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Differentiating Between Precursor and Control Variables When Analyzing Reasoned Action Theories

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Abstract

This paper highlights the distinction between precursor and control variables in the context of reasoned action theory. Here the theory is combined with structural equation modeling to demonstrate how age and past sexual behavior should be situated in a reasoned action analysis. A two wave longitudinal survey sample of African-American adolescents is analyzed where the target behavior is having vaginal sex. Results differ when age and past behavior are used as control variables and when they are correctly used as precursors. Because control variables do not appear in any form of reasoned action theory, this approach to including background variables is not correct when analyzing data sets based on the theoretical axioms of the Theory of Reasoned Action, the Theory of Planned Behavior, or the Integrative Model

Keywords

Integrative Model; adolescent sexual behavior; African-Americans; structural equation modeling

Introduction

Most behavior change programs related to HIV/STD prevention describe their interventions as theory-based. To make the theory explicit, research reports often include verbal and/or graphical depictions of the “logic model” (Chen, 1990; Renger and Titcomb, 2002) of the intervention theory in operation. Even when logic models are not explicit, there are methods for reconstructing them after the intervention is completed but before the data are analyzed (Leeuw, 2003). An explicit theory highlights the distinctions between background variables (like gender or experimental status) and mediating variables (like condom use self-efficacy) that reflect program processes and produce the program's effects because mediating psychosocial or behavioral variables are the sources of behavior change (Holbert and Stephenson, 2003). Thus, study results are framed in terms of changes in the model mediator variables such as HIV information, condom use self-efficacy, attitudes towards consistent condom use, or condom skills that are causally located *between* intervention exposure and the

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ultimate outcome (DiClemente et al., 2004; Fishbein et al., 2001, Greenberg et al., 2000; Koniak-Griffin et al., 2003; Martino, Collins and Kanhouse, 2005).

An explicit theory also enables a statistical analysis of how the theoretical process operated (or did not operate) to affect the outcome of interest. Structural equation modeling (SEM) is appropriate in this context because it models sequential systems of background, mediator, and outcome variables and estimates the relationships among them (Kline, 2005; Schumacker and Lomax, 2004) and this is essential when psychosocial processes that produce behavioral change are transmitted through short-term mediators (Bryan, Schmiege and Broaddus, 2006; Short and Hennessy, 1994; Yzer, Fishbein and Hennessy, 2008). Thus, the combination of program theory and SEM can provide the bases for the theoretical work of program design (Balassone et al., 1993; Fishbein and Yzer, 2003; Middlestadt et al., 1996) and the empirical work of estimating program impacts (Hennessy and Greenberg, 1999). As Sobel (2008) states:

> Researchers often design treatments to affect subjects' responses on key mediators that are believed to cause the outcomes(s). Thus, they want to know if the program affects the targeted mediators and also if the mediators affect the outcome…Targeted variables that are not affected by the treatment point to problems in program design and/or delivery, whereas targeted variables that do not affect the outcomes of interest point to problems with the substantive theory underlying the program design. Both types of knowledge are useful for designing more effective treatments (pp. 230-231)

That said, using SEM to model data reflecting a theory-based intervention is not a trivial problem. In this paper, we focus on one particularly perplexing issue: the role of background variables in the most commonly used intervention theory in the HIV field (Noar, 2007, p. 397), the "Integrative Model", the latest version of reasoned action theory. Before describing the issue in more detail, we first review the Integrative Model (IM) and note some applications to HIV prevention.

The Integrative Model

Figure I shows the "Integrative Model of Behavior Prediction" (Fishbein, 2000), a psychosocial model of behavior that is a synthesis of the Theory of Reasoned Action (TRA), Social-Cognitive Theory, the Health Belief Model, and the Theory of Planned Behavior (TPB). The focus of the model concerns two central aspects of *intentions to perform a specific behavior* (the "target behavior"): the factors influencing intention formation and the relationship between intentions and subsequent performance of the target behavior.

According to the theory, the immediate determinants of intentions are attitudes, perceived normative pressure, and perceived behavioral control grouped under the column labeled "Direct Measures" in Figure I. For example, direct attitudes are measured using a set of semantic-differential items, such as "Using a condom every time I have vaginal sex with my main partner [the target behavior] would be:" *Pleasant/Unpleasant, Harmful/Beneficial, Simple/Complicated* or *Wise/Foolish*. A direct measure of normative pressure might be "Most people who are important to me think I should [perform the target behavior]" or "Most people my age are [performing the target behavior]". The former are "injunctive" norms and the latter are "descriptive" norms (Cialdini, Reno and Kallgren, 1990). Finally, direct measures of control might be: "Although there may be many barriers to [performing the target behavior], in general, I am certain I am able to do so" and "[Performing the target behavior] is mostly up to me/mostly not up to me."

The immediate determinants of these direct measures are sets of underlying beliefs: beliefs that performing the behavior will lead to certain outcomes ("behavioral" beliefs) and the valence of those outcomes (e.g., "Using a condom every time I have vaginal sex with my main partner [the target behavior] will decrease my sexual pleasure" – a behavioral belief with a negatively

valenced outcome); beliefs about what specific referents think one should do in relation to the behavior ("injunctive norm" beliefs) and to what extent specific others are actually performing the target behavior ("descriptive norm" beliefs); and beliefs concerning one's ability to perform the behavior when faced with specific barriers to doing so ("self-efficacy" beliefs). An example of the latter might be: "I can use a condom every time I have vaginal sex with my main partner [the target behavior] even when I am intoxicated." In Figure I these types of measures are all grouped under the column labeled "Belief Measures."

