An Evaluation of the North Carolina Tobacco.Reality.Unfiltered. Media Campaign

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ABSTRACT

Kelly L. Kandra: An Evaluation of the North Carolina Tobacco.Reality.Unfiltered. Media Campaign
(Under the direction of A. T. Panter, Ph.D.)

With youth smoking rates showing little decline since the late 1990's, the state of North Carolina implemented a multi-component initiative focused on teenage tobacco use prevention and cessation. One component of this initiative is Tobacco.Reality.Unfiltered., or TRU, an anti-tobacco media campaign, aimed at North Carolina youth ages 11 – 17 years. The primary goal of this campaign is to prevent the initiation of tobacco use, especially cigarette smoking, among youth. This research evaluates the progress that the TRU campaign has made in achieving its short term, i.e. campaign awareness and receptivity, and long term, i.e. prevention of tobacco use, goals using a longitudinal telephone survey of North Carolina youth (N = 502). The results indicate that 45% of North Carolina youth had confirmed awareness of at least one TRU ad, with the majority of youth reporting that the ads were convincing, attention-grabbing, and gave good reasons not to smoke. Latent transition analyses indicate that the probabilities at which youth were transitioning into smoking experimentation were not different for youth who were aware of the TRU campaign versus youth who were unaware of the campaign. These results held regardless of whether smoking initiation was measured using a youth's lifetime smoking behavior or current smoking behavior. A difference did emerge in the transition probabilities for younger and older youth regarding current smoking behavior, with older youth transitioning into smoking experimentation at a higher rate than younger youth.

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INTRODUCTION

Tobacco use is the leading cause of preventable death in the United States (U.S. Department of Health & Human Services, 2004). The Centers for Disease Control and Prevention's (CDC) Office of Smoking and Health estimates that there are currently 46.2 million adults in the United States who smoke cigarettes and that their smoking behavior will cause death or disability for half of all regular smokers (U.S. Department of Health & Human Services, 2005). Each year, cigarette smoking causes more than 440,000 deaths, and more than 8.6 million people in the United States have at least one serious illness caused by smoking (U.S. Department of Health & Human Services, 2005). If these trends continue, 6.4 million people currently under the age of 18 years will have a premature death due to a tobacco-related illness. The list of diseases linked to tobacco use has become so extensive that the 2004 Surgeon General's report concludes that smoking harms nearly every organ of the body and causes generally poorer health (U.S. Department of Health & Human Services, 2004). In fact, tobacco use itself can be considered a chronic disease (Goldstein, Gwyther, & Ripley-Moffitt, in press). These health issues translate into more than $75 billion per year in medical expenditures and an additional $80 billion per year resulting in loss of productivity (U.S. Department of Health & Human Services, 2005).

This investigation examines the effectiveness of preventing teenage smoking initiation in one of the anti-tobacco efforts of North Carolina, a state-funded anti-tobacco media campaign branded Tobacco.Reality.Unfiltered. or "TRU." This media campaign was

designed in 2004 using the recommendations of the Centers for Disease and Control (1994) and is a key component of North Carolina's current teenage tobacco use prevention and cessation initiative (Summerlin-Long et al., 2007). A primary campaign goal is to prevent North Carolina youth, ages 11 – 17 years, from initiating the use of cigarettes. The effectiveness of the campaign at reaching this goal was evaluated using latent transition analysis (LTA), a methodology for estimating and testing stage-sequential models of individual growth and change in longitudinal data. Youth in this research were classified as being either "aware" or "unaware" of the TRU media campaign. The probability that these two groups will transition from being a non-smoker to one of the stages of smoking initiation across three points in time was estimated.

To motivate the LTA approach, the existing model of smoking initiation use among adolescents will be presented. Next, trends of teenage tobacco use in the United States will be described. The next section of this paper focuses on the most recent efforts of North Carolina, the largest tobacco-producing state in the country, at preventing tobacco use among teenagers, which also includes prevalence rates of cigarette use by North Carolina youth. The final section provides a detailed description of the LTA model, as this methodological approach will be the major approach for testing movement through the smoking initiation stages.

Initiation of Tobacco Use

Adolescent smoking initiation has been defined as a developmental, stage-sequential process since the early 1980's (Leventhal & Cleary, 1980; Flay et al., 1983). The initial model included four stages: Preparation, Initiation, Experimentation, and Becoming (Flay et al., 1983). As further research was conducted on teenage tobacco use, the model was later

redefined and expanded to include nicotine dependence as a fifth stage (Flay, 1993). In 1994 the U.S. Surgeon General used this model to describe the developmental stages of smoking in a special report Youth and Tobacco: Preventing Tobacco Use among Young People (U.S. Department of Health & Human Services, 1994). In the first or Preparatory Stage, the adolescent forms knowledge and beliefs about the utility of smoking. This stage has sometimes been referred to as a Susceptibility stage (Flay, Hu, & Richardson, 1998). The second stage, Initial Trying, includes the first two or three times that an adolescent tries tobacco (Flay, 1993). Adolescents in the third stage of smoking, referred to as Experimentation, show an increased, but irregular use of tobacco products and are not fully committed to using tobacco (Flay 1993; Mayhew, Flay, & Mott, 2000). The fourth stage of smoking, Regular Use, is characterized by frequent, but still sporadic use of tobacco products. The tobacco products are used in a variety of settings; however, these youth are not smoking every day (Mayhew et al., 2000). In the fifth and final stage of the model, Nicotine Dependence, the adolescent has developed an internal need for nicotine and smokes on a daily basis (Flay, 1993). Figure 1 depicts the five-stage model of adolescent smoking initiation.

Current Trends in Teenage Tobacco Use

According to the 2004 National Household Survey on Drug Abuse (Substance Abuse & Mental Health Services Administration, 2005), 3,900 youth between the ages of 12 and 17 years initiate cigarette smoking each day in the United States, and 1,500 of these 3,900 youth become daily smokers. Before they reach high school, 28% of youth have tried smoking, and by their senior year that number climbs to 53% (Johnston, Bachman, & Schulenber, 2005). Smoking rates for 8th-graders peaked in 1996 at approximately 22% reporting current use,

and smoking rates for 12th-graders peaked the following year at approximately 37% (Johnston et al., 2005). Since the mid-1990's, smoking rates have declined; however, the rate of decline is slowing (U.S. Department of Health & Human Services, 2003). Current rates for cigarette smoking among high school students in the United States are estimated to be at 22.9%, and rates for middle school students are 10.1% (Allen et al., 2003).

Tobacco Use Prevention and Control Programs

With middle school and high school students showing a downward trend, there have been some recent strides in public health outreach and prevention of tobacco use; however, there is still a great need for continued efforts of comprehensive tobacco control programs, especially among high-school age youth, to reduce the rates of tobacco use to improve health outcomes. The CDC recommends that each state establish a tobacco use prevention and control program that is "comprehensive, sustainable, and accountable" (Centers for Disease Control & Prevention, 1999, p.8) The CDC (Centers for Disease Control & Prevention, 1999, p. 7) has conceptualized a comprehensive tobacco control program as reducing disease, disability, and death related to tobacco use by:

- Preventing the initiation of tobacco use among young people.
- Promoting cessation among young people and adults.
- Eliminating nonsmokers' exposure to ETS.
- Identifying and eliminating the disparities related to tobacco use and its effects among different groups

To help individual states establish comprehensive tobacco control programs, the CDC prepared a Best Practices for Comprehensive Tobacco Control Programs report that provides guidance and recommendations about specific funding ranges and programs (Centers for Disease Control & Prevention, 1999). Nine "best practices" were identified through a process of evidence-based analyses of comprehensive state tobacco control programs:

1. Community programs to reduce tobacco use
2. Chronic disease programs to reduce the burden of tobacco-related diseases
3. School programs
4. Enforcement
5. Statewide programs
6. Counter-marketing
7. Cessation programs
8. Surveillance and evaluation
9. Administration and management

A review in 2000 (Wakefield & Chaloupka) evaluated the effectiveness of comprehensive tobacco control programs in several states, including California, Florida, and Massachusetts. The results indicated that, to varying degrees of success, comprehensive tobacco control programs are an effective strategy for reducing teenage smoking.

North Carolina's Tobacco Use Prevention and Control Program

North Carolina utilized the Best Practices guidelines to develop its own strategy to prevent and reduce the negative health effects of tobacco use. In Vision 2010, North Carolina outlined its comprehensive plan to prevent and reduce the health effects of tobacco use. In this plan, the major goal of the state was identified as decreasing overall teen tobacco use to 19.1% (North Carolina Tobacco Prevention & Control Branch, 2001). At the time that Vision 2010 was being formulated, current youth smoking rates in North Carolina had seen little change since 1999. Results from the 1999 North Carolina Youth Tobacco Survey indicated that 15.0% of middle school students and 31.6% of high school currently smoked cigarettes, whereas in 2001 the results showed a slight decrease with 11.3% of middle school students and 27.8% of high school students reporting that they currently smoked cigarettes.

To help accomplish the goal of decreasing teen tobacco consumption, the North Carolina Health and Wellness Trust Fund Commission (HWTFC) allocated $18.6 million over three years to the Teen Tobacco Use Prevention and Cessation Initiative (North

Carolina General Assembly, 2003). A key component of this initiative is a statewide, youth-focused mass media campaign, branded Tobacco.Reality.Unfiltered. or TRU. TRU is designed to educate North Carolina young people about the dangers of tobacco, prevent initiation, and help teen users quit.

The CDC Task Force on Community Preventive Services (TFCPS) strongly recommended mass media campaigns as primary strategies for reducing tobacco use initiation (Hopkins et al., 2001). According to the TFCPS, campaigns are "mass media interventions of an extended duration, using brief, recurring messages to inform and to motivate children and adolescents to remain tobacco free" (Hopkins et al., 2001, p. 12). The CDC Best Practices report highlighted the state media campaigns of California, Massachusetts, Arizona, and Florida, as models in content and production quality (Centers for Disease Control & Prevention, 1999). North Carolina also recognized these states, as well as Oregon and Mississippi, as states that had successful, effective anti-tobacco media campaigns (Malek, Hopkins, Molloy, & McGloin, 2002). Out of these statewide mass media campaigns, only the Florida "truth" campaign was specifically targeting tobacco prevention in youth.

Review of Current Research on Youth-targeted, State-funded Anti-Tobacco Media Campaigns

The Florida "truth" campaign, aimed at youth ages 12 to 17 years, began in the spring of 1998. The campaign strongly emphasized tobacco industry manipulation (Wakefield, Flay, Nichter, & Giovino, 2003). The first-year evaluation and findings from the "truth" campaign showed a promising start (Sly, Heald, & Ray, 2001). The evaluation design of "truth" included six cross-sectional telephone surveys: (1) a baseline sample of youth in Florida; (2)

a comparison sample of national youth at baseline; (3) a six-week follow-up of Florida youth; (4) a six-month follow-up of Florida youth; (5) a one-year follow-up of Florida youth; and (6) a national comparison sample after one year (Sly et al., 2001). Confirmed awareness of the "truth" campaign increased from about 40% after six weeks to approximately 93% after one year. Moreover, findings from the first year summary of the media campaign showed that Florida youth also showed a significant increase in anti-tobacco attitudes/beliefs and declined in their susceptibility to smoking and lifetime cigarette use (Sly et al., 2001).

In addition to using the cross-sectional telephone surveys to describe the efficacy of the "truth" campaign, the Florida team used a follow-up survey of Florida youth six months into the campaign (Sly, Hopkins, Trapido, & Ray, 2001). The researchers categorized youth into one of three categories of ad effectiveness: (1) Time 1 nonsmokers: Youth who were unaware of the "truth" campaign; (2) Time 1 nonsmokers: Youth highly affected by the campaign (i.e., had confirmed awareness of two "truth" ads, who also indicated that both ads made them think about not smoking, and who also reported feeling that tobacco companies were just trying to use them); and (3) Time 1 nonsmokers: Youth mildly affected by the campaign (i.e., only one of two confirmed ads made them think about not smoking and/or reported no or little manipulation by tobacco companies).

A series of logistic regressions predicting smoking uptake (i.e. any use in the past 30 days) indicated that youth in the last category who had been mildly affected by the campaign were 1.3 times more likely to remain nonsmokers. When smoking was defined as smoking six or more days in the past 30 days, and smoking more than five cigarettes on days when they smoked these youth were nearly 2 times more likely to remain nonsmokers. Youth who

had been highly affected by the campaign were almost 2.5 times more likely to remain nonsmokers, using the latter definition of smoking (Sly et al., 2001).

