

## Title Page

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Social psychological predictors of sleep hygiene behaviors in Australian and Hong Kong university students

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## Social psychological predictors of sleep hygiene behaviors in Australian and Hong Kong university students

### Abstract

**Background.** Sleep hygiene behaviors in undergraduate students are associated with night-time sleep duration and quality, fatigue, daytime sleepiness, and psychological distress. This study aimed to identify the social psychological factors that impact on university students' sleep hygiene behaviors in samples from two countries. **Methods.** Participants were undergraduate students from Australia ( $N=201$ ) and Hong Kong ( $N=161$ ). The study used a correlational-prospective design. Individuals self-reported their intention, attitude, subjective norms, perceived behavioral control, and past behavior with respect to sleep hygiene behaviors. Four weeks later, the students self-reported their action plans and participation in sleep hygiene behaviors. **Results.** Analysis indicated acceptable model fit to data for both the Australian and Hong Kong samples. Results showed significant direct effects of attitude, subjective norms, perceived behavioral control, and past behavior on intention, and significant direct effects of action planning and past behavior on prospectively measured sleep hygiene behavior. There were also significant indirect effects of attitude, subjective norms (Hong Kong sample only), and perceived behavioral control on behavior mediated by intention and action planning. Overall, the model predicted a large portion of the variance in sleep hygiene behavior for both the Australian ( $R^2= .524$ ) and Hong Kong ( $R^2= .483$ ) samples. Schenker and Gentleman *t*-tests found no parameters significantly differed between samples. **Conclusions.** Current results indicate that university students' sleep hygiene behaviors are a function of both motivational and volitional processes. This knowledge provides formative data to inform the development of behavior change interventions to improve the sleep hygiene practices of university students.

**Keywords:** social cognition; theory of planned behavior; action planning; sleep hygiene; university students

## Introduction

Sleep is an important biological process, which has shown to impact individuals' psychological health (e.g., emotional stability and stress response) [1,2], physical health (e.g., function of immune system, metabolic rate, and pain tolerance) [2,3], behavior (engagement in health-enhancing rather than health-risk behaviors) [1,4], and cognition (e.g., cognitive performance and memory consolidation) [2,4]. A number of studies have demonstrated that sleep duration, quality, and pattern are positively correlated with academic motivation, achievement, performance, and retention rate of university students [4-7]. In order to maintain optimal health and functioning, it is recommended that adults sleep at least 7 hours per night [8]. However, research has shown that approximately 12% of Australians sleep less than 5.5 hours per night [9]. A similar pattern has been found in the Hong Kong population, with an average sleep duration of 6.5 hours reported [10].

According to the National Sleep Foundation [11], sleep hygiene is a set of behaviors that impact sleep quality and duration [12-13] and can be categorized into five different areas including: 1) behavioral factors (e.g., have regular exercise but avoid strenuous workouts close to bedtime; and avoid food that can trigger indigestion right before sleep such as heavy or rich foods, fatty or fried meals, spicy dishes, citrus fruits, and carbonated drinks), 2) cognitive factors (e.g., avoid worrying and planning right before bedtime), 3) environmental factors (e.g., use comfortable mattress and pillows; be mindful of room temperature, sound, and light; and turn off electronic devices before bed), 4) sleeping pattern (e.g., have a regular sleep schedule and bedtime routine, limit daytime naps to 30 minutes, ensure exposure to sunlight during the day and darkness at night), and 5) substance use (e.g., avoid stimulants such as caffeine and nicotine close to bedtime).

Studies with undergraduate students have revealed that sleep hygiene behaviors are associated with night-time sleep duration and quality, fatigue, daytime sleepiness, and psychological distress [14-15]. Healthy sleep hygiene behaviors help individuals maintain sleep quality and daytime functioning in two different ways. First, individuals who adhere to good sleep hygiene practices are more likely to have sufficient sleep which, in turn, predicts better psychological and physiological functioning [7,12]. Second, sleep hygiene behaviors facilitate the stabilization of circadian rhythms, which are the cycles of melatonin secretion in a 24-hour period [16-18]. Circadian rhythms are controlled environmental factors (e.g., lightness and darkness) [17]. Thus, adhering to sleep hygiene behaviors (e.g., having a regular sleep schedule and bedtime routine and sleeping in a dark room) may assist individuals to maintain a healthy circadian rhythm which, in turn, assists to increase sleep quality and the amount of sleep.

Despite the importance of adhering to good sleep hygiene behaviors, little is known about the social psychological processes involved in predicting this important health behavior and, moreover, tested if processes translate to individuals in different countries. What is well known is that people who are motivated to act often do not behave according to their intentions [19]. The reasons for these failures to act may be because individuals, in particular university students in the context of the current study, are faced with multiple impediments (e.g., competing study demands) that may derail attempts to engage in intended behaviors. If individuals are not equipped with means to meet these obstacles or their cognitive capacity is low (such as during times of heavy assessment), then motivation alone will be insufficient to ensure one acts on their intentions. To overcome this limitation, volitional processes (e.g., action planning) are thought to operate in concert with motivational processes (e.g., attitudes, intentions). To date, there is a dearth of research that has examined how the social psychological constructs that underpin these

processes operate together to explain sleep hygiene behavior, and no attempt has been made to formally test these in samples from different countries.