The direct measures of attitude, normative pressure, and control are the three proximal determinants of intentions to perform the target behavior, and thus in Figure I *only these measures have unmediated effects on intentions to perform the behavior*. Subsequent behavior is a result of intentions to perform the target behavior and the perceived ability to do so, although control may also moderate the effect of intentions on behavior. Yzer (2007) provides a comprehensive review of main versus interaction effects of control. Behavior is also assumed to be determined by context specific environmental conditions (e.g., community-wide condom or sterile injection equipment distribution programs) and individual specific skills and abilities (e.g., negotiation skills), although these contextual factors are not shown in Figure I.

Background Variables and the Integrative Model

Note that in the IM the effect of background variables (grouped under the "External Variables" column in Figure I) such as personality and demographic characteristics, experimental status (in a randomized experimental design), past target behavior, as well as a host of other individual difference characteristics are all assumed to be completely mediated by the IM because the background variables occur prior to the beliefs items. However, it is an empirical question whether the background variables have direct effects on the underlying beliefs. Thus, in Figure I, these paths are dashed. In the TRA/TPB/IM literature this assumption of complete mediation is known as the assumption of "theoretical sufficiency." As Ajzen and Albarracín summarize:

> …the [TRA/TPB/IM] does not deny the importance of global dispositions, demographic factors, or other kinds of variables often considered in social psychology and related disciplines. In fact, the reasoned action approach recognizes the potential importance of such factors…they are considered background variables that can influence behavior indirectly by affecting behavioral, normative, and control beliefs. However, whether a particular background factor does indeed have an impact on beliefs is an empirical question…With the aid of the theory of planned behavior we can not only examine whether a given background factor is related to the behavior of interest but also explain such an effect by tracing it to differences in behavior-relevant beliefs, attitudes, subjective norms, perceptions of behavioral control, and intentions (Ajzen and Albarracín, 2007, pp. 7-8).

Many articles that use the IM or its earlier variants ignore this theoretical maxim and treat background variables as *statistical controls* rather than *precursor* variables. To highlight the issue, here we focus on the direct measures as proximal determinants of intentions, but the general points hold for the fully elaborated model shown in Figure I as well. Figure IIA shows the control variable approach to non-model IM variables. There are two equations. In the first equation, the background variables of age and past behavior are part of a five variable predictor model determining intentions. In this case, the slopes of the IM variables are statistically adjusted for the background variables in the analysis (as well as for the IM variables). In the second equation predicting behavior, there are two independent variables, perceived control over the target behavior and intentions to perform the target behavior. The regression coefficients in this equation represent the net impact of each predictor holding the other constant, a relationship that is consistent with the underlying theoretical assumptions (Ajzen, 1991, p. 184) displayed in Figure I.

Figure IIB shows the correct model for background variables in this example. There are five equations, the first three use the background variables as precursors to predict the direct attitudinal, normative and control measures, the fourth estimates the effects of attitudes, norms and control on intentions, and the fifth estimates the effects of intentions and control on the target behavior. *Note that nowhere in the IM (or its antecedents) is there an explicit theory about the causal ordering of attitude, normative pressure, and control*. Thus, an appropriate SEM approach here is to estimate the correlations between their error terms (Preacher and Hayes, 2008, pps. 882-883). This penalizes the SEM model in terms of R^2 for the mediating IM direct measures because correlated error terms do not contribute to R^2. However, correlated errors do not reduce model fit because recursive causal paths between variables and correlated errors between the same variables are "equivalent models" (MacCallum, Wegener, Uchino and Fabrigar, 1993).

Control Variables Versus Precursors Variables in HIV Research

The use of the control model (i.e., Figure IIA) in analyses of TRA/TPB/IM data is common. For example, Sutton, McVey and Glanz (1999) analyzed their data using a step-wise regression that simultaneously included attitudes, perceived norms, PBC/Self-efficacy, perceived risk, gender, age, social class, age at first vaginal sex, condom use measures, and sexual partner characteristics to predict their target behavior, condom use. Koniak-Griffin et al. (2003) used step-wise regression to predict their target behavior first entering intentions and subjective norms and then in step 2 adding 23 other variables. Their significant predictors were a potpourri of background variables, sexual behavior and contraception items, sexual partner status, and one variable, intentions to use condoms. Bowen et al. (2001) developed a SEM model that predicted condom use intentions from various step-wise regressions. Because of the multiple step-wise regression runs, many of their IM measures never made it into the final analysis. Tremblay and Frigon (2004) predicted age at first intercourse (an outcome that does not meet the definition of a "behavior" in terms of the IM, see Middlestadt, 2007) using a single regression equation that included family factors, delinquency, sex knowledge, age, subjective norms, and contraception and condom use beliefs as predictors. Although Kashima, Gallois and McCamish (1993, p. 230) correctly measured the TRA variables both directly and at the level of beliefs, they analyzed the data with sexual partner characteristics as a control variable, not as a background precursor variable consistent with Figure I. Finally, Collazo (2004) evaluated the additional predictive power of adding self-efficacy to the basic TRA model and also tested the possibility of mediated effects of past behavior, but the final model included the IM variables and gender and past behavior in the same equation. From the viewpoint of the IM and its theoretical antecedents, all of these research reports are theoretically problematic because the statistical model used fails to differentiate between control and precursor background variables.