The cumulative effects of exposure to the Florida "truth" campaign were assessed 22 months after the campaign start with a follow-up telephone survey (Sly, Trapido, & Ray, 2002). Researchers determined a dose effect by summing the number of "truth" ads confirmed by survey participants (11 ads had aired since "truth" began in 1998). Researchers also assessed the influence of the campaign's industry manipulation theme and anti-tobacco industry attitudes using the telephone survey. After controlling for gender, age, and susceptibility to smoking, the findings showed that Time 1 nonsmokers were more likely to remain nonsmokers at Time 2 for both 30-day cigarette use (defined as any cigarette use, even one or two puffs in the last 30 days) and established cigarette use (defined as smoking on six or more days in the past 30 days and smoking five or more cigarettes on these days); as the number of confirmed ads increased, the influence of the campaign message theme increased, and anti-tobacco attitudes increased. These effects were stronger for established cigarette use. When number of ads confirmed, influence of the campaign message theme, and anti-tobacco attitudes were considered simultaneously, only the high levels of confirmed awareness and message theme influence were significantly associated with nonsmokers remaining nonsmokers; however, both medium and high levels of anti-tobacco attitudes were associated with not smoking.

While the Massachusetts statewide mass media anti-smoking campaign did not specifically target youth, this campaign also reduced the rate of smoking initiation among youth who were aware of the campaign (Siegel & Biener, 2000). These researchers conducted a four-year follow-up telephone survey on a sample of Massachusetts youth to

examine the relationship between baseline exposure to the campaign and rates of progression to established smoking. A series of logistic regressions, controlling for exposure to other anti-smoking messages, gender, age, race, baseline smoking status, average hours of television viewing per day, presence of at least one adult smoker in the youth's household (at baseline), and presence of at least one close friend who smoked (at baseline), indicated that youth aged 12 to 13 years (at baseline) who reported exposure to the campaign were significantly less likely to have progressed to established smoking compared to youth who had not reported exposure (Siegel & Beiner, 2000). This result, however, did not hold for older youth in the cohort who were aged 14 to 15 years at baseline.

A limitation of the Florida and Massachusetts anti-smoking media campaign evaluations was the operational definition of the outcome measure, smoking uptake. The CDC recommends a question asking whether or not a person has smoked, even one or two puffs, in the past 30 days, to determine cigarette use (Sly et al., 2001). One argument against this approach is that adolescent smoking is often irregular and that adolescents are unreliable in recalling smoking behavior in the past 30 days (Siegel & Biener, 2000). A recommended solution was to classify youth who smoked over 100 cigarettes (5 packs) in his or her lifetime as an "established smoker" (Pierce et al., 1998; Siegel & Biener, 2000). However, some researchers argued that lifetime recall for a specific number of cigarettes was no more reliable than prior 30-day use; also, older youth would have had substantially more days to smoke 100 cigarettes or more than younger youth (Sly et al., 2001). Regardless of the definition that the researchers used in the evaluations of the Florida and Massachusetts anti-tobacco media campaigns, the outcome measure of smoking uptake was defined either as "no smoking in the past 30 days (non-smoker) / yes smoking in the past 30 days (established

smoker)". This dichotomizing of smoking excludes information about youth who may be transitioning into smoking through situational or irregular use of cigarettes. While the primary goal of these statewide media campaigns is to prevent cigarette use, there may be utility in determining whether these campaigns are effective at stopping the transition from the middle stages of smoking initiation, such as the transition from an experimenting smoker to a regular user. This information would be lost without the inclusion of the transitional stages of smoking initiation in the statistical model. A methodology is needed to: (1) Determine whether or not a statewide media campaign is effective in preventing youth from transitioning from a non-smoking to smoking status; (2) To determine whether there are any secondary benefits of the campaign in keeping middle-stage smokers from transitioning into nicotine dependence; and (3) To understand whether these transitions occur differentially in different contexts for youth. One such methodology is latent transition analysis.

Overview of Latent Transition Analysis

Latent Transition Analysis (LTA) is a methodological approach for estimating and testing stage-sequential models (e.g., progression of cigarette initiation) of individual change in longitudinal data (Collins & Wugalter, 1992; Hyatt & Collins, 2000). LTA extends latent class theory and utilizes the Markov model framework to predict the probability that a person transitions from one stage to another during some given point in time, with a minimum requirement of two time points (Collins et al., 1994). For example, in Figure 2 the probabilities of stage transitions between two time points are represented in a matrix, where $\tau_{2|1}$ is the probability of membership in stage 2 at the end of the time point, given membership in stage 1 at the beginning of the time point. Using the current research, $\tau_{2|1}$ would be the probability of membership at Time 2 in the Preparatory Stage of smoking

initiation given membership at Time 1 in the first smoking initiation stage, No Cigarette Use. Because the elements in the τ matrix are conditional probabilities, the sum of each row is equal to one.

Because Markov models lack response uncertainty and cannot adequately represent latent variables that are so often used in psychological research and theory, several researchers in the late 1960's recognized a solution by incorporating the use of latent class models into the Markov model framework (Collins & Wugalter, 1992). It was not until years later viable estimation methods were developed to test these methods by Bye and Schecter (1986), van de Pol and De Leeuw (1986), and van de Pol and Lagneheine (1989), (as cited in Collins & Wugalter, 1992).

LTA describes movement across latent statuses over time. These latent statuses are measured by dynamic latent variables (Martin, Velicer, & Fava, 1996). The LTA model consists of both a dynamic component and a static component (Graham, Collins, Wugalter, Chung, & Hansen, 1991). The dynamic component or latent status, which changes over times, reflects the movement through the stage sequence, such as movement through the stages of teenage smoking initiation. The static component, which remains constant in the model, is an exogenous predictor (e.g. participation in an anti-tobacco intervention, gender, or age) that can be used to classify a sample into groups or latent classes.

Latent transition analysis involves the estimation of four classes of parameters: (1) γ parameters, which estimate the proportion of the population within each latent class; (2) δ parameters, which estimate the proportion of the population within each latent status at each measurement time; (3) τ parameters, which estimate the conditional probability of transitioning from one latent status to another, given previous latent status membership; and

(4) two sets of ρ parameters, one set associated with the static latent variable representing measurement error and the second set associated with the dynamic latent variable estimating a particular item response conditional on latent status and latent class membership (also representing measurement error) (Martin et al., 1996). For example, in an evaluation of an anti-tobacco intervention for teenagers and how this intervention may vary by gender, the γ parameters would estimate the proportion of males in population who received the intervention and those who did not receive the intervention and the proportion of females in the population who received the intervention and those females who did not; the δ parameters would estimate the proportion of the population in each of the stages of smoking initiation at each data collection time; the τ parameters would estimate the conditional probability of transitioning from each stage of smoking initiation given stage membership at Time 1; the first set of ρ parameters would represent the measurement error of the intervention indicators; the second set of ρ parameters would estimate a teenager's response to a particular item depending on what stage of smoking initiation he or she is currently in and whether or not he or she received the intervention.

The formal LTA model presented below represents a general research situation with three measurement time points, two manifest indicators of the dynamic latent variable at each occasion (e.g. "In the past 30 days, did you smoke a cigarette, even one or two puffs?" and "Do you think you will ever smoke a cigarette in the future?"), and one exogenous static latent variable measured by one manifest indicator (e.g. "Have you seen a TRU ad?" (Collins, Lanza, Schafer, & Flaherty, 2002). The first time point is measured as Time *t*, the second time point is measured as Time t + 1, and the third time point is measured as Time *t* + 2. The two manifest indicators that are measured at three points in time are Item 1, with *i*, *i'*,

i'' = 1, … I response categories; and Item 2 with j ,j', j'' = 1, … J; where i, and j, are the responses from Time t, i' and j', are the responses from Time t + 1, and i'' and j'' are the responses from Time t + 2. The population is divided up into latent classes c = 1, … C by an exogenous latent predictor and is measured by a manifest indicator with m = 1, … M response categories. There are p, q, r = 1, … S latent statuses, with p representing a latent status at Time t, q, representing a latent status at Time t + 1, and r denoting a latent status at Time t + 2.

Let y = {$m, i, j, i', j', i'', j''$} represent one respondent's response pattern, a vector of possible categorical responses composed of one response to the manifest indicator of the exogenous static latent variable and the exogenous responses to the three manifest indicators of the dynamic latent variable at Times t, t + 1, and t + 2 (Collins et al., 2002). Transitions between latent statuses are conditional on latent memberships at Time t – 1, the proportion of individuals with a particular response pattern, $P(Y = y)$ is expressed as:

$$P(Y = y) = \sum_{c=1}^{C}\sum_{p=1}^{S}\sum_{q=1}^{S}\sum_{r=1}^{S}$$

$$\gamma_c \rho_{m|c} \delta_{p|c} \rho_{i|p,c} \rho_{j|p,c} \tau_{q|p,c} \rho_{i'|q,c} \rho_{j'|q,c} \tau_{r|q,c} \rho_{i''|r,c} \rho_{j''|r,c}$$

where

γ_c represents the proportion of individuals in latent class c;

$\delta_{p|c}$ represents the proportion of individuals in latent status p at Time t conditional on membership in latent class c; that is, the proportion of latent class c members whose latent status is p at Time t;

$\tau_{q|p,c}$ is an element of the latent transition probability matrix, representing the probability of membership in latent status q at Time t + 1 conditional on membership in

latent status p at Time t and membership in latent class c; that is, the value indicates the proportion of those in latent class c and latent status p at Time t who are in latent status q at Time $t + 1$;

$\rho_{i|p,c}$ represents the probability of response i to Item 1 at Time t, conditional on membership in latent status p at Time t and on membership in latent class c; $\rho_{i'|p,c}$ represents the probability of response i' to item 1 at Time $t + 1$, conditional on membership in latent status q at Time $t + 1$ and on membership in latent class c, and so on and $\rho_{m|c}$ represents the probability of having a value of m on the indicator of latent class membership, conditional on membership in latent class c.

These five model parameters are estimated using the EM (Expectation-Maximization) algorithm (Guo, Collins, Hill, & Hawkins, 2000). In this algorithm response pattern proportions are computed based on current parameter estimates (the expectation step) and then new parameter estimates are obtained based on the current estimated response patterns so as to maximize the likelihood function (Collins & Wugalter, 1992).

The γ parameters measure the proportion of the population in each class. Because the latent classes are mutually exclusive and exhaustive, the γ's always sum to one. Taking this restriction into account, if C represents the number of latent classes, at most $C - 1$ of these parameters are independently estimated and the remaining category can be obtained by subtraction (Collins et al., 1992).

The δ parameters measure the proportion of the population in each latent status at each time point, conditional on latent class membership. The δ parameters that correspond to occasions other than Time 1 are not independently estimated, but are a function of other model parameters. These parameters always sum to one across latent statuses within a class.

If S is the number of latent statuses, the most δ parameters that can be freely estimated is $C(S - 1)$. Within each latent class, once $S - 1$ of the δ parameters have been estimated, the remaining parameters can be obtained by subtraction (Collins & Wugalter, 1992; Collins et al., 1992).

The τ parameters are the transition probabilities, conditional on latent class membership. Each row of the transition probability matrix adds to one. If there are T times, the maximum number of transition probability parameters that can be independently estimated is $CS(S - 1)(T - 1)$ (Collins & Wugalter, 1992; Collins et al., 2002). There are two sets of ρ parameters, one set which measures probabilities associated with the static latent variable and is conditional on item and latent class membership and one set which measures probabilities associated with the dynamic latent variable and are conditional on item, latent status membership, time, and sometimes class membership. These parameters sum to one across response categories within an item, time, latent status, and latent class combination. If there are I manifest variables measuring the static latent variable with R response categories, then the maximum number of independent ρ parameters associated with the static latent variable is $CI(R - 1)$. If there are J manifest variables, each with M response categories, measuring the dynamic latent variable at T times, there are at most $CTSJ(M - 1)$ independent ρ parameters (Collins & Wugalter, 1992; Collins et al., 2002). The maximum number of parameters estimated is $(C - 1) + C(S - 1) + CS(S - 1)(T - 1) + CI(R - 1) + CSTJ(M - 1)$.

