants who had completed the full intervention. Stated differently, inclusion of people who did not experience the full intervention provides a poor test of the process model concerning changes in autonomy and competence, because they would not have experienced the full intervention. Further, "pulling forward" their data would create a bias toward supporting the hypotheses, because using their data would increase power without adding variance in motivational change.

Preliminary Analyses

The 1,006 participants included in the intention-to-treat analyses had a mean age of 45.5 years, and 63.9% were female. Randomization was effective, as t tests and chi-square analyses showed that the groups did not differ significantly on key demographic variables (see Table 1) or on baseline motivation variables (see Table 2). Those randomized to the intervention (N = 714) had an average of 4.42 visits with a counselor (69% had 4 or more visits). Fifty-one percent of the visits were in person. Of the 714 participants in the intervention, 323 chose to see a study doctor (45%). Participants choosing to see a study doctor had an average of 1.3 visits with the doctor, and 33% of those visits were in person rather than via phone.

Intention-to-Treat Analyses

Effect of the intervention on smoking outcome variables. As shown in Table 3, chi-square analyses confirmed the central hypothesis that the abstinence outcome of 6-month validated 7-day PP was significantly higher in the intensive treatment condition than in community care (11.8% vs. 4.1%), $\chi^2(1) = 14.07$, $p <$

