Chapter 39

Testing the Theory of Planned Behavior with Latent Markov Models

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1. Introduction: The Theory of Planned Behavior

One of the foremost contributions achieving stable predictions of different kinds of behavior was the formulation of the theory of planned behavior (Ajzen 1988, 1989, 1991). A central factor in the theory of planned behavior (Figure 1) is the individual's *intention* to perform a given behavior. Intentions are assumed to capture the motivational factors that influence a behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior. The theory postulates three conceptually independent determinants of intention. The first is the *attitude toward the behavior* and refers to the degree to which the person has a favorable or unfavorable evaluation of the behavior in question. The second predictor is a social factor termed *subjective norm*; it refers to the perceived social pressure to perform or not to perform the behavior. The third antecedent of intention is the degree of *perceived behavioral control*. This factor refers to the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles. As a general rule, the more favorable the attitude and subjective norm with respect to a behavior, and the greater the perceived behavioral control, the stronger an individual's intention to perform the behavior under consideration should be.

Intention, in turn, is viewed as one immediate antecedent of actual behavior. That is, the stronger people's intentions to engage in a behavior or to achieve their behavioral goals are, the more successful they are predicted to be. However, the degree of success will depend not only on one's desire or intention, but also on such partly nonmotivational factors as availability of requisite opportunities and resources (e.g., time, money, skills, cooperation of others, etc.; see Ajzen, 1985, for a review). Collectively, these factors represent people's actual control over the behavior. To the extent that a person has the required opportunities and resources, and intends to perform the behavior, he or she should succeed in doing so.

Of greater psychological interest than actual control, however, is the perception of behavioral control and its impact on intentions and actions. According to the theory of planned behavior, perceived behavioral control, together with behavioral intention, can be used directly to predict behavioral achievement. At least two rationales can be offered for this hypothesis. First, holding intention constant, the effort expended to bring a course of behavior to a successful conclusion is likely to increase with perceived behavioral control. The second reason for expecting a direct link between perceived behavioral control and behavioral achievement is that perceived behavioral control can often be used as a substitute for a measure of actual control. Whether or not a measure of perceived behavioral control can

substitute for a measure of actual control depends, of course, on the accuracy of the perceptions. Perceived behavioral control may not be particularly realistic when a person has relatively little information about the behavior, when requirements or available resources have changed, or when new and unfamiliar elements have entered into the situation. Under those conditions, a measure of perceived behavioral control may add little to the accuracy of behavioral prediction. However, to the extent that perceived control is realistic, it can be used to predict the probability of a successful behavioral attempt (Ajzen 1985, 1991).

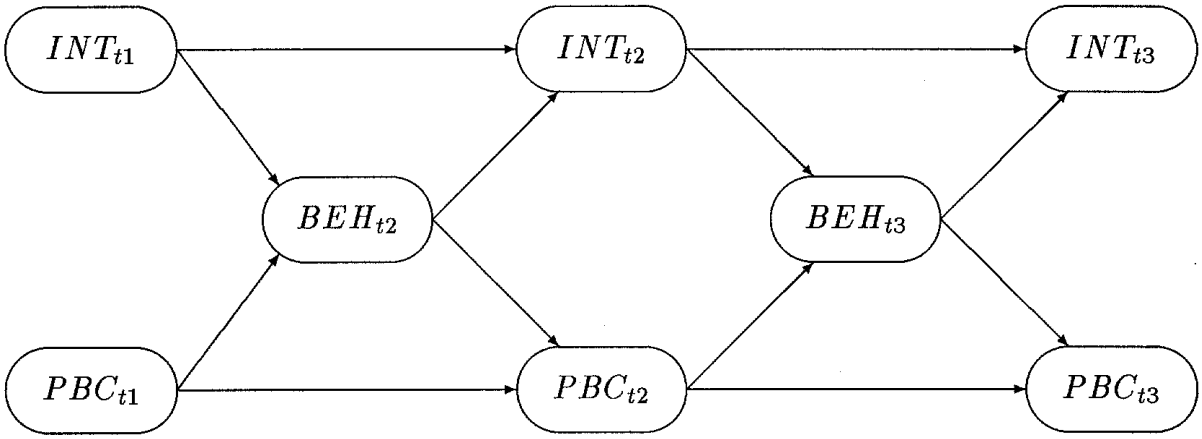

Figure 1: The model of the theory of planned behavior

Studies testing the theory of planned behavior have provided support for its ability to account for intentions and behaviors in various domains. Moreover, in virtually every case, inclusion of perceived behavioral control is found to improve prediction of intentions significantly, and in many instances also prediction of behavior (e.g., Ajzen & Driver, 1992; Beale & Manstead, 1991).