Gaining this knowledge is important as insufficient sleep appears to be a global issue among university students. For example, in Australia, reports indicate that only 49% of university students have 7 hours or more sleep per day, including day-time naps and night-time sleep [20]. In Hong Kong, the average weekday sleep duration reported among university students is 6.9 hours, and nearly 70% report experiencing sleep deprivation [21]. Interestingly, even spending less time travelling to campus, Hong Kong students who are living on-campus report poorer sleep quality and quantity than those living off-campus [21]. One possible reason for the poorer sleep outcomes of Hong Kong students may be that they are more susceptible to the influence of peers. Being in a collective environment, students in Hong Kong may perceive more pressure from important others (e.g., peers) to sacrifice their personal goals (e.g., having a good sleep) for social activities on campus to maintain good relationships [22]. The aim of the current study, therefore, was to identify the social psychological factors that impact on university students' sleep hygiene behaviors and test if the predictions hold across samples in two different countries; Australia and Hong Kong.

### **Social Psychological Predictors**

Taking a theoretical approach to the study of sleep hygiene behaviors is important as it provides an a priori framework on which to base hypotheses and test them against real-world observations. In examining the major theories used to understand health behavior, it is apparent that intention is proposed as the most proximal predictor of behavior. In the theory of planned behavior (TPB) [23], a prominent social-cognitive theory of behavior [24-25], intention is central to the model. Specifically, the TPB states intention as the proximal predictor of behavior, with

intention predicted by attitude (overall evaluations of the behavior), subjective norms (perceived social pressure to perform the behavior), and perceived behavioral control (perceived capacity to carry out the behavior), with perceived behavioral control further hypothesized to predict behavior. It should also be noted that past behavior is often included as a predictor of intention and behavior.

In the process of motivation, intention is often regarded as a kind of ‘watershed moment’ between an initial goal setting phase (motivational phase) and a subsequent goal pursuit phase (volitional phase) [26]. It should be acknowledged, however, that the construct of intention, despite its importance in explaining behavior, has some inherent limitations as a predictor of behavior. This is supported by meta-analytic research which has shown relatively modest correlations for the intention-behavior link [27-28]. For example, when trying to act on intentions, individuals may face various obstacles such as distractions, forgetting, or competing demands, that may thwart their intention. If not equipped with strategies to overcome these obstacles, intention alone will not be sufficient to change behavior. To overcome this limitation, volitional constructs, such as making action plans, are required that operate in concert with the intention.

In attempting to explain individuals’ behavior, hybrid models, such as the health action process approach (HAPA) [29], that combine features of stage and continuum social cognition models, have differentiated between motivational and volitional phases when it comes to understanding motivated action. According to the HAPA, individuals form an intention to engage in a goal directed behavior in the motivational phase. This is followed by a volitional phase where a range of self-regulatory strategies are enacted to ensure an intention is realized. Action planning is an important self-regulatory determinant in the volitional phase. The construct

is theorized as being a proximal determinant of behavior and distinct mediator likely to ensure that one's intention is translated to behavior, previously referred to as a *dual mediation model* [30]; intention fosters planning which, in turn, facilitates behavioral action. Specifically, action planning is considered a prospective strategy that pertains to a mental simulation of when, where and how to act in line with the intention. It aims to create new contingencies between (external) situational cues (e.g., if it is 10pm) and behavioral responses (e.g., then I will go to bed). Previous research in a range of health behaviors has shown support for planning mediating the intention-behavior relationship [31-34], with intervention studies also supporting complementary effects of action planning [35-36].

### **The Current Study**

We aimed to examine the social psychological predictors of sleep hygiene behaviors in Australian and Hong Kong University students using an integrated model of behavior with constructs derived from theories of social cognition and volition. The social-cognitive pathways are represented by the constructs from the TPB [23]. The volitional pathways are represented by the effects of action planning on the intention-behavior relationship, as represented in the HAPA [29]. All of these processes are stated formally in a series of a priori hypotheses listed in Table 1.

Turning first to the motivational effects in the proposed model, and consistent with the TPB [23] and meta-analytic studies in health behavior [24-25], attitude, subjective norms, and perceived behavioral control are proposed to predict intention; and intention and perceived behavioral control are proposed as predictors of behavior. Consistent with the HAPA [29] and meta-analytic research [37] which support a volitional process that operates in a post-decisional manner to facilitate the enactment of goal intentions, it is proposed that intention would predict action planning and action planning would predict behavior. Finally, model effects are expected

to hold while adjusting for past behavior. This is an important consideration as previous research often demonstrates the pervasive effects of past behavior on behavior in tests of psychological theories in health contexts [38-39]. Past behavior is therefore needed to evaluate model efficacy; if past behavior attenuates model effects to trivial values, then the model would be considered redundant. In the current study, it is proposed that significant effects of past behavior on all constructs in the model will emerge. A set of indirect effects are also proposed. Consistent with Ajzen's [23] exposition of the TPB, it is proposed that indirect effects of attitude, subjective norms, and perceived behavioral control on behavior through intention will emerge. Consistent with hypotheses from the HAPA [29], action planning is proposed to mediate the effect of intention on behavior. We make no specific hypotheses regarding differences between the two samples on the social psychological factors, although given previous research on social norms in individualistic (i.e., Australia) and collectivist (i.e., Hong Kong) cultures, it could be speculated that Australian and Hong Kong students might react differently to social pressures regarding sleep [22].

