

Do Processes of Change Predict Smoking Stage Movements? A Prospective Analysis of the Transtheoretical Model

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The transtheoretical model (TTM) posits that processes of change and the pros and cons of smoking predict progressive movement through the stages of change. This study provides both a cross-sectional replication and a prospective test of this hypothesis. As part of a larger study of worksite cancer prevention (the Working Well Trial), employees of 26 manufacturing worksites completed a baseline and 2 annual follow-up surveys. Of the 63% of employees completing baseline surveys, 27.7% were smokers ($N = 1,535$), and a cohort of these smokers completed the 2-year follow-up. Cross-sectional results replicated previous studies with virtually all the processes of change and the cons of smoking increasing in linear fashion from precontemplation to preparation (all $ps < .00001$), and the pros of smoking decreasing ($p < .01$). However, contrary to the hypothesis, the baseline processes of change and the pros and cons of smoking failed to predict progressive stage movements at either the 1- or the 2-year follow-ups. Possible explanations for these findings and concerns about the conceptual internal consistency of the TTM are discussed.

Key words: cancer prevention, smoking, stages of change, social cognitive theory, worksites, health promotion

The transtheoretical model (TTM) of change (Prochaska & DiClemente, 1983) has been very influential in tobacco dependence research during the past decade and has recently been extended to other addictions and health risk behaviors

(Prochaska et al., 1994). This article examines the internal consistency of three core constructs of the TTM as applied to smoking cessation: stages of change, processes of change, and decisional balance.

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Stages of change refers to a set of categorizations describing smokers and former smokers (precontemplation, contemplation, preparation, action, and maintenance). Processes of change, which are derived from several theoretical perspectives, are activities theorized to bring about modifications in smoking behavior. The TTM includes 10 processes of change, divided into two broad categories (Prochaska, Velicer, DiClemente, & Fava, 1988). Experiential processes of change include activities related to thinking and emoting about quitting smoking (consciousness raising, self-reevaluation, dramatic relief, environmental reevaluation, and social liberation). Behavioral processes are categories of behaviors hypothesized to be helpful for smoking cessation (counterconditioning, stimulus control, reinforcement management, self-liberation, and helping relationships). Decisional balance refers to smokers weighing the benefits and costs of smoking with regard to their decision to smoke or not smoke. Decisional balance derives from the decision-making model of Janis and Mann (1977). The Smoking Decisional Balance scale (Velicer, DiClemente, Prochaska, & Brandenburg, 1985) has a two-factor structure: the pros and the cons of smoking.

Most studies of smoking investigating the relationships between processes of change, stages of change, and decisional balance have been cross-sectional. Two large cross-sectional studies reported that virtually all processes of change increased monotonically from precontemplation to contemplation to preparation (DiClemente et al., 1991; Fava, Velicer, & Prochaska, 1995). Prochaska, Velicer,

Guadagnoli, Rossi, and DiClemente (1991) used dynamic typology (Runyan, 1980) and cross-sequential (Schaie, 1968) techniques to further explore the relationship between stages and processes of change. Results revealed a general trend of experiential processes peaking, or being used more extensively, earlier in the stage progression, whereas behavioral processes tended to peak later in the progression.

Several studies of smoking have also demonstrated a consistent cross-sectional relationship between stages of change and the pros and cons of smoking (DiClemente et al., 1991; Fava et al., 1995; Prochaska et al., 1991; Velicer et al., 1985). Precontemplators in each study rated the pros of smoking as more important than the cons. A crossover occurred in each study, however, whereby cons became more important than pros. In each study this crossover took place in either the contemplation or preparation stage.

Cross-sectional and cross-sequential research have inherent limitations. The research discussed here thus far identified associations among processes of change, stages of change, and the pros and cons of smoking. This research did not, however, provide evidence that processes of change and pros and cons predict movement among stages. For this prospective examination of the TTM, process-to-outcome research is needed.