The theory of planned behavior can be directly applied in the domain of AIDS-risk-reduction. The behavior of interest for present purposes is use of condoms in heterosexual intercourse to prevent AIDS. Specifically, the behavioral criterion was defined as using condoms with new sexual partners. It is hypothesized that intentions to use condoms with new sexual partners can be predicted from attitudes, subjective norms, and perceived behavioral control with respect to the behavior; and that actual condom use can be predicted from intentions and perceptions of behavioral control. The prediction of actual behavior, however, depends on the temporal stability of intentions and perceived behavioral control (see Ajzen, 1991; Doll & Ajzen, 1992). If these variables change prior to observation of the behavior, they can no longer permit accurate prediction. In addition, accurate behavioral prediction also depends, as mentioned earlier, on the veridicality of perceived behavioral control. Only if perceptions of control are reasonably accurate will a measure of this variable improve prediction of behavioral achievement.

A small number of previous studies have applied the theory of planned behavior to condom use among young people in cross-sectional studies using small samples of undergraduate college students (Boldero, Moore, & Rosenthal, 1992; Kashima, Gallois, & McCamish, 1993; Nucifora, Gallois, & Kashima, 1993). The present investigation goes

beyond most previous research by focusing on a representative sample of adolescents and young adults in reunified Germany, and more importantly, by using a longitudinal panel design that permits examination of stability and change of attitudes, intentions, and behavior over an extended period of time (Schmidt, Nickel, & Plies, 1994). In addition, most other studies are based on logistic and multiple regression analysis without specification of measurement models. The present investigation uses latent Markov models which differentiate between latent and manifest variables and test stability and change under consideration of different reliabilities (Langeheine & van de Pol, 1990; van de Pol & Langeheine, 1990).

Because of space restrictions, the application of latent Markov models is limited to the relation between perceived behavioral control, intention and behavior (for a complete test of the theory of planned behavior with structural equation models see Reinecke, Schmidt & Ajzen, 1996). The following section 2 describes the sample and the variables under study. The method of applying latent markov models within the framework of the theory of planned behavior and the results are presented in section 3. A comparison of models regarding the expected latent relative frequencies of the latent classes is given in section 4. The summary and the conclusion follow in section 5.

2. Sample and Variables

The data reported in the present article were collected as part of a broad panel study of sexual attitudes and behaviors in a representative sample of young Germans. It was conducted by a commercial institute for social research (GETAS), using a random-route method to select households for the survey. The first wave of data was collected between November, 1991, and January, 1992, followed one year later by the second wave, which was completed in February, 1993. The third and last wave followed a year later and was completed in May, 1994. In the first wave, of 2209 persons approached, 1500 (45% men) agreed to complete a questionnaire at home with instructions to return the questionnaire in an attached self-addressed, stamped envelope. German law requires that participants in the initial survey give their explicit written permission to be reinterviewed. Because of this requirement, and because of the relatively high mobility of the original participants, only 977 could be contacted one year later. Of these respondents, 650 (66.5%) agreed to participate in the second wave (38.2% men). 544 of the remaining 650 respondents could be contacted for the third wave. Of these respondents, 340 (62.5%) agreed to participate in the third wave (34.1% men).

The age of respondents ranges from 14 to 25 years (Mean = 19.7, SD = 2.97) in the initial sample. There was a slight overrepresentation of respondents under 16 years in the subsequent waves. However, structural equation analyses comparing original and reduced samples revealed no differences in the relations among the variables in the theory of planned behavior (Reinecke, Schmidt & Ajzen, 1996).

The questionnaire, which took about one hour to complete, contained a variety of items dealing with sexual behavior patterns, romantic relationships, attitudes toward sexuality, child-bearing, abortion, and attitudes toward AIDS-risk-reduction behaviors. In addition, measures of socio-demographic characteristics and general personality traits (e.g., locus of control) were also obtained. Only questions pertaining to the theory of planned behavior are described below.

All questions of interest for the present study dealt with the behavior of using condoms with new sexual partners. One item measured intentions to perform the behavior of interest. (1) Suppose you met a new partner and wanted to have sex with him/her, would you use a condom? Responses on a 7-point scale (scored 1 to 7) could range from *very likely* to *very unlikely* (*int*). Two 7-point scales assessed perceived behavioral control. The questions posed were (1) How likely is it at the present time that you could properly use condoms with new sexual partners? (*pbc1*), and (2) How difficult is it for you to use condoms with new sexual partners? (*pbc2*). Responses could range from *very likely* to *very unlikely* for the first question and from *very difficult* to *not at all difficult* for the second one. Self-reports of behavior were assessed by means of a two-part question. First, respondents were asked whether or not they had had sexual intercourse with a new sexual partner in the past 12 months. If the answer was affirmative, they were asked to indicate, on a 7-point scale (labeled *almost never* to *every time*), how often they had used condoms (*beh*).

