Drug and Alcohol Dependence xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Using structural equation modeling to understand prescription stimulant misuse: A test of the Theory of Triadic Influence

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ARTICLE INFO

Article history:
Received 16 September 2013
Received in revised form 24 January 2014
Accepted 21 February 2014
Available online xxx

Keywords:
Prescription stimulants
Substance use
Health behavior theory
Prevention

ABSTRACT

Objective: To test a theory-driven model of health behavior to predict the illicit use of prescription stimulants (IUPS) among college students.
Participants: A probability sample of 554 students from one university located in California (response rate = 90.52%).
Methods: Students completed a paper-based survey developed with guidance from the Theory of Triadic Influence. We first assessed normality of measures and checked for multicollinearity. A single structural equation model of frequency of IUPS in college was then tested using constructs from the theory's three streams of influence (i.e., intrapersonal, social situation/context, and sociocultural environment) and four levels of causation (i.e., ultimate causes, distal influences, proximal predictors, and immediate precursors).
Results: Approximately 18% of students reported engaging in IUPS during college, with frequency of use ranging from never to 40 or more times per academic term. The model tested had strong fit and the majority of paths specified within and across streams were significant at the $p < 0.01$ level. Additionally, 46% of the variance in IUPS frequency was explained by the tested model.
Conclusions: Results suggest the utility of the TTI as an integrative model of health behavior, specifically in predicting IUPS, and provide insight on the need for multifaceted prevention and intervention efforts.

1. Introduction

To prevent high-risk behaviors, it is critical to have an understanding of the scope and correlates of a particular problem. According to Holder and colleagues (1999), whose work outlining the phases of alcohol prevention research is useful for studying any number of high-risk behaviors, the phases of prevention research evolve from basic to applied. That is, prior to developing and testing prevention efforts, "foundational research" is needed to first define the problem, determine etiology, and identify risk factors amenable to change (Holder et al., 1999). As behavior is multifaceted, employing meta-theories during foundational research efforts is particularly advantageous, since doing so provides a more comprehensive picture of the influences on a health behavior. Accordingly, the purpose of this study is to elucidate the complex nature of an emerging form of substance use, the illicit use of prescription stimulants (IUPS) in the college population, by applying (and testing) the Theory of Triadic Influence (TTI; Flay and Petraitis, 1994; Flay et al., 2009) through the use of structural equation modeling.

1.1. Foundational research

To date, researchers have taken action to define the magnitude of IUPS in the college population. We characterize IUPS, which has also been referred to as non-medical/nonmedical use, as use of *any* class of prescription stimulants (i.e., amphetamines such as Adderall, dextroamphetamines such as Dexedrine, and methylphenidates such as Ritalin) without a prescription from a health care provider, use for nonmedical purposes (e.g., to stay awake, to enhance the effects of alcohol, etc.) and/or use in excess of what is prescribed. The 2001 College Alcohol Study, which included responses from

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http://dx.doi.org/10.1016/j.drugalcdep.2014.02.700
0376-8716/

over 10,000 students attending 119 four-year campuses, found that past-year prevalence of self-reported nonmedical use of Ritalin, Dexedrine, and/or Adderall varied greatly across campuses, ranging from 0.0% to 25.0% (McCabe et al., 2005). More recent single-campus studies have reported prevalence estimates as high as 43% (Advokat et al., 2008) in the general student population and 55% in high-risk (i.e., fraternity members) populations (DeSantis et al., 2009).

The magnitude of IUPS is cause for concern, as foundational research has also shown the health-related impact of this behavior. For example, engaging in IUPS has been associated with adverse health effects such as cardiovascular events (e.g., hypertension and tachycardia), psychosis (e.g., visual hallucinations and insomnia), seizures, and death (Lakhan and Kirchgessner, 2012). From 2005 to 2010, the prevalence of emergency department visits related to nonmedical use of prescription stimulants among college-aged young adults increased significantly from 1310 visits to 5766 visits (Substance Abuse and Mental Health Services Administration [SAMHSA], 2013). Additionally, students have reported becoming addicted to prescription stimulants following misuse (e.g., Holloway et al., 2013).

Preliminary foundational research has also established a growing number of intrapersonal, interpersonal, and sociocultural correlates of IUPS in the college population. For example, college students who engage in IUPS are more likely than nonusers to report ADHD-like symptoms (e.g., inattention and hyperactivity) (e.g., Arria et al., 2010; Judson and Langdon, 2009; Peterkin et al., 2011; Rabiner et al., 2010; Upadyaya et al., 2010; Weyandt et al., 2009). Living off-campus (DeSantis et al., 2009; Lord et al., 2009), and specifically, living in fraternity or sorority housing (McCabe et al., 2006; Shillington et al., 2006), has also been associated with IUPS. In addition, studies have found the prevalence of IUPS to be greater amongst college students than their non-college attending peers (e.g., Herman-Stahl et al., 2007; Johnston et al., 2011; Wu et al., 2007). However, as reported earlier, use across colleges varies greatly. Researchers (McCabe et al., 2005) have found a greater prevalence at schools with competitive admissions standards, which parallels research showing motives for IUPS are primarily academic in nature (e.g., Teter et al., 2006). In addition, rates of IUPS are higher at non-religious than religious schools (Bavarian et al., 2013), which may reflect the varying attitudes toward substance use that exists across campuses.

