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## Psychometric evaluation of the smoking cessation Processes of Change scale in an adolescent sample<sup>☆</sup>

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### Abstract

The Processes of Change are the cognitions, behaviors, and emotions that people employ to change their behaviors. However, the processes of change remain the least studied dimension of the transtheoretical model. The present study presents a psychometric evaluation of the short form of the processes of change inventory for smoking cessation in an adolescent sample of 798 ninth-grade smokers from 22 Rhode Island high schools. The majority of the sample was white (87.2%), split approximately evenly as regards to gender (48.1% female), with an average age of 14.3 (SD=0.6) years of age. The same hierarchical model established on the adult sample was fit to the 20-item inventory. This model included 10 primary factors representing the processes of change and two second order factors that grouped the processes into five behavioral and five experiential processes of change. Model fit indices (RMSEA=0.08, CFI=0.92) supported the hypothesized structure. External validation was established by testing for stage differences in the use of the ten processes. A significant MANOVA ( $F(4, 793)=18.517, p<0.001$ ) and separate ANOVAs demonstrated that the use of all ten processes increased across the stages, as predicted by the transtheoretical model of behavior change. The processes of change help guide researchers, clinicians, and intervention program developers towards effective strategies to assist individuals at all stages of change progress towards healthier behaviors.

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The importance of adolescent smoking cessation to prevent smoking related diseases and death has long been recognized. Among adults who have ever smoked daily, 82% tried their first cigarette before the age of 18 (US Department of Health and Human Services, 1994), and it is estimated that almost one half of current adolescent smokers who continue to smoke regularly will die from a smoking related disease (US Department of Health and Human Services, 2000). Smoking rates for grades 9 through 12 have declined in recent years after a peak in 1997. While recent improvements are encouraging, they represent a regaining of the ground lost in the early 1990s, and to date smoking rates remain unacceptably high at approximately 27% for 12th graders (Johnston, O'Malley, Bachman, & Schulenberg, 2005). In fact, for most adolescent subgroups, rates of tobacco use must still be at least halved to meet Healthy People 2010 target criteria (US Department of Health and Human Services, 2000).

Adolescent smoking cessation research has gained momentum in recent years yet remains in its infancy. The currently available database on adolescent smoking cessation research is limited in size and is characterized by little success and methodological inadequacies (Mermelstein et al., 2002; Sussman, Lichtman, Ritt, & Pallonen, 1999). Usually, the many methodological challenges of this research area are highlighted in regards to primary treatment outcomes (Mermelstein et al., 2002; Sussman, 2002; Sussman et al., 1999), but these challenges also persist in all the other aspects of this research area, including the construction and validation of appropriate secondary outcome and process measures.

To date, most interventions for adolescent smokers have been based on adult treatment models and have not been tailored to adolescents (Henningfield, Michaelides, & Sussman, 2000). The numerous psychological, social, and physical changes that characterize adolescence, however, make it unlikely that measures developed for adult smokers can be borrowed without adaptation for adolescent smokers (Mermelstein et al., 2002). This paper addresses the need for the adaptation of measures by presenting the empirical validation of the processes of change inventory previously developed for adult smokers (Prochaska, Velicer, DiClemente, & Fava, 1988) for adolescent smokers.

## 1. Processes of change inventory

The transtheoretical model (Prochaska & Velicer, 1997) can be conceptualized as involving three dimensions: the temporal dimension, the independent variable dimension, and the intermediate variable dimension. The central organizing construct of the model is the temporal dimension, represented by five Stages of Change describing different levels of readiness to change. The independent dimension is composed of the processes of change that act as strategies to bring about change. The intermediate dimension (Velicer, Rossi, Prochaska, & DiClemente, 1996) is represented by behavioral measures, the Decisional Balance Inventory (Velicer, DiClemente, Prochaska, & Brandenburg, 1985) and the Self Efficacy or Situational Temptations Inventory (Velicer, DiClemente, Rossi, & Prochaska, 1990).

Of these three dimensions, the processes of change (Prochaska et al., 1988) is the dimension that has received the least attention. The Processes represent cognitive, emotional, and behavioral strategies for changing one's behavior. The ten Processes have an hierarchical structure with ten primary factors and two higher order factor that represent two broad dimensions, experiential and behavioral (Prochaska et al., 1988). Behavioral processes include Stimulus Control, Counter Conditioning, Reinforcement Management, Self Liberation, and Helping Relationships. Experiential processes include Consciousness Raising, Dramatic Relief, Environmental Reevaluation, Self-reevaluation, and Social Liberation.