As stated in section 1, measures of intention, perceived behavioral control and behavior are used for latent Markov modeling. To avoid a high amount of empty cells in the multivariate contingency table (due to sparse data), every scale is transformed to a 3-point scale with low, medium and high categories of the underlying variable.

Manifest Variable	*low (1)*	*medium (2)*	*high (3)*	*Total*
$pbc1_{t1}$	37 (11.1%)	99 (29.7%)	198 (59.3%)	334 (100%)
$pbc1_{t2}$	34 (10.1%)	86 (25.5%)	217 (64.4%)	337 (100%)
$pbc1_{t3}$	14 (2.1%)	70 (20.6%)	254 (74.4%)	338 (100%)
$pbc2_{t1}$	33 (9.9%)	147 (44.1%)	154 (46.1%)	334 (100%)
$pbc2_{t2}$	37 (10.9%)	121 (35.9%)	179 (53.1%)	337 (100%)
$pbc2_{t3}$	20 (5.9%)	112 (33.0%)	207 (60.9%)	339 (100%)
int_{t1}	19 (5.7%)	44 (13.1%)	274 (81.3%)	337 (100%)
int_{t2}	29 (8.6%)	63 (18.7%)	246 (72.7%)	338 (100%)
int_{t3}	20 (5.8%)	66 (19.4%)	252 (74.1%)	338 (100%)
Manifest Variable	never (1)	sometimes (2)	always (3)	Total
beh_{t2}	72 (42.4%)	46 (27.1%)	52 (30.6%)	170 (100%)
beh_{t3}	57 (55.4.%)	21 (20.4%)	25 (24.3%)	103 (100%)

Table 1: Distributions of the Manifest Variables. The indices of the manifest variables represent the panel waves „ t_1 “ indicates the first, „ t_2 “ the second and „ t_3 “ the third wave.
Differences to the total of 340 are dur to missing values.

Table 1 gives descriptive information regarding the manifest variables under study. Results are reported for the 340 respondents who took part in all three waves of the study. Of these respondents, 172 reported having had sex with new partners between the first and the second wave, 103 reported having had sex with new partners between the second and the third wave.

The distributions of perceived behavioral control variables show that respondents expected less difficulties with condoms over time and that the capability to handle condoms in new sexual contacts increased. Looking at the first manifest variable (*pbc1*), the proportion of adolescents who perceive high behavioral control increased from 59.3% in the first wave to 74.4% in the third wave. For the second variable (*pbc2*) proportions increased from 46.1% to 60.9%. The development of intention was somewhat different. The skewest distribution occured in the first wave with over 81% having high intentions to use condoms in new sexual contacts. This value decreased to 72.7% from the first to the second wave and remained stable up to the third wave. In contrast to their intention, most of the persons with new sexual contacts did not use condoms. This tendency increased across waves.

3. Latent Markov Models

Comparisons between the distributions of the same manifest variables over time imply changes in the corresponding latent variable. However, every difference on the manifest level is affected by measurement error so that substantive interpretations may result in wrong conclusions. This disadvantage can be solved by analyzing panel data with latent markov models. These models combine the indicators with the latent variables by using a measurement model, i.e., a latent class model. Thus, change or stability on the latent level (true change or stability) is due to unreliability of the manifest variables indicators (cf. Langeheine & van de Pol 1990, p. 421).The latent variable perceived behavioral control (*PBC*) has two measures (*pbc1, pbc2*), each of the latent variables intention (*INT*) and behavior (*BEH*) has one measure (*int* and *beh*).