## **Method**

### **Participants**

At Time 1 (T1), undergraduate university students from Australia (N = 329) and Hong Kong (N = 285) completed study measures. Twelve students from the Hong Kong sample were excluded due to incomplete T1 data. At the Time 2 (T2) follow-up, four weeks later, 126 Australian and 112 Hong Kong participants did not provide complete data. Further, two Australian participants were flagged as significant multi-variate outliers (Mahalanobis distance  $p < .001$ ). Thus, the final sample comprised 201 undergraduate students from Australia ( $M_{Age} = 22.82$ ,  $SD_{Age} = 8.89$ ; 36 Male, 165 Female) and 161 undergraduate students from Hong Kong

( $M_{\text{Age}} = 20.47$ ,  $SD_{\text{Age}} = 7.80$ ; 77 Male, 84 Female). See Table 2 for the demographic characteristics of the two samples.

## Measures

The social psychological constructs were measured on multi-item psychometric instruments developed using standardized guidelines [23,40] and adapted for use with the target behavior in the current study. The TPB constructs of attitude, subjective norms, perceived behavioral control, and intention as well as past sleep hygiene behavior were assessed at T1. Sleep hygiene behavior and action planning were assessed four weeks later, at T2. Sleep hygiene behaviors were defined according to the National Sleep Foundation [11], and participants were asked to keep these behaviors in mind when answering the questions. All measures are presented in full in Table 3.

**Demographics (T1).** Demographic information was assessed with items requesting participant age, sex, marital status, level of education, and university attendance status.

**Past behavior (T1) and behavior (T2).** Sleep hygiene behavior over the previous month was measured using a two item self-report scale assessing the frequency of sleep hygiene behaviors, scored (1) *never* to (7) *very often* (e.g., “Think about the past month, how often did you follow good sleep hygiene habits”).

**Intention (T1).** Student intention to perform sleep hygiene behaviors in the next month was measured using four items, scored (1) *strongly disagree* to (7) *strongly agree* (e.g., “I intend to follow good sleep hygiene habits”).

**Attitude (T1).** Students’ attitude towards performing sleep hygiene behaviors in the next month was assessed using 5 semantic differential items with the common stem “For me, to

follow good sleep hygiene habits every day in the next month would be...". Each item was scored 1 to 7 on a bipolar scale (e.g., (1) *good* to (7) *bad*).

**Subjective norms (T1).** Subjective norms for sleep hygiene behavior was assessed using five items assessing how likely students' believe important others in their life would want them to perform sleep hygiene behaviors as well as do the behaviors themselves, scored (1) *strongly disagree* to (7) *strongly agree* (e.g., "In regards to following good sleep hygiene habits every day in the next month, most people would want me to follow good sleep hygiene habits").

**Perceived behavioral control (T1).** Perceived behavioral control was assessed using four items measuring students' level of self-efficacy and control over performing sleep hygiene behavior, scored (1) *strongly disagree* to (7) *strongly agree* (e.g., "In regards to following good sleep hygiene habits every day in the next month, I am confident I can follow good sleep hygiene habits")

**Action planning (T2).** Action planning was measured by four items developed by Sniehotta, Schwarzer, Scholz, and Schuz [40] and assessed the extent to which individuals' had made a plan in relation to performing sleep hygiene behaviors. Participants were required to respond to the stem: "I have made a plan regarding..." followed by the four items of the scale (e.g., "...when to perform sleep hygiene behaviors") on Likert scales ranging from *not at all true* (1) to *exactly true* (7).

## **Design and Procedure**

The study was conducted at two major universities in Australia and Hong Kong. The University Human Research Ethics Committee of both universities approved the study. Participants were recruited across the University, and completed both the T1 and T2 questionnaire during the University term. The data collection period was similar between the two

universities (i.e., 4 months). The study used a prospective-correlational design with a four-week behavioral follow-up. At Time 1 (T1), students completed a questionnaire either face-to-face (Hong Kong students) or on-line (Australian students) assessing social psychological constructs of attitude, subjective norms, perceived behavioral control, intention, and past behavior.

Demographic variables were also collected. At Time 2 (T2), students' action planning was assessed as well as their self-reported sleep hygiene behavior over the previous four weeks. Both the English and traditional Chinese versions of the surveys were piloted tested by two Australian and two Hong Kong university students, respectively. This was to assess for the clarity of language expression and instructions, as well as to estimate the time to complete the survey. The survey took about 10-15 minutes to complete and both English and traditional Chinese surveys were deemed comprehensible. Consent was gained through the completion of the T1 questionnaire, and consent to contact participants for the T2 follow-up was given through the provision of contact details. On completion of the study, eligible Australian students were awarded course credit, no other incentives were offered.

### **Data Analysis**

Data were analyzed using scripts R using the LAVAAN package [41-42]. Scripts were based upon templates available in the ShareSEM project [43]. In the proposed model, and based on the TPB, attitudes, subjective norms, and perceived behavioral control were specified as predictors of intention, intention as a predicted behavior, and attitudes, subjective norms, and perceived behavioral control as predictors of behavior indirectly via intentions. Perceived behavioral control was also specified as a direct predictor of behavior. Further, the volitional construct from the HAPA, action planning, was specified as a mediator of the intention-behavior

relationship. Past behavior was included as a direct predictor of all study constructs and follow-up sleep hygiene behavior.

