Running Head: Dental flossing, planning, and self-efficacy

Translating dental flossing intentions into behavior: A longitudinal investigation of the mediating effect of planning and self-efficacy in young adults

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Abstract

Purpose: Although poor oral hygiene practices can have serious health consequences, a large number of adults brush or floss their teeth less than the recommended time or not at all. This study examined the mediating effect of two key self-regulatory processes, self-efficacy and planning, as the mechanisms that translate dental flossing intentions into behavior. Methods: Participants (N = 629) comprised young adults attending a major university in Queensland, Australia. A longitudinal design guided by sound theory was adopted to investigate the sequential mediation chain for the effect of dental flossing intentions (Time 1) on behavior (Time 3) via self-efficacy and planning (Time 2). Results: A latent variable structural equation model with standardized parameter estimates revealed the model was a good fit to the data. Controlling for baseline flossing, the effect of intentions on behavior was mediated via self-efficacy and planning, with 64% of the flossing variance accounted for by this set of predictors. Controlling for age and sex did not change the results. Conclusions: The results extend previous research to further elucidate the mechanisms that help to translate oral hygiene intentions into behavior and make a significant contribution to the cumulative empirical evidence about self-regulatory components in health behavior change.

Key words: self-efficacy, planning, dental flossing, oral hygiene

Introduction

Worldwide estimates for the prevalence of oral health conditions indicate that nearly 100% of the adult population experiences dental caries (i.e. tooth decay) and 15% to 20% of adults aged 35-44 years severe periodontal (gum) disease [1]. These findings suggest the need for intervention in early adulthood to prevent periodontal disease as the disease can have profound effects leading to other serious conditions such as diabetes [2], chronic respiratory diseases [3], and some cancers (most notably associations between periodontal disease or tooth loss, and oral, gastric, and pancreatic cancers have been found [4]). Although life expectancy in Australia has risen by more than 30 years since the late 1800s, Australians are increasingly living with lifestyle-related ongoing or 'chronic' diseases and associated health conditions, health risks, and disability [5]. This includes latest evidence to suggest that despite the oral health of Australians improving overall, these positive health trends may now be on the decline [6]. From 2011 to 2012, there were 63,327 potentially preventable hospitalisations due to dental conditions, which may have been avoided with early intervention through improved oral hygiene practices [6].

Interdental cleaning, including the practice of regular use of dental floss or interdental brushes, is an effective preventive measure which impacts on both dental caries and periodontal disease [7-9]. Interdental cleaning is the practice of removing trapped food between the teeth and the biofilm of bacteria (dental plaque) that forms around the teeth and gums. Traditionally, dental floss has been used to achieve this and a systematic review concluded that flossing, in addition to toothbrushing, reduces gingivitis compared to toothbrushing alone [8]. For this reason, both the American and Australian Dental Associations recommend flossing at least once a day to help remove plaque [10,11]. Although a small number of studies have been conducted investigating dental flossing behaviors, with the majority conducted in young adult or adolescent populations [12-16], there is currently a dearth of research investigating the psychological factors underpinning oral health decisions. Indeed, a recent systematic review suggested a need for further prospective and experimental studies examining a range of psychological factors in relation to oral health in young people [17]. Given a large number of adults brush or floss their teeth less than the recommended time or not at all [18], the current study investigated the self-regulatory processes that impact dental flossing behavior in a sample of young adults attending university.

A lack of self-regulatory skills is associated with a disinclination to change health behaviors. This is because individuals are faced with multiple impediments that can have the consequence of forgetting to perform the behavior (i.e., prospective memory failure) and/or other goal-directed behaviors taking priority (i.e., goal reprioritization); or because individuals engage in sub-optimal intention elaboration and, thus, do not engage in sufficient detail of particular actions and opportunities that would allow realization of the intention [19]. If

individuals are not equipped with the means to meet these obstacles, then motivation alone will not be sufficient to change people's behavior. To overcome this limitation, self-regulatory processes are thought to operate in concert with motivational processes to ensure an intention is realized.