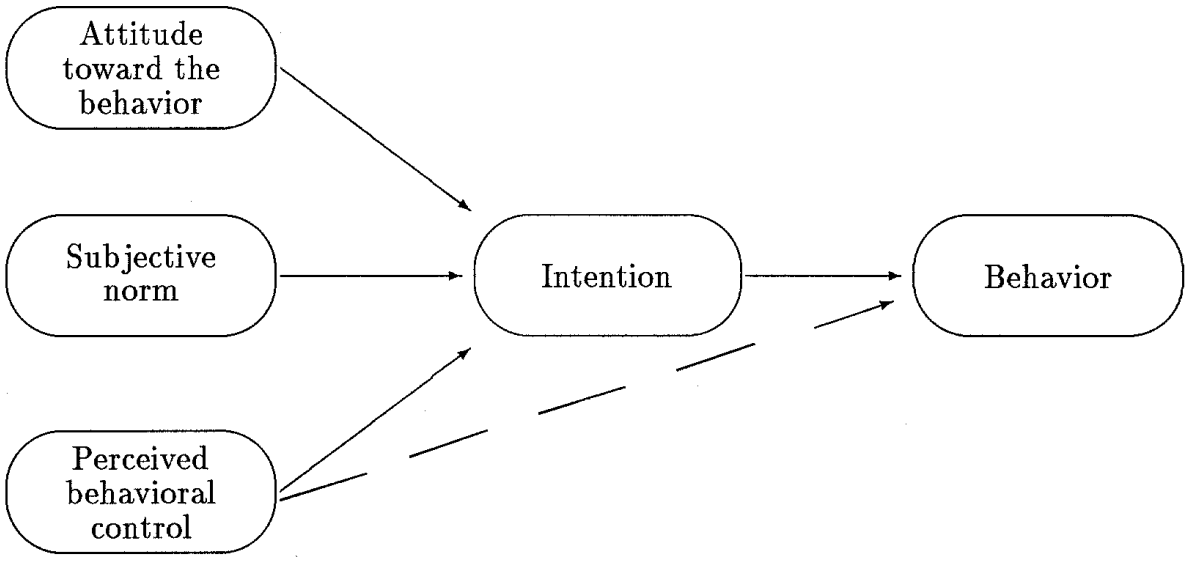

Figure 2: The Relation between Perceived Behavioral Control, Intention and Behavior over Three Panel Waves. The indices of the latent variables represent the panel waves.

Figure 2 shows the relation between the latent variables over time with respect to the hypotheses of the theory of planned behavior and the possibilities to test these relations with latent Markov models. In the following section 3.1, the stabilities of intention and perceived behavioral control over all waves are tested. In section 3.2, the longitudinal relation between intention and behavior is analyzed; whereas in section 3.3, the same procedure is applied for the relation between perceived behavioral control and behavior.

3.1 Stabilities of Intention and Perceived Behavioral Control

To test the stabilities of intention and perceived behavioral control two latent Markov models are specified according to equation 44 in chapter 1:

$$p\left(\text{int}_{t1,t2,t3}\right) = \sum_{abc} \delta^{1}_{a}\, \rho^{1}_{\text{int}_{t1}|a}\, \tau^{21}_{b|a}\, \rho^{2}_{\text{int}_{t2}|b}\, \tau^{32}_{c|b}\, \rho^{3}_{\text{int}_{t3}|c} \tag{1}$$

$$p\left(\text{pbc1}_{t1,t2,t3}, \text{pbc2}_{t1,t2,t3}\right) = \sum_{abc} \delta^{1}_{a}\, \rho^{1}_{\text{pbc1}_{t1}|a}\, \rho^{1}_{\text{pbc2}_{t1}|a}\, \tau^{21}_{b|a}\, \rho^{2}_{\text{pbc1}_{t2}|b}\, \rho^{2}_{\text{pbc2}_{t2}|b}\, \tau^{32}_{c|b}\, \rho^{3}_{\text{pbc1}_{t3}|c}\, \rho^{3}_{\text{pbc2}_{t3}|c}\,. \tag{2}$$

δ is the unconditional probability (latent class probability) for the first wave, ρ the conditional probability for the manifest variables and τ the transition probability on the latent level (further descriptions are given in section 2.2 of chapter 1). The models are tested by using the program PANMARK (cf. van de Pol, Langeheine & de Jong, 1991) which allows different restrictions on the unconditional, conditional and transition parameters.

The manifest variables of intention and perceived behavioral control have three categories in each wave. Categories were not changed between the waves so that the probabilities of the latent classes (δ) are three for each latent variable. The measurement models for the latent variables are restricted in the way that the same manifest variables have equal conditional

probabilities (ρ) over the waves. The first specification of each model tested the assumption that the transition probabilities are the same between the waves ($\tau^{21}_{b|a} = \tau^{32}_{c|b}$) against the alternative model with unequal transition probabilities. Table 2 shows the goodness-of-fit measures of both specifications. The AIC and BIC criterions (Read & Cressie, 1988) are lower in the models assuming equal transition probabilities[1].

Latent Variable	$\tau^{21}_{b\|a} = \tau^{32}_{c\|b}$		$\tau^{21}_{b\|a} \neq \tau^{32}_{c\|b}$	
	AIC	BIC	AIC	BIC
INT	1300.22	1353.57	1305.89	1382.12
PBC	3042.23	3122.13	3046.21	3140.92

Table 2: Goodness-of-Fit Measures.
AIC = Akaike Information Criterion, BIC= Best Information Criterion