The original processes of change inventory (Prochaska et al., 1988) was a 40-item measure that focused on adult smoking cessation. A 20-item version of the measure (2 items per primary factor) has been developed (Fava, Rossi, Velicer, & Prochaska, 1991) and used extensively in intervention studies. Available information about the short form, however, is limited.

## 2. Current study

The goal of the current study was to evaluate the psychometric properties of the processes of change inventory for smoking cessation in a large representative sample of adolescent smokers. The study will provide information about the appropriateness of the measure for adolescents as well as providing information about the short form of the measure.

## 3. Method

### 3.1. Participants

The sample was a subset of a sample of 2808 ninth-grade students from 22 Rhode Island high schools who completed a computer-based expert system smoking questionnaire as part of a multiple-risk intervention program during the 1995–1996 school year. There were 798 (28.4%) current or former smokers in the overall ninth-grade sample. The majority of the sample was white (87.2%), with 4.6% Hispanics, 2.9% African Americans, 2.6% Asians, 0.9% American Indian/Alaska Natives, and 1.8% describing themselves as “other”. The sample was 48.1% female. The average age was 14.3 (SD=0.6) years of age. Further information about the overall sample is available elsewhere (Plummer et al., 2001).

### 3.2. Procedure

The data presented were gathered as part of the baseline assessment of a 4-year, multiple-risk intervention study. The participants used laptop computers provided in their classrooms to provide their baseline information. For further detail on the design, recruitment, and implementation of the overall study, please refer to Meier et al. (submitted for publication).

### 3.3. Measures

#### 3.3.1. Current smoking status

To distinguish between smokers, non-smokers, and ex-smokers, participants were asked two questions, where the second question served to verify the students' responses to the first question. First, they were asked: “Have you ever smoked a cigarette?” The four possible answer choices were (1) “No, I have never smoked even one cigarette”, (2) “Yes, a few times, but never weekly”, (3) “Yes, I used to smoke weekly or more but quit”, and (4) “Yes, I smoke right now”. The verifying follow-up question was: “Which of these statements best describes your smoking now?” The four possible answer choices were (1) “I have never smoked cigarettes”, (2) “I have tried smoking a few times but do not smoke now”, (3) “I used to smoke regularly, but I quit”, and (4) “I am a smoker”. Participants who indicated having

regularly smoked in the past or being a regular current smoker (i.e., answer choices 3 and 4 for the two questions, respectively) were included in the present sample.

### 3.3.2. Stages of change

An algorithm of two to three items was used to determine the participants' stage of change for smoking cessation, consistent with algorithms developed for adults (DiClemente et al., 1991; Velicer, Prochaska, Rossi, & Snow, 1992). The first two questions pertained to the participants' intentions to quit smoking. Participants were first asked whether they intended to quit within the next 6 months (Question 1) and then whether they intended to quit within the next 30 days (Question 2). The third question addressed participants' quit attempts within the past year. Stage of change was classified as follows: (1) participants were placed into the Precontemplation stage if they were not considering quitting within the next 6 months; (2) participants were placed into the Contemplation stage if they intended to quit smoking within the next 6 months or intended to quit smoking within the next 30 days without a prior quit attempt in the past year; (3) participants were placed into the Preparation stage if they intended to quit smoking within the next 30 days and had made a prior quit attempt within the past year; (4) participants were placed into the Action stage if they indicated having successfully quit within the last 6 months; and (5) participants were placed into the Maintenance stage if they had successfully quit more than 6 months ago.

### 3.3.3. Processes of change for smoking cessation

The measure consisted of 20 items to assess the participants' use of the 10 processes of change for smoking cessation within the past 30 days. Participant ratings were made on a 5-point Likert scale, ranging from "never" to "very often".

## 4. Results

The analyses for the validation of the processes of change for smoking cessation for adolescents scale involved two steps. First, the internal validity was assessed for the adolescent sample through a confirmatory factor analysis. Second, the external validity of the processes of change for smoking cessation model for adolescents was determined by replicating the predicted relationship of the processes of change with the stages of change, as outlined by the transtheoretical model of behavior change. An alpha level of 0.05 was used for all statistical tests.