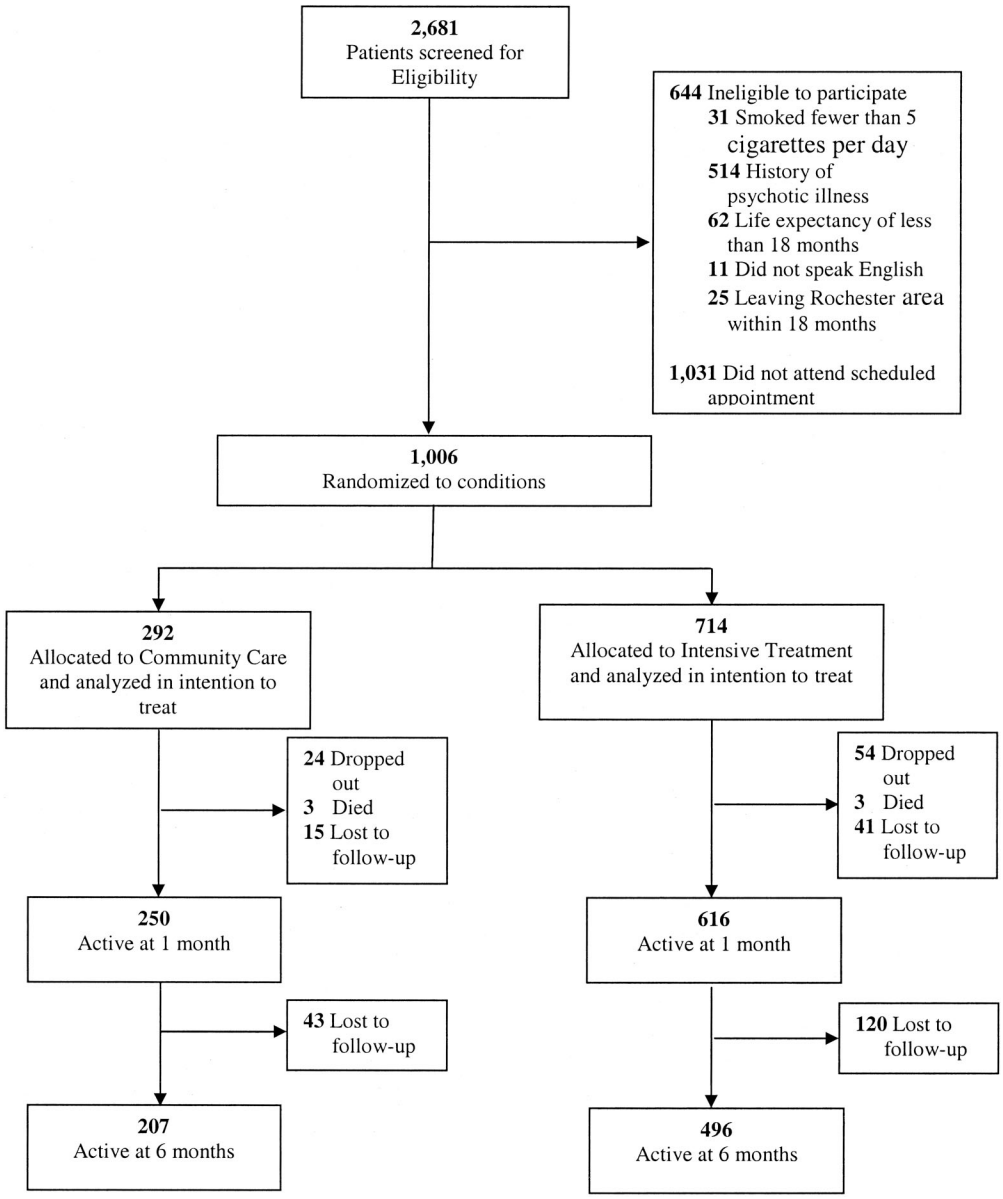

Figure 1. CONSORT recruitment and retention of participants.

.001; number needed to treat (NNT)[2] = 13.1. Similarly, 6-month PA differed by condition (11.2% vs. 3.8%), $\chi^2(1) = 13.93$, $p < .001$; NNT = 13.5. The 6-month nonvalidated 7-day PP was also significantly higher in the intervention than community control (14.1% vs. 5.8%), $\chi^2(1) = 13.87$, $p < .001$; NNT = 12.0. Furthermore, *t* tests confirmed that participants in the intensive intervention condition had significantly more days since their last cigarette (20.1 vs. 5.7 days), $t(1004) = 4.15$, $p < .001$, and had more continuous days not smoking in the first 6 months of the study (25.1 vs. 9.4 days), $t(1004) = 4.99$, $p < .001$. The 1-month 7-day PP was also significantly increased by the intervention (19.5% vs. 3.8%), $\chi^2(1) = 33.087$, $p < .001$. Thus, in terms of smoking cessation, the intervention had significant effects.

Effect of intervention on medication taking. Chi-square analyses showed that a higher percentage of participants in the intensive intervention reported making a serious quit attempt (49.7% vs. 39.0%), $\chi^2(1) = 9.47$, $p < .005$, and taking medications (30.8% vs. 15.8%), $\chi^2(1) = 24.16$, $p < .001$. A *t* test confirmed that these participants reported taking the medications for more days (29.1 vs. 9.2), $t(1004) = 4.75$, $p < .001$.

Effect of the intervention on motivation variables. As shown in Table 2, *t* tests confirmed that patients in the intensive treatment group perceived greater autonomy support than those in community care, $t(1004) = 6.19$, $p < .001$. Analysis of covariance (ANCOVA) revealed that intensive-treatment patients internalized

[2] NNT represents the number of participants that need to be treated in the intensive intervention that results in 1 additional participant to stop smoking for 6 months.

Table 1
Baseline Characteristics for Both the Intention-to-Treat Sample and the As-Treated Sample by Treatment Group

Characteristic	Community care group (n = 292)	Intensive treatment group (n = 714)	p
Sex (% female)	66.8	62.7	.22
Age (*M*)	44.8	45.5	.93
SES (1–9)	4.34	4.36	.93
Martial status (% married or living as married)	46.6	47.1	.53
Ethnicity (% White)	80.8	81.9	.87
Cigarettes per day (*M*)	20.9	20.3	.43
Fagerstrom AS (*M*)	4.97	5.02	.74

Note. SES = socioeconomic status; AS = addiction severity.

more autonomous motivation for taking medications, $F(1, 988) = 9.42$, $p < .01$, and more competence motivation, $F(1, 1001) = 30.38$, $p < .001$, from baseline to 1 month than did those in community care. However, intensive-treatment patients did not internalize significantly more autonomous motivation for stopping smoking, $F(1, 1001) = 1.42$, $p = .23$. A subgroup analysis revealed that autonomous motivation for cessation was significantly increased for intervention patients who elected to see a study physician compared with those in community care, $F(1, 615) = 6.25$, $p = .01$.