As with other latent class models, the estimation of LTA model parameters depends on the model being identified. There has to be enough independent information in the data for stable estimation of the parameters. The necessary, but not sufficient condition that the number of parameters to be estimated not exceed one less than the number of response

patterns is almost always met in LTA. Identification can be examined by determining the rank of the matrix of partial derivatives of $N - 1$ of the cell probabilities with respect to each of the parameters to be estimated or the semipartial derivatives of the log-likelihood function. The model is identified if these matrices are of full rank (Collins & Wugalter, 1992). Identification problems can be solved by placing restrictions on the model. One type of restriction sets a parameter estimate to some specific value, i.e., no data are used to estimate it. These restrictions are useful in models where no "backward" movement is allowed through the stage-sequential model. For example, using life time use to define the stage of smoking initiation, it would be impossible to report smoking over five packs of cigarettes in a life time at Time 1 (Nicotine Dependence) and then report having only taken one or two puffs of a cigarette in a lifetime at Time 2 (Initial Trying). These restrictions would be defined in the transition probability matrix. A second type of restriction sets two or more parameters to be equal to one another (i.e., equality constraints). In LTA it is useful to constrain the ρ parameters to be equal across time, to retain the meaning of the latent statuses over time or across classes (Hyatt & Collins, 2000). For example, the transition probability between the Preparatory Stage and the Initial Trying Stage would not be meaningful if the definition of these stages varied across time.

To evaluate the hypothesized LTA model, it is common to use the likelihood-ratio statistic G^2. This statistic compares the observed and predicted response pattern frequencies of the manifest indicators of the latent statuses. If the hypothesized model provides a good fit to the data, then the predicted and observed frequencies will be close to one another. The G^2 statistic is calculated as:

$$G^2 = 2\sum f_{ijk} \ln(f_{ijk} / \hat{f}_{ijk})$$

where f_{ijk} is the observed frequency of response pattern *ijk* and $\hat{f}_{ijk}$ is the frequency predicted by the model (Collins et al., 2002). The degrees of freedom are equal to $(k - p - 1)$, where k is the number of possible response patterns, and p is the number of parameters estimated.

Study Aims

There are two primary research aims: (1) To assess overall awareness of the TRU media campaign to ensure that the campaign is reaching its target audience of youth ages 11 to 17 and that youth are responding well to the ads; and (2) To use campaign awareness to assess whether or not the TRU media campaign is effective at preventing North Carolina youth from initiating cigarette use. The effectiveness of the campaign will also be examined using different contextual variables, such as gender, age at onset of the campaign, and race. The use of latent transition analysis to accomplish the second research goal will allow the effectiveness of the campaign over time to be tested across all stages of smoking initiation. To test these goals, a six-stage model is hypothesized and is presented in Figure 3. The difference between this model of smoking initiation and the standard model of smoking initiation (Flay, 1993) is the inclusion of a stage defined by no cigarette use. The inclusion of this stage ensures that the model will include the full sample of adolescents, not just the ones who are already contemplating smoking in the Preparatory stage.

Another secondary goal of the proposed research is to assess whether different definitions (i.e., past 30-day use versus lifetime use) of the hypothesized stages of smoking have different results regarding the effectiveness of the TRU campaign.

METHOD

TRU Ads

The TRU campaign launched in April of 2004 with three ads featuring youth telling personal stories of loved ones who had suffered serious health consequences from tobacco use. The ads were developed based in part on information from an unpublished report on best practices in youth tobacco prevention ads compiled by the University of North Carolina Tobacco Prevention and Evaluation Program based on a literature review, published reports and interviews with state and national experts in tobacco countermarketing campaigns. The report concluded that one potentially effective component of a mass media campaign in a major tobacco producing state would include real people (not actors) from North Carolina telling personal stories about the serious health consequences of tobacco use. These stories should also elicit negative emotional tone in the viewer. Such an approach, it was hypothesized, would be effective in North Carolina, would elicit little political opposition, and could generate ongoing support if deemed successful. A detailed description of the TRU ads that were created can be found in the appendix.

The ads, called *Anna*, *Jacobi*, and *Brad*, featuring family stories of tobacco addiction from youth, ran from April – October of 2004. A fourth ad which ran in the fall of 2004 called Travelogue featured a young man who wanted to quit smoking and a woman with a tracheotomy who had started smoking as a teen. Each ad featured the TRU logo, as well as two slogans: *Tobacco.Reality.Unfiltered.* and *What's it gonna take?*

Research Design

A baseline survey was conducted in March and April of 2004, which preceded the Tobacco.Reality.Unfiltered. (TRU) campaign launch in April 2004. This survey collected basic demographic information (such as gender, age, and race), lifestyle information, smoking behaviors and intentions, tobacco-related knowledge and attitudes, involvement in anti-tobacco activities, and awareness, comprehension, and reaction to two national anti-tobacco television ads and brand awareness of several anti-tobacco themes or slogans.

The second survey wave took place 8 months later, immediately following the fall flight of the TRU campaign. The follow-up survey was identical to the baseline survey in assessing lifestyle information, smoking behaviors and intentions, and involvement in anti-tobacco activities. Some tobacco-related knowledge and attitude questions were revised to reflect more accurately the interest of the researchers. Awareness, comprehension, and reaction to two national anti-tobacco ads and the four North Carolina specific anti-tobacco ads were also assessed, as well as brand awareness for these and other anti-tobacco media campaigns.

The third survey wave took place in January and February of 2006, 22 months after baseline data collection. Again, this survey was very similar to the Time 1 and Time 2 surveys in assessing demographics, smoking behaviors and intentions, and awareness, comprehension, and reaction to the various anti-tobacco media campaigns. Several of the tobacco-related knowledge and attitude questions were again revised to reflect research interests.

Samples

To be eligible for survey participation, a household had to have at least one child between the ages of 11 and 17 years, speak English, and have a telephone.

In total, 2,624 telephone numbers were called at baseline. These calls resulted in 48 random-digit-dial baseline interviews and 589 targeted interviews (total interviews = 637). Three hundred seventy-eight numbers were classified as no interview/no response, with 234 of those numbers being direct refusals or break-offs, 31 numbers reached households where the respondents were unavailable during the interview period, and 113 numbers reached households where the respondent was excluded for a medical or cognitive reason. There were 1,176 numbers classified as ineligible for the following reasons: number changed; number no longer in service; business & other nonresidential number, number reached a barracks or institution; number not a primary residence; no adult in household, respondent unavailable for length of study; household does not speak English or has a language impairment to the point that eligibility cannot be established; and no eligible child. Four hundred thirty three numbers were assigned an unknown status in cases were eligibility could not be determined (no answers, busy lines, recorded messages, or no contact). The final weighted response rate was 54.1%.[1]

At the second wave of data collection, 94.8% of the sample completed follow-up interviews, with 19 respondents refusing to participate. Over 80% of the sample completed the third wave of interviews, with 502 interviews being completed. Approximately 49.7% of the sample is male, 84.3% is white, and 63.0% was 11 to 14 years old at Time 1.

[1] The response rate was calculated using Response Rate 4 from the American Association for Public Opinion Research (AAPOR) Standard Definitions (2000). Response Rate 4 takes the unknown eligibility numbers into account by determining which proportion of them, if contacted, should be eligible. If this value is assumed to be zero, then our final weighted response rate would be 64.3%.

Measures

Awareness for the four North Carolina specific anti-tobacco ads was assessed using aided recall questions at Time 2. Each of the four ads was summarized in a one-sentence description. For each of the four ads, the interviewer asked the respondent whether he or she had seen an ad followed by that description. For example, "Have you seen an anti-smoking ad where a young African American talks about smoking and its effects on his uncle?" was a question on the survey for one of the TRU ads.[2] If the respondent answered positively to this question, he or she was then asked what happened in the ad and what the ad's main message was. The first question was used to measure a level of confirmed awareness for the ads. Two independent judges read over the transcripts of responses and determined whether or not the response accurately depicted what happened in the ad. The judges then came together to reconcile their codes (Coefficient Kappa = .85).

Data Analytic Strategy

There were three major aspects to the data analytic strategy: (1) Awareness of the TRU campaign; (2) effectiveness of the TRU campaign; and (3) effectiveness of the TRU campaign in the context of gender, age at onset of the campaign, and race.

Awareness of the TRU Campaign

The awareness of the TRU campaign was assessed using the confirmed awareness responses. Youth were classified as "TRU aware" if he or she saw at least one TRU ad and their ad description was judged to be accurate according to the guidelines set forth by the independent judges. To account for the complex sampling design (e.g. stratification and

[2] The other *TRU* ad survey questions are (1) Have you seen an anti-smoking ad where a teenage girl talks about smoking and its effects on her grandmother? (2) Have you seen an anti-smoking ad where a teenage boy talks about smoking and its effects on his best friend? and (3) Have you seen an anti-smoking ad that talks about a road trip around North Carolina, in which various people talk about the problems with smoking?

population-based sampling weights), campaign awareness was analyzed using SAS-Survey Procedures (e.g., PROC SURVEYFREQ and PROC SURVEYLOGISTIC). Basic frequencies of awareness, as well as logistic models predicting awareness from gender, age at onset of the campaign, and race are presented.

Effectiveness of the TRU Campaign

To determine the effectiveness of the TRU campaign, a latent transition analysis was employed. While the data used in this analysis was the same data used to measure campaign awareness, in these analyses sampling weights were not incorporated into the model. The sampling weights were in part based on the criterion that only youth ages 11 to 17 were eligible to participate in the survey and could not be applied to youth who had aged out (i.e. were 18 years or older) of the survey by T3. Therefore, to include respondents 18 and older (those more likely to use tobacco), sampling weights were not applied to these models.

The latent statuses were also tested using two different measurement approaches. First, latent status was measured using the CDC definition of smoking (i.e., past 30-day use), with the following question: *During the last 30 days, on how many days did you smoke cigarettes even 1 or 2 puffs?* Three questions were also used to measure intent to smoke: (1) *Do you think you will ever smoke a cigarette anytime in the future?* (2) I*f one of your best friends offered you a cigarette, would you smoke it? and* (3) *Do you have a best friend who smokes?*

In latent transition analysis, the transition probability matrix describes movement of an individual from one stage to another at each time point (Martin et al., 1996). Each probability is represented as $\tau_{B|A}$, where τ is a probability and *A* is the latent status at Time 1, and *B* is the latent status at Time 2 conditional on membership in latent status *A* at Time 1

(Martin et al., 1996). Elements above the diagonal in the transition probability matrix reflect forward movement through the stages, whereas elements below the diagonal show individuals who move backward through the stages. The diagonal of the matrix represents stability of latent status. To illustrate, past 30-day behavior can be used to measure forward or backward movement among the smoking initiation stages. At Time 1 an individual may be classified as a regular smoker, but at Time 2, if the individual does not report smoking the past 30 days and does not intend to smoke in the future, he or she would be classified as a non-smoker. Because backward movement is possible, the transition probability matrix for past 30-day use is a full probability matrix. Assuming two occasions of measurement, the 6 x 6 transition probability matrix for stages of smoking initiation would be conceptually similar to Figure 4, which shows a full transition probability matrix for the hypothesized stages of smoking, past 30-day use, where $\tau_{NCU|NCU}$ is the probability of membership in the No Cigarette Use stage at Time 2 conditional upon membership in the No Cigarette Use stage at Time 1.

Additionally, latent status was also assessed using lifetime smoking behavior, with the following questions: (1) *Have you ever tried cigarette smoking, even 1 or 2 puffs*? and (2) *About how many cigarettes have you smoked in your entire life*? Again, three questions were used to measure intent to smoke: (1) *Do you think you will ever smoke a cigarette anytime in the future*? (2*) If one of your best friends offered you a cigarette, would you smoke it*? and (3) *Do you have a best friend who smokes*?

In estimating latent transition parameters using lifetime smoking behavior to measure latent status, certain parameters of the transition probability matrix were constrained to zero, as depicted in Figure 5, to prevent backward movement through the implausible latent

statuses (e.g., someone who smoked more than 100 cigarettes in their entire life at Time 1 could not return to the experimentation stage at Time 2). Constraining certain τ parameters is common practice in testing substance abuse stage-sequential models (see Hyatt & Collins, 2000; Graham, Collins, Wugalter, Chung, & Hassen, 1991).

Two sets of ρ parameters are estimated in the model – one set is estimated for the static latent class and the other set is estimated for the dynamic latent status (Hyatt & Collins, 2000). However, because of the nature of the ρ parameters associated with the static latent classes (i.e. there is no measurement error associated with being aware/unaware of the TRU campaign, male/female, younger/older, or minority/non-minority) and because only one indicator was used to measure each of these latent classes, the parameters were constrained in the model to reflect the certainty of youth being in each of these groups. The ρ parameters estimated for the dynamic latent status variable represent the probability of a particular response to the items measuring cigarette use conditional on latent status membership (e.g., Preparatory Stage) and latent class membership (e.g., TRU campaign aware).