We computed direct and indirect effects using covariance based multi-group structural equation modeling with a Satorra-Bentler adjusted maximum likelihood estimator and robust standard errors. Model fit was assessed using  $\chi^2$  Goodness-of-fit index, which should ideally be non-significant; the comparative fit index (CFI) and the Tucker-Lewis index (TLI), which should be above .9 for adequate fit; the standardized root mean squared residual (SRMR), which should ideally be below .08; and the root mean square error of approximation (RMSEA), which should be below .08 and not significantly difference from .05 ( $\alpha = .05$ , 1 tailed). Standardized factor loading over .5 were considered acceptable. Parameter estimates between the two samples were compared with a series of Schenker and Gentleman *t*-tests [44]. As 28 parameters are compared, a Bonferroni corrected  $\alpha$  of .002 was adopted for *t*-tests. All data, codes, and materials are available at <https://osf.io/ufq2v/>.

## Results

### Preliminary Statistics

Full demographic information is presented in Table 2. Attrition analysis indicated that for both samples, participants who completed the T2 follow-up survey did not significantly differ from the T1 sample on gender (Australia  $\chi^2(1) = .51, p = .474$ ; Hong Kong  $\chi^2(1) = .91, p = .341$ ) or university attendance status (Australia  $\chi^2(1) = 1.71, p = .192$ ; Hong Kong  $\chi^2(1) = 1.32, p = .250$ ). In the Australian sample, older participants were more likely to complete the follow-up survey ( $t(327) = 3.28, p = .001, d = .36$ ); however, no significant difference was found regarding Hong Kong participants ( $t(283) = 1.89, p = .060$ ). Participants who did not complete follow-up survey also did not differ from those who completed only T1 on past behavior or on the social

psychological variables (Australia Pillai's Trace = .023,  $F(5,324) = 1.32$ ,  $p = .255$ ,  $\eta_p^2 = .020$ ; Hong Kong Pillai's Trace = .033,  $F(5,268) = 1.84$ ,  $p = .105$ ,  $\eta_p^2 = .033$ ). Correlations, descriptives, and reliability statistics for all constructs in the final samples are presented in Table 4.

### **Multi-Group Structural Equation Modelling**

Analysis indicated acceptable model fit to data ( $\chi^2(518) = 846.49$ ,  $p < .001$ ; CFI = .942; TLI = .932; RMSEA = .059 (.053, .065),  $p = .009$ ; SRMR = .068). The model in both samples is presented in Figure 1 and all parameter estimates are presented in Table 5. Factor loadings were acceptable for all items<sup>1</sup>.

As expected, the effect of intention on follow-up sleep hygiene behavior was mediated through action planning in both samples, yet the expected direct effect of intention on follow-up behavior was not found. Consequently, despite the significant positive paths to intention from attitude, subjective norms, and perceived behavioral control, no TPB constructs predicted follow-up sleep hygiene behavior indirectly through the direct intention-behavior path. Instead, attitudes and perceived behavioral control positively predicted follow-up sleep hygiene behavior indirectly via intention and action planning in both samples, as predicted. Subjective norms also positively predicted follow-up sleep hygiene behavior indirectly via intention and action planning in the Hong Kong sample, but not in the Australian sample. Perceived behavioral control did not significantly predict follow-up sleep hygiene behavior in either sample. The predicted direct positive relationship between past and follow-up sleep hygiene behavior was found in both samples. Past behavior also indirectly positively predicted follow-up behavior in both samples via action planning. The TPB variables significantly positively mediated the role of

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<sup>1</sup> For completeness, model invariance testing was conducted (see Supplementary Material). Results are available at <https://osf.io/tfq2v/>

past behavior on follow-up sleep hygiene behavior in Hong Kong students, but this effect was not present in the Australian sample. Overall, the model predicted a large portion of the variance in follow-up sleep hygiene behavior for both the Australian ( $R^2 = .524$ ) and Hong Kong ( $R^2 = .483$ ) samples. Schenker and Gentleman *t*-tests [44] found no parameters significantly differed between samples (all  $p$ 's > .011).

### **Discussion**

The beneficial effects of good sleep are undeniable, and good sleep hygiene behaviors have been shown to impact sleep quality and quantity [14-15]. Thus, this study aimed to gain an understanding of the social psychological predictors of sleep hygiene behaviors in a sample of Australian and Hong Kong University students. A key contribution of the current research is the confirmation of multiple pathways by which students' social psychological constructs affect their sleep hygiene behavior. Of note, and consistent with the theorizing of major theories of social cognition, specially the HAPA [29], action planning was found to account for the intention-behavior effect and, moreover, the social cognitive factors of the TPB were found to effect behavior mediated via intention and action planning. These findings indicate that university students' sleep hygiene behaviors are a function of both motivational and volitional processes, and provide necessary formative data to inform the development of behavior change interventions to improve the sleep hygiene practices of university students.

Based on current findings that both motivational and volitional processes predict sleep hygiene behaviors, future interventions should target these dual processes to increase good sleep hygiene behaviors among university students, ideally using a multifaceted approach, and assess the effects of the techniques on both behavior change and the targeted integrated theory constructs. By identifying key theory-based constructs, the findings of the current study can be

translated into practice by linking key predictors identified with relevant behavior change techniques [45], to develop effective empirical- and theory-based interventions to facilitate students' engagement in good sleep hygiene behaviors.