Effect of the motivation variables on smoking outcomes. Correlations of the motivation variables with the smoking outcome variables are presented in Table 4. Logistic and multiple regressions were used to test the mediational effect of the block of change in motivation variables on the relation between the intervention and the smoking outcomes. Specifically, each smoking outcome was regressed on intervention condition and baseline motivation variables in Step one, and then on the 1-month motivation variables in Step two. Mediation is considered to be evident when the effect of the intervention on the outcome, controlling for the change in motivation variables from baseline to 1 month, drops either by a significant degree or to nonsignificance (Baron & Kenny, 1986).

Using the Wald criterion for z in logistic regression, the intervention condition significantly predicted both 6-month validated 7-day PP and 6-month PA controlling for the baseline motivation variables, $z(1) = 12.68$, $p < .001$, OR = 3.10 (95% confidence interval [CI]: 1.66, 5.76) and $z(1) = 12.48$, $p < .001$, OR = 3.21 (95% CI: 1.68, 6.12). The addition of the 1-month motivation variables to the equation yielded a significant effect for the block in both the 6-month 7-day PP, $\chi^2(3) = 31.58$, $p < .001$, and 6-month PA outcomes, $\chi^2(3) = 34.40$, $p < .001$. Intervention condition at the second step did not fall to nonsignificance, but its effect was reduced from $z(1) = 12.68$, $p < .001$, to $z(1) = 7.26$, $p = .01$, for 6-month 7-day PP, and reduced from $z(1) = 12.48$, $p < .001$, to $z(1) = 6.89$, $p = .01$, for 6-month PA, indicating partial mediation.

Ancillary Analyses

These analyses were fully replicated for the 527 participants who reported at baseline that they did not want to quit smoking, with the exception that the motivation variables as a block fully mediated the relation between the intervention and each of the abstinence outcomes. As before, the intervention group perceived greater autonomy support (6.21 vs. 5.61, $p < .001$), had greater change in autonomous reasons for using medications (5.19 vs. 4.91, $p < .05$), perceived competence (4.24 vs. 3.59, $p < .001$), had greater days on medications (26.75 vs. 3.75, $p < .001$), validated 7-day PP (9.8% vs. 3.7%, $p < .02$), and 6-month PA (9.0% vs. 3.1%, $p < .05$). In addition, across those who did not want to quit smoking, autonomous motivation for cessation was significantly increased for intervention patients who elected to see a study physician compared with those in the community care

Table 2
Baseline and 1-Month Mean Differences of Motivation Variables Between Community Care and Intensive Intervention Conditions

Variable	Community care	Intensive intervention	p	α
Baseline variables				
Intention to quit in 30 days (%)	44.3	48.1	.37	—
Autonomous motivation for quitting	5.99	6.11	.12	.85
Autonomous motivations for taking medication	5.21	5.30	.40	.87
Perceived competence	4.30	4.38	.50	.90
1-month variables				
Autonomy support	5.66	6.26	<.001	.95
Autonomous reasons for quitting at 1 month	6.16	6.22	.23	.88
Autonomous reasons for taking medication at 1 month	5.21	5.46	.002	.90
Competence motivation at 1 month	4.25	4.74	<.001	.92

Note. Mean values reported for autonomous reasons for quitting, autonomous reasons for taking medication, and competence motivation are adjusted for each variable's baseline covariate.

Table 3
Smoking Cessation Outcomes and Cessation Medication Use by Treatment Group for Both Intention-to-Treat and As-Treated Samples

Outcome	Community care	Intensive intervention	Odds ratio	Confidence interval	*p*
Used medication	15.8%	30.8%	2.38	1.67, 3.39	.001
Days on medications	5.67	20.05	—	—	.001
Validated 6-month PP	4.1%	11.8%	3.11	1.67, 5.79	.001
6-month PA	3.8%	11.2%	3.22	1.69, 6.15	.001

Note. PP = point prevalence; PA = prolonged abstinence.

group, $F(1, 284) = 6.75$, $p < .01$. Mediational analyses showed the addition of the block of 1-month motivation variables predicted significant variance in validated 7-day PP, $\chi^2(3) = 17.88$, $p < .001$, and 6-month PA, $\chi^2(3) = 18.19$, $p < .001$. Of importance, the addition of the 1-month variables reduced the effect of the intervention to nonsignificant (from $z = 5.23$, $p = .02$, to $z = 2.13$, $p = .15$, for validated 7-day PP, and from $z = 5.29$, $p = .02$, to $z = 2.15$, $p = .14$, for 6-month PA). Thus, the SDT motivation variables fully mediated the intervention effect on the abstinence outcomes for those who did not want to quit.