For each measurement approach the number of latent statuses used in the LTA was empirically determined using a latent class procedure in SAS. A series of latent class analyses (LCA) were conducted, extracting a maximum of six classes to a minimum of two classes for both lifetime cigarette use and current cigarette use. As the number of subsequent classes was decreased from six, the breakdown of response categories for the smoking behavior questions was modified to represent the smaller number of classes. A six latent class solution using current smoking had the following six response categories: 0 days, 1 or 2 days, 3 to 5 days, 6 to 9 days, 10 to 29 days, or all 30 days. Subsequently, a five latent class solution using current smoking had: 0 days, 1 or 2 days, 3 to 5 days, 6 to 9 days, 10 to 30

days. The response category breakdown for the smoking behavior questions are presented in Table 1 (lifetime use) and Table 2 (current use).

While the TRU campaign was designed to appeal to a diversity of youth, the campaign may have different effects across gender, age, and race. It is hypothesized that if the TRU campaign is effective it will have differential effects on these groups. Specifically, males will transition into the later stages of smoking initiation at a higher rate than females, older youth will transition into the later stages of smoking initiation at a higher rate than younger youth, and there will be no differences in the transition probabilities between minorities and non-minorities. Table 3 shows the number of youth who fall into each of the categories for these models.

RESULTS

Awareness of the TRU Campaign

Forty-five percent [95% *CI* 39.7, 50.4] of North Carolina youth had confirmed awareness of at least one TRU ad at T2. Youth who saw one or more TRU ads responded positively to the ads. Across all ads, over 90% of the youth seeing the ads reported that the ad they saw gave good reasons not to smoke, over 87% of youth reported that the ads were convincing and over 78% said the ads grabbed their attention. A much lower number of youth, ranging from 5% to 32%, reported talking to their friends about the ad they had seen. Figure 6 presents the breakdown of receptivity across each individual ad.

Campaign awareness was modeled using a logistic regression, with gender, race, and age as predictors. At T2, awareness of any TRU ad differed across races, with minority youth more likely to have seen any TRU ad than non-minority youth [*OR* 1.79; 95% *CI* 1.03, 3.10].

Model Selection – Lifetime Cigarette Use

While the original intent of utilizing the LTA method was to test transition probabilities across the six-stages of smoking initiation, the estimated model must first fit the data well. To that end, a series of latent class analyses were performed, extracting from two to six latent classes (statuses) from the data. In these analyses, the questions, *Have you ever tried cigarette smoking, even 1 or 2 puffs?* and *About how many cigarettes have you smoked in your entire life?* were combined to form one indicator with the following response categories: *Zero, One or more puffs but never a whole cigarette, 1 to 5 cigarettes, 6 to 25*

cigarettes, 26 to 99 cigarettes, and 100 cigarettes or more. As can be seen from the goodness of fit indices in Table 4, the model with the best (albeit poor) fit to the data involved a three latent status solution [G^2 (9) = 130.14, AIC = 142.14, BIC = 167.45]. The ρ parameters presented in Table 5 show that for the first latent status, there is a relatively low probability of responding "yes" to each of the questions, *Have you ever smoked a cigarette even one or two puffs?, Do you think you will ever smoke in the future*?, *If one of your best friends offered you a cigarette would you smoke it*?, and *Does one of your four best friends smoke*?. For the second latent status, there is also a relatively low probability of responding "yes" to the question, *Have you ever smoked a cigarette even one or two puffs*?, but there is a high probability of responding "yes" to the questions, *Do you think you will ever smoke in the future*?, *If one of your best friends offered you a cigarette would you smoke it*?, and *Does one of your four best friends smoke*?. For the third latent status, there is a high probability of responding "yes" to all four of the latent status indicators. Based on these results, it seems plausible that the first latent status represents a "Non-smoking Not Susceptible Stage," the second latent status represents a non-smoking susceptible or "Preparing Stage," and the third status represents a smoking or "Experimenting Stage."

Model 1 Effectiveness of the TRU Campaign Using Lifetime Cigarette Use

In this first model the effectiveness of the TRU campaign was evaluated using lifetime cigarette use as a latent status indicator. To illustrate the underlying logic of the LTA method, the response category cross-tabulations are presented in Tables 6 and 7. The overall model fit was G^2 (8165) = 2156.87.

The δ parameters presented in Table 8 indicate the probability of latent status membership, conditional on latent class at Time 2 and Time 3. Time 1 δ parameters are not

presented because of the nature of the data collection, i.e. Time 1 was “baseline” data before the TRU campaign was aired on television and therefore youth could not be aware of TRU at Time 1.The Preparing latent status had the highest expected membership for both youth who were aware and youth who were unaware of the TRU campaign at Time 2, with probabilities of .77 and .72, respectively. The Preparing latent status also had the highest expected membership at Time 3, with TRU aware youth having a .71 probability of being in this status and TRU unaware youth having a .67 probability. Membership in the Experimenting latent status at Time 2 was twice as likely for youth who were unaware of the TRU campaign than youth were aware of it, with the probability being .10 for TRU unaware youth and .05 for TRU aware youth. By T3 however, the gap between the two latent statuses had almost closed – the probability that TRU aware youth were in the Experimenting stage was .09, with TRU unaware youth having a .11 probability of being in the Experimenting stage.

Table 9 presents the transition probabilities from T1 to T2 and T2 to T3 for the TRU aware youth. Table 10 presents the transition probabilities for the TRU unaware youth. The transition probabilities were tested to determine whether or not they significantly differed across awareness of the TRU campaign. Constraining the probabilities to be equal across latent classes did not result in a significant change in the model fit [ΔG^2 (8) = 7.62, $p > .05$] suggesting that the transitions between latent statuses did not differ for youth who were aware of the TRU ads and youth who were not aware of the ads.

As can be seen in Table 11, there was a great deal of stability across time, as evidenced by high values on the diagonals of the transition matrices. From T1 to T2 there was a .78 probability of remaining in the Non-smoking stage and a .91 probability of remaining in the Preparing stage. From T2 to T3, youth in the Non-smoking stage had a .80

probability of remaining a non-smoker, while youth in the Preparing stage had a .91 probability of remaining in this stage. No youth in the Preparing stage transitioned into the Experimenting Stage. The only youth to transition into the Experimenting stage at either T2 or T3 were Non-smoking youth. The probability of a T1 non-smoker transitioning into experimentation at T2 was .08. A T2 non-smoker had a .12 probability of transitioning into the Experimenting stage at T3. Although no Preparing youth transitioned into the Experimenting stage, some did transition backwards into the Non-smoking stage. The probability that a youth who was in the Preparing stage at T1 transitioned into the Non-smoking stage at T2 was .09 and the probability of a youth in the Preparing stage at T2 transitioning backwards at T3 to the Non-smoking stage was .10.

Based on the above findings, the TRU campaign has not yet had an effect on the rates at which youth progress through the stages of smoking initiation. Therefore, the next three models will not be examining the contextual effects of the campaign, but simply whether or not there are demographic differences in the rate of progression through these three stages of smoking initiation. As the ρ parameters were always constrained to be equal across time and latent class, they will not be presented in subsequent analyses.

Model 2 Gender Differences in Smoking Initiation Rates Using Lifetime Use of Cigarettes

The second analysis tested whether or not males and females transition through the stages of smoking initiation at the same rate. The overall model fit was G^2 (8165) = 2172.47. The δ parameters are presented in Table 12. The Preparing stage had the highest expected membership for both males and females across time. The probability that a male was in the Preparing stage at T1 was .78, at T2 the probability was .71 and at T3 the probability was .65. For females, the probability of being in the Preparing stage at T1 was .82, at T2 the

probability was .77 and at T3 the probability was .65. While females had a slightly higher probability of being in the Preparing stage across time, males were slightly more likely to be in the Non-smoking stage across time. At T1, the probability of being in the Non-smoking stage for males was .16 versus .12 for females. At T2 it was .21 for males and .15 for females. The T3 probabilities for the Non-smoking stage were .24 for males and .19 for females. Males and females, however, seemed to be equally likely to be in the Experimenting stage across time. At T1, both males and females had a .06 probability of being in the Experimenting stage. The probability was .08 for males and .07 for females at T2 and at T3 the probabilities were .10 for males and .09 for females.

The transition probabilities separated by gender are presented in Tables 13 and 14. Constraining the probabilities to be equal across gender did not result in a significant change in the model fit [ΔG^2 (8) = 2.63, $p > .05$] suggesting that the transitions between latent statuses did not differ among males and females. The results in Table 15 indicate that while a lot of youth remained in the same stage across time, there was also some backwards movement across the stages. Youth in the Preparing stage transitioned backwards into the Non-smoking stage with a transition probability of .09 from T1 to T2 and T2 to T3. Non-smoking youth had a .80 probability of remaining stable from T1 to T2 and a .81 probability of remaining stable from T2 to T3. From T1 to T2, the probability of a youth remaining in the Preparing stage was .91 and the probability of a youth remaining in the Preparing stage from T2 to T3 was also .91. The only youth to transition into the Experimenting stage from both T1 to T2 and T2 to T3 were youth in the Non-smoking stage. The probability of a T1 non-smoker transitioning to the Experimenting stage at T2 was .09 and the probability of a T2 non-smoker transitioning to the Experimenting stage at T3 was .12.

Model 3 Age Differences in Smoking Initiation Rates Using Lifetime Use of Cigarettes

This analysis investigated whether or not there were differences in the transition rates among younger (11-14 years old) and older (15 – 17 years old) youth. Overall model fit was G^2 (8165) = 2211.97. The δ parameters are presented in Table16. Although the Preparing status had the highest expected membership for both younger and older across time, younger youth had a higher likelihood of being in this status at each time than did older youth. The difference in probabilities ranged from .19 to .24. Older youth were more than twice as likely as younger youth to be in the Experimenting status across all three time periods. At T1 younger youth had a .04 probability of being in the Experimenting stage with older youth having a .10 probability. The probability was still .04 for younger youth at T2, but the probability of an older youth being in the Experimenting stage increased to .13. At T3 younger youth had a .06 probability of being in the Experimenting stage, versus a .17 probability for older youth. Older youth also had higher expected probabilities in the Non-smoking stage across all three time points. Older youth were more than twice as likely to be in this stage, with a probability of .23 and .28 at T1 and T2, respectively, compared with .09 and .13 for younger youth. While older youth still had a higher probability of being in the Non-smoking stage at T3, the difference was not quite as pronounced as previous times, with older you having of .28 probability of being in this stage at T3 and younger youth having a .17 probability.

Tables 17 and 18 present the transition probabilities. It does not appear that the transitions between latent statuses differ among younger and older [ΔG^2 (8) = 8.42, $p > .05$]. From T1 to T2 youth remained relatively stable, with Non-smoking youth having a .85 probability of remaining there and Preparing youth having .92 probability of remaining in the

Preparing stage (see Table 19). The probability of a youth remaining in the Non-smoking stage from T2 to T3 was .81 and the probability of a youth remaining in the Preparing stage was .91. The only youth to transition into the Experimenting stage were youth in the Non-smoking stage. The probability of a T1 non-smoker transitioning to the Experimenting stage at T2 was .09 and the probability of a T2 non-smoker transitioning to the Experimenting stage at T3 was .12. Youth in the Preparing stage also transitioned backwards into the Non-smoking stage from T1 to T2 ($\tau = .08$) and T2 to T3 ($\tau = .09$).

Model 4 Race Differences in Smoking Initiation Rates Using Lifetime Use of Cigarettes

The fourth analysis examined the transition probabilities for race differences. Overall model fit was G^2 (8165) = 2101.62. As can be seen in Table 20, the Preparing status had the highest expected membership for both minority and non-minority youth across time. Across the three time points, minority youth had a .83, .74, and .76 probability of being in the Preparing stage. For non-minority youth the probabilities were .79, .74, and .68. At T1 and T3, non-minority youth had a .05 higher expected membership in the Non-smoking stage than minority youth, but at T2 the membership probability of being a non-smoker was .19 for minorities and .18 for non-minorities. Minority youth had a constant probability of .07 of being in the Experimenting stage across time, while non-minority youth had a .06 probability at T1, a .08 probability at T2, and a .10 probability at T3.

The transition probabilities for minority youth are presented in Table 21 and for non-minority youth the transition probabilities are presented in Table 22. No differences were found among the transition probabilities across race [ΔG^2 (8) = 5.46, $p > .05$]. While some youth in the Preparing stage transitioned backwards into the Non-smoking stage from T1 to T2 ($\tau = .08$) and T2 to T3 ($\tau = .09$), there was also a great deal of stability across time (see

Table 23). The probability of a non-smoking youth remaining in this stage was .80 from T1 to T2 and .81 from T2 to T3. The probability of a youth remaining in the Preparing stage was .91 for both T1 to T2 and T2 to T3. Some youth in the Non-smoking stage exhibited forward movement to the Experimenting stage, with a T1 Non-smoking youth having a transition probability of .09 to Experimenting at T2 and a T2 Non-smoking youth having a transition probability of .12 to Experimenting.