Only one smoking study to date has reported on the use of processes of change and pros and cons to attempt to predict stage movements (Prochaska, DiClemente, Velicer, Gimpil, & Norcross, 1985). This study used discriminant analyses, and thus effect sizes and significance levels were not available for individual processes of change and pros and cons. Furthermore, although some results of this study were in the predicted direction, many results were not. Taken as a whole, the results of this study were not supportive of the TTM (see Sutton, 1996). Perz, DiClemente, and Carbonari (1996) used processes of change to predict changes in smoking behavior at two follow-ups. However, participants in this study were in a composite of the contemplation and preparation stages at baseline, and stage membership was not differentiated at the two follow-ups. Perz et al. (1996) further stated that, at the follow-ups, "participants could be in any stage of change, and most were in contemplation or preparation at those times" (p. 463). Because this study did not investigate stage movements, the results are not informative about whether or not processes of change and pros and cons predict progressive stage movements. Thus, although more than 16 years of published studies exist on the TTM, the prospective relationships among the core constructs of the TTM have not yet been adequately studied.

Our study has two objectives. The first is to replicate the findings of the two cross-sectional studies (DiClemente et al., 1991; Fava et al., 1995) measuring stages, processes, pros, and cons through the first three stages. The second objective is to test the hypothesis that processes of change and pros and cons of smoking predict individuals' subsequent stage movements. These analyses address the limitations of previous cross-sectional studies, helping to clarify the potential value of using the core constructs from the TTM to identify mechanisms that can advance our theories

of health behavior and eventually improve the tailoring of interventions to individual characteristics of smokers.

Method

Participants and Setting

The Working Well Trial was a large, worksite-based cancer prevention study that encompassed four study centers and 114 worksites (see Abrams et al., 1994; Sorensen et al., 1996). Our analysis uses data from only one of the study centers, the Brown University School of Medicine and The Miriam Hospital. The Brown study center encompassed 26 worksites, which ranged in size from 250 to 1,000 employees (average employees per worksite = 337). Worksites were randomized into intervention and control conditions. The intervention involved several cancer prevention activities over a 2-year period, including a kick-off event, interactive activities, brochures, and educational classes. The control worksites received a minimal intervention including smoking cessation information. Two-year follow-up results of the Working Well Trial revealed no significant smoking cessation differences between intervention and control worksites (Sorensen et al., 1996).

All participants in our study were smokers for whom we had stage data at baseline. The stage distribution of smokers at baseline included 46.8% precontemplators, 37.4% contemplators, and 15.8% in the preparation stage. This distribution closely parallels statewide random-digit-dial survey data and national data on stage distributions in the larger Working Well Trial (41%, 38%, and 20%, respectively; see Velicer et al., 1995). The sample had a mean age of 39.3 years ($SD = 11.2$). Fifty-two percent were men and 57% were married. Twenty-five percent had not completed high school. The participants were 93% Whites, 3% Hispanics, 3% African Americans, and 1% Asians.

Procedure

There were three rounds of data collection: the initial questionnaire (baseline), a 1-year follow-up, and a 2-year follow-up. Sixty-three percent of eligible employees (5,542 out of 8,788) at the 26 worksites completed surveys at baseline; of these, 1,535 (27.7%) were current smokers. Of the 1,535 current smokers at baseline, stage of change classification data were available for 1,390 (91%) of the participants. The analyses reported in this article pertain only to the 1,390 smokers for whom baseline stage classification data were available. Of these 1,390 participants, stage classification data were available at the 1-year follow-up for 606 (44%).

Because of the attrition from baseline to the 1-year follow-up, it was important to examine differences between participants who completed surveys at baseline and the 1-year follow-up and those who participated only at baseline. There were virtually no differences between participants and those who dropped out for stage distribution, processes of change scores, and pros and cons. Those who participated in both the baseline and the 1-year follow-up surveys were in a larger percentage White (95.4% vs. 91.5%), were in a larger percentage women (51.6% vs. 45.9%), were more likely to have graduated from high school (77.9% vs. 73.3%), and less likely to be in the intervention condition (39.3% vs. 47.7%) than were participants who completed baseline but not the 1-year follow-up survey.