To show stability and change of the latent variables under study, latent class probabilities ($\delta^{(t-1)}$) of previous waves are multiplied with the corresponding matrices of the transition probabilities (T):

$$\delta^{(t)'} = \delta^{(t-1)'} * T. \tag{3}$$

Changes in the distribution of the latent classes of the current wave ($\delta^{(t)}$) reflect changes in the latent variables. Using the parameter estimates of δ and τ for the latent variable intention, the latent class probabilities of each wave are calculated according to equation (3):

$$\underset{\delta^{(t_1)'}}{(.022\ .317\ .661)} \quad \overset{T}{\begin{pmatrix} 1.00 & .000 & .000 \\ .000 & 1.00 & .000 \\ .000 & .104 & .896 \end{pmatrix}} = \underset{\delta^{(t_2)'}}{(.022\ .386\ .592)} \quad \overset{T}{\begin{pmatrix} 1.00 & .000 & .000 \\ .000 & 1.00 & .000 \\ .000 & .104 & .896 \end{pmatrix}} = \underset{\delta^{(t_3)'}}{(.022\ .448\ .530)}$$

Because of the restriction $\tau^{21}_{b|a} = \tau^{32}_{c|b}$ the matrices of transition probabilities T contain equal values between the waves. Transition probabilities show perfect stabilities (1.0) in the first and second category (low and medium intention) and a high stability (.896) in the third category (high intention) of the latent variable. A 10% transition probability to change from the third category of the former wave to the second one in the present wave occurs, indicating that respondents tend to decrease their intention to use condoms in new sexual contacts. As a consequence, the latent class probability of the second category increases from .317 (first wave) to .448 (third wave), whereas the third category decreases from nearly .661 (first wave) to .530 (third wave).

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[1] It should be noted that the index of dissimilarity (Δ, cf. Shockey 1988) is Δ > .05 in the model containing perceived behavioral control. A test of unobserved heterogeneity by modeling two Markov chains does not improve the value of this index. By comparing observed and expected frequencies the presumption is probable that autocorrelated measurement errors are responsible for the discrepancies. These autocorrelated measurement errors should not be neglected but cannot yet be modelled and specified in PANMARK.

Using the parameter estimates of δ and τ for the latent variable perceived behavioral control equation 3 result in:

$$\delta^{(t_1)'}\begin{pmatrix}.108 & .378 & .514\end{pmatrix}\begin{pmatrix}.430 & .358 & .212\\ .061 & .587 & .352\\ .024 & .041 & .935\end{pmatrix}^{T} = \delta^{(t_2)'}\begin{pmatrix}.082 & .282 & .636\end{pmatrix}\begin{pmatrix}.430 & .358 & .212\\ .061 & .587 & .352\\ .024 & .041 & .935\end{pmatrix}^{T} = \delta^{(t_3)'}\begin{pmatrix}.068 & .221 & .711\end{pmatrix}$$

Only in the third category the value of the transition probability has a nearly perfect stability (.935), whereas in the first and second category (low and medium perceived behavioral control) the stability has medium values (.430 and .587). In contrast to the respondents' intention, their perceived behavioral control increases over time: The probability to change from the first to the second category is nearly 36%, the probability to change from the second to the third category is nearly 35%. Thus, the latent class probabilities of the first and second category decrease from .108 to .068 and .378 to .221, whereas the third category increases from nearly .514 to .711.

3.2 The Relation between Intention and Behavior

According to Figure 2, the latent variable behavior will influence the stabilities of intention and perceived behavioral control. A first model analyzes the relation between intention (first wave), behavior (second wave) and future intention (second wave). The same analysis is done in a second model regarding the measurements of the second and third wave.

For the first model, equation 1 can be modified by dropping the third-wave measurement of intention and adding the second-wave measurement of behavior:

$$p\left(\text{int}_{t1,t2}, \text{beh}_{t2}\right) = \sum_{ab} \delta_a^1 \, \rho^1_{\text{int}_{t1|a}} \, \tau^{21}_{b|a} \, \rho^2_{\text{beh}_{t2|b}} \, \tau^{22}_{b|b} \, \rho^2_{\text{int}_{t2|c}} \tag{4}$$

The analyses are based on all respondents who had new sexual contacts between the first and second wave (N = 172).

For the second model, equation 1 can be modified by dropping the first-wave measurement of intention and adding the third-wave measurement of behavior:

$$p\left(\text{int}_{t2,t3}, \text{beh}_{t3}\right) = \sum_{bc} \delta_b^2 \, \rho^2_{\text{int}_{t2|b}} \, \tau^{32}_{c|b} \, \rho^3_{\text{beh}_{t3|c}} \, \tau^{33}_{c|c} \, \rho^3_{\text{int}_{t3|c}} \tag{5}$$

The analyses are based on all respondents who had new sexual contacts between the second and third wave (N = 103). Instead of using separate models according to equations 4 and 5, one could use all three waves simultanuously as specified in equation 1. However, this strategy requires data from those persons who had new sexual contacts between *all* waves. The number of persons (N = 34) was too small to justify a three-wave latent Markov model including behavior.

