Personal, Social and Cultural Predictors of Intention to Misuse Prescription Stimulants among Medical Students: a Test of the Theory of Triadic Influence

Abstract

Objective: The misuse of prescription stimulants among students has been identified as a public health problem. To date, most research has focused on *individual-level* determinants of stimulant misuse, making research on the *socio-cultural* context of students' misuse a priority. This study aims to test the applicability of the Theory of Triadic Influence, capturing three influence streams (personal, social and cultural) and three causational levels (ultimate, distal and proximal).

Method: A questionnaire on stimulant misuse was distributed among all bachelor's and master's students from the five Flemish medical faculties. In total, 3159 students participated (48.99% response rate). Data were analyzed using structural equation modeling.

Results: Multiple *personal* (i.e., fear of failure, procrastination, self-perceived ADHD, sensation-seeking, academic stress, controllability), *social* (i.e., living situation, peer endorsement, social norm) and *cultural* (i.e., competitive study-environment, financial worries, positive and negative expectancies, attitude) factors were identified as risk factors of misuse intention. The strongest ultimate to distal pathway was found between self-perceived ADHD and positive expectancies, meaning that students who believed they have ADHD, although not diagnosed, were more likely to have positive expectancies about stimulants. Moreover, the strongest distal to proximal pathways were found between expectancies and attitudes toward stimulant misuse (i.e., more positive and fewer negative expectancies were associated with more favorable attitudes). Finally, attitudes were most strongly related to misuse intention.

Conclusions: The current study shows that the TTI is an important framework to understand the risk factors of stimulant misuse among medical students. This study offers a strong basis for prevention initiatives.

Keywords: prescription stimulants, misuse, Theory of Triadic Influence, determinants, students, enhancement, socio-cultural context

1 Introduction

The misuse of prescription stimulants among students has received increasing interest in both the academic and the public debate [1, 2]. These stimulants are generally used by people with ADHD or narcolepsy, but research indicated that they are also popular among students to increase their academic performance [3]. A review study by Benson et al. [2] reported prevalence rates of students' stimulant misuse of between 5% and 35%. This misuse is not without risks, as previous research has highlighted, amongst others, cardiovascular complications, increased blood pressure, panic episodes and the risk of dependence [4].

To date, most research on stimulant misuse has focused on prevalence rates and individual level correlates, such as gender or personality characteristics [2, 5-7]. However, if we want to prevent healthy students from misusing these medicines, we should not only understand *individual level* determinants of misuse, but also the *socio-cultural context* in which students reside and study [8-10]. As students spend a large proportion of their time in an academic environment, amongst fellow students, influences from (1) peers and (2) the particular study climate of the faculty (e.g., level of competitiveness) seem inevitable. If we fail to take into account this myriad of factors, prevention strategies risk being too narrowly focused and ultimately fail in their intended purpose.

1.1 Theoretical foundation

In this study, we build on the insights of the Theory of Triadic influence (TTI). It combines ideas from several 'smaller' theories, such as the social-learning theory and the theory of planned behavior, into a comprehensive framework indicating the importance of personal, social and cultural factors in explaining health behavior [8, 11]. The framework consists of three streams of influence: personal, social and cultural, as well as three levels of causation: ultimate, distal and proximal. The *ultimate* underlying causes are the furthest removed from the

health behavior, with *distal* predisposing influences acting as mediators, while the *proximal* immediate predictors are linked the closest to the behavior. To be specific, the TTI states that (1) within the *personal* stream, biology and personality traits influence an individual's ability to perform or avoid certain behavior; (2) within the *social* stream, the micro social situation (e.g., peer environment) influences social normative beliefs; and (3) within the *cultural* stream, the cultural environment influences a person's attitudes. It is important to note that there are also inter-stream associations, for example, the cultural context can be related to constructs in the personal stream.