Of the 1,390 participants at baseline, 591 (42.5%) also com-

pleted surveys at the 2-year follow-up. Differences between those who completed surveys at baseline and the 2-year follow-up and those who completed surveys only at baseline were similar to the baseline to 1-year follow-up differences.

Finally, of the 1,390 smokers completing surveys at baseline, 413 also completed surveys at both the 1-year and 2-year follow-ups. Thus, of the 606 participants in the baseline-to-1-year follow-up analysis, 68.2% (413 out of 606) were also in the baseline-to-2-year follow-up analysis. Of 591 participants in the baseline-to-2-year follow-up analysis, 68.7% (413 out of 591) were also in the baseline-to-1-year follow-up analysis.

Measures

Stages of Change for Smoking Cessation

Stages of change were measured by using the most recent version of the staging algorithm developed by Prochaska, DiClemente, and colleagues (e.g., DiClemente et al., 1991). Precontemplators were not seriously thinking about quitting smoking in the next 6 months. Contemplators were seriously thinking about quitting in the next 6 months and (a) were not seriously thinking about quitting within the next 30 days, (b) had not made at least one 24-hr quit attempt in the past year, or (c) both. Preparation stage smokers were seriously thinking about quitting in the next 30 days and had at least one 24-hr quit attempt in the past year. The action stage was defined by the first 6 months of smoking abstinence, and the maintenance stage represented abstinence beyond 6 months.

Processes of Change

To shorten the overall length of the Working Well surveys only six processes of change were measured: two experiential (consciousness raising and self-reevaluation) and four behavioral (counterconditioning, reinforcement management, self-liberation, and stimulus control) processes. Aggregate variables were computed by averaging the four behavioral (behavioral aggregate) and two experiential (experiential aggregate) processes for each participant. All processes-of-change questionnaire items were anchored by 1 (*almost always*) and 5 (*never*). For ease of interpretation, however, processes-of-change scores were reverse scored in the Results section, so that larger values always represented increased usage of processes of change.

The short-form version of the Processes of Change Inventory was used, which contains two items for each process of change. The psychometric properties of this instrument are described in Fava, Rossi, Velicer, and Prochaska (1991) and in Fava et al. (1995). The short-form Processes of Change Inventory was derived from the long-form Processes of Change Inventory, which contained four items per process of change. The psychometric properties of the long-form Processes of Change Inventory are detailed in Prochaska et al. (1988). Previous research yielded short-form-long-form correlations ranging from .87 to .94, with a mean of .92 for the processes of change used in our study (J. L. Fava, personal communication, April 2, 1998). Alpha reliabilities for the individual processes of change in our study ranged from .63 to .81, with a mean of

.74. These reliabilities were similar to those reported by Fava et al. (1991). Processes-of-change scores were collected at baseline and the 2-year follow-up, but not at the 1-year follow-up.

Pros and Cons of Smoking

The short form of the Decisional Balance Inventory was used (see Fava et al., 1991, for psychometric properties). This instrument is correlated with the long-form Decisional Balance Inventory ($r = .88$ for pros and cons; J. L. Fava, personal communication, April 2, 1998). The psychometric properties of the long-form Decisional Balance Inventory are delineated in Velicer et al. (1985). The short-form Decisional Balance Inventory contains three items each for pros and cons. All decisional balance questionnaire items were anchored by 1 (*extremely important*) and 5 (*not important*). Pros and cons scores were also reverse scored for ease of interpretation. Alpha reliabilities for the pros and cons were .79 and .64, respectively, which were similar to those reported by Fava et al. (1991). Pros and cons scores were collected at baseline and the 2-year follow-up, but not at the 1-year follow-up.