Model Selection – Current Cigarette Use

As was the case with lifetime cigarette use, a series of latent class analyses were performed, extracting from two to six latent classes (statuses), to find the best-fitting model for the data. The goodness of fit indices for models ranging from two to six latent classes (statuses) are presented in Table 24. This time, with past 30 day use being an indicator of latent status, only a two status solution seemed appropriate [G^2 (9) = 192.93, AIC = 202.93, BIC = 224.03]. The ρ parameters presented in Table 25 show that for the first latent status, there is a low probability of responding "yes" to each of the questions, *Have you ever smoked a cigarette even one or two puffs*?, *If one of your best friends offered you a cigarette would you smoke it*?, and *Does one of your four best friends smoke*?. The probability of responding "yes' to the question *Do you think you will ever smoke in the future*? is substantially higher (ρ =.33), indicating a moderate amount of measurement error for this indicator. Conversely, for the second latent status, there is a high probability of responding "yes" to three of the four latent status indicators: *Have you ever smoked a cigarette even one or two puffs*?, *If one of your best friends offered you a cigarette would you smoke it*?, and *Does one of your four best friends smoke?,* but the probability of responding "yes" to the question, Do you think you will ever smoke in the future? is substantially lower than the other indicators (ρ =.67). These

results suggest that the first latent status represents a “Non-smoking” stage, while the second latent status represents an “Experimenting” stage.

Model 5 Effectiveness of the TRU Campaign Using Current Cigarette Use

This model investigated whether or not the TRU campaign had an effect on the rates at which youth transitioned through two latent statuses, Non-smoking and Experimenting. Overall model fit was G^2 (8175) = 1681.02. The probability of latent status membership, conditional on campaign awareness at T2 and T3 are presented in Table 26. The Non-smoking latent status had the highest probability of expected membership, regardless of TRU campaign awareness. The expected membership for TRU aware youth in the Non-smoking status was .92 at T2 and .93 at T3. For TRU unaware youth it was .90 at both times.

Table 27 presents the transition probabilities for the TRU aware youth. The transition probabilities for the TRU unaware youth are presented in Table 28. The transitions between Non-smoking and Experimenting did not differ between youth who were aware of the TRU ads and youth who were not aware of the ads [ΔG^2 (4) = 2.37, $p > .05$]. The transition probabilities in Table 29 show that while there was stability in latent status from T1 to T2, there was substantial backward movement from T2 to T3. From T1 to T2 all youth who were in the Experimenting stage at T1 remained there and the probability of remaining in the Non-smoking stage was .93. The non-smokers also showed stability from T2 to T3, with a transition probability of .97 for remaining in the Non-smoking stage. However, youth in the Experimenting stage at T2 had a .32 probability of transitioning backward at T3 to the Non-smoking stage. From T1 to T2, the rate of transition from Non-smoking to Experimenting was .07 and was only .03 from T2 to T3.

Model 6 Gender Differences in Smoking Initiation Rates Using Current Use of Cigarettes

This model tested for gender differences in transition rates. The overall model fit is G^2 (8175) = 1694.46. The δ parameters presented in Table 30 show that the majority of youth were in the Non-smoking status across all three time points. The probability of expected membership for males to be in the Non-smoking status was .96 at T1, and .88 at T2 and T3. For Females, the probability of being in the Non-smoking status was .98 at T1, .93 at T2, and .95 at T3. Males had a slightly higher expected membership in the Experimenting status, which increased over time. At T1, the probability of males being in the Experimenting status was .04 compared to a probability of .02 for females. At T2, the comparison was .12 for males and .07 for females, while it was .12 for males and .06 for females at T3.

Tables 31 and 32 present the transition probabilities for males and females. The transition probabilities were not significantly different across gender [ΔG^2 (4) = 2.37, $p >$ .05]. As can be seen in Table 33, all youth who were in the Experimenting stage at T1 remained there at T2, but from T2 to T3 the probability of remaining in the Experimenting stage dropped to τ = .68. Thus, the probability of transitioning backwards from the Experimenting stage to the Non-smoking stage was τ = .32. Non-smoking youth remained quite stable, with the Non-smoking youth only having a .07 probability and a .03 probability of transitioning into the Experimenting Stage from T1 to T2 and T2 to T3, respectively.

Model 7 Age Differences in Smoking Initiation Rates Using Current Use of Cigarettes

This model examined whether younger and older youth have different transition rates through these two stages of smoking initiation. The δ parameters are presented in Table 34. At all three time points, the Non-smoking latent status had the highest expected membership, regardless of age. The expected membership of younger youth in the Non-smoking latent

status across time was 1.00 at T1, .97 at T2 and .96 at T3. For older youth, the expected membership in the Non-smoking status was .92 at T1, .79 at T2, and .82 at T3. Older youth did, however, have substantially higher rates in the Experimenting status. At T1, there were no younger youth in the Experimenting status, but the probability of older youth being in this status was .08. By T2, the probability of an older youth being in the Experimenting status was seven times more than that of a younger youth, δ=.21 and δ=.03, respectively. By T3, the probability of younger youth being in the Experimenting status was .04, with .older youth having a .18 probability of being in this stage.

The transition probabilities for younger youth are presented in Table 35 and Table 36 presents the transition probabilities for older youth. There were significant differences in the transitions [ΔG^2 (4) = 21.71, $p < .05$]. The results indicate that older youth are transitioning into the Experimenting stage at a higher probability than younger youth from T1 to T2. The probability of a Non-smoking older youth experimenting with cigarettes by T2 was .14, but the probability of a Non-smoking younger youth Experimenting was only .03. Additionally, older youth are less likely to transition out of the Experimenting stage by T3. The probability of being in the Experimenting stage at T3 given that the youth was Experimenting at T2 was .73 for older youth and.34 for younger youth.

Model 8 Race Differences in Smoking Initiation Rates Using Current Use of Cigarettes

The eighth and final model tested examined racial differences in the transition probabilities between the Non-smoking and Experimenting stage. The overall model fit was G^2 (8175) = 1646.40. The δ parameters are presented in Table 37. The majority of youth were in the Non-smoking status across all three time points. Minority youth had a 1.0 expected probability of being in the Non-smoking status at T1, a .97 probability at T2, and a

.96 probability at T3. Non-minority youth had a .97 expected probability of being in the Non-smoking status at T1, a .89 probability at T2, and a .90 probability at T3. However, at T1, T2 and T3, non-minority youth were more likely to be in the Experimenting stage than minority youth. Non-minority youth had a .02 probability of being in the Experimenting stage at T1, while minority youth had a .00 probability of being in this stage. The difference between minority and non-minority youth was .08 at T2 and .06 at T3.

Tables 38 and 39 present the transition probabilities for minorities and non-minorities. No significant differences were found among the probabilities [ΔG^2 (4) = 2.87, p > .05] suggesting that minorities and non-minorities transition between Non-smoking and Experimenting at approximately the same rate. The transition probabilities in Table 40 show that all youth who were in the Experimenting stage at T1 remained there at T2. The probability of remaining in the Non-smoking stage from T1 to T2 was .93. Non-smoking youth also showed stability from T2 to T3, with a transition probability of .97. Youth in the Experimenting stage at T2 had a .32 probability of transitioning backward at T3 to the Non-smoking stage. From T1 to T2, the rate of transition from Non-smoking to Experimenting was .07 and was only .03 from T2 to T3.

DISCUSSION

There are three unique contributions of this research. First, this research assesses the awareness of a mass media anti-smoking campaign for the largest tobacco-producing state in the country. Second, latent transition analysis is employed to describe the effectiveness of the campaign. Third, this research also measures cigarette use using two different approaches: past 30-day use and lifetime use.

Awareness of the TRU Campaign

As North Carolina continues to use state-funded money to support its commitment to making teenage tobacco use prevention a priority in the state, it is important that the media campaign is striving to reach its target audience of NC youth, ages 11 – 17 years old and that youth are responding well to the ads. Overall, TRU campaign awareness was moderate among youth, with 45% of NC youth having confirmed awareness. What was particularly surprising was that minority youth were 79% more likely to have confirmed awareness of the ads than non-minority youth. The TRU ads were developed based in part on information from an unpublished report on best practices in youth tobacco prevention ads compiled by the University of North Carolina School of Medicine's Tobacco Prevention and Evaluation Program based on a literature review, published reports and interviews with state and national experts in tobacco countermarketing campaigns. The report concluded that the ads should feature multi-cultural, every-day North Carolina citizens in order to appeal to a diversity of youth. While the *Anna* and *Brad* ads feature Caucasian teenagers, the *Jacobi* ad

features a young African American man and the *Travelogue* ad features several youth of various races. In fact, during focus group testing the *Travelogue* ad was repeatedly favored by North Carolina youth because of the variety of youth appearing in the ad (Summerlin-Long et al., 2007). As the evaluation of the TRU campaign continues, and new series of ads continue to air on television, it will be important to follow up on this finding. If minority youth have consistently higher levels of awareness of the TRU campaign, then the intended effects of the campaign may be diminished for non-minority youth.

For the most part, ad receptivity among those who saw one or more TRU ads was quite positive. Across all four ads, at least 90% of the youth who had seen the ads found them to be convincing and at least 92% found that the ads gave good reasons not to smoke. Ninety-four percent of youth who had seen *Travelogue* found it to be attention grabbing; however the other ads were found to have lower attention-grabbing rates, with 78 – 85% of youth responding that *Anna, Jacobi*, and *Brad* were attention grabbing. There was a wide range in the rates at which youth responded that they had talked to their friends about the ads. The *Travelogue* ad had a high "chat value" rate of 32%, but the *Jacobi* ad had a low "chat value" of 5%. Overall, that the ads appear to be well received by youth highlights the capacity the TRU campaign has to spread to other youth through social networking if the ads can consistently reach higher levels of "chat value," like *Travelogue*.

It is also encouraging that the ads were well received without the use of an industry manipulation theme. Many successful state countermarketing campaigns have utilized industry manipulation themes, including the Florida "truth" campaign reviewed earlier. These themes show how the tobacco industry uses deceptive marketing practices that target youth, most often driven by profits. While such themes have shown success, they come at a

political risk. For instance in Florida, despite the success of their anti-industry campaign, the acting director of the tobacco prevention program was forced to resign, with the intention of shifting the focus to an education and cessation campaign. The Florida program budget was then severely cut the year after its inception, resulting in discontinuation of the media program (Givel & Glantz, 2000). Arizona's campaign also came under attack from the tobacco industry and was banned from using anti-industry messages in their campaign (Friend & Levy, 2002). It is unlikely that, even if an anti-industry theme had been well received by North Carolina youth, it would have been able to sustain political support and funding over time.

Several campaigns have utilized themes other than industry manipulation. One review found that themes of second-hand smoke, showing a smoker as a negative role model, teaching refusal skills, and deceptive marketing practices should be considered for state-based campaigns (Pechmann & Reibling, 2000). Ad campaigns that address the negative and serious health effects of smoking have also shown some success (Wakefield et al., 2003; McKenna, Gutierrez, & McCall, 2000). Other studies also indicate that youth respond positively to ads that feature a combination of both serious health consequences from smoking and graphic depictions that evoke a negative emotional response (Wakefield et al., 2003; White, Tan, Wakefield & Hill, 2003; Terry-McElrath et al., 2005). As North Carolina youth responded quite positively to the TRU ads, the results from the current research provide further evidence that youth respond well to the utilization of the serious health consequences of tobacco use theme in anti-tobacco mass media campaigns.

Furthermore, despite the evidence that supports the receptivity of a serious health consequences theme in media campaigns, no published data exists about how to design,

carry-out and sustain a state-based countermarketing campaign in a traditional tobacco-producing state. Other tobacco-producing states interested in establishing an anti-tobacco media campaign may find the current research particularly useful, as it provides information on how the ads were created, as well as a detailed description of the surveillance tool, i.e. the longitudinal telephone survey, used to monitor ad awareness and receptivity. This second point is particularly important given that a recommendation made to all public health mass media campaigns is to conduct some sort of evaluation, particularly a process evaluation (Noar, 2006).

Effectiveness of the TRU Campaign using Latent Transition Analysis

The intended use of LTA for this research was to not only describe the effects the TRU media campaign has on the probability of non-smokers becoming smokers, but to also describe the effects the campaign may have on slowing down the progression of youth who already smoke, i.e., initial trying to regular use. Unfortunately, limitations in the data prevented this second goal of being accomplished.