Previous empirical research into the risk factors of stimulant misuse have already identified associations with several factors within the TTI-framework. First, with respect to the *personal stream*, several studies have investigated the impact of a range of personality characteristics (ultimate level) on the misuse of stimulants, such as fear of failure [12], experiencing ADHD symptoms [1, 6, 13-15], sensation-seeking [16-18] and procrastination tendencies [19]. With respect to sensation-seeking, previous research shows mixed results. Most research indicates a positive correlation between sensation-seeking and misuse [16, 18]. However, the study of Bavarian et al. [17], which uses a similar methodology (i.e., structural equation modeling) and theory (i.e., theory of triadic influence) as our study, indicates that the correlation between sensation-seeking and misuse is mediated by other variables. For example sensation-seeking is negatively related to academic concern, and positively related to friend endorsement. In addition, previous research has shown that students who have higher stress levels (distal level) are more likely to misuse prescription stimulants [20]. Finally, research has indicated that the perception of controllability about performing the behavior (proximal level) is linked with the misuse of stimulants [19, 21].

Second, the *social* stream in the TTI indicates that the micro social environment of an individual influences his or her health behavior [8]. In a student setting, this means that perceived attitudes

and behaviors of peers and fellow students, i.e., social norms, play a very important role in substance use behavior. For example, previous research has indicated that members of college fraternities or sororities are more likely to misuse stimulants [2]. This may be due to the perception of members that these stimulant medications are safer and that more members misuse stimulants compared to perceptions of nonmembers. Moreover, it is also likely driven by access to the stimulants within these organizations as most students obtain these medications via peers [2]. Transferring this to the Belgian campus life, it might be that students living together with peers, away from the parental home (ultimate level), are more likely to misuse stimulants than students who live with their parents. Moreover, several studies highlight the positive association between perception of peer approval/endorsement towards stimulant misuse (distal level), as well as perceived stimulant misuse among peers (proximal level), and the individual's own use [17, 22].

Finally, the *cultural* stream refers to the influence of the macro environmental setting on an individual's health behavior. For students, an important macro setting is the university in which they reside and study. Previous research indicated an important impact of the perceived competitiveness within the faculty (ultimate level) on stimulant misuse [20]. In this respect, students studying in more competitive climates, can feel the need to misuse stimulants as they believe it leads to achieving higher grades. In addition, socio-economic status (SES) can be a major predictor. Research by Bavarian et al. [9] uses financial situation as a cultural ultimate level proxy for SES and shows that students who report having more financial worries are more likely to engage in stimulant misuse. Due to (high) college costs, it is possible that students with more financial worries feel more pressure to succeed and therefore turn to stimulants as they believe these medicines might help them succeed. Moreover, research has indicated that having more positive expectancies and fewer negative expectancies about stimulants (distal level), and

thus having a more positive attitude towards misuse (proximal level) is linked to personal use [17, 19].

We investigate the TTI in a subpopulation of medical students as they might be more at risk for misusing medication. Medical faculties are characterized by an intensive and highly demanding curriculum, in which the pressure to succeed is high, and students are competing with their fellow students to obtain high grades [23-25]. On an individual level, medical students might thus experience more fear of failure and more stress because of the high academic demands compared to students from other faculties [26, 27]. On a sociocultural level, it is possible that the competitive study climate makes them more vulnerable to stimulant misuse. Moreover, their future role as medication gatekeepers might be impeded when they misuse medication themselves during their academic career. Research focusing on medical students is thus warranted [28].

1.2 Hypotheses

Based on empirical research into the predictors of stimulant misuse, clarified in the previous section, as well as on the theoretical and applied TTI literature, indicating that ultimate variables influence distal variables, which in turn influence proximal variables [8, 17], we can derive a set of hypotheses (H).

> **H1 – personal stream**: Students who (a) perceive themselves to have ADHD; (b) report lower scores on sensation-seeking; (c) report higher scores on fear of failure; and (d) report higher scores on procrastination (ultimate level), will report higher levels of academic stress (distal level), and will in turn report higher scores on controllability (proximal level), which results in a higher likelihood of intent to misuse stimulants.
>
> **H2 – social stream:** Students who are living in a student residence away from the parental home (ultimate level) will report more approval from peers for misusing the

medication (distal level), and will in turn perceive a higher percentage of misuse within their student environment (proximal level), which results in a higher likelihood of intent to misuse stimulants.