On the basis of the findings of the intention-to-treat analyses, SEM was used to confirm the relations among the SDT mediators. This SEM analysis examined the relations among the process model variables for those patients who reported completing four contacts in 6 months for the intervention group and those in the community control group who were active at 4 weeks into the trial. The 6-month 7-day PP between-groups difference for the as-treated analysis was 13.6% versus 4.8%, $\chi^2(1) = 14.09$, $p < .01$.

Multigroup Analysis of the SDT Process Model

Model estimation and fit criteria. Structural equation models of the data were conducted using AMOS 5 (Arbuckle, 2003). The maximum-likelihood method was used to estimate parameters, and goodness-of-fit was assessed by examining the following indices: the chi-square statistic, the incremental fit index (IFI), the comparative fit index (CFI), and the root-mean-square error of approximation (RMSEA). A model is considered to have adequate fit when the IFI and CFI have values that exceed .90 and when the RMSEA is less than .08 (Bollen, 1989; Byrne, 2001; Kline, 1998). Because of the inclusion of the dichotomous point prevalence as an indicator of the latent 6-month cessation variable, a tetrachoric correlation matrix was used as input for the estimation of the SEM analyses (see Bollen, 1989, pp. 440–445, and Kline, 1998, pp. 237–238). In addition to the evaluation of model fit, standardized parameter estimates were evaluated to determine whether the hypothesized relationships were supported by the data.

SDT model equivalence across intervention conditions. Multigroup SEM analyses were performed to examine whether the SDT model differed across the two intervention conditions. Specifically, these multigroup SEM analyses tested whether the relations between the observed indicators and their respective latent variables (the measurement model) and also the hypothesized interrelations among the latent variables (the structural model) were variant versus invariant across the community care and intervention groups (Byrne, 2001). Preliminary analyses tested the SDT model in each group independently and determined that the fits of Model A (community care) and Model B (intensive intervention) were adequate (Byrne, 2001), and thus we proceeded with the analysis (see Table 5). The SDT model was then tested simultaneously across the two intervention groups, and the factor loadings, variances, covariances, structural paths, and latent means were allowed to vary freely (Model 0). The fit of Model 0 was adequate (see Table 5). Model 0 thus represents the best possible fit of the data to the model.

Model invariance is determined by comparing the baseline model (Model 0) to successively restrictive models (ones in which factor loadings, covariance, or structural paths are constrained to be equal across the groups). A model whose fit is not significantly different from that of Model 0 (assessed as difference in the magnitude of chi-square) is deemed invariant or equal to Model 0,

Table 4
Intercorrelations Between Motivation Variables and Smoking Outcome Variables

Variable	1	2	3	4	5	6	7	8	9
1. Baseline autonomous motivation for cessation	—								
2. Baseline autonomous motivation for taking medication	.46**	—							
3. Baseline perceived competence	.40**	.19**	—						
4. 1-month autonomy support	.19**	.13**	.13**	—					
5. 1-month autonomous motivation for cessation	.76**	.39**	.34**	.23**	—				
6. 1-month autonomous motivation for taking medication	.40**	.68**	.12**	.25**	.49**	—			
7. 1-month perceived competence	.38**	.20**	.66**	.24**	.45**	.23**	—		
8. Longest time not smoking	.08*	.06†	.08*	.12**	.11**	.10**	.28**	—	
9. Days since last cigarette	.07*	.05	.09**	.11**	.09**	.08*	.19**	.71**	—

† $p < .10$. * $p < .05$. ** $p < .01$.