1.2. Theoretical guide

Another key component of foundational research aiming to prevent high-risk health behaviors is using theory to develop and test models of behavior (Holder et al., 1999). We tested the Theory of Triadic Influence (TTI; Flay and Petraitis, 1994; Flay et al., 2009), a meta-theory that includes constructs found in a number of theories, including but not limited to, expectancy-value theory (Feather, 1982), social cognitive theory (Bandura, 1986), and the theory of planned behavior (Ajzen, 1988). The TTI unifies multiple theories into a single framework where independent variables are organized in three streams of influence and four levels of causation. The three streams of influence represent characteristics of one's biology and personality that influence self-efficacy (i.e., the intrapersonal stream), interpersonal characteristics that influence behavioral norms (i.e., the social situation/context stream), and broader cultural environmental factors that influence attitudes toward a behavior (i.e., the sociocultural stream). Moreover, the four levels of causation range from ultimate causes (which an individual has the least control over) to distal influences to proximal predictors to immediate precursors (which an individual has the most control over).

In the theoretical flow hypothesized by the TTI, ultimate causes influence distal constructs; this occurs not only within the same stream of influence, but also across streams. Similarly, distal constructs influence proximal predictors, namely, self-efficacy (intrapersonal stream), behavioral norms (social situation/context stream), and attitudes toward a behavior (sociocultural stream), within and across streams. These three proximal predictors then influence behavioral intention, which is the immediate precursor to behavior (Ajzen, 2012).

1.3. Prior research using the TTI to examine IUPS

To date, a limited number of related studies from our research team have used the TTI to examine IUPS in the college population. In a secondary analysis of the American College Health Association's National College Health Assessment II (NCHA II) Spring 2009 dataset, constructs from the TTI found in the NCHA II were used to examine the use of prescription stimulants without a prescription (Bavarian et al., 2013a). Results from this study highlighted the need for an instrument that broadly defines the behavior of prescription stimulant misuse (i.e., as more than use without a prescription) and includes constructs from all streams of influence and levels of causation found in the TTI (to allow for a more comprehensive etiological understanding). To address this need, the Behaviors, Expectancies, Attitudes, and College Health Questionnaire (BEACH-Q) was developed (Bavarian et al., 2013b). A separate study (Bavarian et al., 2013c) has since used the BEACH-Q and nested regression analyses to provide a comprehensive overview of the relationship between various measures and IUPS *within* each stream of influence in the TTI. To date, however, no study has used structural equation modeling to test one parsimonious, meta-theory-guided, model of IUPS in the college population that examines relationships within *and* across streams of influence. Doing so is an essential step for prevention efforts as it can help identify the most necessary targets for change at the behavioral, social, and sociocultural levels (Holder et al., 1999).

The purpose of our study was to use structural equation modeling to test a theory-driven model of IUPS among college students. The study sample and setting for this study differs from what has been used in our past studies, and the instrument used in this study is an updated version of the BEACH-Q. This is also, to our knowledge, the first test of the full TTI with respect to any health behavior. We hypothesized that within and across each stream of influence in the TTI, ultimate underlying causes would be associated with distal predisposing influences, which, in turn, would be associated with proximal predictors. We hypothesized each proximal predictor would be associated with behavioral intentions which would be associated with frequency of IUPS behavior.

2. Methods

2.1. Study design

The study sample was obtained using one-stage cluster sampling. An e-mail requesting 20 min of class time to administer a health behavior survey was sent to instructors of 150 randomly selected eligible undergraduate classes (e.g., academic courses with an instructor name on record, that were not special research courses) at a California public university offered during the Spring 2013 academic term. Students attending class on the day of data collection were informed of the voluntary and anonymous nature of the survey. Eligible students (undergraduate students over 18 years of age) choosing to participate were compensated with a $5.00 gift certificate to a campus vendor. The study methods were approved by the Institutional Review Boards of the University of California, Berkeley and the Pacific Institute for Research and Evaluation.

2.2. Participants

Overall, 554 students from 24 classrooms participated in the survey (eligible student response rate = 90.5%). Approximately 34% of the students self-identified as White, 32% as Asian/Pacific Islander, 19% as Hispanic, 4% as South Asian, 3% as Black

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Non-Hispanic, and 8% as Other. The majority of participants were female (58%), under the age of 25 (89%), and enrolled in school full-time (99%). Percentage breakdown by year in school was as follows: 15.9% 1st year students, 11.7% 2nd year, 25.3% 3rd year, 40.8% 4th year, 5.6% 5th year or more, and less than 1% identified as post-baccalaureate or "Other", respectively. The sample was similar demographically to the total undergraduate population (results not shown).

2.3. Measures

Students completed an updated version of the BEACH-Q (Bavarian et al., 2013b). The 100-item questionnaire included measures from each stream of influence and level of causation of the TTI. As compared to the original instrument, the updated survey included more items for each proximal predictor (i.e., avoidance self-efficacy, behavioral norms, attitudes toward IUPS) and immediate precursor (i.e., behavioral intentions). Response options for some measures were also revised between the two survey versions. Reliability analyses (see Table 1) showed that the updated version of the BEACH-Q was psychometrically stronger than the original version.

Our primary analysis incorporated at least one construct from each of the TTI's streams of influence and levels of causation that prior research (e.g., Bavarian et al., 2013c) suggested is associated with IUPS. Measures, response options, descriptive statistics, and internal consistency reliabilities (where applicable) are shown in Table 1.