Other researchers use Figure I appropriately. Flores, Tschann and Marin (2002) used the TRA measures of attitude and norms to predict intentions to have sex using a sample of Hispanic women. As precursors they used past sexual experience, acculturation, and dating habits in a theoretically consistent set of path analyses. They concluded that for their population of respondents and for their targeted behavior, norms were a better predictor of intentions than attitudes. Gillmore et al. (2002) used the TRA model combined with SEM to model the relationships between the behavioral beliefs, the direct measures, intentions, and their target behavior of sexual intercourse for a sample of high school students. Their main research interest was looking at differences in TRA model parameters for males vs. females and virgins vs. non-virgins. Few gender differences were found but intentions seemed more determined by norms for virgins and more determined by attitudes for non-virgins (Gilmore et al., 2002, p. 894). Beadnell et al. (2007) used TPB constructs to predict intentions to have vaginal or anal intercourse in a sample of approximately 800 high school students. They were concerned with

precursor intrapersonal (e.g., sensation seeking, smoking, moral beliefs) and interpersonal (e.g., family interaction, peer relationships) variables that might add to the prediction of intentions to have sex as well as to the prediction of actual behavior one year later. They found that the TPB model alone fit well but only after a direct effect of (injunctive) norms on behavior was added to the model (Beadnell et al., 2007, p. 2861). When they added the precursors, most of the intrapersonal variables were totally mediated by the TPB variables, but three of the four interpersonal precursors were found to have direct as well as indirect effects on behavior (Beadnell et al., 2007, p. 2863). One of these "interpersonal" variables was a measure of descriptive norms not included in the model elsewhere. A similar approach was used in a subsequent analysis of condom use using a sample of males between 18 and 40 focusing on a different set of intrapersonal and interpersonal precursors (Beadnell et al, 2008).

Analyzing the IM

In this paper we present an example of a substantive analysis of data relating to the intentions to have vaginal sex collected from a sample of African-American adolescents as part of a multi-site longitudinal intervention study (Project iMPPACS). We use a direct measure model of the IM and investigate the following research questions:

- What are the effects of two particular background variables of interest, respondent age and past sexual behavior, when treated first as *control* and then as *precursor* variables?
- How should the analysis proceed if the effects of important precursor variables are not fully mediated by the IM?

Study Design and Methods

Project iMPPACS

Project iMPPACS is a longitudinal intervention project for African-American youth designed to evaluate the effect of community-wide media campaigns to supplement and reinforce (i.e., act as "booster sessions") the small group-based interventions. African-American adolescents were selected because surveillance data show that among African-American adolescents the prevalence of AIDS is five times greater than among White adolescents (CDC, 2005) and seroprevalence surveys point to higher HIV prevalence rates among African-American teens than among other ethnic groups (Rangel et al., 2006). The media boosters are implemented because small group prevention programs do motivate teens to lower their risk for HIV and other STIs, but the impact of such programs on sexual risk reduction diminishes over time (Kalichman et al., 1996; Pedlow and Carey, 2003).

Project iMPPACS was designed to address this "sustainability problem." By examining the combined impact of a small group prevention program with a community-wide mass media HIV-prevention campaign, the researchers sought to determine the extent to which a culturally-tailored, mass media campaign can augment and maintain the effects of small group individual-level intervention programming. In addition, because the media campaign targeted the entire community of at-risk teens, Project iMPPACS provided the opportunity to evaluate the extent to which mass media can contribute to community-wide behavior change programs to reduce African-American teens risk for HIV and other STIs.

Project iMPPACS: Study Design

The design of Project iMPPACS is a 2 (sexual risk reduction or a general health promotion intervention) by 2 (media present or media absent) by 5 (time: pretest, 3, 6, 12-, and 18-month post-intervention) randomized controlled trial implemented in two northern cities (Providence, RI and Syracuse, NY) and two southern cities (Columbia, SC and Macon, GA). Approximately

1,600 African-American adolescents (ages 14-17) were recruited in cohorts of 25-30 youth for random assignment to one of two interventions: Focus on Youth, the treatment status (Stanton et al., 1997), or Promoting Health among Teens, the control status program (Jemmott et al., 2005). Once recruited and consented, adolescents completed a baseline audio computer-assisted self-interview (ACASI) to assess their attitudes, beliefs and sexual behaviors. Subsequently, adolescents completed follow-up assessments at 3, 6, 12 and 18 months to determine the long term impact of the interventions. More information on Project iMPPACS can be found in Vanable et al. (in press).

In this paper, in order to demonstrate the appropriate analysis of the IM with background variables, we use the data collected from *control participants in non-media cities* during the baseline phase as well as self-reported sexual behavior data collected during the first follow-up. At the baseline data collection, 415 participants met our inclusion criteria. Of these, 58% were female, the average age was 15.13 years of age (*SD* = 1.16), and 53% reported having had vaginal sex at the baseline interview and 40% reporting have had vaginal sex during the follow-up recall period.

Project iMPPACS: Measures

The target behavior here is the self-report of having vaginal sex in the last 3 months (the recall period for the follow-up data collection). All other measures come from the baseline data collection which was administered before randomization to the experimental or control group intervention. The measures of intentions, attitude, and perceived normative pressure were from Hennessy, Bleakley, Fishbein and Jordan (2008) and the measure of control was used in the same study (the "Annenberg Sex and Media Study") but not reported on in that article.

Intentions to have vaginal sex was measured as the average of two items originally scaled from 1- 6 coded from "strongly disagree" to "strongly agree": "I am willing to have vaginal sex in the next 3 months" and "I intend to have vaginal sex in the next 3 months". The polychoric correlation between the original items was .91 ($p < .05$).