Table 5
Goodness-of-Fit Indices From the Multigroup Analysis

Model	χ^2	*df*	*p*	$\Delta\chi^2/\Delta df$	Δp	IFI	CFI	RMSEA
Model A (usual care)	472.30	150	<.001	—	—	.92	.92	.093
Model B (intervention)	537.49	150	<.001	—	—	.96	.95	.065
Model 0 (both groups)	1,010.23	300	<.001	—	—	.95	.95	.052
Model 1 (factor loadings constrained)	1,018.94	313	<.001	8.72/13	.79	.95	.95	.051
Model 2 (BL covariance constrained)	1,019.53	314	<.001	9.31/14	.81	.95	.95	.051
Model 3 (all paths constrained to be equal)	1,046.84	322	<.001	36.62/22	.026	.95	.95	.051
Model 4 (BL to 1M motivation paths constrained)	1,022.34	316	<.001	12.12/16	.736	.95	.95	.051
Model 5 (AS to 1M motivation paths constrained)	1,022.86	318	<.001	12.64/18	.81	.95	.95	.051
Model 6 (autonomy 1M to competence 1M constrained)	1,022.89	319	<.001	12.67/19	.86	.95	.95	.051
Model 7 (autonomy 1M to medication taking constrained)	1,022.95	320	<.001	12.72/20	.89	.95	.95	.050
Model 8 (competence 1M to cessation constrained)	1,044.07	321	<.001	33.85/21	.037	.95	.95	.051
Model 9 (medication taking to cessation constrained)	1,030.52	321	<.001	20.30/21	.50	.95	.95	.051

Note. $\Delta\chi^2$ represents the difference in chi-square between Model 0 and the specific model in question; Δdf represents the difference in degrees of freedom between Model 0 and the specific model in question; Δp represents the probability value of the difference in chi-square (given the associated difference in degrees of freedom) between Model 0 and the specific model in question. IFI = incremental fit index; CFI = comparative fit index; RMSEA = root-mean-square error of approximation; BL = assessment at baseline; 1M = assessment at 1 month; AS = autonomy support.

and thus the components constrained to be equal in that model are considered equivalent across groups (Byrne, 2001). Results are presented in Table 5.

Equivalence of the measurement model. Equivalence was tested by constraining the factor loadings of the indicators on the latent variables to be equal across the intensive intervention and the community care conditions (Model 1). Model 1 fit the data adequately and did not differ significantly from Model 0, $\Delta\chi^2(13) = 8.72$, $p = .79$, indicating the latent constructs were represented and understood equivalently across the two groups.

Equivalence of covariances within the structural model. In this analysis, the covariance between baseline autonomous motivation and baseline perceived competence was constrained to be equal (Model 2). Model 2 provided a satisfactory fit to the data and did not differ significantly from Model 0, $\Delta\chi^2(14) = 9.31$, $p = .81$. This indicates that covariance between latent autonomous motivation and perceived competence at baseline were equal across the two groups.

Testing the equivalence of the SDT process model. Next, all structural paths (those between the latent constructs) were constrained to be equal (Model 3). Although Model 3 fit the data adequately (see Table 5), the fit differed significantly from that of Model 0, $\Delta\chi^2(22) = 36.62$, $p < .05$, indicating that at least one of the constrained paths in the model is variant across the two groups.

Determination of invariant paths in the SDT process model. The next three models tested the invariance of the structural paths between the motivation variables in the SDT process model (Models 4, 5, and 6). Model 4 constrained the paths between baseline and 1-month autonomous motivation, and between baseline and 1-month perceived competence, to be equal across groups. Model 4 fit the data adequately and did not differ significantly from Model 0, $\Delta\chi^2(16) = 12.12$, $p = .74$. Model 5 constrained the paths between autonomy support and 1-month autonomous motivation and between autonomy support and 1-month perceived competence to be equal. The fit of Model 5 was satisfactory and did not differ significantly from Model 0, $\Delta\chi^2(18) = 12.64$, $p = .81$. Model 6 constrained the path between 1-month autonomous motivation and 1-month perceived competence to be equal. Model 6 provided an adequate fit to the data and did not differ significantly from Model 0, $\Delta\chi^2(19) = 12.67$, $p = .86$. Thus, the paths composing the motivational core of the SDT model were not significantly different between the intensive intervention and the community care groups, and they support our hypotheses that the process of internalization of autonomy and competence was the same for patients in both groups.