Results

Cross-Sectional Results

Table 1 displays the cross-sectional data for processes of change, pros of smoking, and cons of smoking for the precontemplation, contemplation, and preparation stages. The data largely replicate the findings of two recent cross-sectional studies (DiClemente et al., 1991; Fava et al., 1995). For each process of change, the behavioral and experiential aggregates, and the pros and cons of smoking, a linear contrast (Rosenthal & Rosnow, 1985) was calculated by using the following contrast weights: precontemplation = -1 , contemplation = 0 , preparation = $+1$ (contrast weights were reversed for the pros of smoking, which are hypothesized to decrease with each progressive stage). These weights were assigned on the basis of the results of previous studies (DiClemente et al., 1991; Fava et al., 1995) indicating a monotonic, nearly linear pattern of increasing means for virtually all processes of change and the cons for smoking from precontemplation to contemplation to preparation (the opposite trend was revealed for the pros of smoking). Baseline data revealed that all six processes of change increased in a linear fashion through the first three stages (see Table 1). The contrasts for these processes were each significant at $p < .00001$. The behavioral and experiential aggregates were also significant in the predicted direction ($ps < .00001$). Consistent with past research, the pros of smoking decreased in a linear fashion from precontemplation to contemplation to preparation ($p < .01$), whereas the cons of smoking increased linearly ($p < .00001$).

Prospective Analyses

Prospective analyses can be divided along two dimensions. Half of the analyses assessed movements by individu-

Table 1
Baseline Stages, Processes, and Pros and Cons

Processes at baseline	Precontemplation <i>n</i> = 651 (46.8%)		Contemplation <i>n</i> = 520 (37.4%)		Preparation <i>n</i> = 219 (15.7%)		Effect size (<i>r</i> for linear contrast)
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Aggregate behavioral**	1.71	0.55	2.20	0.59	2.57	0.62	.46
Counterconditioning**	1.78	0.83	2.22	0.86	2.64	0.94	.33
Reinforcement management**	1.51	0.88	1.79	0.99	1.98	1.12	.17
Self-liberation**	2.37	1.06	3.27	0.92	3.86	0.82	.46
Stimulus control**	1.18	0.45	1.50	0.71	1.84	0.86	.34
Aggregate experiential**	1.91	0.77	2.71	0.88	2.99	0.83	.41
Consciousness raising**	1.80	0.84	2.40	1.00	2.53	1.03	.26
Self-reevaluation**	2.03	1.04	3.02	1.10	3.46	1.09	.42
Pros of smoking*	2.63	1.16	2.46	0.98	2.41	0.94	.07
Cons of smoking**	2.32	0.87	2.87	0.90	3.18	0.88	.32

Note. For processes of change, 1 = never, 5 = almost always. For pros and cons, 1 = not important, 5 = extremely important.

*Linear contrast is significant at $p < .01$. **Linear contrast is significant at $p < .00001$.

als between baseline and the 1-year follow-up, whereas the other half analyzed movements by individuals between baseline and the 2-year follow-up. Half of the analyses measured movements between contiguous stages only (e.g., precontemplation to contemplation), whereas the other half examined movements to any of the more advanced stages (e.g., precontemplation to contemplation, preparation, action, or maintenance).

The prospective analyses were dependent on progressive stage movements. If participants had largely remained in one stage throughout the study, the prospective analyses could not have been conducted. The results demonstrated that a majority of participants (51%) were in a different stage at the 1-year follow-up than at baseline. Some of the movement consisted of regression to less advanced stages (e.g., contemplation to precontemplation), but a majority involved progressive stage movement. Similar patterns of movements were observed from baseline to the 2-year follow-up.