In both specifications (equations 4 and 5), the model has one measurement (*int, beh*) for each latent variable. To identify the unknown parameters, the conditional probabilities (ρ) of *int* were restricted to 1. Estimations of the parameters with PANMARK result in acceptable model fits (L^2 = 9.53 with df = 6, p = .146, BIC = 909.40 for equation 4); (L^2 = 3.30 with

df = 6, p = .769, BIC = 587.14 for equation 5). According to equation 3, the distributions of the latent class probabilities of intention change from the first to the second wave as follows:

$$\underset{(.047\ .207\ .746)}{\delta^{(t_1)'}} \underset{\begin{pmatrix}.838 & .000 & .162\\ .000 & .630 & .370\\ .195 & .072 & .733\end{pmatrix}}{\mathrm{T}} = \underset{(.185\ .184\ .631)}{\delta^{(t_2)'}} \underset{\begin{pmatrix}.381 & .512 & .107\\ .222 & .771 & .007\\ .011 & .000 & .989\end{pmatrix}}{\mathrm{T}} = \underset{(.118\ .237\ .645)}{\delta^{(t_2)'}}$$

The relation between intention (t_1) and behavior (t_2) show a high probability of congruency for the first category (.838) and a medium one for the second and third category (.630 and .733). The probability to have low or medium intentions and to always use condoms in the future is .162 or .370. For the opposite (high intentions and never or sometimes using condoms), the probability is .195 and .072. The relation between behavior and intention within the second wave show a low probability of congruency for the first category (.381), a medium one for the second (.771) and a high one for the third category (.989). The probability to use sometimes condoms in new sexual contacts and to have a low intention to use them in the future is .222. For the opposite (never using condoms and medium intention) the probability is .512.

According to equation 3, the distributions of the latent class probabilities of intention change from the second to the third wave as follows:

$$\underset{(.119\ .168\ .713)}{\delta^{(t_2)'}} \underset{\begin{pmatrix}.345 & .388 & .267\\ .513 & .219 & .268\\ .293 & .000 & .707\end{pmatrix}}{\mathrm{T}} = \underset{(.336\ .083\ .581)}{\delta^{(t_3)'}} \underset{\begin{pmatrix}.177 & .509 & .315\\ .000 & 1.00 & .000\\ .000 & .108 & .892\end{pmatrix}}{\mathrm{T}} = \underset{(.059\ .317\ .624)}{\delta^{(t_3)'}}$$

Compared to the first model, the relationship between intention (t_2) and behavior (t_3) is much weaker. A relatively high congruency is only estimated for the third category (.707). Respondents who have low or medium intentions in the second wave can show any kind of behavior in the third wave. Even those with high intentions (third category) are classified with about 29% in the lowest category of behavior (never used condoms). Transition probabilities from behavior to intention within the third wave are similar to the first model.

Comparing the distribution of latent class probabilities of behavior (beh_{t2}: .185, .184, .631 and beh_{t3}: .082, .282, .636) one can see that respondents tend to polarize between non-user and regular user of condoms in new sexual contacts. The process of polarization leads to the tendency of respondents to lower their intentions to use condoms. For example, the latent class probability of high intention (third category) decreases from .746 in the first wave to .624 in the third wave.

3.3 The Relation between Perceived Behavioral Control and Behavior

Similar to the last section the relation between perceived behavioral control (first wave), behavior (second wave) and future behavioral control (second wave) is analyzed with a latent Markov model. In difference to equation 4 (first model), the model contains two measurements for the latent variable perceived behavioral control and one measurement for the latent variable behavior. Equal conditional probabilities (ρ) across the panel waves have been specified for the same measurements $(\text{e.g. } \rho^{1}_{pbc1_{t1}|a} = \rho^{2}_{pbc1_{t2}|b})$.

Similar to equation 5 a second model regarding the measurements of the second and third wave is specified as follows. Again, model tests are based on all respondents who had new sexual contacts between the first and the second wave, and the second and third wave, respectively.

Estimations of the parameters with PANMARK result in good model fits ($L^2 = 122.77$ with df = 210, p = .999, BIC = 1574.06 for the first model; $L^2 = 95.50$ with df = 210, p = .999, BIC = 906.34 for the second model). According to equation 3 the distributions of the latent class probabilities of perceived behavioral control change from the first to the second wave as follows:

$$\delta^{(t_1)'} \quad {}^{T} \qquad \delta^{(t_2)'} \quad {}^{T} \qquad \delta^{(t_2)'}$$
$$(.132\ .346\ .522) \begin{pmatrix} .616 & .310 & .073 \\ .161 & .063 & .776 \\ .152 & .000 & .848 \end{pmatrix} = (.216\ .063\ .721) \begin{pmatrix} .567 & .433 & .000 \\ .292 & .708 & .000 \\ .000 & .110 & .890 \end{pmatrix} = (.141\ .217\ .642)$$

