

The Measure of Stage of Readiness to Change: Some Psychometric Considerations

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Previous research in the smoking cessation literature has shown that the key component of the transtheoretical model of change, the stage of readiness to change, is a valid independent measure (C. C. DiClemente & J. O. Prochaska, 1985; C. C. DiClemente et al., 1991; W. F. Velicer, J. S. Rossi, J. O. Prochaska, & C. C. DiClemente, 1996). Recently, however, other health service researchers (e.g., A. J. Farkas et al., 1996b) have begun to question the utility of this model; especially its predictive validity (e.g., A. J. Farkas et al., 1996a). However, no research to date has examined the reliability and stability of the stage of readiness to change measure. In this study, the longitudinal measurement of stage of readiness to change was treated as a quasi-simplex model (K. G. Jöreskog, 1970). Estimates of the stability and reliability for 261 female smokers in a general community sample were obtained. Results indicate that the stage of change measure has desirable psychometric properties.

Perhaps one of the most influential models in the area of health behavior change within the past 20 years has been the transtheoretical model of change (TTM; DiClemente et al., 1991; Prochaska & DiClemente, 1983; Prochaska, DiClemente, Velicer, & Rossi, 1993). The TTM is a model of a stage-based theory of behavioral change. It predicts that individuals systematically change their readiness to adopt a health behavior on the basis of what they perceive to be balances between the costs and benefits of maintaining the behavior and the costs and benefits of change. This balance between costs and benefits of the behavior and changing the behavior is generally referred to as “decisional balance” (Velicer, DiClemente, Prochaska & Brandenburg, 1985).

The TTM is a multidimensional model, as it incorporates (a) movement through the stages of change, (b) independent variables (e.g., processes of change; Prochaska, Velicer, DiClemente, & Fava, 1988), (c) dependent variables (e.g., decisional balance and self-efficacy among many others), and (d)

outcome measures. The model is described as transtheoretical because it incorporates cognitive, motivational, social learning, and relapse prevention theories. In this model interventions are typically designed to measure the individual's current readiness to accept ideas related to behavioral change and then to provide information that will help the individual move closer to taking the desired action.

The TTM has been applied in such diverse areas as smoking cessation, weight control, alcohol consumption, and condom use (Prochaska et al., 1992). However, the model has been most thoroughly evaluated in the smoking cessation literature (Davidson, 1992).

The key feature of this model states that health behavior change progresses through a series of steps or stages. Although the number of stages has been modified (DiClemente et al., 1991) and refined (Crittenden, Manfredi, Lacey, Warnecke, & Parsons, 1994), the stages can generally be described in the following progression: (a) *Precontemplation* involves no thought of quitting; (b) *contemplation* involves the thought of quitting; (c) *preparation* involves preparing to quit; (d) *action* involves actually quitting; and (e) *maintenance* involves abstinence. The stage of readiness to change measure has been found to be a good predictor of a variety of smoking cessation outcomes (Prochaska et al., 1993; DiClemente et al., 1991; Crittenden, Manfredi, Warnecke, Cho, & Parsons, 1998).

However, the stages of change measure has also come under critical review within the past few years (Farkas et al., 1996a, 1996b). Farkas et al. (1996a, 1996b) have paid particular attention to the predictive validity of the readiness of stage to change measure. In one article, Farkas et al. (1996b) compared the original Prochaska and DiClemente (1983) model of stages of change with the revised model of stages of change (DiClemente et al., 1991) and found that the revised model fared no better than the original model in predicting smoking cessation.

In another article, Farkas et al. (1996a) compared the readi-

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This research was funded by Grant CA42760 from the National Cancer Institute. We acknowledge Timothy Dollear for data management responsibilities in the earlier part of the study, Richard Campbell and Albert Maydeu-Olivares for data-analytic suggestions, Jesus Chavez for constructing the figures in this brief report, Andrea van Proyen and Marya Ryan for editorial assistance, and Robin Mermelstein for comments on an earlier draft of this article.