Attitude was the average of two items: "Having vaginal sex in the next 3 months would be": "very un-enjoyable" to "very enjoyable" and "very bad for you" to "very good for you". Each item was scored from 1 (unenjoyable/bad) to 4 (enjoyable/good). The polychoric correlation between the two items was .65 ($p < .05$).

Normative Pressure was measured as the average of two standardized items, one measuring injunctive norms and one descriptive norms. The injunctive norm item was: "Do the people who are most important to you think you should or should not have vaginal sex in the next 3 months?" coded on a 1- 4 scale from "definitely should not have vaginal sex" to "definitely should have vaginal sex". The descriptive norm item was: "Thinking about your friends who are your age, how many would you say have had vaginal sex?" coded on a 1- 6 scale from "none" to "almost all of them". The polychoric correlation between the two original ordinal items was .30 ($p < .05$).

Control was framed in terms of the perceived behavioral control (PBC) over having vaginal sex. The item was: "How much would it be up to you to have vaginal sex in the next 3 months?" The responses were coded as not at all up to you, somewhat up to you, and very up to you.

Project iMPPACS: Statistical Analysis

For the SEM analysis of the IM with background variables, we use the program Mplus because the PBC mediator is ordinal and the target behavior is a dichotomy (Muthén and Muthén, 1998-2007). When Mplus encounters categorical outcomes it implements a weighted mean and variance estimator that has been shown to have excellent statistical qualities even with

small samples (Flora and Curran, 2004). The estimator assumes a probit regression metric when the dependent variable is categorical, so all regression coefficients predicting having vaginal sex are in a Z score metric. All of the standard errors are adjusted for possible non-independence due to study site and intervention cohort, a clustering variable that has 37 discrete values in this selected data set. The average sample size per cluster is 11.2 respondents (range: 6 to 18).

Results

Correlations Between IM Variables

Table I shows the correlations between the precursor, IM, and the behavioral outcome variables. Of the three proximal determinants of intention, attitude has the strongest association with intentions to have vaginal sex (.74) and PBC the lowest (.08). The correlation between intentions and subsequent behavior is .50. It appears then that intention to have vaginal sex is primarily driven first by attitudes and then normative pressure in this sample of African-American adolescents.

Analyzing the IM: Age and Past Behavior as Control Variables

Figure IIIA has the results for the analysis. We find that attitudes, normative pressure, and PBC predict intentions although the PBC coefficient is not discernable from zero. Past behavior is associated with intentions but age is not. Because we include both precursor variables as control variables, these results are conditional on no change in the other IM predictors. Looking at the behavioral outcome three months later, we see that only intention has a significant effect on behavior. The confounder model fits relatively poorly using the standard criteria and the R^2 is .06 predicting vaginal sex at the follow-up. Of course, there is nothing “wrong” with this analysis except that it is not consistent with the assumption that age and past behavior are precursors of the IM measures. These results also demonstrate that age is not a statistical confounder of intention, but this finding is irrelevant to the analysis of the IM.

Analyzing the IM: Age and Past Behavior as a Precursors

Figure IIIB shows the results. Age is not associated with attitudes toward the behavior or PBC, but older respondents report significantly more normative pressure than younger respondents. Looking at past behavior it can be seen that respondents who reported past vaginal sex have more positive attitudes towards vaginal sex (2.35 standard deviations) and perceive more normative pressure to have sex (.71 standard deviations) than virgin respondents. However, PBC is not different between virgins and non-virgins after adjusting for age. When sexual behavior is the outcome, only intention has a statistically discernable relationship with subsequent behavior. Again, the model fits relatively poorly although the R^2 predicting vaginal sex is .22. We conclude that one of the three direct measures (normative pressure) of the proximal determinants of intentions differs by age when age is placed appropriately in the IM, and that past behavior differentiates between respondents on two of the three direct measures. Compared to the earlier analysis using a model of statistical control, we come to a different – and more nuanced - interpretation of the role of age and past behavior in predicting intentions and behavior.

Analyzing the IM: Testing Mediation

The relatively poor fit of the IM with precursors implies that the assumption of theoretical sufficiency of the precursors effects on intention and/or behavior seems to be unwarranted. Many SEM programs (including Mplus) provide fitted model diagnostics (i.e., “modification indices”) that suggest where paths should be added to improve the fit (Brown, 2006, p. 119). In a situation with an *a priori* model, the use of the modification indices may be helpful when considered in a theoretical context. When a SEM model of the IM fits poorly, the appropriate

modification index to examine is one that reflects a non-mediated path between the precursor and intentions and/or behavior. For the results in Figure IIIB, the largest modification index (45.64) suggests allowing past behavior to predict directly sexual behavior at follow-up. Although Mplus suggests no modification indices at all that include age, for comparison purposes we also add a direct effect of age on sexual behavior at follow-up. Our expectation for this path is that it will be not discernable from zero. In other words, age should be totally mediated by the IM variables consistent with the sufficiency hypothesis.