Research has shown that telephone surveys typically yield lower estimates than school-based, self-administered surveys (Currivan, Nyman, Turner, & Biener, 2004). Despite the fact that several questions were included in the survey on whether or not the youth was alone when answering the questions and whether or not his or her answers would have been different if he/she had been alone, it is still very likely that some of the youth being interviewed, particularly younger youth, may be uncomfortable answering the questions, and thus under-reporting their behaviors. A comparison of the data used in this research with estimates from a statewide youth tobacco survey indicates large discrepancies in cigarette use rates. Baseline data for this research was collected spring 2004 and had a lifetime cigarette

use rate of 12.7% and a 2.8% rate for current cigarette use. Data from the state, collected in the fall of 2003, showed the rate of lifetime cigarette use was 59.6% for high school students and 29.5% for middle school students, with 27.3% of high school students currently using cigarettes and 9.3% of middle school students currently using cigarettes (North Carolina Tobacco Prevention & Control Branch, 2003). Time 3 data collection for the current research took place in the winter of 2006 and showed lifetime cigarette use rates of 25.5% and current cigarette use rates of 8.8%. State data, collected in the fall of 2005, showed that 54.3% of high school students and 25.8% of middle school students had ever used cigarettes, with 20.3% of high school students reporting current cigarette use and 5.8% of middle school students reporting current use. While there was an expectation that the rates of cigarette use from the telephone survey would be lower, it was not expected that the rates from T2 to T3 of the telephone survey would show virtually no increase in current use rates, and that lifetime cigarette use rates increased at almost the same rate from T2 to T3 as from T1 to T2, especially considering that almost an entire year had elapsed between data collection from T2 to T3 and only six months elapsed between T1 and T2.

In addition to telephone surveys yielding lower estimates than other survey measures of cigarette smoking, another factor that could have contributed to the lower smoking prevalence rates in the current research is that multiple school and community coalitions are currently at work in North Carolina to prevent youth from using tobacco products. Given the current rates of cigarette smoking in North Carolina presented above, youth tobacco use is at an historic low in the state. While the entire state has been showing a downward trend since the 1990's, it was unanticipated that results from the most recent youth tobacco survey would have such a sharp decline from the previous years.

Because of smoking rates in the data, it was inappropriate to fit a model that had six stages of smoking initiation for both lifetime and current use. Thus, LTA could only be employed to test the effectiveness of the TRU campaign at keeping non-smokers from becoming susceptible or experimenting with cigarettes. The results from this research indicate that while the campaign is reaching its target audience and youth are responding well to the ads, the TRU campaign has so far not been an effective deterrent at keeping youth from becoming susceptible or experimenting. However, research indicates that it often takes time for a countermarketing media campaign to have a significant effect on youth tobacco consumption and the effectiveness of the campaign is also tied to a continuous presence of the campaign and a high dose of the campaign (Farrelly et al., 2005).

Previous research has indicated that the Florida "truth" anti-smoking campaign and the Massachusetts anti-smoking campaign have been successful at keeping youth from initiating with cigarettes (Sly, Hopkins, Trapido & Ray, 2001; Sly, Trapido, & Ray, 2002; Siegel & Biener, 2000). The Florida "truth" campaign was able to demonstrate that only after six months, youth who were aware of these ads had a lower risk of smoking initiation than youth who did not have awareness. However, it is important to note that the Florida "truth" campaign was funded at $26.5 million in its first year and that the confirmed awareness rate for this campaign was close to 90% (Sly, Hopkins, Trapido & Ray, 2001). The Florida "truth" campaign also utilized an industry manipulation theme in the ads, which highlights the manipulative and profit-driven practices of the tobacco industry. In contrast, the TRU campaign was funded at $2.6 million in its first year, achieved an awareness rate of 45%, and utilized a serious health consequences theme because an industry manipulation theme was thought to be politically infeasible in a tobacco-producing state. Therefore, it is possible that

with more time and increased funding, the TRU campaign may still become an effective deterrent for the initiation of tobacco use.

Some of the limitations of the TRU campaign, most notably lower funding and awareness levels, are not limitations for other anti-tobacco media campaigns. If these campaigns, some of which have already been shown to be effective, utilized LTA to provide evidence for slower progression to the later stages of smoking initiation, then these campaigns could face a more secure future (and more secure funding) as a key component of a state's tobacco control plan.

There are, however, several limitations that should be noted when using latent transition analysis for similar research. In LTA, the exogenous predictor has to be measured toward the beginning of data collection. In this research, the first flight of the TRU campaign immediately followed T1 data collection. Because the time lag between T1 data collection and exposure to the campaign was minimal, any changes that occurred in the outcome variable (i.e. smoking behavior) could still potentially be attributed to awareness of the campaign. Additionally, as the LTA model becomes more complex (e.g. more indicators or time points), there is likely to be sparse cells in the contingency table which could result in an inaccurate distribution for the G^2 statistic. Currently, there is no alternative measure to assess model fit. However, a good rule of thumb for LTA models is that a good-fitting model has a G^2 lower than its degrees of freedom (Hyatt & Collins, 2000).

Another limitation for LTA exists in the context of hypothesis testing. Currently, there is no available software that can accurately calculate the standard errors of the various LTA parameters when complex survey data is utilized. Overall group differences can be tested using the change in G^2 values; however differences in individual parameters cannot be

tested. There have been recent advances in LTA hypothesis testing that utilizes data augmentation to estimate standard errors (see Lanza, Collins, Schafer, & Flaherty, 2005), but this method is limited to non-survey data.

Finally, with this specific research it should be noted that the static latent classes (ρ parameters) were constrained to have no measurement error in each of the LTA models. As gender, age, and race only have one indicator each to measure them, these variables truly do not have measurement error. However, one could argue that awareness of the TRU campaign does potentially have measurement error associated with it. The decision not to include measurement error for this latent class was made again based on having only one indicator from utilizing a confirmed awareness approach utilized in this research. Using confirmed awareness created certainty that the respondents coded as "aware" had actually seen the TRU ads, especially given the high level of agreement between the two independent judges.

Demographic Differences in Cigarette Smoking Initiation

As the TRU campaign has yet to be shown effective at preventing youth from initiating cigarette use, demographic differences were then investigated to examine differences in transition rates. The only difference to emerge was between younger and older youth in the two-stage model using current cigarette use as an indicator. The finding that older youth were more likely to transition into the experimenting stage by T2 and less likely to transition out of this stage from T2 to T3 is consistent with previous research. Several studies have shown a positive relationship between age and cigarette smoking initiation (Botvin, Baker, & Goldberg, 1992; Dusenbery, Kerner, & Baker, 1992; Camp, Klesges, & Relyea, 1993; Alexander et al., 1983; McNeil et al., 1989). Additional studies have also indicated that age of onset of experimenting with cigarettes is predictive of regular smoking

(Escobedo, Marcus, Holtzman, & Giovino, 1993) and a decreased likelihood of quitting smoking (Breslau & Peterson, 1996).

The finding that males and females do not have significant differences in the transition rates of smoking initiation is, for the most part, consistent with previous research. The 1994 U.S. Surgeon General's report on preventing tobacco use among young people indicates that while higher rates of tobacco use had previously been found among males, the gender gap in prevalence rates had seemingly disappeared in more recent times (U.S. Department of Health & Human Services, 1994). However, there have been some studies that indicate that the trend in tobacco use has reversed and that females now have a higher incidence of tobacco use over males. In two separate reviews of predictors related to adolescent cigarette smoking, being female showed an increased risk of cigarette smoking initiation (Conrad, Flay, & Hill, 1992; Tyas & Pederson, 1998), but only in some studies. The review by Tyas and Pederson did point out that often times the rates of smoking among males and females were similar and that many studies reported non-significant gender differences. The results from this study provide more evidence that the gender gap has disappeared and that males and females are equally likely to experiment with cigarettes.

There were also no significant differences found in the transition rates among minority and non-minority youth. Research has consistently shown that African-American youth have significantly lower initiation rates of smoking and significantly lower current smoking rates than both Caucasian and Hispanic youth (Tyas & Pederson, 1998). There are several possible reasons why the current research failed to find any racial differences. First, and perhaps most importantly, only a relatively small proportion of the sample was minority – 16% minority versus 84% non-minority. Also, the minority youth included anyone who did

not identify themselves as white, which included Hispanics and Native Americans, in addition to African Americans. The classification of all these youth as minority could have suppressed any true racial differences in the data. The lower estimates of smoking rates could also have had played a role in failing to find significant racial differences in smoking initiation rates. Perhaps if the smoking rates had been closer to the estimates projected from North Carolina's state tobacco survey data, a difference could have emerged between minority and non-minority youth.

Comparison of Measurement Approaches to Cigarette Use

The third intended contribution of this research was to determine whether the effectiveness of an anti-smoking media campaign is tied to a specific form of measurement for cigarette smoking initiation. Previous evaluations of statewide media campaigns (Siegel & Biener, 2000; Sly et al., 2001, Sly et al., 2001) have been inconsistent in which measurement approach has the most utility. Evaluations of the Florida "truth" campaign used past 30-day use as their chosen measurement of cigarette use and showed that the campaign had a significant effect of keeping youth from initiating cigarette use. Evaluation of the Massachusetts campaign, however, used lifetime cigarette use and showed that the campaign was successful at preventing younger youth from experimenting with cigarettes. A limitation of both forms of measurement is that cigarette smoking is dichotomized as a "Yes/No" variable, despite the idea that youth smoking initiation is a developmental, stage-sequential process. It was this limitation that prompted the conceptualization of the current research in the first place. If youth smoking truly is a stage-sequential process and if a media campaign is designed to prevent youth from initiating smoking, then a data analytic strategy that incorporates movement through the stages should be employed to test the effectiveness of the

campaign. However, the analysis is tied to the data and the data in this research did not support a model of smoking initiation that included six stages. For lifetime cigarette use, three stages (Non-smoking, Preparing, and Experimenting) could be extracted from the data and for current cigarette use, only two stages (Non-smoking and Smoking) could be extracted.

Nevertheless, with a three-stage solution for lifetime cigarette use, there was potential for evaluating the effectiveness of the TRU campaign across more than just a dichotomy of smoking initiation. The inclusion of a second stage of smoking, a preparing stage, could highlight whether the campaign is effective at preventing non-smokers from transitioning into the preparing stage, preparers from transitioning in to experimenters, or non-smokers from transitioning directly into experimenting with cigarettes. Unfortunately, the results from the current study did not indicate that the TRU campaign was effective at preventing youth from any of these transitions. Furthermore, no demographic differences were found in the latent transition analyses utilizing this three stage model.

Based on the current research, one might hypothesize that perhaps the reason that smoking initiation is so often dichotomized and analyzed using logistic regression is simply because in most data collected involving teenage smoking rates lack the variability to include anything more than two stages (non-smoker/smoker) in the analysis. Yet, it is interesting to note that the evaluations of the Florida "truth" campaign included two separate sets of logistic regressions – one to model smoking uptake rates from being a non-smoker to any use in the past 30 days and one to model smoking uptakes rates from being a non-smoker to being an established user in the past 30 days (smoking on six or more days in the past 30 days and smoking more than five cigarettes on each of those days). As there are least two

different stages of smoking initiation in the Florida evaluation data, it would seem that this is the very sort of data that would be benefit from using an LTA approach. Additional research that includes a multi-stage process of smoking initiation used a “bogus pipeline” saliva sampling procedure to increase the validity of self-reported smoking behavior (Stern, Prochaska, Velicer, & Elder, 1987). It would appear then that with the appropriate data, LTA could provide more insight into the data than logistic regression and should not be discounted because of its failed utility in the current research.

CONCLUSION

With tobacco use being the leading cause of preventable death in the United States, public health leaders are continually working to reduce the rates of tobacco use and improve health outcomes. Although the rate of teenage tobacco use has been steadily declining since the mid-1990's, the decline has recently slowed down. The Teen Tobacco Use Prevention and Cessation Initiative was created in North Carolina in 2001 to help prevent youth from using tobacco products. One of the key components of this initiative is Tobacco.Reality.Unfiltered. or TRU, a statewide, youth-focused anti-tobacco mass media campaign. The purpose of the current research was to evaluate the campaign on two levels: 1) To assess awareness levels of the campaign and reactions to the various ads among North Carolina youth, ages 11 – 17 and 2) To determine the effectiveness of the campaign at keeping youth from initiating cigarette use.