The relation between perceived behavioral control (t_1) and behavior (t_2) show a high probability of congruency in the third category (.848), a medium one in the first (.616) and a low one in the second category (.063). The probability to have medium perceived behavioral control and to always use condoms subsequently is .776. The probabilities that respondents who have medium or high behavioral control but tend to use condoms only sometimes or never are .161 and .152. The relation between behavior and perceived behavior control within the second wave show a medium probability of congruency for the second (.708) and a high probability for the third category (.890), meaning that people who use condoms sometimes or always have equivalent knowledge. But for those who never use condoms, more than one third perceive medium behavioral control (.433).

According to equation 3, the distributions of the latent class probabilities of perceived behavioral control change from the second to the third wave as follows:

$$\delta^{(t_2)'} \quad {}^{T} \qquad \delta^{(t_3)'} \quad {}^{T} \qquad \delta^{(t_3)'}$$
$$(.323\ .123\ .553) \begin{pmatrix} .774 & .000 & .226 \\ .000 & 1.00 & .000 \\ .012 & .000 & .988 \end{pmatrix} = (.248\ .123\ .619) \begin{pmatrix} .183 & .817 & .000 \\ .000 & .485 & .515 \\ .000 & .000 & 1.00 \end{pmatrix} = (.046\ .262\ .682)$$

Compared to the first model, the relationship between perceived behavioral control (t_2) and behavior (t_3) is much stronger. Perfect and nearly perfect stabilities occur in the second (1.0) and third category (.988). Again, there is a nonignorable probability (.226), that people have limited behavioral control but always use condoms in new sexual contacts. Looking at the transition probabilities between behavior (t_3) and perceived behavioral (t_3) control, one can see that the trend within the second wave continues in the third wave. The majority of the respondents who never used condoms perceive medium behavioral control (.817) and over half of the respondents who sometimes used condoms perceive high behavioral control (.515).

4. Comparison of Models

The results of the latent class models are now compared in terms of expected relative frequencies of the latent classes. Table 3 contains those frequencies for the latent variable intention, and perceived behavioral control.

Intention				*Perc. Beh. Contr.*			
t	t_+			t	t_+		
	$\delta_1^{t_+}$	$\delta_2^{t_+}$	$\delta_3^{t_+}$		$\delta_1^{t_+}$	$\delta_2^{t_+}$	$\delta_3^{t_+}$
δ_1^t	1.00	.00	.00	δ_1^t	.21	.37	.42
	.32	*.43*	*.25*		*.44*	*.49*	*.07*
	.06	**.59**	**.35**		**.14**	**.63**	**.23**
δ_2^t	.00	1.00	.00	δ_2^t	.07	.38	.55
	.14	*.49*	*.37*		*.11*	*.20*	*.69*
	.09	**.51**	**.40**		**.00**	**.49**	**.52**
δ_3^t	.00	.20	.80	δ_3^t	.04	.07	.89
	.10	*.16*	.74		*.09*	*.16*	.75
	.05	**.23**	**.72**		**.00**	**.01**	**.99**

Table 3: Expected relative frequencies of the latent classes for intention and perceived behavioral control $(t \text{ to } t_+)$

Values from the three-wave model (section 3.1) are in the first rows of each subtable (small caps). Values from the two-wave models (section 3.2 and section 3.3) are in the second (italics) and third rows (boldface).

The relative expected frequencies in the first rows of each subtable are calculated from the parameters of the three-wave Markov model (cf. section 3.1). These frequencies show the amount of stability and change from the first to the third wave. 20% of the respondents with high intentions in the first wave (δ_3^t) are expected to have medium intentions in the third wave $(\delta_2^{t_+})$. Respondents' low and medium intentions $(\delta_1^t \text{ and } \delta_2^t)$ remain stable. The inclusion of behavior and considering respondents with new sexual contacts between the first two waves give a different picture.

The relative expected frequencies in the second rows of each subtable are calculated from the parameters of the first two-wave Markov model in section 3.2. These frequencies show the amount of stability and change of intention from the first to the second wave considering the behavior between the waves. There is, for example, a 37% expectancy to change from medium intentions in the first wave (δ_2^t) to high intentions in the second one $(\delta_3^{t_+})$. The opposite change is expected to be 16%.

The relative expected frequencies in the third rows of each subtable are calculated from the parameters of the second two-wave Markov model in section 3.2. These frequencies show the amount of stability and change of intention from the second to the third wave considering the behavior between the waves. The probability to change from medium intentions in the second wave to high intentions in the third wave is 40% and the opposite change is expected to be 23%. However, the absolute number of persons who decrease their intentions (opposite change) between both waves is higher than the number of persons who increase their intentions. These opposite changes lead to the interpretation that respondents with new sexual contacts become more realistic about their intention to use condoms next time.