H3 – cultural stream: (a) The more students perceive their faculty as competitive and (b) the more financial worries students experience (ultimate level), the more likely they are to report more positive and fewer negative expectancies about stimulants (distal level). As a result, these students will have a more favorable attitude towards misuse (proximal level) and are thus more likely to intend misusing the medication.

Figure 1 shows a visual representation of our hypotheses.

insert Figure 1

To date, a limited number of studies have used the TTI in order to examine the determinants of stimulant misuse among students [9, 17, 18, 29, 30]. Our study contributes to the current scientific knowledge on several aspects: (1) We add additional predictors to the TTI-model, i.e. procrastination, fear of failure, academic stress, financial worries and competitiveness within the faculty's study climate (2) we test this model in a subpopulation of medical students, who might be more vulnerable to misuse and (3) we use a large sample (i.e. approximately half of all Flemish medical students participated in this research) within a European context. Previous research testing the TTI-model on students' stimulant misuse, mostly use smaller sample sizes and are performed in a US context.

2 Methodology

2.1 Participants and study design

A web survey on stimulant misuse was distributed among all bachelor's and master's medical school students (equivalent to pre-med and medical school students in the US) from the five

Flemish medical faculties. Students were invited to participate through email and other methods (e.g., oral promotion during classes, use of social media, announcements on the intranet and promotion by student associations). The questionnaire was reviewed and approved by the Board of Deans of the five Flemish medical faculties, the Ethics Committee of Social Sciences and Humanities of the University of Antwerp (file SHW_14_25_06) and the Medical Ethics Committee of the Ghent University Hospital (file 2016/0579). In order to increase response rate, we sent reminder emails in which social norm approaches (i.e. "a lot of students have already filled in the questionnaire") were used to convince students to participate. Moreover, we offered 50 movie tickets as incentives. In total, 3159 students (48.99% response rate) filled in the questionnaire anonymously during May to June 2016. Students who only completed the demographic questions (n=221) were excluded from our sample. The sample descriptives can be found in Table 1. Students who reported being officially diagnosed with ADHD (n = 128) or who did not answer this question (n = 70) were also excluded from analyses to ensure we only included students who potentially misused the medication. This resulted in a total sample of 2740 students.

insert Table 1

2.2 Measures

The questionnaire was developed in order to capture measures of the TTI's three streams of influence (personal, social and cultural) as well as the three causational levels (ultimate, distal and proximal), similar to the methodological approach of Bavarian et al. [17]. Misuse of stimulants was defined as *the use of stimulants without having a prescription to enhance study performance (e.g., to improve studying during exams) and/or the use of stimulants with prescription to enhance study performance but not as part of a treatment (e.g., prescription from a general practitioner to study better and not as part of an ADHD or narcolepsy*

treatment). This definition takes into account the fact that students sometimes acquire the medication from physicians off-label, which is often overlooked in previous research, but nonetheless important to recognize since (1) it happens relatively often [31-34] and (2) medical guidelines discourage this behavior [35, 36]. The following stimulants were included in our study: methylphenidate (e.g., Ritalin®), modafinil (e.g., Provigil®) and (dextro)amphetamine (e.g., Adderall®).

Stimulant misuse was measured through *intention to misuse stimulants* (3-item continuous latent construct). We included *intention* to use as our dependent variable and not *actual* use for three reasons: (1) Methodologically, intention is measured as a latent continuous construct whereas actual behavior is measured as a manifest variable. In SEM models, latent constructs are preferred over manifest variables. (2) Theoretically, by using intention to use, i.e. future health behavior, we comply with the longitudinal character of the TTI model. (3) Intention to use and actual use are highly correlated [8, 17]. The specific questions, as well as items of latent constructs, response options, means, standard deviations and reliability analysis (Cronbach's alpha) can be found in Table 2.

insert Table 2

2.3 Analytic strategy

Basic descriptive analyses were performed using IBM SPSS Statistics 22. Confirmatory factor analysis (CFA) and structural equation modeling (SEM) were conducted using Mplus 7 [37].