This research provides several contributions to the literature on evaluations of anti-tobacco mass media campaigns. First of all, no published data exists on anti-tobacco mass media campaigns from tobacco-producing states. This research may provide insight to other tobacco-producing states interested in developing and evaluating their own media campaigns. Secondly, it uses latent transition analysis to evaluate the effectiveness of the TRU campaign. The majority of published research on state-sponsored anti-smoking media campaigns uses logistic regression. Researchers interested in answering the question about whether or not a media campaign prevents youth from smoking may be interested in an analysis that can

provide insight into transitions of the different stages of smoking initiation instead of transitions from a non-smoking stage to a smoking stage. Finally, the research utilizes two forms of measurement of smoking initiation, lifetime use and past 30-day use, in the same analysis. Researchers trying to decide on one method over the other may be interested in a direct comparison of the two.

Investigators of youth cigarette smoking initiation may also find this research relevant to their field. The results provide evidence for an age effect in smoking, i.e. older youth are more likely to experiment with cigarettes. The results also provide evidence that the gender gap has closed when it comes to cigarette smoking rates and males and females are experimenting with cigarettes at equal rates.

Despite the recent public health gains that have been made regarding smoking in North Carolina and the rest of the country, there is still a long way to go in the years ahead. While the TRU campaign has yet to shown as effective, more time, increased funds, and a continuous presence on television (all of which are occurring) may eventually point to a different conclusion.

Table 1 Lifetime smoking behavior response categories for latent class analyses

Number of latent classes	Lifetime Use of Cigarettes Response Category Breakdown
6	0 cigarettes 1 or 2 puffs but never a whole cigarette 1 to 5 cigarettes 6 to 25 cigarettes 26 cigarettes or more
5	0 cigarettes 1 or 2 puffs but never a whole cigarette 1 to 5 cigarettes 6 cigarettes or more
4	0 cigarettes 1 or 2 puffs but never a whole cigarette 1 cigarette or more
3	0 cigarettes 1 or 2 puffs of a cigarette or more
2	0 cigarettes 1 or 2 puffs of a cigarette or more

Note. In the telephone survey the lifetime use of cigarettes indicator was phrased as, "*About how many cigarettes have you smoked in your entire life*?"

Table 2 Current smoking behavior response categories for latent class analyses

Number of latent classes	Lifetime Use of Cigarettes Response Category Breakdown
6	0 days 1 to 2 days 3 to 9 days 10 to 29 days All 30 days
5	0 days 1 to 2 days 3 to 9 days 10 to 30 days
4	0 days 1 to 2 days 3 to 30 days
3	0 days 1 to 30 days
2	0 days 1 to 30 days

Note. In the telephone survey the current use of cigarettes indicator was phrased as, *"During the last 30 days, on how many days did you smoke cigarettes, even 1 or 2 puffs*?"

Table 3 Awareness of the TRU media campaign by gender, age, and race

	Aware of TRU Campaign	No Awareness of TRU Campaign
Males	104	146
Females	105	147
11 to 14 years old	141	176
15 to 17 years old	68	117
Non-minority	169	254
Minority	40	39

Note. The total $N = 502$ represents survey respondents who participated in all three waves of data collection.

Table 4 Lifetime Cigarette Use Model Selection

Number of Statuses	df	Fit Indices G^2	AIC	BIC
6	30	245.60	263.60	301.56
5	23	239.49	255.49	289.24
4	16	251.51	265.51	295.04
3	9	130.14	142.14	167.45
2	10	182.71	192.71	213.81

Table 5 ρ parameters: Probabilities for responding yes

Latent Status	Tried Cigarettes	Smoke in the Future	Smoke if Best Friend Offered	Have Best Friend who Smokes
Non-smoking	.12	.23	.05	.23
Preparing	.12	.77	.95	.77
Smoking	.88	.77	.95	.77

Note. All parameters were constrained to be equal across time and latent class.

Table 6 Time 3 Response Frequencies for TRU Aware Youth

TRU Aware	Tried Cigarettes Yes	Smoke in the Future Yes	Friend Offered Yes	Friend Yes	4
				Friend No	14
			Friend Offered No	Friend Yes	3
				Friend No	1
		Smoke in the Future No	Friend Offered Yes	Friend Yes	0
				Friend No	1
			Friend Offered No	Friend Yes	5
				Friend No	3
	Tried Cigarettes No	Smoke in the Future Yes	Friend Offered Yes	Friend Yes	17
				Friend No	4
			Friend Offered No	Friend Yes	30
				Friend No	5
		Smoke in the Future No	Friend Offered Yes	Friend Yes	0
				Friend No	1
			Friend Offered No	Friend Yes	102
				Friend No	19

Table 7 Time 3 Response Frequencies for TRU Unaware Youth

TRU Unaware	Tried Cigarettes Yes	Smoke in the Future Yes	Friend Offered Yes	Friend Yes	6
				Friend No	22
			Friend Offered No	Friend Yes	4
				Friend No	8
		Smoke in the Future No	Friend Offered Yes	Friend Yes	1
				Friend No	0
			Friend Offered No	Friend Yes	13
				Friend No	7
	Tried Cigarettes No	Smoke in the Future Yes	Friend Offered Yes	Friend Yes	16
				Friend No	10
			Friend Offered No	Friend Yes	29
				Friend No	15
		Smoke in the Future No	Friend Offered Yes	Friend Yes	3
				Friend No	1
			Friend Offered No	Friend Yes	133
				Friend No	25

Table 8 δ Parameters: Probability of latent status membership across awareness of campaign

Latent Status	Time 2	Time 3
Non-smoking		
TRU Aware	.18	.21
TRU Unaware	.18	.22
Preparing		
TRU Aware	.77	.71
TRU Unaware	.72	.67
Smoking		
TRU Aware	.05	.09
TRU Unaware	.10	.11

Table 9 τ parameters: Transitions across time for TRU aware youth

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.92	.00	.08
	Preparing	.11	.89	.00
	Experimenting	.00	.00	1.00
		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.77	.03	.20
	Preparing	.09	.91	.00
	Experimenting	.00	.00	1.00

Table 10 τ parameters: Transitions across time for TRU unaware youth

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.74	.18	.09
	Preparing	.07	.92	.02
	Experimenting	.00	.00	1.00

		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.83	.12	.04
	Preparing	.10	.90	.02
	Experimenting	.00	.00	1.00

Table 11 τ parameters: Transitions across time for all TRU Aware and TRU Unaware youth with equality constraints imposed

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.78	.14	.08
	Preparing	.09	.91	.00
	Experimenting	.00	.00	1.00

		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.80	.09	.12
	Preparing	.10	.91	.00
	Experimenting	.00	.00	1.00

Table 12 δ Parameters: Probability of latent status membership across gender

Latent Status	Time 1	Time 2	Time 3
Non-smoking			
Male	.16	.21	.24
Female	.12	.15	.19
Preparing			
Male	.78	.71	.65
Female	.82	.77	.73
Experimenting			
Male	.06	.08	.10
Female	.06	.07	.09

Table 13 τ parameters: Transitions across time for males

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.85	.05	.10
	Preparing	.09	.91	.00
	Experimenting	.00	.00	1.00

		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.84	.05	.11
	Preparing	.09	.91	.00
	Experimenting	.00	.00	1.00

Table 14 τ parameters: Transitions across time for females

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.72	.21	.08
	Preparing	.08	.92	.00
	Experimenting	.00	.00	1.00
		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.76	.13	.11
	Preparing	.09	.91	.00
	Experimenting	.00	.00	1.00

Table 15 τ parameters: Transitions across time for males and females with equality constraints imposed

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.80	.11	.09
	Preparing	.09	.91	.00
	Experimenting	.00	.00	1.00

		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.81	.08	.12
	Preparing	.09	.91	.00
	Experimenting	.00	.00	1.00

Table 16 δ Parameters: Probability of latent status membership across age

Latent Status	Time 1	Time 2	Time 3
Non-smoking			
Younger	.09	.13	.17
Older	.23	.28	.28
Preparing			
Younger	.87	.83	.77
Older	.68	.59	.54
Experimenting			
Younger	.04	.04	.06
Older	.10	.13	.17

Table 17 τ parameters: Transitions across time for younger youth

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.68	.24	.08
	Preparing	.07	.93	.00
	Experimenting	.00	.00	1.00

		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.84	.08	.08
	Preparing	.08	.92	.00
	Experimenting	.00	.00	1.00

Table 18 τ parameters: Transitions across time for older youth

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.92	.00	.08
	Preparing	.11	.86	.03
	Experimenting	.00	.00	1.00
		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.77	.10	.14
	Preparing	.12	.88	.00
	Experimenting	.00	.00	1.00

Table 19 τ parameters: Transitions across time for older and younger youth with equality constraints imposed

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.85	.06	.09
	Preparing	.08	.92	.00
	Experimenting	.00	.00	1.00

		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.81	.08	.12
	Preparing	.09	.91	.00
	Experimenting	.00	.00	1.00

Table 20 δ Parameters: Probability of latent status membership across race

Latent Status	Time 1	Time 2	Time 3
Non-smoking			
Minority	.10	.19	.17
Non-minority	.15	.18	.22
Preparing			
Minority	.83	.74	.76
Non-minority	.79	.74	.68
Experimenting			
Minority	.07	.07	.07
Non-minority	.06	.08	.10

Table 21 τ parameters: Transitions across time for minority youth

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	1.00	.00	.00
	Preparing	.11	.89	.00
	Experimenting	.00	.00	1.00

		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.86	.11	.03
	Preparing	.00	1.00	.00
	Experimenting	.00	.00	1.00

Table 22 τ parameters: Transitions across time for non-minority youth

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.80	.10	.09
	Preparing	.08	.92	.00
	Experimenting	.00	.00	1.00

		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.81	.07	.13
	Preparing	.10	.90	.00
	Experimenting	.00	.00	1.00

Table 23 τ parameters: Transitions across time for minority and non-minority youth with equality constraints imposed

		Time 2		
		Non-smoking	Preparing	Experimenting
Time 1	Non-smoking	.80	.11	.09
	Preparing	.08	.91	.00
	Experimenting	.00	.00	1.00

		Time 3		
		Non-smoking	Preparing	Experimenting
Time 2	Non-smoking	.81	.08	.12
	Preparing	.09	.91	.00
	Experimenting	.00	.00	1.00

Table 24 Current Cigarette Use Model Selection

Number of Statuses	df	Fit Indices G^2	AIC	BIC
6	30	202.00	220.61	258.58
5	23	199.22	215.22	248.97
4	16	201.76	215.76	245.29
3	9	194.70	206.70	232.01
2	10	192.93	202.93	224.03

Table 25 ρ parameters: Probabilities for responding yes

Latent Status	Tried Cigarettes	Smoke in the Future	Smoke if Best Friend Offered	Have Best Friend who Smokes
Non-smoking	.01	.33	.15	.23
Experimenting	.99	.67	.85	.77

Note. All parameters were constrained to be equal across time and latent class.