### 4.1. Internal validity

The structural equation modeling software package EQS 6.1 (Bentler and Wu, 2003) was used to fit the hypothesized confirmatory factor analysis model (Fig. 1) to the sample of 798 adolescents. Cronbach's (1951) Coefficient Alpha was calculated for each of the two item scales (see Table 1). Values ranged from a low of 0.60 to a high of 0.84 with most values in the low 0.70 to mid 0.80 range. These reliability estimates are slightly lower than the reliability estimates reported previously for the four-item processes of change scales for adults (Prochaska et al., 1988). They were acceptable given the fact that they were based on two-item instead of four-item scales.

The model fit was very good with  $\chi^2(159)=964.88$ ,  $\chi^2/df$  ratio=6.068, RMSEA= 0.08, and CFI (Bentler, 1990)= 0.92. All structural paths were statistically significant at the 0.05 level, and are

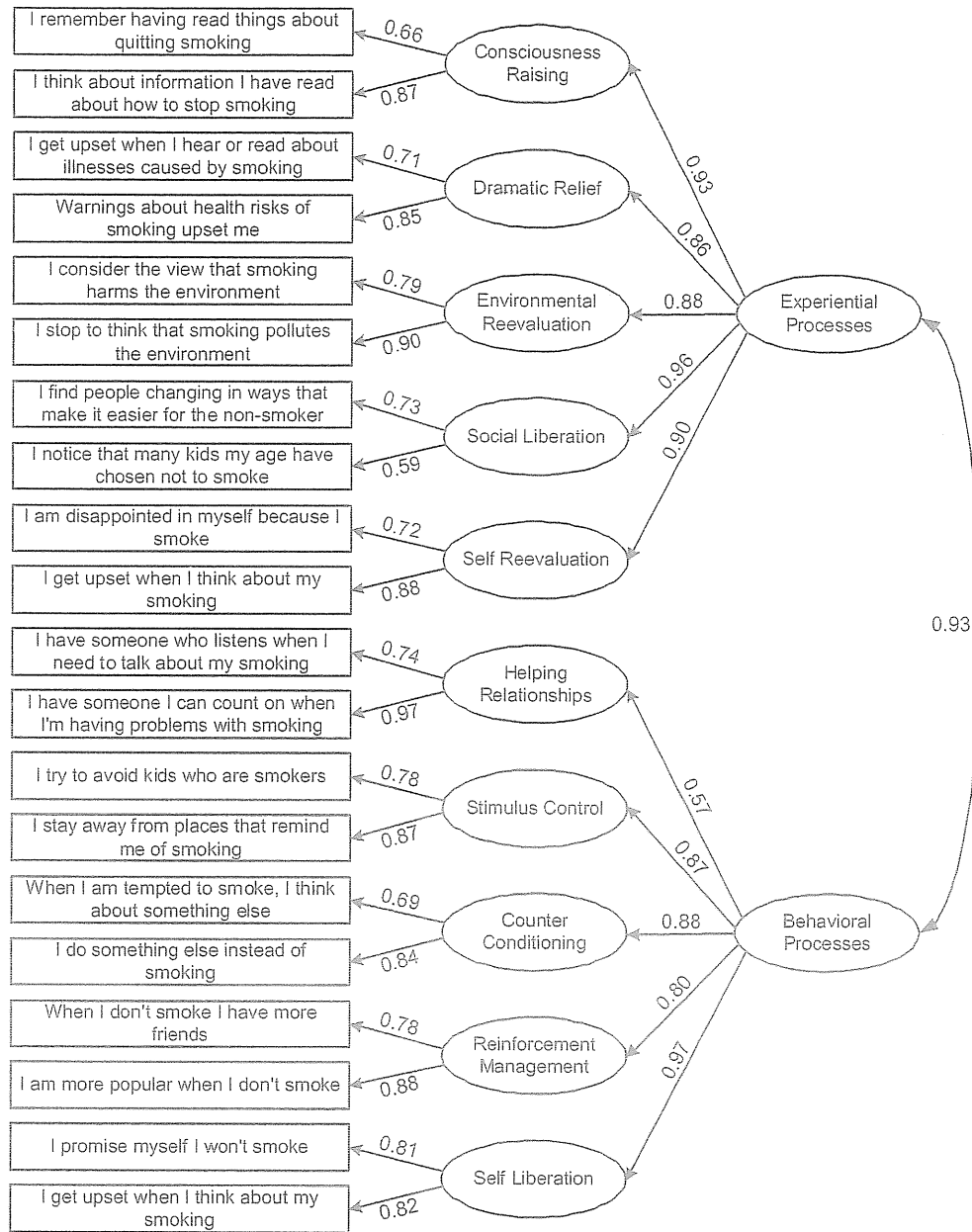


Fig. 1. Structural equation model for the 20-item, 10-subscale smoking cessation processes of change scale for adolescents ( $N=798$ ).