An easy approach might be to increase awareness and knowledge through information provision (e.g., information about antecedents, information about health consequences, pros and cons,) and communication-persuasion (e.g., credible source, framing/reframing) about sleep hygiene behaviors. Such approaches are arguably the most common methods used in changing behavior [46], and often work through changing attitudes [47-48]. However, reviews on health behavior interventions suggest that the evidence relates more to short-term effects rather than sustained, longer-term impact [49]. Another approach could be the use of sleep education programs that include the use of sleep diaries in addition to knowledge giving about sleep, sleep disorders, and sleep-promoting behaviors [50-51]. Such education programs have shown to significantly improve students' knowledge of sleep and sleep-promoting behaviors [51]. It has also been suggested that these education programs be integrated into lectures, especially for health science students (e.g., nursing students), as students' knowledge about managing patients as well as their own sleep related issues increases [50]. Further, it is suggested that multi-component programs achieve greater success in changing health behavior [52]. Thus, other approaches in addition to those focused on changing attitudes and behavior through information provision and communication-persuasion are needed for effective and long-term behavior change [53].

Based on current findings, therefore, strategies to increase students' perceptions of social norms, especially in Hong Kong students (e.g., social support provisions), and perceptions of control (e.g., mastery experience, behavioral modelling) could also be considered to promote

intentions and, indirectly, behavior. For example, interventions to improve self-efficacy (also conceptualized in the construct perceived behavioral control) 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, as have interventions that provide feedback on past or others' performance [54-55]. It should be noted that the indirect effect of subjective norms on behavior was only found in the Hong Kong sample. Although this may provide preliminary evidence for differences between the samples, suggesting that students from collectivist cultures (i.e., Hong Kong) may be more influenced by social pressures [22], no parameters were found to significantly differ between samples.

Another key finding was the direct effect of action planning on behavior, and the indirect effect of intention on behavior via action planning. This suggests that it is important that students learn and implement planning techniques with regard to their sleep hygiene behaviors. Whereas intentions can be thought of as “what” individuals pursue, action planning involves the further specification of the intention encompassing the “when”, “where” and “how” elements of the behavior [29]. It is important to note that the effect of planning for future behavior may depend on the skill of the planner and the quality of the plan; good plans matter [56]. Students, therefore, could be taught how to make SMART plans – where plans need to be *specific* (a narrow behavior), *measurable*, *assignable* (who will perform), *realistic*, and *time-related* (when to perform the action) [57]. These principles could also be incorporated into an implementation intention; also termed “if-then” plans, whereby a link is forged between a cue and subsequent behavioral response [58].

### **Strengths and Limitations**

To date, there is a dearth of research that has investigated how social psychological factors operate to explain sleep hygiene behavior or that has attempted to integrate multiple processes into a testable model and test the model across samples from different countries. The current study addresses these limitations by applying an integrated model incorporating motivational and volitional components to the area of sleep hygiene behaviors and testing the model in an Australian and Hong Kong sample. Although the current study design does not permit the inference of causality on the basis of the data, only theory, findings do highlight important potential routes to behavioral engagement, which can be used as a basis for intervention. In addition, the large samples of university students across two countries enable model effects to be tested in different cultural groups.

Despite these strengths, current findings should be considered in light of some limitations. As shown in Table 2, the sample predominately comprised non-married, full-time students, with a greater proportion of females in the Australian sample. Thus, current results may not generalize across other student groups. Self-report measurement limitations also need to be taken into account when interpreting the findings, which may be susceptible to social desirability and recall bias. It has been suggested, however, that both objective and subjective measures are equally important for sleep research, as they represent unique and equally significant constructs for sleep studies [59]. Also, due to university policy and resource constraint, the recruitment methods (i.e., online- versus paper-based questionnaires) and incentive structures were different between the two samples. A study comparing response bias of online- and paper- based surveys has shown that research participants only tend to skip sensitive questions on online survey designs [60]. As no sensitive questions were asked in the current study, the different types of survey delivery perhaps presents limited problems. In addition, research has demonstrated

support for the presence of measurement equivalence in data obtained from online and paper-based surveys [61].

A further potential limitation was the difference in incentive structures between the samples which could have affected the response and attrition rates of the Hong Kong sample [62]. Also, in the current study all the sleep hygiene behaviors were combined in an overall measure. This decision was made based on the idea that good sleep hygiene behavior does not necessarily require performing of all the sleep hygiene behaviors simultaneously and, thus, separate measures of individual sleep hygiene behaviors are not essential to reflect good sleep hygiene behavior. Nevertheless, given some sleep hygiene behaviors may be more common than others, it may be advantageous for future research to identify students' specific intentions and behaviors by examining individual sleep hygiene behaviors. Further, future research may consider investigating other factors that affect university students' sleep hygiene practices. For example, a research showed that approximately 10% of college students prefer eveningness chronotype [63]. This sleeping practice not only violates healthy sleep hygiene practices, but also increases individuals' daytime sleepiness [63]. It is also suggested that the use of electronic devices, exercise frequency, perceived stress, and alcohol and drug use are common factors causing poor sleep among young adults [64]. Thus, it may be useful for researchers to identify the effects of these factors on sleep hygiene practices.

## **Conclusion**

The current study investigated the social psychological factors predicting sleep hygiene behaviors in university students across two different countries. Overall, we found support for the majority of the core proposed effects among the motivational and volitional factors in the model, as well as their effects on students' sleep hygiene behavior. The current study fills a knowledge

gap in the literature on the social psychological processes that guide sleep hygiene behavior and suggests that motivational and volitional processes may have utility in explaining this important health behavior. Despite the correlational design of the current study, findings suggest multiple potential routes to behavioral performance that can serve as a basis for the development of future interventions that promote good sleep hygiene behavior and enable further testing of effects of the techniques on both behavior change and the targeted theory constructs.