With these two direct paths added, virtually all the results shown in Figure IIIB are replicated except for the final equation predicting behavior. There is now a significant direct effect from past behavior to subsequent behavior (partially standardized **β** = 1.49, SE = 6.05, p < .05) and no significant direct effect of age on subsequent behavior (**β** = .10, SE = 1.38, p > .05). As with Figure IIIB, the effect of PBC on behavior is still non-significant (**β** = -0.03, SE = -.37, p > .05) while the effect of intentions on behavior is discernable from zero (**β** = .17, SE = 2.15, p < .05). The revised model fits well, $\chi^2 = 10.22$, df = 3, p = .02, CFI = .97, RMSEA = .08 and the R^2 predicting vaginal sex is .47, although the RMSEA is still high due to the low df. The reduction in χ^2 between the results in IIIB and the revised model due to the two direct paths is statistically significant when the difference between the two chi-squared is tested (χ^2 difference is 40.57, *df* = 2, *p* < .05).

Because there are now both mediated and unmediated effects of the background variables on the behavior at follow-up, Table II identifies all of the indirect paths from the background variables to the behavioral outcome at the follow-up. (The direct effects of age and past behavior on behavior were identified above). For each precursor variable, there is one two-way path and three three-way paths. For age, none of the indirect paths attain statistical significance, which is consistent with the lack of suggested modification indices. However, for past behavior, the indirect paths via attitudes and also normative pressure (as well as the overall indirect effect, which is the sum of all the possible mediated effects of past behavior to behavior at follow-up), are very close to a *p* value less than .05. Multicollinearity between the indirect paths is inevitable and this will attenuate the conditional indirect paths (Preacher and Hayes, 2008) and the more complex the indirect path, the more difficult statistical significance is to obtain because all the coefficients used must be large for their product to be discernable from zero. However, in this case it seems reasonable to assume that age is completely mediated by the TRA mediators and it appears that past behavior probably is not completely mediated.

Discussion

The Search for Theoretical Sufficiency

Including past behavior in the IM raises interesting theoretical problems because the interpretation of non-mediated effects of past behavior on intentions or future behavior is unclear. The TRA/TPB/IM's sufficiency assumption suggests that all background variables (presumably including past behavior, but see Ajzen's opinion on the use of past behavior in the TPB below) should be mediated through the mediating IM belief and direct measures. Although sufficiency is often defined as the ability of the TRA/TPB/IM to completely mediate *any* kind of precursor variable such that there are never direct effects of any precursor on intentions or behavior (Beadnell et al., 2007, p. 2847), we believe that the test of model sufficiency should be restricted to the prediction of intentions only because all reliable variance in intention should be predicted by attitudes, perceived normative pressure and perceived control. In contrast, the IM's assumptions about the roles of skills and abilities and/or environmental constraints as moderators or as additional potential predictors of behavior suggest that these variables may contribute to the prediction of behavior over and above intentions and perceived control. To the extent that assessments of past behavior capture the influence of these types of actual (as opposed to perceived) control variables, measures of past

behavior may be found to have direct as well as indirect effects on future behavior. Thus, direct, non-mediated effects of past behavior on future behavior should not be taken as a challenge to the TRA/TPB/IM sufficiency assumption.

However, Ajzen has argued that past behavior should not be included as a direct determinant of behavior in a TPB analysis because it is not a "substantive predictor" of future behavior (Ajzen, 1991, pp. 202-3). From this perspective, the observed correlation between past and present behavior is more of an uninteresting behavioral tautology than some theoretically important psychological insight. In other words, explaining variance in the target behavior by using lagged values of the target behavior is uninformative theoretically, even if the R^2 is high.

Other definitions of sufficiency are possible. There could be a more comparative definition of sufficiency that would reflect the TRA/TPB/IM's performance in relation to some other theoretical set of predictor variables and their interrelationships. Sometimes these sorts of comparisons are made; Malotte et al. (2000) compared the IM with Prochaska, DiClemente and Norcross' (1992) Stages of Change Theory. This comparative definition of sufficiency is probably superior to a theory-specific one given that there is never complete knowledge of the extent to which the variance associated with a particular outcome measure is reliable, and therefore predictable, or unreliable and always producing a non-zero error term.

Finally, another alternative view is to question whether methodological attempts to test the sufficiency assumption with respect to either the prediction of behavior or the prediction of intention are meaningful. A better research agenda than the quest for absolute or comparative sufficiency might be to identify additional variables that, for the specific target behavior and research population, are significantly associated with intentions and/or the target behavior. After these additional variables are identified, researchers might ask: how do these variables fit into the IM? Are they simply background variables whose effects are mediated by the variables in the model or do they have non mediated effects on intention or behavior? In the latter case, can they be considered to be indicants of skills and abilities (i.e., respondent qualities to enhance) or indicants or measures of social-structural environmental constraints (i.e., characteristics to ameliorate or eliminate)?

What is the Correct Analysis Strategy?

Two issues of analysis strategy are highlighted by our earlier methodological review of the literature and by our results. One concerns the use of specification search methods such as step-wise regression. From our point of view, the *a priori* nature of the IM makes any sort of computer-based specification search inappropriate because the IM defines a theoretical model that pre-specifies a set of measurement assumptions, hypotheses about causal order, and a specific model for the role of precursor variables (e.g., mediated effects are expected). Thus, the use of step-wise regression in the context of the TRA, TPB or IM is totally unjustified.

A more subtle issue refers to the choice of appropriate model-wide goodness of fit measures for IM analysis. There are multiple options here because the available measures incorporate different operational definitions of "a good fit." For example, measures such as the χ^2 test, the GFI, and the RMSEA reflect the difference between the covariance matrix of the observed variables and the predicted covariance matrix based on the results of the analysis. Other measures such as the Tucker-Lewis Index (TLI) and the Comparative Fit Index (CFI) compare the fit of the estimated model with a simpler or "baseline" model of no association (see Schumacher and Lomax, 2004 or Kline, 2005 for details on all these tests). Some (e.g., the TLI) are also designed to penalize the goodness of fit estimate for non-significant parameters, a feature that is justified through the quest for statistical parsimony (similar to the rationale for the difference between the adjusted and non-adjusted R^2 in the case of a single regression equation).