Firstly, we checked the level of normality of all indicators, as well as the correlation between indicators, to identify possible multicollinearity issues. Since most variables were non-normally distributed, we used the MLR estimator in Mplus which is robust to non-normality. Then, we estimated the measurement model (CFA) to test the construct validity of the latent constructs in our model. Finally, the structural path model was built based on the TTI requirements. This

means that paths were specified from all ultimate to distal variables and from all distal to proximal variables. It is important to note that not only pathways within each stream are allowed, but also cross-pathways between streams (e.g., the influence of academic stress on attitudes). We also included sex as a covariate in this structural model, since research indicated a significant difference between men and women with respect to stimulant misuse [2].

For both the measurement and the structural model, we assessed the fit using several goodness of fit indicators: Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR) and Comparative Fit Index (CFI). The following cut-off criteria were used: SRMR < 0.08 [38]; RMSEA < 0.08 (adequate fit) and < 0.05 (good fit) [39]; CFI > 0.90 (adequate fit) and > 0.95 (good fit) [38, 40]; factor loading (FL) > 0.40 [40].

3 Results

Firstly, we tested the measurement model in which we only included the latent constructs of our model. This model provided a good fit to the data: the standardized factor loadings were all higher than 0.57 (Appendix 1 provides an overview of all the standardized factor loadings), well exceeding the minimum cut-off of 0.4, and fit indices were very good (RMSEA = 0.031; CFI = 0.971; SRMR = 0.035). Because of the good fit, we could use the latent variables in the structural model.

Secondly, we tested the structural model, in which the pathways were identified from ultimate to distal, from distal to proximal, and from proximal to intention variables. Sex was also included as a covariate. The structural model indicated a good model fit: RMSEA = 0.036; CFI = 0.940; SRMR = 0.053. Figure 2 provides a visual representation of all significant pathways; Table 3 provides all (significant and non-significant) standardized coefficients. The study variables, including the covariate sex, explained 43.2% of the total variance of medical students' intentions to misuse prescription stimulants.

insert Figure 2

insert Table 3

Hypothesis 1 – personal stream: Students who (a) perceive themselves to have ADHD; (b) report lower scores on sensation-seeking; (c) report higher scores on fear of failure; and (d) report higher scores on procrastination (ultimate level), will report higher levels of academic stress (distal level), and will in turn report higher scores on controllability (proximal level), which results in a higher likelihood of intent to misuse stimulants.

Our results indicated significant positive associations between fear of failure (β = 0.29; $p < 0.001$), procrastination (β = 0.15; $p < 0.001$) and academic stress, and a negative statistical association, although rather weak, between sensation-seeking and academic stress (β = -0.09; $p < 0.01$), as was hypothesized. No significant relationship was found between self-perceived ADHD and academic stress. Moreover, academic stress was, as expected, positively, but weakly, related to controllability (β = 0.09; $p < 0.01$), which in turn related to the intention to misuse stimulants (β = 0.19; $p < 0.001$). Thus, H1a was only partly confirmed, since self-perceived ADHD was not significantly associated with academic stress but H1b, H1c and H1d are fully confirmed. We also detected some interesting inter-stream associations. For example, although self-perceived ADHD was not related to academic stress, it was significantly and strongly related to peer endorsement (β = 0.34; $p < 0.01$) as well as to both negative (β = -0.41; $p < 0.001$) and positive expectancies (β = 0.66; $p < 0.001$). This means that students who believed they have ADHD were more likely to believe their peers would approve of them using stimulants. These students were also more likely to think positively about the medication and believe it would have positive effects and fewer negative effects. This was the same for sensation-seeking, which had a rather weak association with academic stress, but was significantly and rather strongly related to peer endorsement (β = 0.21; $p < 0.001$), and both

negative (β = -0.22; p < 0.001) and positive expectancies (β = 0.21; p < 0.001) towards the medication. Also, people with more procrastination tendencies or fear of failure were more likely to have positive expectancies (respectively β = 0.13 and β = 0.18; p < 0.001) about the medication.