**Informed consent:** Informed consent was obtained from all individual participants included in the study.

**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***The Stated Hypotheses for the Current Study*

Independent Variable		Mediators	Dependent Variable	Prediction
<b>Direct Paths</b>				
H1	Attitude	-	Intention	Effect (+)
H2	Subjective Norms	-	Intention	Effect (+)
H3	Perceived Behavioral Control	-	Intention	Effect (+)
H4	Intention	-	Action Planning	Effect (+)
H5	Intention	-	Behavior	Effect (+)
H6	Action Planning	-	Behavior	Effect (+)
H7	Perceived Behavioral Control	-	Behavior	Effect (+)
H8	Past Behavior	-	Behavior	Effect (+)
H9	Past Behavior	-	Attitude	Effect (+)
H10	Past Behavior	-	Subjective Norms	Effect (+)
H11	Past Behavior	-	Perceived Behavioral Control	Effect (+)
H12	Past Behavior	-	Intention	Effect (+)
H13	Past Behavior	-	Action Planning	Effect (+)
<b>Indirect Effects</b>				
H14	Intention	Action Planning	Behavior	Effect (+)
H15	Attitude	Intention Action Planning	Behavior	Effect (+)
H16	Subjective Norms	Intention Action Planning	Behavior	Effect (+)
H17	Perceived Behavioral Control	Intention Action Planning	Behavior	Effect (+)
H18	Attitude	Intention	Behavior	Effect (+)
H19	Subjective Norms	Intention	Behavior	Effect (+)
H20	Perceived Behavioral Control	Intention	Behavior	Effect (+)
H22	Past Behavior	Intention Action Planning	Behavior	Effect (+)
H23	Past Behavior	Action Planning	Behavior	Effect (+)
	Past Behavior	Attitude Subjective Norms Perceived Behavioral Control Intention Action Planning	Behavior	Effect (+)

**Table 2***Demographic Information for the Australian and Hong Kong Samples*

	Hong Kong Sample		Australian Sample	
	Number	Percentage	Number	Percentage
Marital Status				
Never Married	161	100%	171	85%
Married	0	0%	16	8%
De Facto	0	0%	6	3%
Divorced or Separated	0	0%	8	4%
University Attendance Status				
Full Time	161	100%	181	90%
Part Time	0	0%	20	10%
Year of Study				
Undergraduate: First Year	42	26%	144	72%
Undergraduate: Second Year	38	24%	31	15%
Undergraduate: Third Year	55	34%	16	8%
Undergraduate: Fourth Year or Above	26	16%	10	5%
Gender				
Male	77	48%	36	18%
Female	84	52%	165	82%

**Table 3***Scale Items for All Self-Report Measures in Predicting Sleep Hygiene Behaviors*

For the following questions, please think about your sleep hygiene habits. The National Sleep Foundation proposes several guidelines for **good sleep hygiene habits** including:

- Limiting daytime naps to 30 minutes.
- Avoiding stimulants such as caffeine and nicotine close to bedtime.
- Having regular exercise but avoiding strenuous workouts close to bedtime.
- Avoiding food that can be disruptive right before sleep (e.g., heavy or rich foods, fatty or fried meals, spicy dishes, citrus fruits, and carbonated drinks can trigger indigestion for some people).
- Ensuring exposure to sunlight during the day and darkness at night.
- Having a regular sleep schedule and bedtime routine.
- Making sure that the sleep environment is ideal (e.g., comfortable mattress and pillows; ideal room temperature, sound and light; turn off electronic devices before bed).

**Please keep these good sleep hygiene habits in mind for the next set of questions.**

Variable	Item	Scale
Past Behavior / Behavior Attitude	Think about the past month. In general, how often did you follow good sleep hygiene habits?	[1] Never to [7] Very Often
	Think about the past month. In general, to what extent did you follow good sleep hygiene habits?	[1] I Did Not to [7] A Very Large Extent
	For me to follow good sleep hygiene habits everyday in the next month would be...	[1] Unpleasant to [7] Pleasant [1] Bad to [7] Good [1] Awful to [7] Nice [1] Unwise to [7] Wise [1] Unnecessary to [7] Necessary
Subjective Norms	Most people who are important to me would approve of me following good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree
	Other people like me follow good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree
	Most people would want me to follow good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree
	Other people like me to think that following good sleep hygiene habits is a good thing to do	[1] Strongly Disagree to [7] Strongly Agree
	Most people think I should follow good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree
Perceived Behavioral Control	I have complete control over whether or not I follow good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree
	It is up to me whether or not I follow good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree
	I am confident I can follow good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree
	It would be easy for me to follow good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree
Intention	I intend to follow good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree
	I plan to follow good sleep hygiene habits	[1] Strongly Disagree to [7] Strongly Agree

It is likely I will follow good sleep hygiene habits

[1] Strongly Disagree to [7] Strongly Agree

Action

I have made a plan regarding...