Separate logistic regression analyses were performed for each of the six processes of change, the behavioral and experiential aggregates, and the pros and cons of smoking to determine which of these variables measured at baseline could predict progressive stage movements at the 1-year follow-up or 2-year follow-up, or both. The intervention versus control group distinction was dummy coded and included as a covariate in each logistic regression. The intervention versus control variable was not significant in any of the analyses reported in the next section, indicating that it was not predictive of stage movement. In summary, there were 10 predictor variables: six processes of change, two aggregate variables, and the pros and the cons ($6 + 2 + 2 = 10$). The capacity of each of these 10 predictor variables was tested for each category of analysis (i.e., 1-year and 2-year follow-ups; contiguous progressive stage at follow-up and any progressive stage at follow-up). This yielded a total of 120 statistical tests (12 categories of stage progression \times 10 predictor variables).

Because of the large number of statistical tests involved in the study, we adjusted the criterion for statistical significance

to $p < .01$ to avoid capitalizing on chance. The $p < .01$ criterion is still quite liberal compared with other adjustments that could have been applied, such as the Bonferroni procedure (Rosenthal & Rosnow, 1985).

Participants in Precontemplation at Baseline

One hundred sixty (57%) of the 279 participants originally in precontemplation had remained in precontemplation at the 1-year follow-up, whereas 66 (24%) had progressed to contemplation at the 1-year follow-up. The results revealed that the individual processes of change, the behavioral and experiential aggregates, and the pros and cons failed to predict movement from precontemplation to contemplation (see Table 2).

A set of analyses identical to those presented in Table 2 was performed to assess movement to the contemplation stage at the 2-year follow-up. None of the predictor variables was significant. Furthermore, two sets of analyses (one for the 1-year follow-up, and one for the 2-year follow-up) were conducted to test the capacity of the processes of change and pros and cons to predict movement out of precontemplation into any other stage. No significant predictive relationships were found for any of the independent variables.

Participants in Contemplation at Baseline

Analyses were conducted to determine if processes of change and pros and cons predicted movement out of the contemplation stage. The first two analyses (one for the 1-year follow-up, and one for the 2-year follow-up) assessed the capacity of processes of change to discriminate between participants who remained in contemplation from those who progressed to preparation. The results demonstrated that none of the processes of change nor the pros or cons were significant predictors of movement from the contemplation stage to the preparation stage. Table 3 presents the 1-year follow-up results.

Two additional sets of analyses (one for the 1-year

Table 2
Baseline Means for Processes of Change and Pros and Cons

Predictor variable	Interim stage				Wald	p	R
	Precontemplation		Contemplation				
	M	SD	M	SD			
Aggregate behavioral	1.67	0.54	1.69	0.53	0.07	.79	.00
Counterconditioning	1.68	0.75	1.85	0.83	1.90	.17	.00
Reinforcement management	1.49	0.91	1.46	0.77	0.02	.89	.00
Self-liberation	2.35	1.05	2.26	0.94	0.40	.53	.00
Stimulus control	1.13	0.35	1.16	0.40	0.12	.73	.00
Aggregate experiential	1.90	0.75	2.10	0.85	2.64	.10	.05
Consciousness raising	1.74	0.76	1.80	0.81	0.10	.75	.00
Self-reevaluation	2.05	1.04	2.40	1.16	4.39	.04	.09
Pros of smoking	2.60	1.16	2.65	1.17	0.20	.66	.00
Cons of smoking	2.34	0.90	2.41	0.86	0.16	.69	.00

Note. Participants were in precontemplation at baseline and either precontemplation (n = 160) or contemplation (n = 66) at the 1-year follow-up. For processes of change, 1 = never, 5 = almost always. For pros and cons, 1 = not important, 5 = extremely important. R = the partial correlation between the predictor and the outcome, after adjusting for treatment versus control.

follow-up, and one for the 2-year follow-up) compared participants who remained in contemplation with those who moved to the preparation, action, or maintenance stages. One significant result emerged: Participants moving into preparation, action, or maintenance at the 2-year follow-up had significantly lower pros scores than did participants remaining in contemplation (Wald = 7.59, p = .006).