represented in Fig. 1. The primary loadings were generally in the moderate (0.60 to 0.80) and high range (more than 0.80). The loadings for the secondary structure were all in the high range. The average absolute standardized residual (AASR) was 0.034, and the largest standardized residual was 0.162. The disturbances for all latent factors were fixed at 1.00.

Table 1  
Means, standard deviations, and coefficient alphas for the processes of change scales

Process of change		Stage of change					Alpha
		Precontem ( <i>N</i> =268)	Contem ( <i>N</i> =165)	Prepar ( <i>N</i> =99)	Action ( <i>N</i> =141)	Main ( <i>N</i> =125)	
Consciousness raising	Mean	2.09	2.89	2.96	3.05	3.36	0.729
	(SD)	(0.98)	(1.01)	(1.04)	(1.21)	(1.39)	
Dramatic relief	Mean	2.15	3.03	3.24	3.20	3.26	0.754
	(SD)	(1.05)	(1.09)	(1.05)	(1.12)	(1.48)	
Environmental reevaluation	Mean	1.99	2.84	2.94	3.15	3.57	0.828
	(SD)	(1.02)	(1.11)	(1.14)	(1.27)	(1.39)	
Social liberation	Mean	1.88	2.40	2.60	2.77	3.20	0.600
	(SD)	(0.87)	(0.88)	(0.99)	(1.12)	(1.23)	
Self-reevaluation	Mean	1.65	2.60	2.97	3.00	2.96	0.776
	(SD)	(0.89)	(1.08)	(1.19)	(1.22)	(1.53)	
Helping relationships	Mean	2.21	2.73	2.80	2.77	2.94	0.839
	(SD)	(1.28)	(1.25)	(1.34)	(1.42)	(1.60)	
Stimulus control	Mean	1.30	1.72	1.99	2.27	2.80	0.804
	(SD)	(0.56)	(0.86)	(0.99)	(1.25)	(1.49)	
Counter conditioning	Mean	1.84	2.54	2.79	3.49	3.82	0.729
	(SD)	(0.86)	(0.86)	(0.86)	(0.98)	(1.26)	
Reinforcement management	Mean	1.54	1.78	2.15	2.57	3.25	0.815
	(SD)	(0.86)	(0.89)	(1.16)	(1.31)	(1.38)	
Self liberation	Mean	1.54	2.48	2.88	3.47	3.84	0.799
	(SD)	(0.76)	(1.04)	(1.11)	(1.27)	(1.22)	

#### 4.2. External validity

The transtheoretical model postulates that individuals differ in their use of the processes of change based on their current stage of change. In order to establish the external validity of the processes of change for smoking cessation scale for adolescents, a multivariate analysis of variance (MANOVA)

Table 2  
ANOVA tests with follow-up Tukey tests for the 10 processes of change

Process of change	<i>F</i> -value	$\eta^2$	Tukey pattern
I. Experiential processes			
Consciousness raising	$F(4, 793)=37.50^*$	.16	PC<C=P=A=M
Dramatic relief	$F(4, 793)=36.35^*$	.16	PC<C=P=A=M
Environmental reevaluation	$F(4, 793)=48.89^*$	.20	PC<C=P=A<M
Social liberation	$F(4, 793)=44.51^*$	.18	PC<C=P=A<M
Self-reevaluation	$F(4, 793)=52.13^*$	.21	PC<C=P=A=M
II. Behavioral processes			
Helping relationships	$F(4, 793)=8.89^*$	.04	PC<C=P=A=M
Stimulus control	$F(4, 793)=55.86^*$	.22	PC<C=P=A<M
Counter conditioning	$F(4, 793)=123.32^*$	.38	PC<C=P<A<M
Reinforcement management	$F(4, 793)=62.98^*$	.24	PC=C=P<A<M
Self liberation	$F(4, 793)=68.46^*$	.42	PC<C<P<A<M

\*  $p < 0.001$ .

was conducted using the ten processes as the dependent variables and stage membership as the grouping variable. These results showed that the combined dependent variables (i.e., the ten processes of change) differed significantly in their means by stage of change for smoking cessation based on Wilks' Lambda ( $F(40,2974.69)=18.517, p<0.001$ ). An ANOVA was performed on each of the 10 dependent variables and a Tukey test was used as a follow-up test for significant results. Table 1 presents the means and standard deviations for each of the 10 processes across each of the five stages of change.