The Health Action Process Approach (HAPA) [20,21] provides a theoretical framework for the influence of intentional and self-regulatory factors in health behavior change. The HAPA proposes self-efficacy and planning as two key self-regulatory processes and assumes both operate in synergy to translate a behavioral intention into action. These processes involved in behavior change apply to the adoption as well as to the maintenance of health-enhancing behaviors. Beneficial effects of self-regulatory skills on health behaviour [22-26], including oral hygiene behaviours [27-30], have been reported. Thus, given the importance of self-regulatory factors such as self-efficacy and planning on interdental cleaning behaviors, the mediating effect between these factors are examined in the context of dental flossing.

Coping Self-efficacy: A Phase Specific Perception of Self-efficacy

If an individual does not believe in their capability to perform a desired action (i.e., lack of perceived self-efficacy), efforts to initiate or maintain the action may be difficult. Such beliefs can be the moving force to action or inaction while a person proceeds through a self-regulatory cycle. Schwarzer and Renner [31] suggest that at different points in time in the decision making process different patterns of social-cognitive predictor sets may emerge. This indicates that optimistic self-beliefs may be phase-specific within a self-regulatory cycle. For example, some individuals may have high confidence in their ability to floss their teeth on a daily basis and take initiative but have little confidence in their ability to maintain the desired behavior. In contrast, others may have high confidence in their ability to resist competing demands that could potentially thwart a flossing routine and to recover from the setback but have little confidence in getting started. Thus, perceived self-efficacy is seen as functional at different levels and at different points in time within a self-regulatory goal attainment process [20,31]. Whereas, task self-efficacy is a belief about individuals' confidence in their ability to execute a difficult or resource-demanding behavior and, thus, makes a difference in the preactional phase; coping self-efficacy describes optimistic beliefs about individuals' capability to deal with barriers that arise during the adoption and maintenance periods [20,31]. Adopting a new health behavior might be much more difficult to adhere to than originally expected; but, a self-efficacious person responds confidently with better strategies, more effort, and prolonged persistence to overcome such hurdles. Once an action has been taken, individuals with high coping self-efficacy invest more effort and persist longer than those who are not self-efficacious, and when setbacks occur, they recover more quickly and maintain commitment to their goals [20,31].

Planning: A Prospective Self-regulatory Skill

Planning is regarded as a prospective self-regulatory skill where an individual specifies the situational context in which one will enact to ensure behavioral performance is achieved. Behavioral intentions are more likely to be translated into action when people develop preparatory strategies, such as making action plans of approaching a difficult task. In this regard, plans are not actions and planning requires a mental representation of how to achieve some future outcome that allows the individual to mentally link the intended behavior with a particular context for its enactment, thus connecting the individual with good opportunities to act [19,32-34]. Planning may also include the anticipation of barriers and the generation of alternative behaviors to overcome those [20]. Thus, unlike action plans that connect the individual with good opportunities to act through a task-facilitating strategy (i.e., specifying when, where, and how to enact a behavior), coping plans protect good intentions from anticipated obstacles via a distraction-inhibiting strategy [20,35].

The Proposed Self-regulatory Mechanisms

Meta-analyses support the effects of self-efficacy and planning on health behaviours [36,37]. In the context of oral self-care, both self-regulatory processes have been found instrumental to improving people's oral hygiene practices [16,28,29,38-41]. Planning is conceptually distinct from concepts such as self-efficacy [42], which defines an individual's belief in their ability to succeed in performing specific actions and which may determine the amount of perseverance and effort invested in performing the action. When it comes to translating intentions into action, the most tested and, thus, well-established mechanism is to specify planning as a mediator between predictor and outcome variables [43]. Nonetheless, even when people make good plans, this does not guarantee that they will perform and maintain the planned action. They may try to floss a few times, but eventually discontinue their actions. Thus, coping self-efficacy may be needed. However, the functional role of self-efficacy, especially in the postintentional phase, is not well understood. Self-efficacy can be a facilitator of behavior as well as a consequence of behaviour [42].

The current study examined, using a longitudinal design guided by a theoretically driven sequential sequence, the mediating effect of coping self-efficacy and planning in translating dental flossing intentions into behaviour in a sample of young adults attending university. According to the HAPA [20,21], the influence of intentional and self-regulatory factors in the health behavior process can be specified as a sequential mediation chain, with self-regulatory processes not only acting as an immediate outcome of intentions but also as a predictor of subsequent behavior. Thus, it was predicted that the effect of intentions on behavior would be mediated via self-efficacy and planning, with those who are more self-efficacious and plan their behavior observed to have greater frequencies of dental flossing.