Participants in Preparation at Baseline

The final category of analyses assessed the processes of change with regard to predicting movement out of the preparation stage. None of the analyses, for movements at the 1-year follow-up or 2-year follow-up, or for movement to the action stage or the action or maintenance stages combined, yielded significant results.

Summary of Results

One hundred twenty tests were conducted to determine if processes of change or pros and cons predicted progressive stage movements. One out of 120 tests was significant at the p < .01 level. Had we (inappropriately) used p < .05 as the criterion for significance, we would have yielded seven significant results out of 120, a proportion consistent with chance. (In addition to the null significance tests, effect sizes throughout this study were very small [85% of R values = .00], indicating that the null results were not due to a lack of statistical power.) Furthermore, five out of the six results approaching significance (i.e., ps between .01 and .05) involved either the behavioral aggregate or the behavioral process self-liberation predicting movement out of the precontemplation or contemplation stages. These findings are in contrast with the tenets of the TTM, which posits that

Table 3
Baseline Means for Processes of Change and Pros and Cons

Predictor variable	Interim stage				Wald	p	R
	Contemplation		Preparation				
	M	SD	M	SD			
Aggregate behavioral	2.19	0.57	2.25	0.49	0.38	.54	.00
Counterconditioning	2.25	0.88	2.31	0.83	0.16	.69	.00
Reinforcement management	1.67	0.85	1.64	0.91	0.04	.85	.00
Self-liberation	3.29	0.86	3.45	1.02	0.75	.39	.00
Stimulus control	1.55	0.78	1.63	0.72	0.24	.63	.00
Aggregate experiential	2.84	0.84	2.78	0.78	0.13	.71	.00
Consciousness raising	2.50	0.96	2.58	0.83	0.20	.65	.00
Self-reevaluation	3.19	1.06	2.99	1.12	0.86	.35	.00
Pros of smoking	2.58	1.00	2.33	0.76	1.49	.22	.00
Cons of smoking	2.96	0.92	3.13	0.88	0.94	.33	.00

Note. Participants were in contemplation at baseline and either contemplation (n = 95) or preparation (n = 37) at the 1-year follow-up. For processes of change, 1 = never, 5 = almost always. For pros and cons, 1 = not important, 5 = extremely important. R = the partial correlation between the predictor and the outcome, after adjusting for treatment versus control.

experiential, rather than behavioral processes, foster movement through the early stages (e.g., DiClemente, 1993; Prochaska, DiClemente, & Norcross, 1992).

Discussion

The results indicate that processes of change and the pros and cons of smoking do not predict progressive movement out of the precontemplation, contemplation, or preparation stages. Furthermore, because the cross-sectional results and the characteristics of the cohort, stage distribution, participant demographics, and psychometric properties of the instruments used were similar to those of previous studies (e.g., Fava et al., 1991, 1995), it is unlikely that the Working Well data set differs fundamentally from previous data sets measuring stages of change, processes of change, and pros and cons.

There are two essential empirical criteria by which the TTM should be evaluated. First, for the TTM to be internally consistent, it is necessary that progressive stage movements represent progress toward cessation. If this is not the case, stage movements become meaningless and the model is denuded of value. Although several studies have shown stages of change to be predictive of cessation (e.g., DiClemente et al., 1991), recent research by Farkas et al. (1996) demonstrated that stages of change loses much of its predictive power when included in a multivariate analysis with several other behavioral predictors. In contrast, Velicer, Prochaska, Rossi, and Snow (1992) suggested that stages of change be conceptualized as an intermediate outcome along the pathway to cessation. The issue of whether stages is a robust predictor of cessation, although important and controversial, is not the focus of this article.

This research addresses the second essential criterion by which the TTM should be evaluated. If we stipulate, for the purposes of discussion, that progressive stage movements do signify progress toward cessation, then the TTM would be of even more incremental value as a theory if it were known how progressive stage movements could be encouraged or brought about. There is currently no research to suggest that processes of change or pros and cons predict or bring about progressive stage movements (see Sutton, 1996). Although our study is not decisive on this issue (no single study could be), it is the first straightforward test of the prospective relationships among the stages, processes of change, and pros and cons. As such, this study calls into question the conceptual internal consistency of the TTM (Bandura, 1997, pp. 412–415).