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ness of stage of change measure with a competing addiction model and found partial support for the stage of change model (individuals in the preparation stage exhibited higher levels of smoking cessation than did individuals in the contemplation stage). Moreover, Farkas et al. (1996a) showed that their addiction model had better predictive validity than did the single stage of change measure. As Prochaska and Velicer (1996) appropriately pointed out, multiple variables can almost always account for more variation than any single measure, and thus, the comparison of the two models is not appropriate.

Another current shortcoming in research associated with the readiness of stage to change measure is the absence of information regarding its reliability and stability. A method for obtaining estimates of reliability and stability is discussed.

Simplex Models and Quasi-Simplex Models

One way to obtain estimates of reliability and stability of a single manifest variable is to fit either a simplex model or a quasi-simplex model to a variable that is longitudinally measured (Jöreskog, 1970). A quasi-simplex model is a covariance structure that considers measurement error in longitudinal studies when the variable is repeatedly measured. Unlike quasi-simplex models, simplex models assume that the observed variable contains little or no measurement error.

The estimation of quasi-simplex models for variables that are longitudinally measured can be beneficial. Change in a health behavior measure may be confounded with the unreliability of the health behavior measure in longitudinal data. In other words, the lack of association between measures of a variable at multiple time points may reflect (a) the lack of stability in the health behavior measure, (b) unreliability of the health behavior, or (c) a combination of these two points. Therefore, a clear advantage for estimating a quasi-simplex model over a manifest variable approach (e.g., computing measures of linear association) is that the error in the health behavior measure can be separated from the true score for the measure.

Many researchers (Alwin & Krosnick, 1989; Heise, 1969; Wiley & Wiley, 1970) have obtained estimates of reliability and stability by estimating a three-wave simplex model (e.g., a model in which the variable of interest has been measured at three time points). In a quasi-simplex model, reliability is defined as the complement of the amount of observed error in the manifest variable. Stability, on the other hand, is defined as the inverse of the amount of change in the true measure of the manifest variable at each sequential time point. Stability can also be interpreted as the test-retest reliability of the true score of the manifest variable at each sequential time point.

Following a strategy of Jöreskog and Sörbom (1996), we fit an identified six-wave quasi-simplex model (e.g., a model in which the estimates of the path coefficients are unique up to six waves) by equating the errors of measurement between the first two observed variables and equating the errors of measurement between the last two observed variables (see Figure 1).

In Figure 1, BL Stage refers to stage of readiness to change at baseline; IP Stage refers to stage of readiness to change at immediate postintervention; Stage 6 refers to stage of readiness to change at 6 months postintervention; Stage 12 refers to stage of readiness to change at 12 months postintervention; Stage 18

refers to stage of readiness to change at 18 months postintervention; and Stage 24 refers to stage of readiness to change at 24 months postintervention. Measures of stability are represented by the beta coefficients from each true measure of stage of readiness to change (denoted by the η s in Figure 1) to the next measure. Measures of reliability, the squared multiple correlations for each of the observed variables, represent how consistently the true measure of stage of readiness to change accounts for the variation of the observed measure of stage of readiness to change. The measure of reliability at each longitudinal time point is also the complement of the amount of observed error in the manifest variable (denoted by the ϵ s in Figure 1).

We will estimate the quasi-simplex model in Figure 1 to obtain estimates of reliability and stability of the stage of readiness to change measure for female smokers in the general population. We were interested in determining the reliability and stability of the longitudinal assessments of the Crittenden et al., (1994, 1998) elaboration of the stage of readiness to change measure over a 24-month period. If the stage of readiness to change measure is a psychometrically sound measure, we would expect to find high measures of reliability and stability.

Method

Data Collection

Data were collected as part of a larger smoking intervention that started in 1993. Details of the intervention can be found in Morera et al. (1998). All data were collected through phone interviews, and data were first collected at baseline (prior to the intervention) and again immediately after the intervention (immediate postintervention). We continued to interview respondents at 6, 12, 18, and 24 months following the immediate postintervention interview. This brief report is based on a total of 261 female smokers in the general population.

Measure of Stage of Readiness to Change

Participants were classified according to the Crittenden et al. (1994, 1998) elaboration of the Prochaska-DiClemente measure into six stages of change: precontemplative-1 (not contemplating quitting or cutting down); precontemplative-2 (not contemplating quitting); precontemplative-3 (contemplating quitting, but not within 6 months); contemplative; prepared for action; and action (quitting). Measures of stage of readiness to change were collected at the six time points in the intervention.