Three models tested the equivalence across the two groups of the motivation variables in the SDT process model on medication taking and abstinence outcomes. Model 7 constrained the path between 1-month autonomous motivation and medication taking to be equal across groups. The fit of Model 7 was adequate and did not differ significantly from Model 0, $\Delta\chi^2(20) = 12.72$, $p = .89$, indicating that regardless of condition, there was a positive relation between change in autonomous motivation and medication taking. Model 8 constrained the path between 1-month perceived competence and abstinence to be equal across groups. Model 8 provided an adequate fit to the data; however, Model 8 did differ significantly from Model 0, $\Delta\chi^2(21) = 33.85$, $p < .05$, indicating that the strength of the path from perceived competence to abstinence was different in the two groups. Perceived competence at 1 month was a significant positive predictor of abstinence at 6 months ($\beta = .24$, $p < .001$) in the intensive intervention, but competence did not predict abstinence at 6 months ($\beta = -.05$, $p = .50$) in community care. Model 9 constrained the path between medication taking and abstinence to be equal across the groups. Model 9 provided an adequate fit to the data, but the fit did not differ significantly from that of Model 0, $\Delta\chi^2(21) = 20.30$, $p < .50$. Thus, these analyses indicate equivalence of the models except that perceived competence for the intervention patients led to greater abstinence, whereas it did not for the community care patients. Path coefficients of the models are presented in Figure 2.

Discussion

This clinical trial is the first to demonstrate that an intervention based on SDT facilitated the internalization of autonomous motivation and perceived competence and that the internalization of these motivations, in turn, resulted in increased use of cessation medications and 6-month prolonged abstinence from tobacco. The

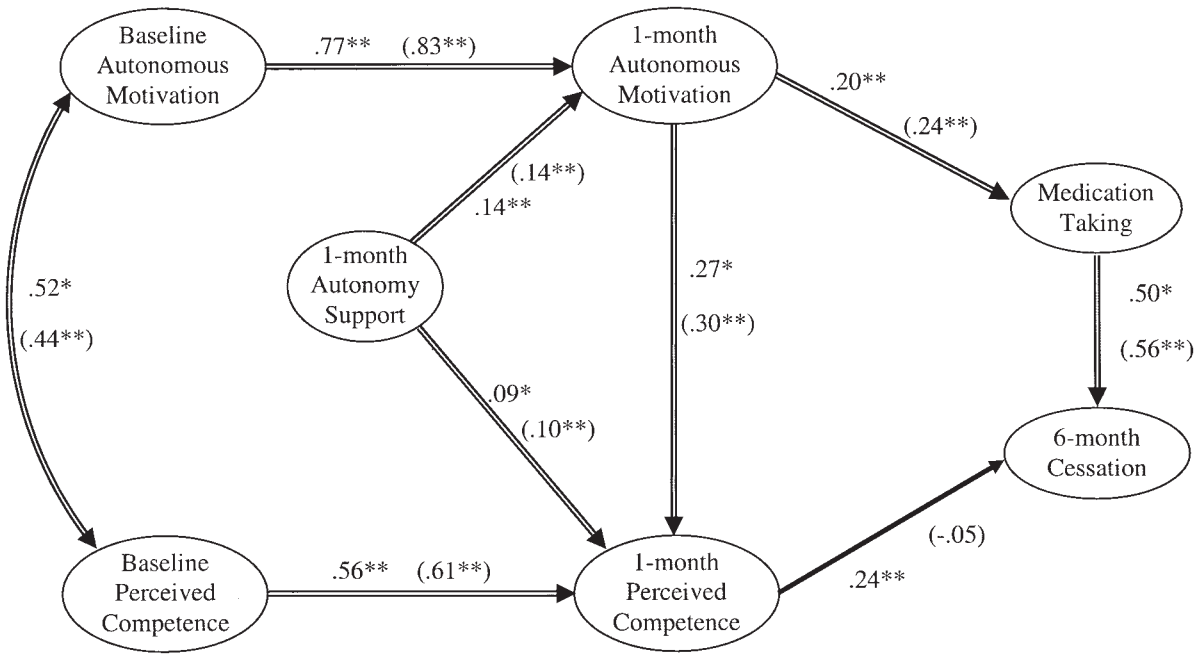

Figure 2. Testing the self-determination theory process model across groups for smoking cessation. Model fit: $\chi^2(332) = 1{,}030.52$, $p < .001$; comparative fit index = .95; incremental fit index = .95; root-mean-square error of approximation = .051. Double lined paths are invariant across groups. Values represent standardized path estimates; those in parentheses are for the community care group. *$p < .05$. **$p < .01$.