Our preference is not to use such parsimony adjusted measures with the IM because the purpose of the analysis does not include theoretical "model trimming" based on empirical results. That is, because of the *a priori* nature of the model, non-significant parameters in the IM are important substantive findings, not statistically irrelevant coefficients that should be constrained to zero. This has an important practical implication because it suggests that the CFI, for example, is a superior measure of goodness of fit than the TLI because the purpose of the SEM in a reasoned action context is to identify if *for a particular behavior and/or for a particular population group* intention to perform the target behavior is a function of some or all of the IM's three main determinants (e.g., Smith-McLallen and Fishbein, 2009). In the example presented here, PBC does not appear to play a substantive role in predicting intentions for this survey sample. This result raises the issue: are White adolescents of the same age equally immune to the effects of PBC on intentions to have vaginal sex? In other words, "null findings" in the context of reasoned action theory can lead to other interesting research questions.

Summary

All of the problematic features identified in past analyses of the IM have a common source: not taking Figure I seriously as both the basic theoretical and analytic model. Researchers who use the control variable approach treat the IM as an elaborate method of identifying a list of possibly relevant variables. But Figure I depicts the causal model of how the TRA/TPB/IM is supposed to operate. Thus, the statistical analysis should reflect the relationships in Figure I. The control variable role for background variables appears nowhere in the IM, and thus this use of background variables, although appropriate in other research contexts, is not correct when analyzing data sets based on the theoretical axioms of the reasoned action approach.

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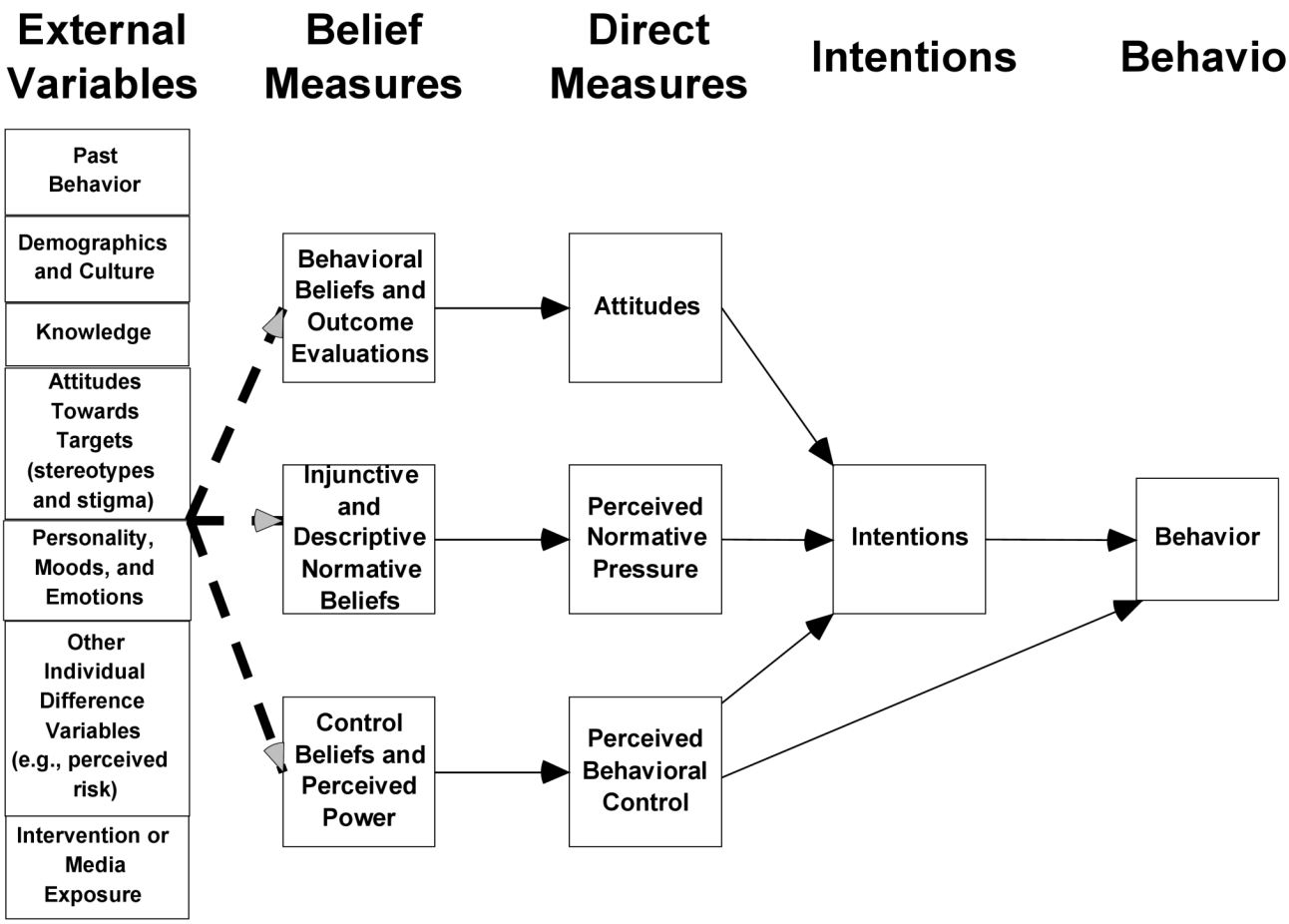