Statistical Procedure

The covariance matrix (calculated between stages and across participants) was treated as a quasi-simplex structure and analyzed over six different time points by using the LISREL 8 program (Jöreskog & Sörbom, 1996) in order to obtain estimates of reliability and stability for the 261 smokers in the general population.¹

Results

A quasi-simplex model was fit for the data provided by the 261 smokers in the population. This model constrained all stability coefficients to equality. The fit of this constrained model was

¹ Stage of readiness to change, a 6-point variable, was treated as continuous, and maximum likelihood estimation was used.

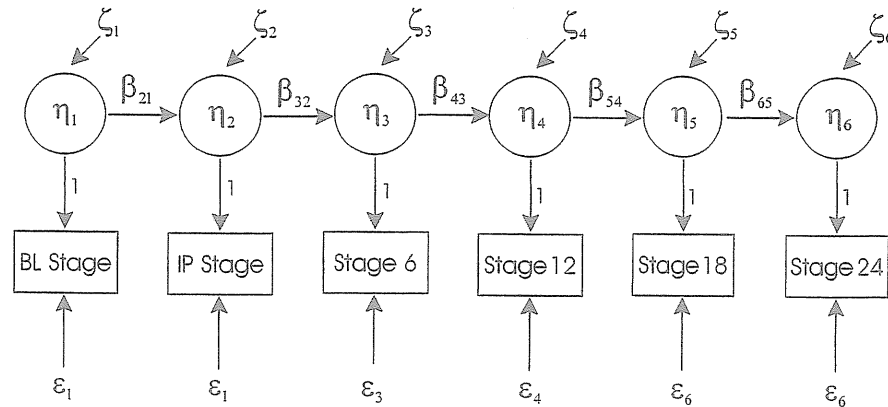


Figure 1. An example of an identifiable quasi-simplex model. BL = baseline; IP = immediate postintervention.

adequate, $\chi^2(10, N = 261) = 6.33, p < .79$, with an adjusted goodness of fit index of .98. This measure of model fit indicates that constraining the stability coefficients to equality provides a very good measure of model fit. The unstandardized coefficient estimates and their standard errors are provided in Table 1.

The quasi-simplex model provided in Figure 2 shows the completely standardized solution from this model.² As can be seen from Figure 2, measures of stability ranged from a low of .38 (from BL Stage to IP Stage) to a high of .98 (from Stage 12 to Stage 18). In addition, measures of reliability (the complement of the amount of observable measurement error) ranged from a low of .69 ($1.00 - .31$) at baseline stage to a high of .76 ($1.00 - .24$) at Stage 12. These measures of reliability and stability suggest that the stage of readiness to change measure has sound psychometric qualities.

Discussion

The debate surrounding the measure of stage of readiness to change and the transtheoretical model has concerned the pre-

dictive validity of the measure (Farkas et al., 1996a; 1996b). The goal of this article was to investigate the reliability and stability of the stage of readiness to change measure in a population of female smokers over a 2-year period.

To achieve these goals, we analyzed the longitudinal measurement of the Crittenden et al. (1994; 1998) stage of readiness to change by using a quasi-simplex model (Jöreskog, 1970). The quasi-simplex model makes certain assumptions that have come into question. For example, a quasi-simplex model assumes that change occurs through a Markovian process (i.e., that the true measure of stage of readiness to change at time T_N , has no influence on stage of readiness to change at time T_{N+2}). This assumption has been questioned by Rogosa (1988) and Bautista-Fouget, Coenders, and Saris (1996).

In addition, the simplex model also assumes that there are no correlated measurement errors across the different points in a longitudinal panel study. If this assumption is violated, low estimates of unreliability would be obtained (Alwin, 1989; Alwin & Krosnick, 1989). Despite these potential shortcomings, Alwin (1989) has indicated that the simplex model seems well suited to obtaining estimates of reliability and stability.