For the intrapersonal stream of influence, we used a six-item measure of *ADHD-like symptoms* (an ultimate-level, continuous measure, with higher scores reflecting more ADHD-like symptoms), a three-item measure of sensation seeking (ultimate; continuous, with higher scores reflecting greater sensation seeking), a three-item measure of *study habits* (distal; continuous, with higher scores reflecting better study habits), a three-item measure of *academic concern* (distal; continuous, with higher scores reflecting more concern) and a four-item measure of *avoidance self-efficacy* (proximal; continuous, with higher scores reflecting greater self-efficacy). For the social situation/context stream, we used a single-item measure of community *residence* (ultimate; coded as 0 = Non-Community Housing [i.e., live with parent or guardian or at off campus location] and 1 = Community Housing [i.e., live in campus residence hall or in Greek housing]), a single-item measure of *endorsement* of IUPS by friends (distal; continuous, with 1 = none to 5 = all), and a three-item measure of friends' IUPS *behavioral norms* (proximal; continuous, with higher scores reflecting greater perceived norms). For the sociocultural environment stream, we used a single-item measure of perceived campus *drug culture* (ultimate; continuous, with 1 = strongly disagree to 5 = strongly agree), a four-item measure of religiosity (ultimate; continuous, with higher scores reflecting more religiosity), a six-item measure of negative IUPS expectancies (distal; continuous, with higher scores reflecting more negative expectancies), a four-item measure of positive academic-related IUPS expectancies (distal; continuous, with higher scores reflecting more positive expectancies), and a three-item indicator of attitudes toward IUPS (proximal; continuous, with higher scores reflecting more positive attitudes).

The immediate precursor used in this analysis was a three-item measure of IUPS intentions (continuous, with higher scores reflecting greater intent). Our dependent variable, *IUPS*, was a continuous outcome measuring frequency of IUPS during college (response options ranged from "Never" to "40 or more times per academic term").

2.4. Data analysis

Prior to estimating the structural equation model, normality of indicator items was examined using Stata version 12.1. We first checked the skewness (i.e., the measure of symmetry) and kurtosis (i.e., the measure of peakedness) of indicators; a skewness value of zero and a kurtosis value less than 3 indicates a normal distribution. Next, correlations between indicators were examined to rule out multicollinearity.

The structural equation model (Fig. 1) was estimated using MPlus version 6.0, as this software is able to manage non-normal data. Within each stream, paths from ultimate to distal to proximal to immediate precursor were specified. In accordance with the TTI, cross-stream paths were also included from ultimate to distal and from distal to proximal independent variables. For example, paths were specified from ADHD-like symptoms (ultimate-level measure in the intrapersonal stream) to study habits and academic concern (distal-level measures in the intrapersonal stream), friend endorsement of IUPS (distal-level measure in the social situation/context stream) and positive and negative IUPS expectancies (distal-level measures in the sociocultural environment stream). Exogenous variables (i.e., the ultimate-level variables) were allowed to freely covary. Missing data, which was minimal in our dataset (i.e., for each item in the analyses, at least 97% of respondents provided a response), were handled using maximum likelihood. Given the non-normality of some indicators, as well as our outcome measure, this model was estimated using bootstrapping with 1000 iterations.

We used several indicators to assess the fit of the structural equation model. Given the study's relatively large sample size, and the fact that having a large sample size increases the likelihood of a significant chi-square value (Ford and Schroeder, 2009; Brown, 2006), additional measures of model fit (i.e., The Comparative Fit Index (CFI), Root Mean Squared Error of Approximation; RMSEA) were examined. According to Hu and Bentler (1999), RMSEA below 0.06 and CFI values in the range of 0.90–0.95 or above indicate acceptable model fit. Though not a measure of model fit, we also report the R^2 for our dependent variable, which refers to the proportion of the variance in IUPS frequency explained by the model.

3. Results

3.1. Preliminary analyses

Approximately 18% of students reported engaging in IUPS during college, and the distribution for frequency of use was positively skewed. In addition, the distribution of indicators for independent variables varied from normally distributed to both positively and negatively skewed. Similar to the outcome variable, items measuring behavioral norms (proximal), attitudes toward IUPS (proximal), and IUPS intentions (immediate precursor) were positively skewed; items measuring avoidance self-efficacy, a proximal measure expected to have an inverse association with the outcome variable, were negatively skewed. Multicollinearity was not apparent, as items measuring the same construct were more correlated with one another than with items measuring other constructs (results not shown).

3.2. SEM results

Fit indices for the final model indicated acceptable fit (CFI = 0.90; RMSEA = 0.05). The R^2 for IUPS frequency in college was 0.46 for the model. In other words, 46% of the variance in IUPS frequency was explained by the model.

The unstandardized model results (i.e., parameter estimates and standard errors) are presented in Table 2 and via an abbreviated illustration in Fig. 2 (only significant paths are shown for brevity). In the measurement portion of the model (Table 2), indicators loaded strongly and significantly on the specified latent variable. For example, the unstandardized factor loading for Avoidance 2 ("Confident you would refuse if offered [prescription stimulants] by friend, family, acquaintance") onto the latent construct Avoidance Self-Efficacy was 1.63 with a standard error [SE] of 0.11, and was significant at the $p < 0.01$ level.

We present results of the structural portion of the model by level of causation (i.e., ultimate, distal, proximal, and immediate precursor) and stream of influence (i.e., intrapersonal, social situation/context, and sociocultural environment). As a reminder, the TTI posits that independents variables flow down (e.g., from ultimate to distal, distal to proximal, proximal to immediate, and immediate to behavior). The theory also hypothesizes that an independent variable will be associated not only with measures in its own stream (within stream), but also with measures in the two additional streams (cross stream).

The structural portion of the model shows that *within* streams of influence, most paths from ultimate to distal were significant at the $p < 0.05$ and/or $p < 0.01$ levels. For example, in the intrapersonal stream, a one-unit increase in ADHD-like symptoms was associated with a 0.24 (SE = 0.05) decrease in study habits, and a 0.52 (SE = 0.07) increase in academic concern. Greater sensation seeking was associated with significantly less positive study habits ($b = -0.13$, SE = 0.05) and lower academic concern ($b = -0.30$, SE = 0.09). In the social situation/context stream, the path from ultimate (i.e., community residence) to distal (i.e., endorsement of IUPS by friends) was marginal with a community residence associated with reporting more friends who endorse IUPS than a non-community residence ($b = 0.13$, SE = 0.08). In the sociocultural environment stream, perceived campus drug culture was directly associated with both positive ($b = 0.22$, SE = 0.05) and negative expectancies ($b = 0.13$, SE = 0.05), whereas religiosity was associated only with negative expectancies ($b = 0.10$, SE = 0.04). In summary, consistent with the TTI, within each stream of influence,

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Table 1
Descriptive statistics for items used in structural equation model ($N = 554$ students).