Planning

When to follow good sleep hygiene habits

[1] Strongly Disagree to [7] Strongly Agree

Where to follow good sleep hygiene habits

[1] Strongly Disagree to [7] Strongly Agree

How often to follow good sleep hygiene habits

[1] Strongly Disagree to [7] Strongly Agree

How to follow good sleep hygiene habits

[1] Strongly Disagree to [7] Strongly Agree

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**Table 4***Bivariate Correlations, Descriptives, and Reliability for Statistics for Demographic Variables and Constructs used to Predict Sleep Hygiene*

Variables	1	2	3	4	5	6	7	8	9	Mean	SD	Reliability
1. Age	-	-.112	-.087	-.161*	-.020	-.070	-.110	.018	.105	20.47	1.80	-
2. Gender	-.031	-	.074	.125	.004	-.045	.145	.028	-.057	-	-	-
3. Past Behavior	.135	.037	-	.286***	.295***	.509***	.499***	.430***	.484***	4.01	1.42	.91
4. Subjective Norms	.063	.081	.144*	-	.369***	.220**	.519***	.197*	.098	5.44	1.06	.92
5. Attitude	.046	.167*	.342***	.410***	-	.362***	.641***	.276***	.240**	5.39	1.12	.90
6. PBC	.088	.201**	.463***	.377***	.436***	-	.556***	.396***	.408***	4.46	1.24	.87
7. Intention	.086	.096	.530***	.443***	.572***	.647***	-	.425***	.373***	4.99	1.15	.90
8. Action Planning	.137	.060	.398***	.369***	.362***	.403***	.531***	-	.605***	4.61	1.26	.96
9. Sleep Hygiene	.188**	-.059	.604***	.176*	.296***	.242***	.367***	.523***	-	4.16	1.28	.92
Mean	22.82	-	4.19	5.58	6.08	5.10	5.31	4.91	4.34			
Standard Deviation	8.56	-	1.56	.99	.96	1.30	1.25	1.39	1.46			
Reliability	-	-	.93	.84	.88	.87	.93	.96	.95			

Note. Statistics above the diagonal are from the Hong Kong sample ( $N = 161$ ); Statistics from below the diagonal refer to the Australian sample ( $N=201$ ).

\* $p < .050$ ; \*\* $p = .010$  level; \*\*\* $p = .001$  level. PBC = Perceived behavioral control

**Table 5**

*Parameter Estimates for Predicting Sleep Hygiene Behaviors in Australian and Hong Kong University Students*

Path	Australian Sample				Hong Kong Sample				<i>p</i> Diff.
	<i>B</i>	SE <i>B</i>	<i>p</i>	$\beta$	<i>B</i>	SE <i>B</i>	<i>p</i>	$\beta$	
<b>Direct Paths</b>									
Attitude → Intention	.304**	.099	.002	.257	.409***	.071	<.001	.414	.389
Subjective Norms → Intention	.273*	.124	.028	.169	.357***	.091	<.001	.281	.585
Perceived Behavioral Control → Intention	.453***	.117	<.001	.391	.473***	.127	<.001	.353	.908
Intention → Action Planning	.481***	.093	<.001	.440	.316**	.120	.009	.295	.278
Intention → Behavior	-.125	.119	.297	-.107	-.020	.118	.866	-.018	.531
Action Planning → Behavior	.430***	.088	<.001	.404	.512***	.082	<.001	.498	.496
Perceived Behavioral Control → Behavior	-.131	.109	.227	-.098	.149	.163	.361	.101	.154
Past Behavior → Behavior	.553***	.085	<.001	.585	.229*	.094	.015	.244	.011
Past Behavior → Attitude	.259***	.057	<.001	.377	.281**	.086	.001	.325	.831
Past Behavior → Subjective Norms	.058	.039	.135	.114	.204**	.060	.001	.303	.042
Past Behavior → Perceived Behavioral Control	.416***	.057	<.001	.592	.382***	.069	<.001	.598	.704
Past Behavior → Intention	.155*	.063	.014	.191	.098	.064	.124	.115	.526
Past Behavior → Action Planning	.161*	.074	.030	.181	.282*	.110	.010	.307	.362
<b>Covariances</b>									
Attitude ↔ Subjective Norms	.288***	.076	<.001	.417	.285**	.092	.002	.307	.980
Attitude ↔ Perceived Behavioral Control	.284**	.083	.001	.365	.216*	.085	.011	.292	.567
Subjective Norms ↔ Perceived Behavioral Control	.253**	.074	.001	.413	.031	.058	.600	.053	.019
<b>Indirect Effects</b>									
Intention → Action Planning → Behavior	.207**	.063	.001	.178	.162*	.070	.021	.147	.633
Attitude → Intention → Action Planning → Behavior	.063*	.027	.019	.046	.066*	.030	.030	.061	.941
Subjective Norms → Intention → Action Planning → Behavior	.056	.032	.075	.030	.058*	.028	.038	.041	.963
Perceived Behavioral Control → Intention → Action Planning → Behavior	.094**	.034	.006	.070	.077*	.037	.040	.052	.735
Attitude → Intention → Behavior	-.038	.039	.334	-.028	-.008	.048	.866	-.007	.628
Subjective Norms → Intention → Behavior	-.034	.038	.372	-.018	-.007	.042	.867	-.005	.634
Perceived Behavioral Control → Intention → Behavior	-.056	.053	.290	-.042	-.009	.056	.867	-.006	.543
Past Behavior → $\left\{ \begin{array}{l} \text{Intention} \\ \text{Intention} \rightarrow \text{Action Planning} \end{array} \right\} \rightarrow \text{Behavior}$	.013	.015	.398	.013	.014	0.16	.896	.015	.964
Past Behavior → Action Planning → Behavior	.069*	.029	.017	.073	.144*	.056	.010	.153	.235
Past Behavior → $\left\{ \begin{array}{l} \text{Attitude} \\ \text{Subjective Norms} \\ \text{PBC} \end{array} \right\} \rightarrow \left\{ \begin{array}{l} \text{Intention} \\ \text{Intention} \rightarrow \text{Action Planning} \end{array} \right\} \rightarrow \text{Behavior}$	-.031	.044	.471	-.033	.109*	.053	.041	.116	.043
<b>Total Effects</b>									
Intention → Behavior	.082	.095	.388	.071	.142	.126	.260	.129	.704
Perceived Behavioral Control → Behavior	-.094	.100	.345	-.070	.216	.141	.126	.146	.074
Past Behavior → Behavior	.604***	.063	<.001	.639	.497***	.085	<.001	.527	.313