For the five experiential processes, all five tests were significant ( $p<0.001$ ) and produced large effect sizes (see Table 2). Effect size interpretations were based on Cohen's (1988) descriptive guidelines for Eta squared ( $\eta^2$ ). A "small" effect is about 1% of the variance, a "medium" effect is about 6% of the variance, and a "large" effect is about 14% or more of the variance. All effect size estimates were large. There were two distinct patterns observed for the follow-up tests. For Consciousness Raising, Dramatic Relief, and Self-reevaluation, the only significant difference was between Precontemplation and Contemplation. For Environmental Reevaluation and Social Liberation, there were significant differences between both Precontemplation and Contemplation and between Action and Maintenance. Fig. 2 illustrates the pattern of differences across the stages of change.

For the five behavioral processes, all five tests were significant ( $p<0.001$ ) and four of the five produced large effect sizes (see Table 2). Helping Relationships produced only a small effect size ( $\eta^2=0.04$ ). The results for the other four processes ranged from large (Stimulus Control,  $\eta^2=0.22$ ; Reinforcement Management,  $\eta^2=0.24$ ) to very large (Counter Conditioning,  $\eta^2=0.38$ ; Self Liberation,  $\eta^2=0.42$ ). A different pattern of differences was observed for each of the five processes. For Helping Relationships, only the difference between Precontemplation and Contemplation was significant. For Self Liberation, all stage differences were significantly different. For Stimulus Control, there were

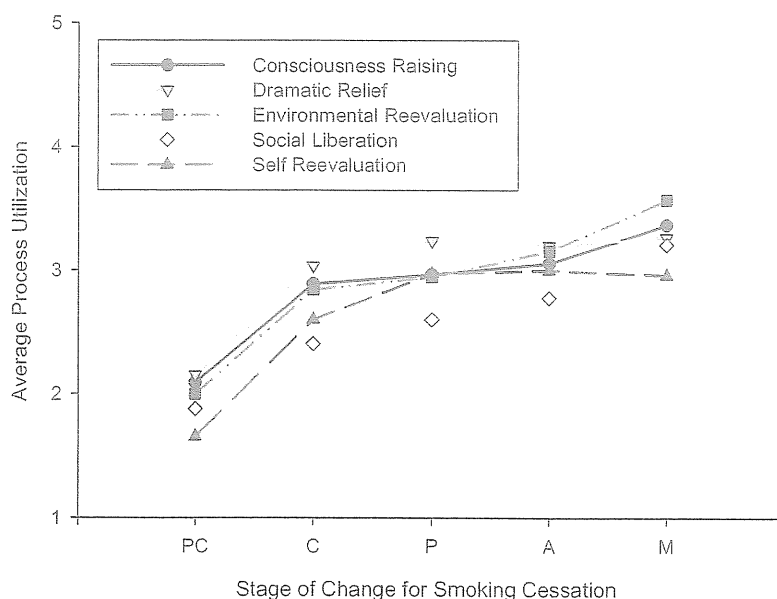


Fig. 2. Experiential processes of change utilization across stages of change.

significant differences between both Precontemplation and Contemplation and between Action and Maintenance. For Counter Conditioning, there were significant differences between Precontemplation and Contemplation, Preparation and Action and Action and Maintenance. For Reinforcement Management, there were significant differences between Preparation and Action and Action and Maintenance. Fig. 3 illustrates the pattern of differences for the behavioral processes across the stages of change.

## 5. Discussion

Using a large representative sample of adolescent smokers and ex-smokers, this study validated the adolescent version of the short form of the processes of change inventory for smoking cessation (Prochaska et al., 1988). This evidence supports both the internal and external validity of this adapted and abbreviated scale.

The Coefficient Alphas were generally lower than reported for the 40-item adult versions. The range reported there was 0.69 to 0.92 with most values above 0.80 while the range here was 0.60 to 0.84 with most values above 0.70. This is largely explained by the difference in the number of items (2 per scale here vs. 4 per scale in the adult version), illustrating the trade off between increased reliability and decreased subject response burden. Researchers wanting greater internal consistencies could consider using a version that includes 3 items per scale. There was a third item with a relatively high loading available for each process in the original paper (Prochaska et al., 1988).