Item	Response options Mean (SD)	Reliability (in α)
Intrapersonal stream of influence		
ADHD-like symptomology	1 = strongly disagree to 5 = strongly agree	0.79
It is difficult for me to pay attention during classes	2.68 (1.02)	
It is difficult for me to concentrate on academic work	2.89 (1.06)	
I have difficulty keeping track of school assignments	2.36 (1.03)	
I often feel restless	2.98 (1.06)	
I am an impulsive person	2.73 (1.11)	
I rarely plan ahead	2.16 (1.00)	
Sensation seeking	1 = strongly disagree to 5 = strongly agree	0.66
I like "wild" parties	2.58 (1.35)	
I enjoy getting into situations where I do not know how things will turn out	2.35 (1.08)	
I prefer friends who are unpredictable	2.45 (0.95)	
Study habits	1 = none of the time to 5 = all of the time	0.64
Attended class	4.41 (0.67)	
Read assigned course readings	3.61 (0.91)	
Worked on course assignments	4.64 (0.65)	
Academic concern	1 = none of the time to 5 = all of the time	0.84
Worried about your academic performance	3.73 (1.01)	
Helpless about your academic performance	2.56 (1.13)	
Stressed about your academic performance	3.65 (1.07)	
Avoidance self-efficacy	1 = not at all confident to 5 = completely confident	0.87
Confident would not use more than was prescribed to you	4.03 (1.15)	
Confident you would refuse if offered by friend, family, acquaintance	3.76 (1.33)	
Confident you would not ask if knew someone with access to the drug	4.13 (1.16)	
Confident would not misuse if you had limited time to do work	3.93 (1.30)	
Social situation/context stream of influence		
Residence	Campus housing, parent/guardian's home, other off-campus housing, fraternity or sorority house	NA
Where do you currently live?	NA	
Friend IUPS endorsement	1 = none to 5 = all	NA
How many of the following people have ever suggested you engage in prescription stimulant misuse during college? (Friends)	1.68 (0.88)	
Friends IUPS norms	1 = 0% to 6 = more than 75%	0.93
Proportion of close friends who use without a prescription	2.33 (1.31)	
Proportion of close friends who use for nonmedical reasons	2.46 (1.33)	
Proportion of close friends who use in excess of what was prescribed	2.08 (1.24)	
Sociocultural environment stream		
Religiosity	1 = none of the time to 5 = all of the time	0.93
Attended a place of worship	2.05 (1.30)	
Relied on religious teachings when you had a problem	2.01 (1.36)	
Turned to prayer or meditation when you faced a personal problem	2.36 (1.43)	
Relied on your religious beliefs as a guide for day-to-day living	2.21 (1.47)	
Perceived campus drug culture	1 = strongly disagree to 5 = strongly agree	NA
College is a time when students experiment with different drugs	3.80 (1.09)	
Negative IUPS expectancies	1 = none of the time to 5 = all of the time	0.89
I would feel anxious	2.93 (1.27)	
I would feel dizzy/lightheaded	2.82 (1.17)	
My heart would race	3.23 (1.18)	
I would not be able to sleep	3.26 (1.16)	
I would get in trouble	2.55 (1.32)	
I would get headaches	2.92 (1.19)	
Positive IUPS expectancies	1 = none of the time to 5 = all of the time	0.90
I would get better grades	2.42 (1.18)	
I would find studying more enjoyable	2.34 (1.25)	
I would be able to stay awake	3.09 (1.25)	
I would be able to concentrate/focus better	2.91 (1.29)	
IUPS attitudes	1 = strongly disagree to 5 = strongly agree	0.89
I think it is okay for college students to...		
Use prescription stimulants without a prescription	2.13 (1.05)	
Use prescription stimulants for nonmedical reasons	2.20 (1.07)	
Use prescription stimulants in excess of what has been prescribed	1.80 (0.95)	
Immediate Precursor		
IUPS intentions	1 = definitely would not to 5 = definitely will	0.91
How likely is it that, during your time in college, you will use prescription stimulants...		
Without a prescription from a health care provider	1.69 (1.07)	
For nonmedical purposes	1.79 (1.13)	
In excess of what may be prescribed to you	1.44 (0.85)	
IUPS behavior	1 = never to 8 = 40 or more occasions	NA
During your time in college, on how many occasions per academic term have you participated in prescription stimulant misuse?	1.44 (1.08); range: 1–8	

$^{*}p < 0.05$, $^{**}p < 0.01$.