Hypothesis 2 – social stream: Students who are living in a student residence away from the parental home (ultimate level) will report more approval from peers for misusing the medication (distal level), and will in turn perceive a higher percentage of misuse within their student environment (proximal level), which results in a higher likelihood of intent to misuse stimulants.

Our findings indicated no significant association between living situation and peer endorsement, but there was a positive significant association between peer endorsement and social norm (β = 0.24; p < 0.001). So, students who believed their peers would approve of them using the medication, were more likely to believe their fellow students misused these stimulants as well. Moreover, the higher the perceived rate of peer stimulant misuse, the greater the intention to misuse the medication themselves, although this association was weak (β = 0.06; p < 0.01). Thus, H2 was partly confirmed, as living situation was not significantly associated with peer endorsement, but there was, however, a significant pathway between peer endorsement and social norm, as well as between social norm and intention. When we investigated inter-stream relations, living situation had a significant association with expectancies, meaning that students who were living alone in a student residence, compared to students living at home, were less likely to have negative expectancies (β = -0.14; p < 0.05) and more likely to have positive expectancies (β = 0.19; p < 0.01) towards the medication. Peer endorsement also showed significant and strong inter-stream associations with controllability (β = 0.16; p < 0.001) and attitudes (β = 0.29; p < 0.001).

Hypothesis 3 – cultural stream: (a) The more students perceive their faculty as competitive and (b) the more financial worries students experience (ultimate level), the more likely they are to report more positive and fewer negative expectancies about stimulants (distal level). As a result, these students will have a more favorable attitude towards misuse (proximal level) and are thus more likely to intend misusing the medication.

Results indicated that the more students perceived their study-environment as competitive, the more negative expectancies (β = 0.06; p < 0.01) and the more positive expectancies (β = 0.07; p < 0.01) they had towards the medication, although the effect sizes were weak. Having financial worries was also significantly, but weakly, related to having positive expectancies (β = 0.06; p < 0.05), but not to negative expectancies. As hypothesized, negative expectancies were negatively related (β = -0.39; p < 0.001) and positive expectancies were positively related (β = 0.38; p < 0.001) to attitudes, which in turn influenced the intention to misuse the medication (β = 0.59; p < 0.001). Thus, H3a was confirmed, and H3b was partially confirmed as there was no significant association between financial worries and negative expectancies. When we investigated inter-stream associations, both perceived competitiveness and financial worries were positively related to the other distal variables, but these associations were rather weak. Expectancies, both negative and positive, were also significantly related to controllability (respectively β = -0.14 and β = 0.15; p < 0.001), but not related to social norm.

4 Discussion

Stimulant misuse among students has been identified as a public health problem [2]. If we want to develop prevention strategies to tackle this misuse, understanding the determinants of students' health behavior is crucial [8, 10, 11]. The aim of this research was to understand the determinants of stimulant misuse among medical students, by deductively testing the

applicability of the TTI. This framework consists of three streams of influence (personal, social and cultural), and three levels of causation (ultimate, distal, proximal).

The current study shows that the TTI is an important framework to understand the factors related to stimulant misuse among medical students. As hypothesized, the intention to misuse stimulants was associated with proximal factors from the three streams, i.e., controllability, social norms and attitudes. This means that the more students believed it was their own choice to use the medication, the more they reported misuse among other students and the more they had a favorable attitude towards misuse, the more likely they intended to misuse stimulants. The strongest proximal predictor was attitude.