current trial also showed that the intervention, which was consistent with the PHS guidelines for intensive treatment of tobacco dependence, was perceived as being more autonomy supportive than was community care. The SEM analyses provide evidence linking the SDT process model to the behavioral outcome, thus fulfilling a central goal of NIH in issuing the request for applications (Ory, Jordan, & Bazzarre, 2002). Further, mediational analyses were consistent with the causal role the SDT process model has in tobacco dependence treatment.

In several ways, this study extends the previous empirical support for the process model found in predicting maintenance of glucose control for diabetes (Williams, McGregor, et al., 2004) and maintained tobacco abstinence for smokers treated by primary care physicians (Williams, Gagné, et al., 2002) or through self-help (Curry, Wagner, & Grothaus, 1991). This trial is the first to demonstrate that patient perception of autonomy support can be significantly increased, as the previous tobacco trial relied on observer ratings of autonomy support. Second, neither of the previous interventions significantly increased autonomous motivation or perceived competence compared with the control groups. Third, this trial confirmed that autonomous motivation and perceived competence represent independent paths to the tobacco abstinence outcome and that facilitating autonomous use of medications is an important goal of the clinical intervention because it increased medication taking, which led to greater abstinence.

Multigroup SEM invariance analyses showed that, overall, the SDT process model was the same in the intensive group as in the community group. Autonomy support appears to be a critical factor for enhancing motivation and for promoting behavior change across the treatment conditions. In particular, paths in the model from autonomy support to change in autonomous motivation and to change in perceived competence were invariant, as was the path from change in autonomous motivation to change in perceived competence. Also, change in autonomous motivation invariantly predicted use of medications across the two groups. However, although perceived competence at 1 month predicted cessation in the intervention group, this relation was not present in the community care group. Thus, the internalization of autonomy in the intervention condition led to a change in competence that independently contributed to abstinence after controlling for medication use, whereas perceived competence internalized from the community setting did not contribute to abstinence beyond that of medication use. This difference suggests the following conclusions. First, all hypothesized paths among the SDT variables were the same in both groups—thus, internalization of autonomy and competence was confirmed as a proactive process of change in smoking behavior across types of treatment, as suggested by the PHS meta-analysis (Fiore et al., 2000, p. 31) and by the U.S. Preventive Services Task Force (Whitlock, Orleans, Pender, & Allan, 2002). Second, medication use was the only proximal predictor of abstinence in community care, whereas competence and medication use both predicted abstinence in intensive treatment. The intensive treatment was able to provide the kinds of interpersonal supports that bolstered perceived competence and promoted abstinence independent of medication use. The failure of community care competence to independently predict cessation is consistent with community practice. The community care physicians were less autonomy supportive, and the result was that their patients were less autonomously motivated to use the medications. Further, the community physicians were not likely to have spent

much time working to build a quit plan, nor on actually engaging their patients in the problem solving and skills building needed for perceived competence and sustained change. SDT uniquely predicts and demonstrates that only when perceived competence is accompanied by the experience of autonomy will it motivate sustained change.

We note that, in the intention-to-treat analyses, autonomous motivation for cessation was increased from baseline to 1 month by the intervention only for a subgroup of patients who chose to see both a counselor and a study physician. The failure to increase autonomous motivation for cessation for all smokers in the intervention group may have occurred because the 1-month follow-up was measured before the full intervention was experienced and because 140 participants did not return after the first visit, thus limiting the effect of the intervention. The fact that autonomous motivation for cessation was increased in the subgroup of patients who met with both a study physician and a counselor is consistent with the PHS meta-analysis and 5A's (ask, advise, assess, assist, and arrange) model, which indicate a unique effect for physicians in counseling smokers to quit (Fiore et al., 2000; Whitlock et al., 2002), and suggests that physician counseling may have its effect by increasing autonomous motivation for cessation.