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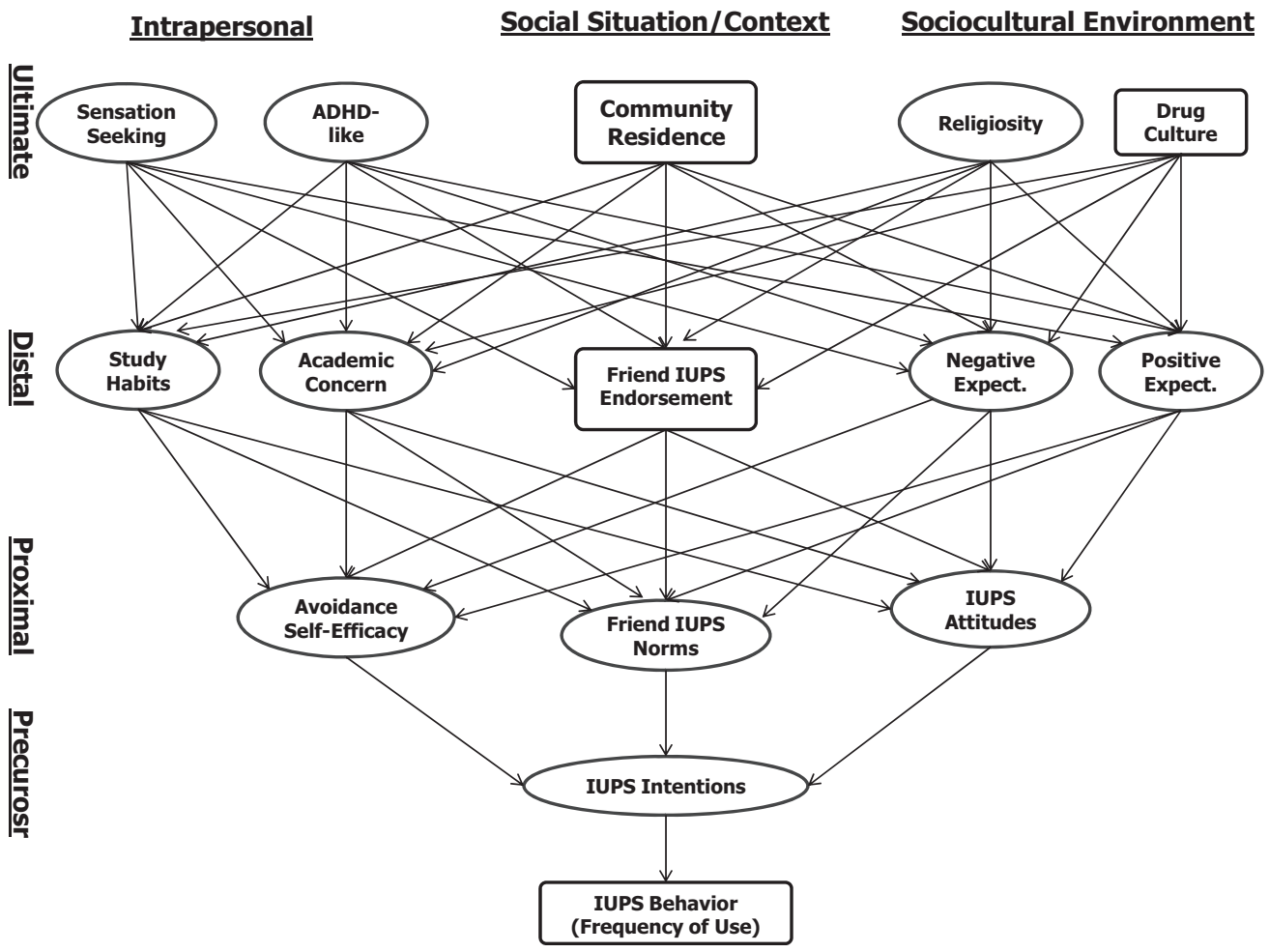

Fig. 1. Abbreviated* structural equation model applying the Theory of Triadic Influence to the Illicit Use of Prescription Stimulants (IUPS). (**Note:* Abbreviated in that the following were not shown for brevity: (1) paths for indicators of latent variables (circles) and (2) exogenous variables were allowed to freely covary.)

higher-order, ultimate independent variables had strong associations with distal independent variables that were more proximal to the behavior.

Some cross-stream paths from ultimate to distal variables were significant. For example, greater ADHD-like symptomology (intrapersonal stream) was associated with greater endorsement of IUPS by friends (social situation stream; $b = 0.15$, SE = 0.07) and positive IUPS expectancies (sociocultural environment stream; $b = 0.39$, SE = 0.08). Also, greater sensation seeking (intrapersonal stream) was associated with greater endorsement of IUPS by friends ($b = 0.36$, SE = 0.07). The cross-sectional paths from community residence to the distal measures in the intrapersonal stream (i.e., study habits and academic concern) were both significant, but paths to the sociocultural stream measures (i.e., positive and negative expectancies) were not. For the ultimate-level measures in the sociocultural stream, perceptions of greater campus drug culture were associated with greater endorsement of IUPS by friends ($b = 0.17$, SE = 0.04). Religiosity, however, was not significantly associated with distal measures in either the intrapersonal (i.e., study habits and academic concern) or social situation/context (i.e., residence) streams. In summary, these results support one proposition of the TTI, that independent variables from one stream of influences are associated with independent variables in conceptually different streams of influence.

For the social situation/context and sociocultural environment streams of influence, the cross-sectional paths from distal measures to proximal measures *within* streams were significant at the 0.01 level. For example, a one-unit increase in endorsement of IUPS by friends was associated with a 0.71 (SE = 0.07) increase in friend IUPS norms, and a one unit increase in negative IUPS expectancies was associated with a 0.22 (SE = 0.05) decrease in pro-IUPS attitudes. Contrary to what the TTI would hypothesize, none of the distal level measures in the intrapersonal stream were associated with the proximal level measure within this same stream of influence.

Of the ten possible cross-stream paths between distal and proximal influences, five were significant. For example, the associations between friend IUPS endorsement (social situation stream), positive expectancy and negative expectancy (sociocultural stream) to avoidance self-efficacy (intrapersonal stream) were all significant. However, the cross-stream paths to friend IUPS norms was significant only for positive IUPS expectancies ($b = 0.20$, SE = 0.07). With respect to IUPS attitudes (sociocultural stream), a one unit increase in friend IUPS endorsement was associated with a 0.30 (SE = 0.06) increase in attitudes.