The hierarchical model from the original inventory produced a good fit to these data. The underlying structure of the processes of change for adolescents is comparable to that observed for adults. That is, for both adolescents and adults the 20 observed items can be organized by 10

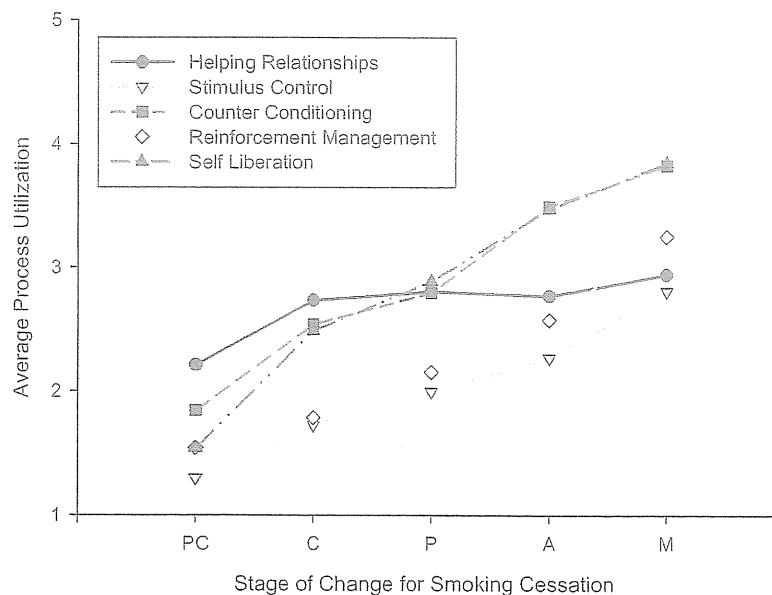


Fig. 3. Behavioral processes of change utilization across stages of change.

processes of change. Further, the 10 processes can be organized into five behavioral and five experiential processes of change. The relationship between the 10 first order factors and the two second order factors was generally higher in the adolescent sample. The correlation between the two second order factors (behavioral and experiential processes) was also higher in the adolescent sample ( $r=0.93$ ) than the adult sample ( $r=0.77$ ; (Prochaska et al., 1988)). This higher correlation may simply reflect the fact that the two items selected were the items having high loadings in the adult sample and the inclusion of items with low loadings served to reduce the path coefficients in the structural part of the model. Alternatively, it may reflect less differentiation between experiential and behavioral processes among adolescent smokers. Future research can address this issue more clearly.

This adolescent version also exhibited external validity in its relationship to the stages of change. The transtheoretical model would predict that the utilization of these processes would increase across the stages of change, e.g., the average utilization of the processes by adolescents in the Contemplation stage would be higher than that of adolescents in the Precontemplation stage. Large to very large effect sizes were observed for 9 of the 10 processes and the pattern across the stages supported the model. Adolescents in the maintenance stage had the highest utilization of all of the 10 processes, followed by adolescents in the action, preparation, contemplation, and precontemplation stages, in the theorized order. Furthermore, the strength of the relationships between the utilization of the 10 processes of change and the stages of change underscore the importance of this construct in the behavior change process.

Based on these results, and given the existing need for age-appropriate tailored measures for smoking cessation (Henningfield et al., 2000), this adolescent version of the processes-of-change scale for smoking cessation is recommended for use as a brief, validated, and appropriately adapted measure for assessments and interventions for smoking cessation with adolescents.

Beyond serving as an assessment tool, the processes of change scale can also be used for intervention purposes as part of TTM-tailored expert system interventions (Velicer et al., 1993). The efficacy of such interventions in targeting smoking cessation for adults has been supported by previous research (Prochaska, Velicer, Fava, Rossi, & Tsoh, 2001; Prochaska et al., 2004; Redding et al., 1999; Velicer, Prochaska, Fava, LaForge, & Rossi, 1999), and supports the adaptation and evaluation of comparable TTM tailored expert system smoking cessation interventions for adolescents (Pallonen et al., 1998; Redding et al., 1999). Increasing adolescent cessation as well as prevention efforts can have important impacts on adolescent smoking rates, improving our ability to meet the Healthy People 2010 smoking objectives.

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