This randomized trial also extends earlier findings from observational data (Williams, Rodin, et al., 1998) that providing a more autonomy-supportive intervention increases autonomous motivation for taking medications and self-reported medication taking. The standardized parameter estimates of .2 or greater, and NNTs of near 10, reflect the intervention being clinically significant (Woolf, 1999). A recent meta-analysis of communication in medicine (Epstein, Alper, & Quill, 2004) found a paucity of evidence on how communication style can improve patient participatory decision making and highlights the importance of the empirical evidence that this study provides. Using SDT to guide clinicians in motivating patients to take medications seems likely to have an important effect in tobacco dependence treatment (Pierce & Gilpin, 2002) and in adherence to medications in general.

The 6-month nonvalidated point prevalence in the current study was 14.1% versus 5.8% (OR = 2.7). This absolute quit rate and odds ratio compare favorably to the PHS meta-analysis 5-month nonvalidated point prevalence of 16.8% versus 10.8% and OR = 1.7 for 4- to 8-session intensive treatments (Fiore et al., 2000, Table 17, p. 63). It is possible that the slightly lower absolute abstinence rate found in this intervention (14.1% compared with 16.8% in the PHS meta-analysis) and moderately lower community control absolute abstinence rate in this report (5.8% compared with 10.8% in the PHS meta-analysis) may be due in part to the inclusion of patients who did not initially intend to quit (52%), although there was no significant correlation between intention to quit and the outcome in either group. Another possible explanation of the lower abstinence rates is that we accepted participants with depression, anxiety, and chemical dependence disorders, who are believed to have lower quit rates than populations typically accepted into tobacco dependence trials. Finally, our patients were poor and undereducated relative to the averages in their county, and these factors may have contributed to the lower quit rates, for example, by making use of medications more difficult.

Intensively treated patients' self-reported use of medication and abstinence from tobacco were enhanced whether or not they initially intended to quit. These results add to a growing body of literature showing that patients who do not indicate an initial willingness to stop will stop if they receive appropriate interventions (Curry, McBride, Grothaus, Louie, & Wagner, 1995; Carpenter, Hughes, Solomon, & Callas, 2004). Together, findings from these studies support the PHS guidelines' (Fiore et al., 2000) recommendations for use of the 5R's (relevance, risks, rewards, roadblocks, and repetition) for those who don't want to quit.

Because the intervention was wholly consistent with the PHS guidelines, the results provide the first direct empirical support for autonomy, competence, and autonomy support being three of the psychological variables through which the PHS-recommended intensive treatment works. The fact that medication taking strongly predicted abstinence in both groups, in combination with Carpenter et al.'s (2004) findings that offering medications before smokers stop helps them quit, suggests that the autonomy-supportive discussion of use of cessation medications may be beneficial in all tobacco-dependence interventions, whether or not smokers initially indicate they want to quit.

Limitations of the study include that there was a larger percentage of non-Whites than Whites who dropped out of the study. Continued effort is needed to understand how to better retain minority patients, perhaps by including minority counselors and physicians. Also, patients who felt more autonomous and competent at the start of the study were more likely to drop out. This may be consistent with SDT, as these patients with higher levels of motivation may have felt better able to quit smoking on their own, thus feeling less need to stay in the program. Also, mediators from other theories were not tested, leaving the possibility that other mediators measuring social support, stages of change, or self-efficacy should be tested in future behavior change trials (Fiore et al., 2000; Whitlock et al., 2002). Nonetheless, initial support for the SDT variables mentioned in the PHS guidelines has been found. An additional limitation comes from our accepting only a portion of the population with mental illness, which is ravaged by tobacco-related disease. These limitations indicate additional research is called for that includes patients with other mental illnesses and that is conducted in other intensive treatment centers that have obtained higher quit rates.

In conclusion, an intensive individual tobacco treatment intervention that focused on supporting patients to make a clear choice about whether or not they want to smoke was more effective in promoting abstinence than was community care. The intervention was found to have its effects by facilitating the internalization of autonomous and competence motivations. The utility of providing interventions for tobacco use to those who do not intend to quit was also supported. These data support that the PHS Clinical Practice Guideline *Treating Tobacco Use and Dependence* (Fiore et al., 2000) is effective in part by supporting autonomy (intratreatment support), which results in greater volition (autonomy for cessation and for using medications), which leads to greater competence (through skills building and problem solving) and use of medications to promote abstinence from tobacco.

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