Figure I.
The Integrative Model of Behavioral Prediction

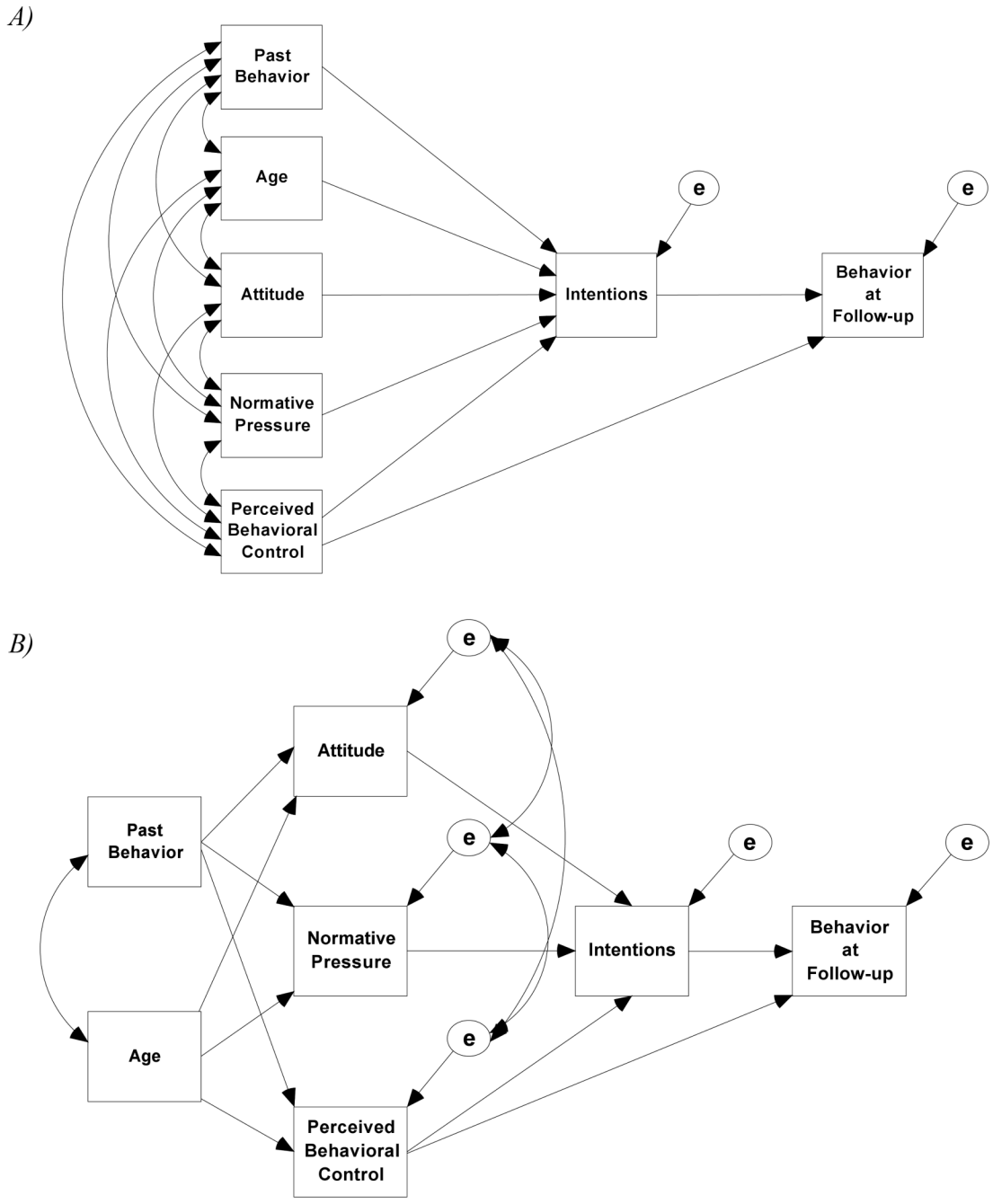

Figure II.
A) The Integrative Model with Background Variables as Controls
B) The Integrative Model with Background Variables as Precursors