Finally, others argue that the estimation of quasi-simplex models ignores the stability of particular stages of readiness to change.³ With use of latent transition analysis (Collins & Wugalter, 1992), Velicer, Martin, and Collins (1996) and Martin, Velicer, and Fava (1996) have shown that precontemplation and maintenance are the most stable stages (i.e., the conditional probabilities of being in precontemplation or maintenance at time T_{N+1} , given that the individual was in precontemplation or maintenance at time T_N , are the largest conditional probabilities). Although latent transition analysis is an appealing statistical methodology, our interest is in determining the stability and reliability of the overall measure of stage of readiness to change

Table 1

Maximum Likelihood Path Coefficients for the Simplex Model of the Population Panel

Parameters	Path coefficient	SE
$\beta_{2,1}$	0.97	0.02
$\beta_{3,2}$	0.97	0.02
$\beta_{4,3}$	0.97	0.02
$\beta_{5,4}$	0.97	0.02
$\beta_{6,5}$	0.97	0.02
$\epsilon_{1,1}$	0.54	0.07
$\epsilon_{2,2}$	0.54	0.07
$\epsilon_{3,3}$	0.56	0.07
$\epsilon_{4,4}$	0.61	0.07
$\epsilon_{5,5}$	0.72	0.07
$\epsilon_{6,6}$	0.72	0.07
$\psi_{1,1}$	1.20	0.14
$\psi_{2,2}$	0.34	0.11
$\psi_{3,3}$	0.32	0.10
$\psi_{4,4}$	0.33	0.09
$\psi_{5,5}$	0.07	0.08
$\psi_{6,6}$	0.11	0.13

² Constraints on the unstandardized solution do not generate constraints on the standardized solution (see Bollen, 1989). Therefore, standardized stability coefficients are not identical. The standardized estimates of the unreliability of the manifest measure are similarly affected.

³ We thank an anonymous reviewer for raising this point and bringing the latent transition analysis methodology to our attention.

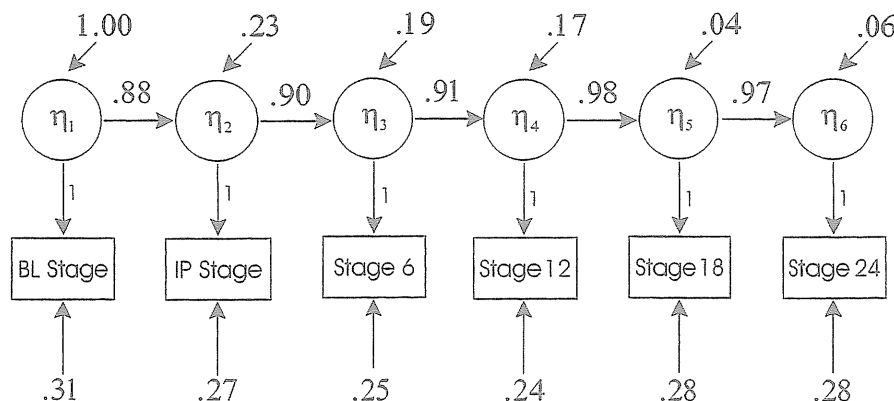


Figure 2. Completely standardized solution for population panel. BL = baseline; IP = immediate postintervention.

(across a set of stages) rather than assessing the stability of an individual stage.

The results from our study indicate that the measure of stage of readiness to change showed high levels of stability and high levels of reliability for these female smokers. These findings, coupled with the predictive and construct validity findings of Crittenden et al. (1998), have shown that the stage of readiness to change measure has desirable psychometric properties.

Although previous research efforts have used the stage of readiness to change as a predictor variable to assess smoking cessation outcomes, the sound psychometric properties of this measure indicate that it may also be useful to consider the stage of readiness to change as an outcome measure. For example, a minimal self-help community intervention that assists in a smoker's progression through the stage of readiness to change classification would be deemed as an effective intervention, even if quitting was not achieved. Furthermore, the sound psychometric properties of this measure indicate that precise, tailored intervention programs (Morgan et al., 1996) can be implemented and based on the measure of readiness of stage to change. In summary, health practitioners should feel quite comfortable with the stage of readiness to change measure.

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Received October 1, 1997

Revision received January 16, 1998

Accepted February 19, 1998 ■