Method

Participants

Participants (N = 629; M_{age} = 21.21, SD = 4.88; female = 78.2%, n = 485) were young adults living in South East Queensland, Australia. Participants were recruited from a major university in Queensland, Australia via three methods: face-to-face at the university, online through email and social media (i.e. Facebook), and posters advertising the study displayed in common areas at the university. As an incentive to participate, individuals were able to enter a prize draw to win one of four AUD25 gift voucher or receive course credit if they were a first year psychology student.

Design and Procedure

The University Human Research Ethics Committee approved the study. A longitudinal design with three waves of data collection, each spaced one week apart, was adopted. This was to avoid common method variance contaminating the data. Measures at each time point were based on an empirically-supported theoretical temporal sequence based on the HAPA [20]. The Time 1 (T1) questionnaire was conducted face-to-face and assessed participants' intentions to floss. Time 2 (T2) and Time 3 (T3) were conducted by telephone and assessed participants' coping self-efficacy and planning (T2) and dental flossing behavior (T3). Consent was gained through the completion of the T1 questionnaire, and consent to contact participants for the T2 and T3 follow-up was given through the provision of contact details. Data across each time point were able to be de-identified and matched using a unique code identifier created by the participant.

Measures

Dental flossing behavior. At T1 and T3, three items measured dental flossing behavior. "Think about the past week. In general, how often did you floss?", scored *never* [1] to *very often* [7]; "Think about the past week. In general, to what extent did you floss?", scored *never* [1] to *a large extent* [7]; Think about the entire past week and count, how many times did you floss _____". As the three items did not have the same metric they could not be averaged to a sum score. Therefore, a single factor analysis over the three items was performed for each assessment point in time, and the factor scores (z values with a mean of 0 and SD of 1.00) were taken for the computation of descriptive results as reported in Table 1 and for the manifest variable regression analyses.

Intention. Intention at T1 was measured by two items [20]: "I intend to floss my teeth at least once a day" and "I intend to floss my teeth more than twice a day", scored *not at all true* [1] to *definitely true* [7]. The two intention items were significantly correlated, r = .61, $p < 0.01$.

Self-efficacy. Self-efficacy at T2 was measured by three items reflecting a sense of confidence about being capable to maintain dental flossing [20]: "I am confident that I can floss my teeth daily on a long-term basis..." "…even when I cannot see any positive changes immediately", "…even when I am in a hurry", and

"…even when it takes a long time to become part of my daily routine", scored *not at all true* [1] to *definitely true* [7]). Cronbach's alpha was .95.

Planning. Planning at T2 was measured by eight items and assessed the extent to which one had made action and coping plans [20,35]: "I have made a plan regarding..." "… when to floss my teeth", "… where to floss my teeth", "… how to floss my teeth", "… how to use dental floss", "… what to do if something interferes with my goal of flossing", "…how to cope with possible setbacks (such as bleeding gums)", "… what to do in difficult situations (such as being in a hurry) in order to stick to my intentions", and "…when I have to pay extra attention to prevent lapses", scored *not at all true* [1] to *definitely true* [7]). Cronbach's alpha was .92.

Analytic Procedures

Computations were performed with SPSS 23, with the SPSS Process macro by Hayes [44] as well as with MPLUS 7.4 [45]. To explore the multiple mediation hypothesis, a manifest variable model was specified in which self-efficacy and planning as putative mediators were regressed on flossing intentions; whereas flossing at T3 was regressed on intentions and the two mediators, self-efficacy and planning, controlling for age and sex. Confidence intervals (95%) were generated by bootstrapping with 5,000 re-samples. Listwise deletion of missing values was applied. The model was then respecified as a multiple-indicator latent-variable model and analysed with MPLUS using the full information maximum likelihood (FIML) estimation that accounts for missing values. Model fit was evaluated in terms of the comparative fit index (CFI), the Tucker-Lewis-Index (TLI) and the root mean square error of approximation (RMSEA).

Results

Means, standard deviations, and intercorrelations are shown in Table 1. As displayed in Table 1, intention, self-efficacy, and planning all significantly correlated with behavior.