In total, the comparison shows that the behavior is responsible for the change of the value of the behavioral intention. The medium and low categories are more affected than the high categories. The stability of the high category of intention only varies between 80% (three-wave model) and 72% (second two-wave model).

The long-term development of perceived behavioral control is quite different from intention. The expected latent frequencies from the three-wave latent Markov model first rows of the subtables in Table 3) show that stability occurs only in the third category: It goes without saying that respondents who entered the survey with high knowledge and ability to handle condoms in new sexual contacts did not lose them in the future. Evidently, respondents with low and medium knowledge and control changed to higher values in subsequent waves.

Regarding the expected frequencies of the first two-wave model (second rows of each subtable) lead to the same interpretation, although the values show different „shifts“ of increasing behavioral control between the waves. There is a 49% expectancy to change from low perceived behavioral control in the first wave (δ_1^t) to medium perceived behavioral control in the second one (δ_2^{t+}). The opposite change is expected to be 11%. There is a 69% expectancy to change from medium perceived behavioral control (δ_2^t) to high perceived behavioral control (δ_3^{t+}) between the same waves. The opposite change is only expected to be 16%.

The shifts to higher values of behavioral control are similar for the second two-wave model (third rows of each subtable). The only differences to the first two-wave model are the expected frequencies with zero values. There is nearly no probability of losing behavioral control over condoms across the panel waves.

In total, the comparison shows that there is increasing knowledge and control to handle condoms in new sexual contacts. Including the behavior in the two-wave models does not lead to a major change compared to the results of the three-wave model. With new sexual experiences, respondents did not increase their knowledge and control more than others who were not involved in new sexual relationships. The expected relative frequencies are higher in the three-wave model than in the second two-wave model only regarding the opposite changes (from high to medium and from medium to low perceived behavioral control).

5. Summary and Conclusion

The hypotheses of the theory of planned behavior emphasizing the relations between intention, perceived behavioral control and behavior, are the theoretical background for the longitudinal analyses presented in this chapter. The analyses with latent Markov models support these hypotheses, although the relations between intention and behavior were not as strong as expected.

In addition to the original model of the theory of planned behavior (cf. Figure 1), stability and change of intention and perceived behavioral control could be analyzed with three-wave latent Markov models, taking into account the unreliability of the measured variables. For both intention and perceived behavioral control, the Markov assumption (i.e., transition probabilities are the same between the waves) was confirmed (cf. section 3.1). These latent Markov models led to the conclusion that perceived behavioral control underwent a great deal of change in the course of the two-year period, whereas intention is more stable. In retrospect, this finding is not unexpected. Especially among the younger participants in the study, many may have had their first sexual experiences during the period under investigation. In addition, all respondents are likely to have been exposed to a great deal of

information concerning safer sex, whether in their schools or at work, via the mass media, or in conversation with friends and family. Many respondents were apparently in the process of acquiring their knowledge with respect to condom use.

As the theory of planned behavior is not specifically designed for spontaneous behavior but for goal-directed behavior, it is not surprising that the relation between intention and behavior in this study is low. At least two reasons for this discrepancy can be suggested.

First, „using condoms with new sexual partners“ is open to interpretation regarding the definition of a new partner. Following the initial sexual contact, we are, strictly speaking, no longer dealing with a new partner. It is, therefore, logically not inconsistent for a person who intends to use condoms with new sexual partners to discontinue the practice after the initial encounter. This, of course, is not a recommended safer-sex behavior, but has been observed in previous research (Laumann, Gagnon, Michael & Michaels, 1994).

Second, and of greater interest for present purposes, the discrepancy between intentions and behavior may be attributable to unrealistic perceptions of control. It has often been observed (e.g., Fisher, Fisher, Williams, & Malloy, 1994) that enacting an intention to use condoms requires a variety of skills, including an ability to act rationally in an emotionally charged situation and interpersonal skills needed to attain the partner's cooperation. Respondents may underestimate or exaggerate the difficulties involved and develop realistic perceptions of behavioral control only with a substantial amount of direct experience.

The results of the present study provide some support for these ideas. The two-wave latent Markov models in section 3.3 revealed a strong effect of behavior on perceptions of control. As might be expected, increased condom use led to a corresponding increase in perceived ability to perform the behavior in question.

Especially in health psychology and social science AIDS research, it would be necessary to combine the broad applicability of the theory of planned behavior and its usefulness as a unified general framework for explaining behavior. Further studies taking into account those factors which may trigger the relationship between intention and behavior can be built upon the present results.

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