Table 26 δ Parameters: Probability of latent status membership across TRU campaign awareness

Latent Status	Time 2	Time 3
Non-smoking		
TRU Aware	.92	.93
TRU Unaware	.90	.90
Experimenting		
TRU Aware	.08	.07
TRU Unaware	.10	.10

Table 27 τ parameters: Transitions across time for TRU Aware youth

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.93	0.07
	Experimenting	0.00	1.00

		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.73	0.27
	Experimenting	0.01	0.99

Table 28 τ parameters: Transitions across time for TRU unaware youth

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.97	0.03
	Experimenting	0.32	0.68
		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.96	0.04
	Experimenting	0.36	0.64

Table 29 τ parameters: Transitions across time for TRU aware and TRU unaware youth with equality constraints imposed

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.93	0.07
	Experimenting	0.00	1.00

		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.97	0.03
	Experimenting	0.32	0.68

Table 30 δ Parameters: Probability of latent status membership across gender

Latent Status	Time 1	Time 2	Time 3
Non-smoking			
Male	.96	.88	.88
Female	.98	.93	.95
Experimenting			
Male	.04	.12	.12
Female	.02	.07	.06

Table 31 τ parameters: Transitions across time for males

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.92	0.00
	Experimenting	0.00	1.00

		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.68	0.32
	Experimenting	0.03	0.97

Table 32 τ parameters: Transitions across time for females

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.95	0.05
	Experimenting	0.00	1.00

		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.98	0.02
	Experimenting	0.48	0.52

Table 33 τ parameters: Transitions across time for males and females with equality constraints imposed

	Time 2		
		Non-smoking	Experimenting
Time 1	Non-smoking	0.93	0.07
	Experimenting	0.00	1.00
	Time 3		
		Non-smoking	Experimenting
Time 2	Non-smoking	0.97	0.03
	Experimenting	0.32	0.68

Table 34 δ Parameters: Probability of latent status membership across age

Latent Status	Time 1	Time 2	Time 3
Non-smoking			
Younger	1.00	.97	.96
Older	.92	.79	.82
Experimenting			
Younger	.00	.03	.04
Older	.08	.21	.18

Table 35 τ parameters: Transitions across time for younger youth

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.97	0.03
	Experimenting	0.00	1.00

		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.97	0.03
	Experimenting	0.65	0.34

Table 36 τ parameters: Transitions across time for older youth

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.86	0.14
	Experimenting	0.00	1.00

		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.97	0.03
	Experimenting	0.27	0.73

Table 37 δ Parameters: Probability of latent status membership across race

Latent Status	Time 1	Time 2	Time 3
Non-smoking			
Minority	1.00	.97	.96
Non-minority	.97	.89	.90
Experimenting			
Minority	.00	.03	.04
Non-minority	.03	.11	.10

Table 38 τ parameters: Transitions across time for non-minority youth

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.97	0.03
	Experimenting	0.00	1.00

		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.98	0.02
	Experimenting	0.47	0.52

Table 39 τ parameters: Transitions across time for non-minority youth

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.92	0.08
	Experimenting	0.00	1.00

		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.97	0.03
	Experimenting	0.47	0.53

Table 40 τ parameters: Transitions across time for non-minority and minority youth with equality constraints imposed

		Time 2	
		Non-smoking	Experimenting
Time 1	Non-smoking	0.93	0.07
	Experimenting	0.00	1.00

		Time 3	
		Non-smoking	Experimenting
Time 2	Non-smoking	0.97	0.03
	Experimenting	0.32	0.68

Figure 1 Five-stage model of adolescent smoking initiation

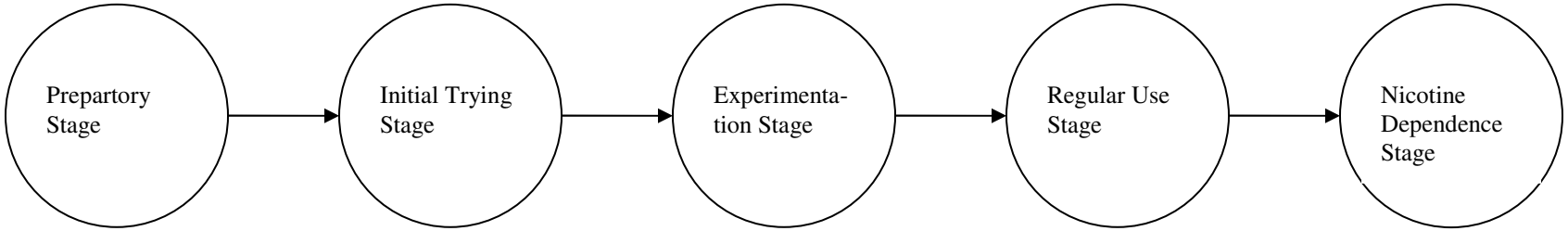


Figure 2 Transition Probability Matrix

$$\begin{array}{cc} & \text{Time 2} \\ \text{Time 1} & \begin{bmatrix} \tau_{1|1} & \tau_{2|1} & \tau_{3|1} & \cdots \\ \tau_{1|2} & \tau_{2|2} & \tau_{3|2} & \cdots \\ \tau_{1|3} & \tau_{2|3} & \tau_{3|3} & \cdots \\ \vdots & \vdots & \vdots & \end{bmatrix} \end{array}$$

Figure 3 Hypothesized six-stage model for adolescent smoking initiation

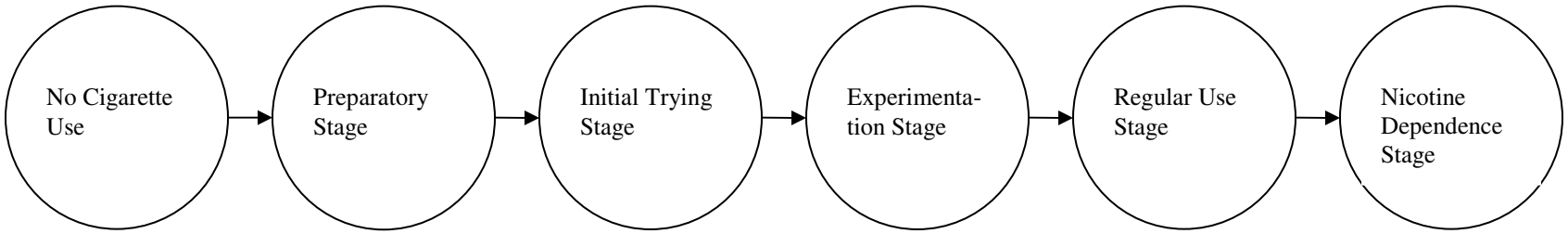


Figure 4 Full transition matrix for stages of smoking status change, lifetime use

$$
\begin{array}{cc}
 & \text{Time 2} \\
\text{Time 1} & \begin{bmatrix}
\tau_{NCU|NCU} & \tau_{P|NCU} & \tau_{IT|NCU} & \tau_{E|NCU} & \tau_{RU|NCU} & \tau_{ND|NCU} \\
\tau_{NCU|P} & \tau_{P|P} & \tau_{IT|P} & \tau_{E|P} & \tau_{RU|P} & \tau_{ND|P} \\
\tau_{NCU|IT} & \tau_{P|IT} & \tau_{IT|IT} & \tau_{E|IT} & \tau_{RU|IT} & \tau_{ND|IT} \\
\tau_{NCU|ES} & \tau_{P|E} & \tau_{IT|E} & \tau_{E|E} & \tau_{RU|E} & \tau_{ND|E} \\
\tau_{NCU|RU} & \tau_{P|RU} & \tau_{IT|RU} & \tau_{E|RU} & \tau_{RU|RU} & \tau_{ND|RU} \\
\tau_{NCU|ND} & \tau_{P|ND} & \tau_{IT|ND} & \tau_{E|ND} & \tau_{RU|ND} & \tau_{ND|ND}
\end{bmatrix}
\end{array}
$$

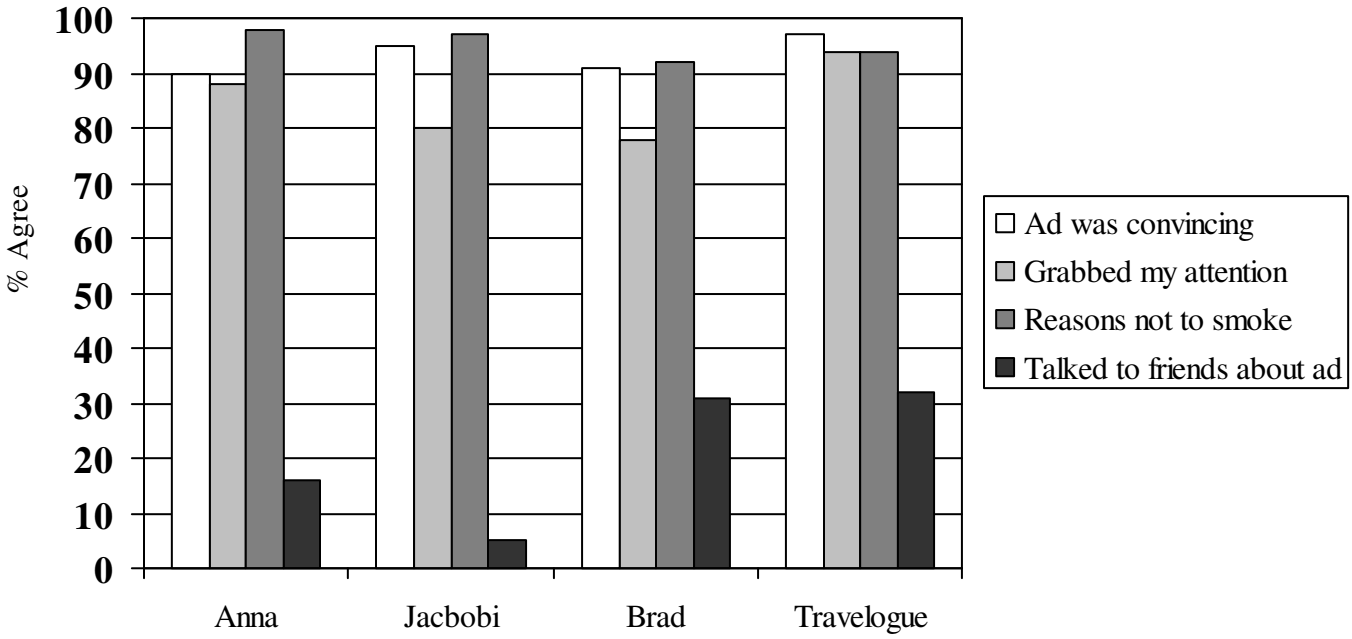
Note. NCU = No Cigarette Use Stage; P = Preparatory Stage; IT = Initial Trying Stage; E = Experimentation Stage; RU = Regular Use Stage; ND = Nicotine Dependence Stage

Figure 5 Constrained transition matrix for stages of smoking status change, lifetime use

$$
\begin{array}{cc}
 & \text{Time 2} \\
\text{Time 1} & \begin{bmatrix}
\tau_{NCU|NCU} & \tau_{P|NCU} & \tau_{IT|NCU} & \tau_{E|NCU} & \tau_{RU|NCU} & \tau_{ND|NCU} \\
0 & \tau_{P|P} & \tau_{IT|P} & \tau_{E|P} & \tau_{RU|P} & \tau_{ND|P} \\
0 & 0 & \tau_{IT|IT} & \tau_{E|IT} & \tau_{RU|IT} & \tau_{ND|IT} \\
0 & 0 & 0 & \tau_{E|E} & \tau_{RU|E} & \tau_{ND|E} \\
0 & 0 & 0 & 0 & \tau_{RU|RU} & \tau_{ND|RU} \\
0 & 0 & 0 & 0 & 0 & \tau_{ND|ND}
\end{bmatrix}
\end{array}
$$

Note. NCU = No Cigarette Use Stage; P = Preparatory Stage; IT = Initial Trying Stage; E = Experimentation Stage; RU = Regular Use Stage; ND = Nicotine Dependence Stage

Figure 6 TRU Ad Receptivity



APPENDIX

Description of TRU Ads

Ad Name	Media Schedule	Description
Anna	4/12/04 to 5/17/04 6/14/04 to 7/19/04 8/16/04 to 9/20/04 10/04/04 to 11/01/04	A teenage girl, Anna, talks about how her grandmother started smoking at the age of 13. Anna tells how her grandmother developed mouth cancer, had half of her tongue removed, and the struggle her grandmother faced learning to talk and eat again. Anna also mentions how her grandmother was very embarrassed about the scare that went from her lip down to her chest. The ad ends with Anna saying, "My grandmother always said you never know which cigarette is going to give you the cancer, so it's better not to smoke at all."
Brad	4/12/04 to 5/17/04 6/14/04 to 7/19/04 8/16/04 to 9/20/04 10/04/04 to 11/01/04	A teenage boy, Brad, says that smoking kills more people in North Carolina every year than car accidents, drugs, and homicides. He then goes on to say that when you add in the people who die from alcohol, suicide, and AIDS, smoking still kills more. Brad also talks about a friend who smokes and cannot run across the street, yet is unable to quit smoking. The ad ends with Brad saying that his friend is hooked on smoking, just like the 1 out of 3 young people their age who tries it and can't stop and that she will probably be hooked until she dies.
Jacobi	4/12/04 to 5/17/04 6/14/04 to 7/19/04 8/16/04 to 9/20/04 10/04/04 to 11/01/04	A young man, Jacobi, says that 200,000 young people in North Carolina will die an early death from smoking cigarettes. He then lists many of the diseases caused from smoking and says that smoking is killing his 34-year-old uncle. The ad ends with Jacobi saying, "Smoking can be as hard to quit as heroin."
Travelogue	10/04/04 to 11/01/04	The ad introduces the TRU Road Trip in North Carolina. A woman who has undergone a tracheotomy shares that she knew she was addicted to cigarettes when she would wake up in the morning and want one. A young man who has been smoking since the age of 8 shares that he is addicted to cigarettes and that it makes him feel low about himself. Youth of varying ages and ethnicities are interspersed throughout the ad, reacting to the woman and young man. The ad ends with the young man saying, "Every time you smoke a cigarette, there goes another breath of your life."

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