[Insert Table 1 about here]

Attrition Analysis

Out of a total N=629 participants who attended the baseline assessment, a subsample of n=288 (46%) and n=254 (40%) completed T2 and T3 data collection, respectively. To examine possible attrition bias, a multivariate analysis of variance was computed with all Time 1 study variables as dependent variables and a drop-out code as fixed factor. The only significant difference (p<0.01) between returning participants and those who had dropped out at T3 was for age (returning: M=22.2 years, SD=6.4, dropped out: M=20.5 years, SD=3.3). Due to the high drop-out rate, all analyses were run twice, first with listwise deletion of missing values, afterwards with the missing imputation procedure provided by default with FIML.

Multiple Mediation Analysis with Manifest Variables

In the single-indicator manifest variable model, the following unstandardized parameters were estimated. The effect of flossing intention on planning was b=0.57, CI 95% [0.47, 0.67], the effect of flossing intention on self-efficacy was b=0.56, CI 95% [0.46, 0.67], the effect of planning on flossing was b=0.16, CI 95% [0.08, 0.23], the effect of self-efficacy on flossing was b=0.15, CI 95% [0.08, 0.21], and the baseline control T1 flossing on T3 flossing was b=0.24, CI 95% [0.11, 0.36]. The total indirect effect of T1 intention on T3 flossing via the two mediators was b=0.17, CI 95% [0.12, 0.23]. Of the T3 flossing variance, 64% were accounted for by this set of predictors. Controlling for age and sex did not change the results.

Structural Equation Model with Multiple-indicator Latent Variables

A structural equation model was specified in which each factor had more than one indicator. All items that were assessed for each construct were chosen to serve as indicators. Thus, the intention factor at T1 had two indicators, planning at T2 had eight indicators, and self-efficacy at T2 had three indicators. Dental flossing behavior at T1 and T3 were composed of three items each. Age and sex were included in the model as exogenous control variables. Model fit was good with $chi^2 = 522.8$, $df=177$, $p<0.01$, CFI=0.94, TLI=0.93, RMSEA=0.056, CI 90% [0.05, 0.06], $p=0.043$. Figure 1 displays the latent variable structural equation model with standardized parameter estimates, and Table 2 reports the estimates for the measurement model.

[Insert Figure 1 about here]

[Insert Table 2 about here]

Discussion

The majority of the population has dental caries, with a significant proportion suffering from severe periodontal disease [1]. Both are major causes of tooth loss which can have negative consequences on individuals' quality of life in terms of functionality, self-esteem, and social relationships [46]. Good oral hygiene, with compliance to protective measures, can prevent oral diseases. However, despite the benefits of adherence to good oral hygiene behaviors, many adults do not brush or floss their teeth according to current recommendations. It is therefore important that intervention efforts target young adults to prevent negative outcomes from poor oral hygiene practices in later adulthood. Self-regulatory skills may be necessary for individuals to action oral hygiene behaviors. Drawing on the HAPA [20,21], the aim of the current study was to examine the mediating effect of two key self-regulatory processes, self-efficacy and planning, as the mechanisms that translate dental flossing intentions into behavior in a sample of young adults attending university.

The findings of the current study support the tenants of the HAPA in that the effects of intention on behavior were mediated via self-efficacy and planning [20,21]. This suggests that self-regulatory skills are needed to equip individuals with the means to cope with obstacles that may arise and potentially thwart their

intentions to floss. It is important, then, for future interventions to improve young people's oral health to include elements of both self-efficacy and planning. Although there have been a small number of oral health interventions using self-regulatory strategies to improve behavior [27-30], these studies have been limited in the time period participants were followed up. Thus, behavioral maintenance is unknown, and process data on the intervention itself (i.e., assessing the number and quality of plans participants generate) were not collected. Further, these studies did not test an intervention that combined self-efficacy and planning as the leading behavior change components. Behavior change interventions need to incorporate methods directly targeting these potential treatment components to determine if indeed these two self-regulatory processes are important in promoting and maintaining regular dental flossing among young adults.