In moving down the TTI's levels of causation, and consistent with the theory's hypothesized flow, we observed that all paths from proximal predictors (i.e., avoidance self-efficacy, friends IUPS norms, and IUPS attitudes) to the immediate precursor of IUPS intentions were significant, with the path from avoidance self-efficacy to intentions having the largest parameter estimate (standardized results not shown). Additionally, the association between immediate precursor (IUPS intentions) to behavior was significant, and had the largest magnitude of all specified paths. Specifically, a one-unit increase in IUPS intentions associated with

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a 0.74 (SE = 0.06) increase in IUPS frequency. These results are consistent with the TTI's hypothesis that independent variables most proximal to a behavior will have the largest influence on that behavior.

4. Discussion

The behavior of IUPS was prevalent in our survey sample, with 18% of students engaging in IUPS; this figure is similar to the 25% prevalence reported in our previous study with a different probability sample of students that defined IUPS identically (Bavarian et al., 2013c). In an effort to build upon the growing foundational research in this area, we used structural equation modeling to test one theoretically-derived model of IUPS. Although our data were cross-sectional in nature, findings suggest that the factors leading to IUPS are multifaceted, with measures from each stream of influence and level of causation having varying degrees of influence.

In the intrapersonal stream, ADHD-like symptomology was an important ultimate-level correlate, as it was associated with weaker study habits and more academic concern (intrapersonal stream), greater IUPS endorsement by friends (social stream), and more positive IUPS expectancies (sociocultural stream). Moreover, the ultimate to distal level path with the largest magnitude was that from ADHD-like symptomology to academic concern. Surprisingly, although distal measures in the social situation/context and sociocultural environment streams were associated with avoidance self-efficacy, neither academic concern nor study habits were associated with this proximal measure of the intrapersonal stream. In the social situation stream, community residence appeared to promote academic strength, as it had a direct association with better study habits and an inverse association with academic concern. Conversely, community residence was associated with greater exposure to friends who endorse IUPS. Friend endorsement of IUPS (distal-level), in turn, was significantly associated with lower avoidance self-efficacy (intrapersonal), greater behavioral norms (social), and pro-IUPS attitudes (sociocultural); moreover, the distal to proximal path with the largest magnitude was that for friend endorsement to friend IUPS norms. In the sociocultural environment stream, religiosity may serve as a buffer against IUPS, as it was associated with negative IUPS expectancies, which was associated with greater avoidance self-efficacy and less positive attitudes toward IUPS. As expected, each proximal predictor was significantly associated with the immediate precursor of IUPS intention, with the path with the largest magnitude being that between avoidance self-efficacy and intention. Behavioral intention, in turn, was strongly and significantly associated with the behavior of IUPS. Findings from the present study support the hypotheses that IUPS is multi-etiological in nature, that a multitude of factors influence IUPS indirectly, and that the pathways are consistent with the TTI and the multiple theories that are integrated into it.

4.1. Limitations and strengths

This study was not without limitations. The measures used are subject to non-response and social desirability bias. However, the instrument was an updated version of a survey that went through extensive pilot testing to promote the use of non-judgmental language (Bavarian et al., 2013b), and missing data was minimal. Also, this study was cross-sectional in nature. As such, one must refrain from making definitive causal statements based on the current