The implications of this research for smoking cessation interventions are unclear because it is unknown why the predictive relationships failed to materialize. One possible explanation for the null results is that the stages-of-change algorithm is not an adequate measure of motivation to quit (Abrams & Biener, 1992; Bandura, 1997, p. 412; Biener & Abrams, 1991). Variables such as self-efficacy and outcome expectations, and concepts derived from the cognitive social learning theory of behavioral self-control (e.g., proximal goal setting), may be better mediators of motivation to

change (Bandura, 1997). The stages of change are based on past quit attempts and a series of yes–no questions regarding whether smokers intend to quit smoking, and if they do, the timetables for these intentions. For example, the minimal criterion for inclusion in the contemplation stage is the intention to quit smoking within 6 months. For some smokers, the 6-month marker may seem arbitrary and unrelated to their plans of quitting. For example, a smoker with only a vague plan of quitting some day in the future may have difficulty answering “yes” or “no” to the question of whether he or she plans on quitting in the next 6 months. (The same criticism holds for the question regarding intentions to quit within 1 month, which is a major criterion for inclusion in the preparation stage.) To the extent that smokers are uncertain in their responses to the stages-of-change questions, error is introduced and sensitivity and validity diminished (see Stockwell, 1996, for a related discussion).

Another possible explanation for the null results is infrequent data collection. It is possible, for example, that increased use of processes of change does bring about changes in stage status, but that this relationship can be detected only if processes of change are measured in the days and weeks immediately before a stage change. Future research should explore this possibility.

The limitations to this study should be noted. First, short-form instruments were used throughout the study. Even though all of these short-form instruments have been used in previous research (e.g., Fava et al., 1995), they are still less stable than the full-length measures they are designed to approximate. Nevertheless, a shift in emphasis has occurred in the field, away from intensive, reactive, clinical interventions and toward minimal, proactive, public health interventions (Abrams, Emmons, Niaura, Goldstein, & Sherman, 1991; Lichtenstein & Glasgow, 1992; Shiffman, 1993). Short-form instruments are now being used *de facto* in population-based intervention research, and responses of smokers to these questions are being used to tailor their interventions (Prochaska, 1994). Second, not all of the baseline stages were included in the study. This limitation existed because processes of change and pros and cons were measured only for current smokers. It is possible that processes of change and pros and cons do predict movement from the action to maintenance stage; our study could not address this question. Third, not all of the processes of change were assessed. This study used 6 out of the 10 processes of change. Fourth, because the study was conducted at the workplace, it is not necessarily applicable to clinic-based or other defined populations.

Finally, the issues of attrition and self-selection pose a threat to the generalizability of the study. Self-selection occurred at several junctures. Most problematic is self-selection at baseline. Demographic and smoking-related data for employees who elected not to complete surveys at baseline were not available, and thus comparisons could not be made with employees who did participate. Baseline demographics, smoking data, and stage distribution, however, were consistent with a previous representative sample of smokers from Rhode Island (Velicer et al., 1995).

Attrition between baseline and the 1-year follow-up, and baseline and the 2-year follow-up, was observed, and demographic differences between participants and dropouts were also noted. To what extent and how these differences affected the results is unknown.

The TTM has had a significant heuristic impact on the smoking cessation field over the past 15 years. Although cross-sectional relationships were largely replicated, the critical hypotheses that link stage movement with processes and pros and cons were not adequately supported in this prospective study. Further research is needed to examine the prospective relationship between process and outcome measures in the TTM. More longitudinal cohort analyses are needed of process-to-outcome relationships to adequately test our theories of health behavior change, help identify mechanisms of action, and ultimately improve interventions and health outcomes.

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