Interventions to improve self-efficacy that have manipulated mastery experience (i.e., practicing a behavior) and vicarious experience (i.e., observing a model performing the behavior) have been shown to be successful [47]. Feedback on past or others' performance has also been found to produce high levels of self-efficacy [36]. For planning, it is important to consider the beneficial effect of planning for subsequent intended behavior may be dependent on the skill of the planner and the quality of the plan [48]. Thus, making good plans may matter. To ensure planning is effective, plans developed may follow the SMART principles. Plans need to be *specific* (a narrow behavior), *measurable*, *assignable* (who will perform), *realistic*, and *time-related* (when to perform the action). These are well-known principles that stem from the field of business management and help to guide individuals in writing goals and objectives [49]. These principles could also be incorporated into a structured plan for task completion, also known as an 'implementation intention' [50]. For example, I will… (action) at… (time) on… (day) before/after…; "I will floss my teeth at bedtime on each night of the week after I brush my teeth".

Although the strengths of the current study include the longitudinal design that was grounded in sound theory following a sequential mediation chain, the findings need to be interpreted in light of its limitations. A phone follow-up method was used to assess behavior; thus, demand characteristics may have influenced reported dental flossing, potentially inflating the recall of flossing instances. Future studies may control for demand characteristics through the use of deception or manipulation checks as suggested by Goodwin [51]. In addition, assessments were self-reported and dental flossing was measured retrospectively for the past week. As an alternative to self-report, one could use on-going behavioral assessments such as dental calendars that allow for constant record keeping [52]. Dental floss could also be provided to objectively measure behavior. In the study by Schüz et al [52] residual dental floss from participants' remaining product that was returned on completion of the study was measured, finding a correlation of $r = .65$ with self-reports. Other studies have found even higher

correlations [53]. Finally, the attrition rate in the current study was 40% and the sample comprised of university students potentially limiting generalizability. However, it should be noted that no differences (except for age) were observed between completers and drop-outs and analyses were conducted twice, first with listwise deletion of missing values then with the missing imputation procedure provided by default with FIML. Other studies have also found attrition to be higher among younger samples, suggesting a lack of participants being recontactable as a reason for the greater dropout rate [54]. To reduce attrition in longitudinal studies, previous research among young adults has suggested that employing social networking (e.g., redirecting participants to a Facebook page of the study) as a communication method may increase response rates [55]. This is because Facebook accounts as opposed to email accounts typically remain constant. Future research may benefit from exploring the use of population social media sites for young adults attending university to improve attrition rates. Overall, the current study extends previous research to further elucidate the mechanisms that translate oral hygiene intentions into behavior. The current study is among the first to adopt a longitudinal design guided by sound theory to investigate the sequential mediation chain for the effect of intention on behavior via postintentional coping self-efficacy and planning. The findings make a significant contribution to the cumulative empirical evidence about self-regulatory components in health behavior change.

Compliance with Ethical Standards

Conflict of interest: Author A declares that he/she has no conflict of interest. Author B declares that he/she has no conflict of interest. Author C declares that he/she has no conflict of interest. Author D declares that he/she has no conflict of interest. Author D declares that he/she has no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Table 1. Descriptive Analysis for the Target Behavior of Dental Flossing: Means (*M*), Standard Deviations (*SD*), and Bivariate Correlations.

	M	*SD*	2.	3.	4.	5.	6.	7
1. Sex (485 women, 135 men)			-.13**	.14**	.15*	.15**	.16**	.14***
2. Age (years)	21.21	4.88		.10*	.09	.04	.01	.02
3. Flossing T1[a]	0	1.00			.68**	.63**	.58**	.58**
4. Flossing T3[a]	0	1.00				.64**	.65**	.69**
5. Intention T1	2.67	1.73					.58**	.61**
6. Self-efficacy T2	4.56	1.73						.64**
7. Planning T2	3.29	1.60						