*Note.* \**p* = < .050; \*\**p* = .010 level; \*\*\**p* = .001 level; PBC = Perceived behavioral control; *p* Diff refers to the *p* value of the difference between estimated model parameters calculated from a Schenkler and Gentleman (2001) *t*-test. As 28 parameters are compared between cultural samples, a Bonferoni corrected  $\alpha$  of .002 was adopted for significance testing. Full *t* and Cohen's *d* statistics for parameter comparisons are available in Supplementary materials.

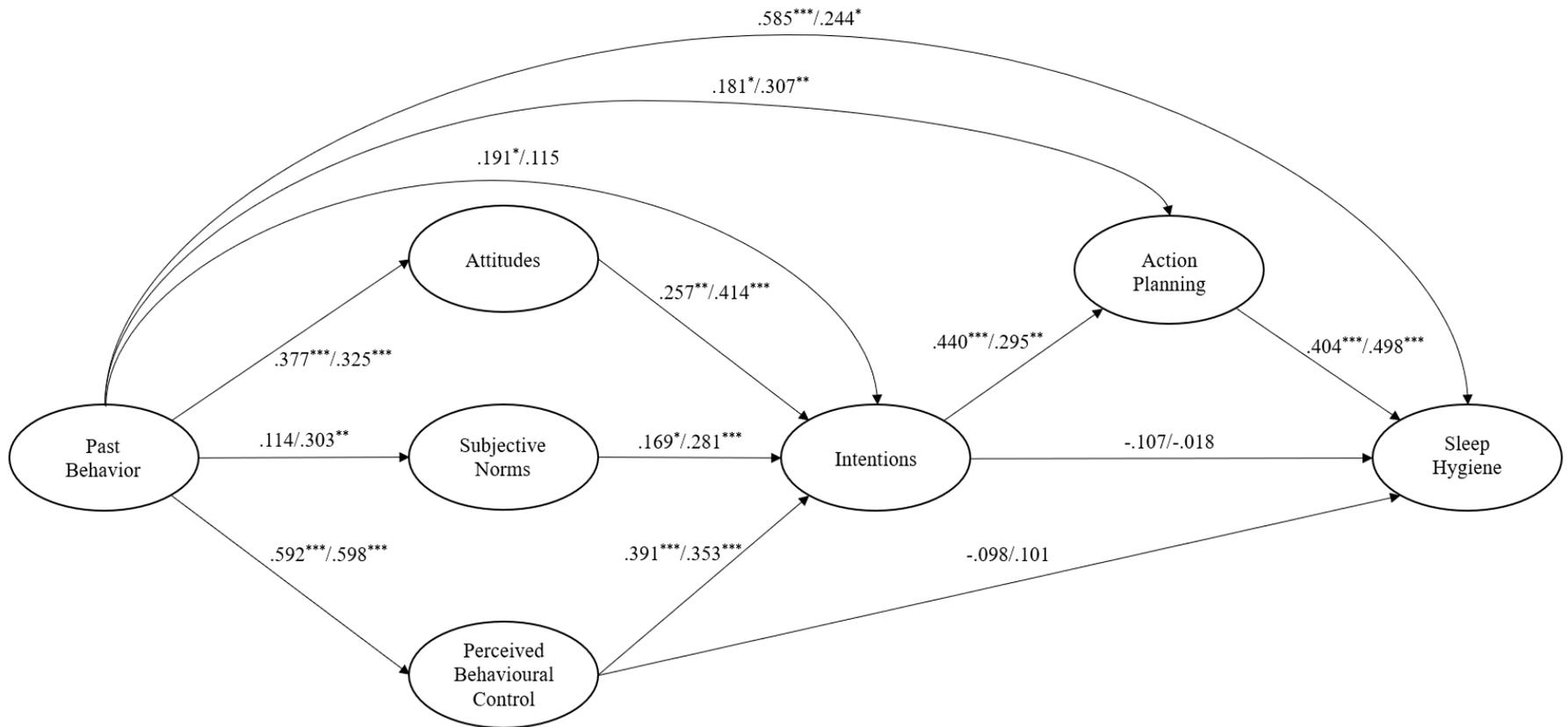


Figure 1. The Structural Equation Model Predicting Sleep Hygiene Behavior in Australian Students and Hong Kong Students. Solid lines represent statistically significant paths ( $p < .05$ ). Broken Lines represent paths where  $p > .05$ . Beta for the Australian sample are presented before the slash, beta weights for the Hong Kong sample are presented after the slash.