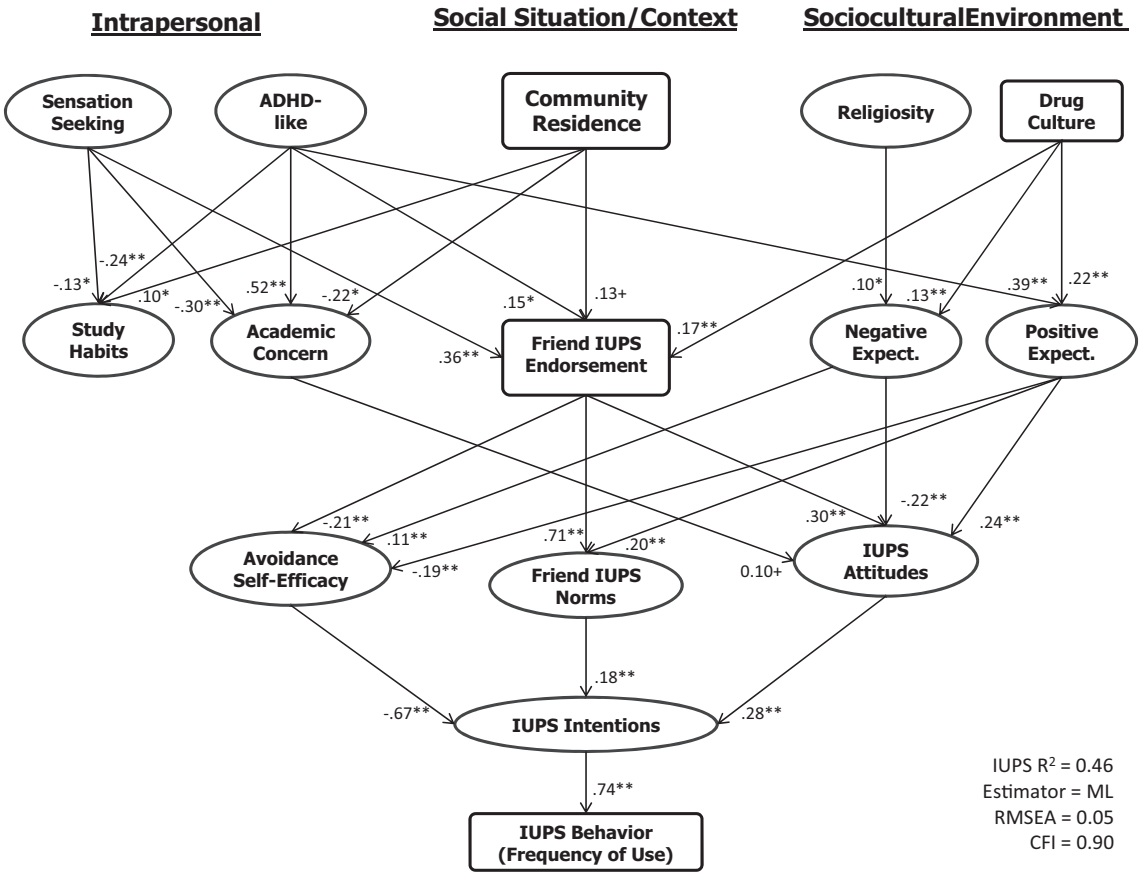

Fig. 2. Abbreviated* results from the structural equation model applying the Theory of Triadic Influence to the Illicit Use of Prescription Stimulants (IUPS; $N = 554$ students; Unstandardized Results). $^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$. (*Note*: Abbreviated in that (1) paths for indicators of latent variables (circles) were not included and (2) only parameter estimates for significant paths are shown for brevity. Exogenous variables were allowed to freely covary. Details are provided in Table 2.)

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Table 2
Structural equation model results ($N = 554$ students; unstandardized results).

	Unstandardized parameter estimates (standard errors)
Measurement model estimates	
ADHD-like → inattention 1	1.00 (ref)
ADHD-like → inattention 2	1.07 (0.06)**
ADHD-like → inattention 3	0.77 (0.07)**
ADHD-like → hyperactive 1	0.91 (0.06)**
ADHD-like → hyperactive 2	0.67 (0.08)**
ADHD-like → hyperactive 3	0.62 (0.08)**
Sensation seeking → sensation seeking 1	1.00 (ref)
Sensation seeking → sensation seeking 2	0.88 (0.18)**
Sensation seeking → sensation seeking 3	0.70 (0.15)**
Study habits → study habits 1	1.00 (ref)
Study habits → study habits 2	1.28 (0.23)**
Study habits → study habits 3	0.98 (0.14)**
Academic concern → academic concern 1	1.00 (ref)
Academic concern → academic concern 2	1.03 (0.07)**
Academic concern → academic concern 3	1.04 (0.05)**
Avoidance self-efficacy → avoidance 1	1.00 (ref)
Avoidance self-efficacy → avoidance 2	1.63 (0.12)**
Avoidance self-efficacy → avoidance 3	1.40 (0.10)**
Avoidance self-efficacy → avoidance 4	1.46 (0.12)**
Friend IUPS norms → norms 1	1.00 (ref)
Friend IUPS norms → norms 2	1.02 (0.03)**
Friend IUPS norms → norms 3	0.79 (0.04)**
Religiosity → religiosity 1	1.00 (ref)
Religiosity → religiosity 2	1.23 (0.05)**
Religiosity → religiosity 3	1.17 (0.06)**
Religiosity → religiosity 4	1.31 (0.06)**
Positive expectancy → positive expectancy 1	1.00 (ref)
Positive expectancy → positive expectancy 2	1.02 (0.04)**
Positive expectancy → positive expectancy 3	0.95 (0.06)**
Positive expectancy → positive expectancy 4	1.15 (0.05)**
Negative expectancy → negative expectancy 1	1.00 (ref)
Negative expectancy → negative expectancy 2	1.06 (0.05)**
Negative expectancy → negative expectancy 3	1.10 (0.05)**
Negative expectancy → negative expectancy 4	0.92 (0.06)**
Negative expectancy → negative expectancy 5	0.81 (0.07)**
Negative expectancy → negative expectancy 6	1.02 (0.06)**
IUPS attitudes → attitudes 1	1.00 (ref)
IUPS attitudes → attitudes 2	0.96 (0.03)**
IUPS attitudes → attitudes 3	0.70 (0.04)**
IUPS intentions → intent 1	1.00 (ref)
IUPS intentions → intent 2	1.08 (0.03)**
IUPS intentions → intent 3	0.62 (0.05)**
Structural model	
ADHD-like → study habits	−0.24 (0.05)**
ADHD-like → academic concern	0.52 (0.07)**
ADHD-like → friend IUPS endorsement	0.15 (0.07)**
ADHD-like → negative expectancy	0.01 (0.07)
ADHD-like → positive expectancy	0.39 (0.08)**
Sensation seeking → study habits	−0.13 (0.05)*
Sensation seeking → academic concern	−0.30 (0.09)**
Sensation seeking → friend IUPS endorsement	0.36 (0.07)**
Sensation seeking → negative expectancy	−0.10 (0.08)
Sensation seeking → positive expectancy	0.14 (0.09)
Community residence → study habits	0.10 (0.04)*
Community residence → academic concern	−0.22 (0.09)**
Community residence → friend IUPS endorsement	0.13 (0.08)+
Community residence → negative expectancy	0.15 (0.10)
Community residence → positive expectancy	−0.01 (0.19)
Religiosity → study habits	0.02 (0.02)
Religiosity → academic concern	0.02 (0.04)
Religiosity → friend IUPS endorsement	−0.02 (0.04)
Religiosity → negative expectancy	0.10 (0.04)*
Religiosity → positive expectancy	−0.04 (0.05)
Drug culture → study habits	0.02 (0.03)
Drug culture → academic concern	0.02 (0.04)
Drug culture → friend IUPS endorsement	0.17 (0.04)**
Drug culture → negative expectancy	0.13 (0.05)**
Drug culture → positive expectancy	0.22 (0.05)**
Study habits → avoidance self-efficacy	0.44 (0.32)
Academic concern → avoidance self-efficacy	−0.04 (0.04)
Friend IUPS endorsement → avoidance self-efficacy	−0.21 (0.04)**
Negative expectancy → avoidance self-efficacy	0.11 (0.04)**
Positive expectancy → avoidance self-efficacy	−0.19 (0.04)**
Study habits → friend IUPS norms	−0.27 (0.33)
Academic concern → friend IUPS norms	−0.01 (0.06)
Friend IUPS endorsement → friend IUPS norms	0.71 (0.07)**
Negative expectancy → friend IUPS norms	−0.02 (0.06)
Positive expectancy → friend IUPS norms	0.20 (0.07)**
Study habits → IUPS attitudes	−0.63 (0.49)
Academic concern → IUPS attitudes	−0.10 (0.06)+
Friend IUPS endorsement → IUPS attitudes	0.30 (0.06)**
Negative expectancy → IUPS attitudes	−0.22 (0.05)**
Positive expectancy → IUPS attitudes	0.24 (0.06)**
Avoidance self-efficacy → IUPS intentions	−0.67 (0.10)**
Friends IUPS norms → IUPS intentions	0.18 (0.03)**
IUPS attitudes → IUPS intentions	0.28 (0.05)**
IUPS intentions → IUPS frequency	0.74 (0.06)**