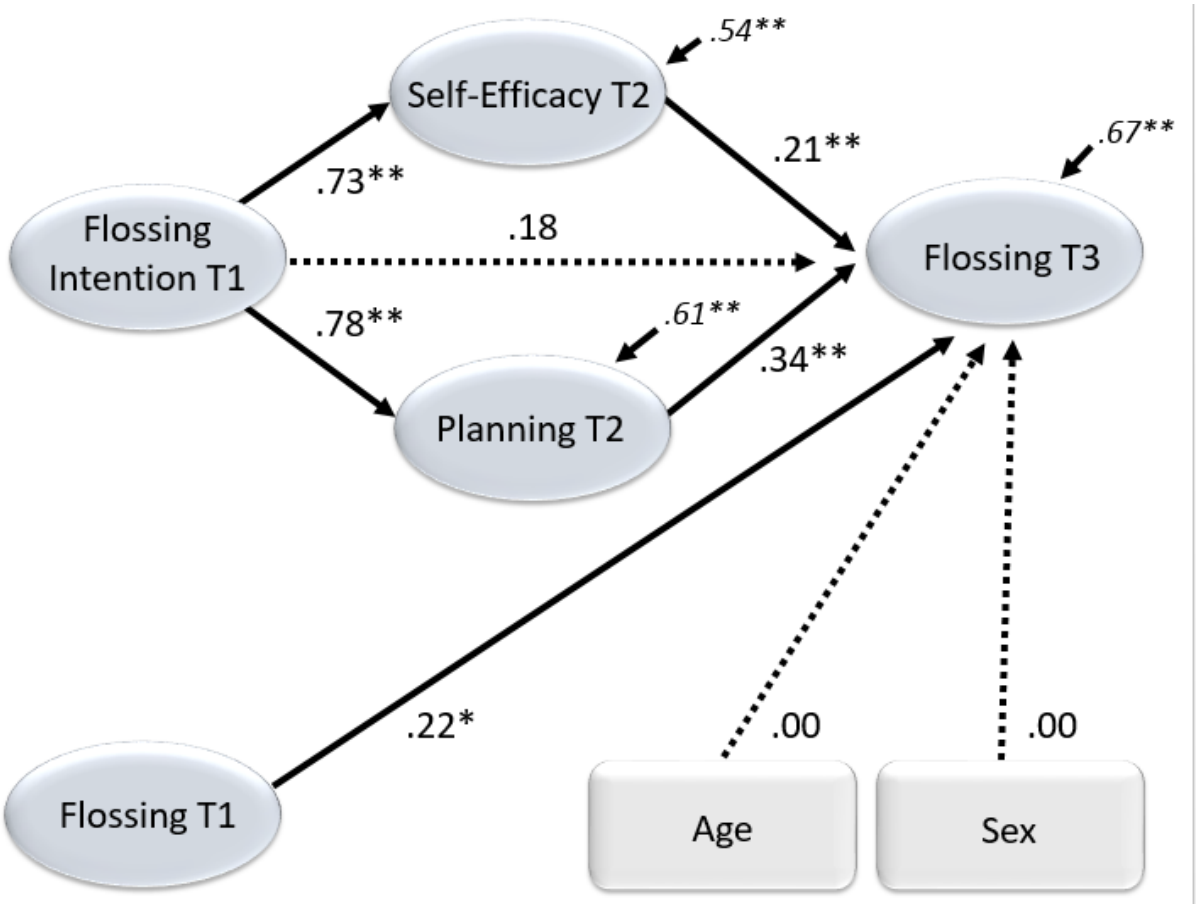
Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; sex: women=0, men=1; a = standardized (z values) based on factor scores

Table 2: Multiple-indicator Measurement Model for Dental Flossing Behavior: Standardized MPLUS Estimates of Factor Loadings.

Factors and Indicators	Loadings	Standard Errors
intent1		
intent11	0.888	0.018
intent12	0.639	0.027
floss1		
floss11	0.979	0.007
floss12	0.928	0.009
floss13	0.640	0.025
floss3		
floss31	0.980	0.007
floss32	0.935	0.010
floss33	0.848	0.018
self2		
self21	0.927	0.011
self22	0.920	0.012
self23	0.925	0.011
plan2		
plan21	0.893	0.015
plan22	0.811	0.022
plan23	0.851	0.019
plan24	0.753	0.027
plan25	0.680	0.034
plan26	0.553	0.043
plan27	0.725	0.030
plan28	0.723	0.030

Note: All estimates significant at $p<0.001$

Figure 1: Latent variable structural equation model with standardized coefficients: self-efficacy and planning at T2 mediate between flossing intention at T1 and flossing behavior at T3, controlling for baseline behavior, age, and sex.



Note: Circles are latent variables, rectangles (sex, age) are exogenous single indicator variables. Multiple indicators and bivariate factor correlations are omitted from the figure. Path coefficients are standardized MPLUS parameter estimates. Dotted lines indicate nonsignificant paths. *$p < 0.05$, **$p < 0.01$