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The impact of adolescent tobacco-related associative memory on smoking trajectory: An application of negative binomial regression to highly skewed longitudinal data

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Abstract

Tobacco use is prevalent in adolescents and understanding factors that contribute to smoking uptake remains a critical public health priority. While there is now good support for the role of implicit (preconscious) cognitive processing in accounting for changes in drug use, these models have not been applied to tobacco use. Longitudinal analysis of smoking data presents unique problems, because these data are usually highly positively skewed (with excess zeros) and render conventional statistical tools (e.g., OLS regression) largely inappropriate. This study advanced the application of implicit memory theory to adolescent smoking by adopting statistical methods that do not rely on assumptions of normality, and produce robust estimates from data with correlated observations. The study examined the longitudinal association of implicit tobacco-related memory associations (TMAs) and smoking in 114 Australian high school students. Participants completed TMA tasks and behavioural checklists designed to obscure the tobacco-related focus of the study. Results showed that the TMA−smoking association remained significant when accounting for within-subject variability, and TMAs at Time 1 were modestly associated with smoking at Time 2 after accounting for within subject variability. Students with stronger preconscious smoking-related associations appear to be at greater risk of smoking. Strategies that target implicit TMAs may be an effective early intervention or prevention tool. The statistical method will be of use in future research on adolescent smoking, and for research on other behavioural distributions that are highly positively skewed.

Keywords: Tobacco; Associative Memory; Adolescent

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1. Introduction

Tobacco use by adolescents is a well-established public health problem (Shadel, Niaura, & Abrams, 2001). A significant number of adolescent high school students smoke cigarettes, a large proportion of non-smoking adolescents will initiate smoking in the immediate future, and about one third of these will develop nicotine dependence in adulthood (CDC, 1998a,b). In Queensland (Australian) high schools, 8% of students aged 12–15 years and 20% of students aged 16–17% reported smoking tobacco in the week prior to survey (Queensland Health, 2006). In some states of Australia, adolescents have higher rates of recent alcohol use, binge drinking, and daily cigarette use than adolescents in the United States (Toumbourou et al., 2005).

Stakeholders in adolescent health are sometimes struck by the well-practiced and absent-minded routines of smoking among some students. While decisions to try smoking for the first time may be conscious and considered, Tiffany (1990) argues that cognitive processes guiding tobacco use quickly become implicit, or outside conscious awareness. Researchers of implicit drug-related cognition propose that drug users have a network of drug-related memory associations (DMAs) that are automatically triggered depending on the learning history of the individual (e.g., Stacy, 1997). These DMAs are assumed to have motivational implications: Certain positive or negative memory associations may be triggered when drug cues are encountered, and the pattern of DMAs may bias behavioural options (Leigh & Stacy, 1998).

DMAs have been previously investigated using cue-association paradigms (Kelly, Masterman & Marlatt, 2005, 2006; Stacy, 1995; Stacy, Leigh, & Weingardt, 1994). In this paradigm participants are presented with a list of words or pictures of objects potentially related to alcohol use, participants write down next to each word the first word that comes to mind and responses are coded for drug-related references. This paradigm has mostly been applied to the cross-sectional prediction of alcohol and marijuana use in university students. Robust cross-sectional associations have been established (Stacy, 1995; Stacy et al., 1994) and there is now good evidence that DMAs longitudinally predict drinking over time (Kelly et al., 2005; Stacy, 1997).

In our own research, we used traditional linear modelling techniques to establish a modest association between tobacco-related memory associations (TMAs) and smoking, each measured at one time point (Kelly et al., 2006). While the results indicated promise for the TMA hypothesis for adolescents, the approach had some limitations. The first limitation is that cross-sectional designs, *ipsae facto*, do not account for within-subject variability in smoking behaviour. By measuring smoking at multiple points in time, measurement error can be reduced, more robust regression coefficients can be estimated, and within-subject variability built into predictive models. A stronger test is to examine how stable the TMA–smoking hypothesis is over time.

A second limitation is that traditional linear models are less than ideal for adolescent smoking on several counts. A common statistical method used to identify the main determinants or drivers of an outcome variable in a cross-sectional study (i.e., where only one observation is recorded for each individual participating in the study) is ordinary least squares (OLS) regression which assumes that the errors are independently and identically distributed as a Gaussian (or normal) probability distribution. In terms of research on smoking, these methods are potentially problematic because smoking data are often in the form of counts and so the probability distribution is typically positive and non-normal. In our recent research we found that a large proportion of adolescents do not smoke, and those that do frequently smoke heavily (Kelly & Jackson-Carroll, in press). Also, as might be expected (given high rates of abstinence), we found that large numbers of students report no TMAs. Second, predictors are commonly assumed to linearly predict substance abuse over time (Byrne, 2001). This limitation is apparent when common drug-