Model information: estimator = ML; bootstrapping with 1000 iterations; RMSEA = 0.05, CFI = 0.90, IUPS frequency $R^2 = 46\%$; exogenous variables were allowed to freely covary.

* $p < 0.05$.
** $p < 0.01$.
\+ $p < 0.10$.

study's SEM results. However, as the proposed temporal ordering was based on a comprehensive behavioral theory, and the relationships observed were in accordance with the theory, it is possible that future longitudinal studies will confirm the causal flow hypothesized in our model. Another limitation of this study is it took place at one university, limiting the generalizability of findings to schools with a similar population of students. Replication of this study across multiple campuses would improve the generalizability of findings.

Limitations notwithstanding, the study had multiple strengths. For example, we used probability sampling, had a high student response rate, the analytical sample was representative of the undergraduate population at the university under study, and missing data was minimal. Our study builds upon our prior work (Bavarian et al., 2013c) and not only supports associations observed in a prior study set in a Pacific Northwest university, but also advances this prior work through its use of structural equation modeling to test a comprehensive, theory-based, model of IUPS in the college population. Additionally, in being the first study (to our knowledge) to test a model based on a full version of the TTI, this study provides support for the utility of this meta-theory.

4.2. Prevention and research implications

We used a meta-theory to guide our measures and analyses, as doing so allows one to more fully understand, and therefore, aim to prevent high-risk behavior using a multitude of approaches. Our findings, though cross-sectional in nature, suggest that optimal prevention will require action at the various levels of causation and streams of influence. For example, results demonstrate the importance of ADHD-like symptomology (i.e., ultimate-level, intrapersonal stream). Accordingly, campus health centers with the capacity to provide screening and diagnosing of Attention Deficit Hyperactivity Disorder that have not already done so, should develop a standardized and rigorous protocol for screening and diagnosing. As suggested by Arria et al. (2010), clinicians can work with students exhibiting signs of inattention to determine whether they meet the clinical criteria for Attention Deficit Hyperactivity Disorder (ADHD); among students not meeting the guidelines for diagnosing, clinicians can promote the use of behavioral strategies designed to ameliorate inattention. Students who receive an

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ADHD diagnoses and opt for medicinal, in addition to behavioral, intervention, could be gradually introduced to a dosage of prescription stimulant that is safe and effective (Arria et al., 2010). Results also suggest the important influence of friends who endorse IUPS (distal-level, social stream). As students endorsing use may have their own prescription for medical stimulants, pharmacists should be encouraged to discuss both the legal and health-related ramifications that come with diverting prescription drugs (Arria and DuPont, 2010; DeSantis et al., 2009). Because pharmacists already provide consultation on how to properly use a medication, including discussions about diversion should not create an extra time burden. In the sociocultural environment stream, positive IUPS expectancies were found to be associated with each proximal measure. Accordingly, campuses could aim to dispel common myths about the capabilities of prescription stimulants when taken by students without an ADHD diagnosis.

The associations between avoidance self-efficacy, behavioral norms, and attitudes toward IUPS (proximal-level, all three streams) with IUPS intentions also provide target areas for prevention. For example, workshops to improve time management skills and decrease procrastination may assist in a student's ability to avoid IUPS should they have a large workload, whereby increasing their avoidance self-efficacy in times of high academic stress (Arria et al., 2010). Results also suggest the potential of social norms strategies. For example, in this study, 18% of the student sample reported engaging in IUPS. These data could be used to correct misperceptions between the perceived versus actual prevalence of IUPS. In addition, social marketing campaigns could be used to counter attitudes that it is okay and/or not harmful to engage in IUPS. According to the TTI, these actions should influence behavioral intention, which should influence the behavior of IUPS.

To our knowledge, this study provides the first test of the full TTI meta-theory, and is also the first to use structural equation modeling to test a comprehensive model of IUPS in the college population. Longitudinal, multi-campus studies would substantiate the temporal ordering proposed by the TTI, as well as improve the external validity of our findings. Our hope is that results from this study will help the field of IUPS research evolve from "foundational" to the second phase of prevention research (i.e., developmental studies that use etiological research to test proposed prevention efforts; Holder et al., 1999).

Role of funding source

This study was funded by the Prevention Research Center Development Fund. Manuscript preparation was supported by NIAAA Training Grant T32 AA014125. The NIAAA had no further role in study design; in the collection, analysis and interpretations of data; in the writing of the report; or in the decision to submit the paper for publication.

Contributors

All authors contributed to the study design. N.B. performed the statistical analyses and wrote the first draft of the manuscript. All authors made an important contribution to and have approved the final manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

Acknowledgements

The authors would like to thank the instructors who invited us into their classrooms and the students who completed the surveys. We would also like to thank Aracely Velazquez for her assistance with data collection.

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