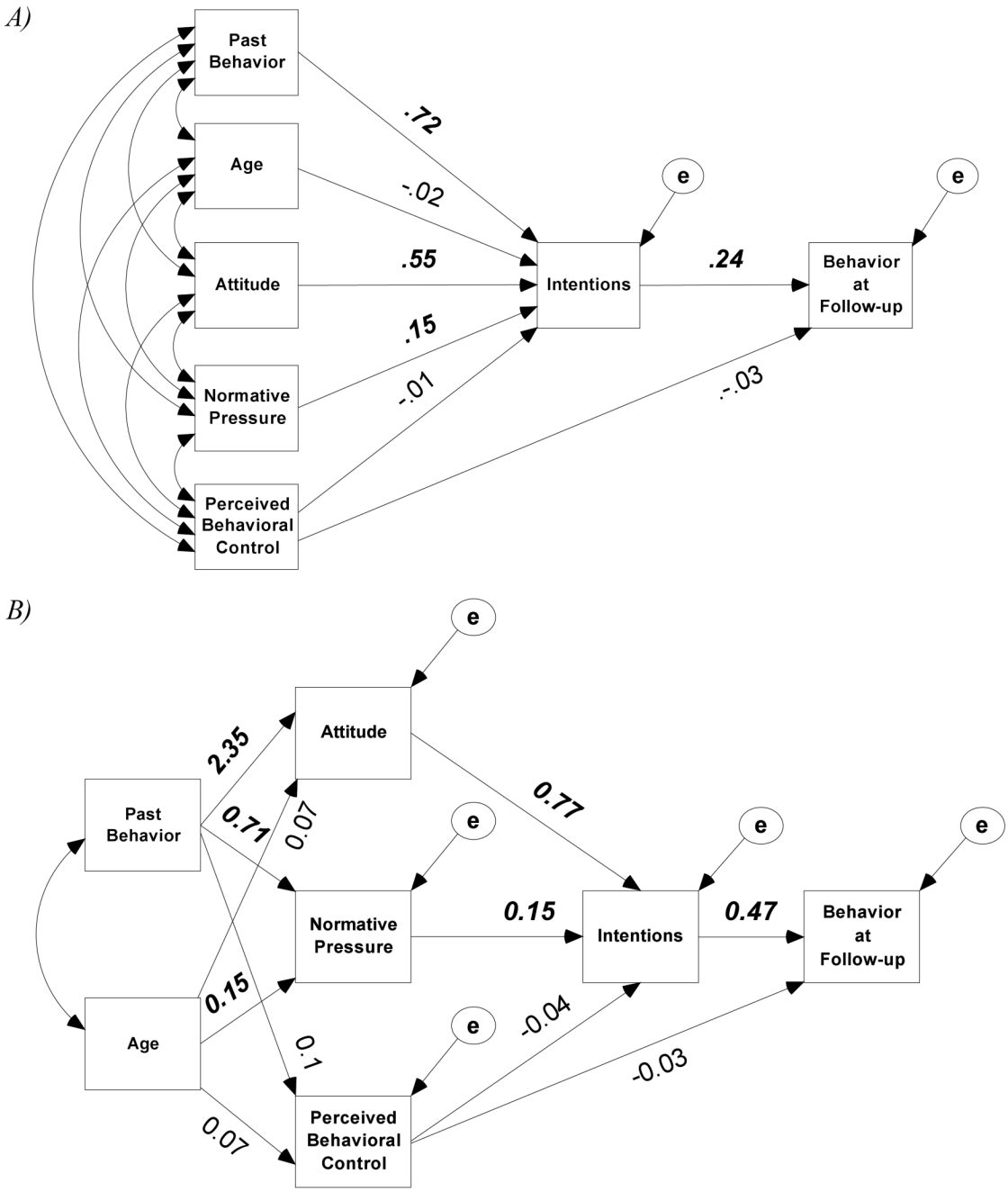

Figure III.

A) Results for Background Variables as Controls (N = 415)

Notes: Statistical model is Figure IIA. Entries are standardized regression coefficients for continuous predictors and partially standardized coefficients for past vaginal sex. Bold, italic coefficients are at least twice their standard error. $\chi^2 = 24.87$, df = 3, $p < .05$, CFI = .82, RMSEA = .13.

B) Results for Background Variables as Precursors (N = 415)

Notes: Statistical model is Figure IIB. Entries are standardized regression coefficients for continuous predictors and partially standardized coefficients past vaginal sex. Bold, italic coefficients are at least twice their standard error. Error correlation between attitude and

normative pressure mediator is .30, between attitude and PBC mediator is .11, and between normative pressure and PBC mediator is .04. $\chi^2 = 53.89$, df = 4, $p < .05$, CFI = .82, RMSEA = .17.

Table I

Correlation Matrix of Integrative Model, Background, and Outcome Variables

	Attitude	Normative Pressure	PBC	Intentions	Age	Vaginal Sex at Baseline
Normative Pressure	***.51*** PS					
PBC	***.14*** PC	.08 PS				
Intentions	***.74*** PS	***.51*** R	.08 PS			
Age	***.27*** PC	***.28*** PS	.09 PC	***.21*** PS		
Vaginal Sex at Baseline	***.70*** PC	***.60*** PS	.11 PC	***.65*** PS	***.36*** PC	
Vaginal Sex at Follow-Up	***.53*** PC	***.45*** PS	.06 PC	***.50*** PS	***.35*** PC	***.83*** TC

Notes: **PS**: Polyserial Correlation. **R**: Pearson Correlation. **PC**: Polychoric Correlation. **TC**: Tetrachoric Correlation. Italic, bold correlations are at least twice their standard error. Sample sizes for correlations in last row is 372, sample size for all others is 415.

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Table II
Indirect Effects of Precursor Background Variables on Behavior at Follow-Up (N = 415)

Specific Indirect Effect	Standardized Effect	Statistical Significance
Precursor Variable is **Age**		
Age →PBC→Behavior	-.002	.71
Age →Attitudes→ Intentions→Behavior	.008	.17
Age →Normative Pressure→ Intentions→Behavior	.004	.11
Age →PBC→ Intentions→Behavior	.000	.61
Total Indirect Effect	.01	.30
Precursor Variable is **Past Behavior**		
Past Behavior→ PBC→Behavior	-.002	.72
Past Behavior→Attitudes→ Intentions→Behavior	.07	.06
Past Behavior→Normative Pressure→Intentions→Behavior	.01	.08
Past Behavior→PBC→ Intentions→Behavior	.001	.64
Total Indirect Effect	.08	.07

Note: Statistical model is Figure IIB with direct paths from past behavior and age to follow-up behavior.