With respect to the personal stream, several personality traits (sensation-seeking, procrastination and fear of failure) were identified as important ultimate predictors of stimulant misuse intention, as indicated by previous research [12, 17, 19]. Moreover, although self-perceived ADHD was not significantly associated with academic stress, there were significant and strong inter-stream associations with peer endorsement (social stream) and with both negative and positive expectancies (cultural stream). In fact, the strongest significant ultimate to distal pathway was found between self-perceived ADHD and positive expectancies. The study by Bavarian et al. [17] also found a significant association with peer endorsement and positive expectancies, but also with academic concern and not with negative expectancies, contrary to our results. However, they measured ADHD slightly differently (i.e., range of several concentration and hyperactivity issues) compared to our method, in which ADHD was measured as a self-perception dummy variable. It might be possible that since our dummy measurement of ADHD was more strict, fewer students identified with having ADHD, and hence no significant association with academic stress was found. Nevertheless, our results clearly showed that problems related to ADHD (e.g., concentration difficulties) played an important role in the pathways leading up to stimulant misuse, as indicated by several other

studies as well [1, 6, 13-15]. Moreover, academic stress (personal stream) was weakly but significantly associated with controllability (personal stream), as well as with attitudes (cultural stream).

Within the social stream, living situation was not significantly associated with peer endorsement, but there was a significant inter-stream association with both negative and positive expectancies (cultural stream). Thus, compared to living at home, students living alone in a student residence/studio/apartment tended to have fewer negative expectancies and more positive expectancies towards stimulants, which in turn was related to having more favorable attitudes towards misuse. This result differs from the research by Bavarian et al. [17] who did not find a significant association with the cultural stream, but rather within the social stream (although only on the level of $p<0.1$, which was considered non-significant in our research) and the personal stream (i.e., academic concern). The difference in results might be explained by different student housing arrangements between the US and Belgium. For example, living in dormitories (and Greek housing) is very much intertwined with US (undergraduate) college life. In Belgium, however, the concept of Greek housing does not exist and dorm life is limited as students also often live in (shared) appartements near campus or with their parents. As a result, living arrangement was measured differently in both studies: Bavarian et al. [17] measured it as a dichotomous concept, coded as either community housing (i.e. living in campus residence hall or in Greek housing) versus non-community housing (i.e. living with parents/guardian or at off-campus location), whereas our study focused more on *whom* the student lives with, i.e. parents, peers, or independently, regardless of it being on- or off-campus. In the study of Bavarian et al. [17] community residence was inversely associated with academic concern, meaning that living within a community among fellow students promotes academic strength. As community living is far less pronounced in Belgian college life, however, it is not surprising we did not find a significant association between living arrangement and

perceived academic stress. Moreover, in our study, peer endorsement was not only significantly related to social norm, but also with controllability (personal stream) and attitudes (cultural stream), which was also the case in the study by Bavarian et al. [17].

Finally, within the cultural stream, both perception of competition and financial worries were significantly related to all distal level measures, except between financial worries and negative expectancies. The statistically significant pathways were, however, rather weak. Both negative and positive expectancies were strongly associated with attitudes, they were in fact the strongest distal to proximal pathways in the model. There was also a statistically significant association with controllability, but not with social norm. Bavarian et al. [17] reported similar results in their research, although they also indicated a significant association between positive expectancies and social norm.

This study has several limitations. As with all cross-sectional studies, we cannot make statements about causality. The strong theoretical basis of our research, however, can lead us to assume that the stated causal relationships hold true. Future longitudinal research could clarify this. Moreover, as the conducted survey is based on self-reporting by students, the measures used are exposed to bias from non-response and social desirability. With respect to non-response, we compared our sample with population data for all Flemish medical students by means of chi-squared tests. These findings indicated that women and undergraduate students were over-represented in our sample, as were students from the Universities of Leuven and Hasselt. Caution is thus needed when generalizing the results. With respect to social desirability, we clearly stated in the survey that students' participation was anonymous.

Despite these limitations, this study also has several strengths. Whereas most previous research on the predictors of stimulant misuse focused on individual level variables, we used a multifaceted approach to understand the personal, social and cultural determinants of this

misuse in a European context (i.e. Belgium). In addition, on a methodological level, students from several universities were included, leading to a fairly large sample. In this respect, our study goes beyond the limitations of the study by Bavarian et al. [17] who did a similar research but at only one university. They indicated that *"replication of this study across multiple campuses would improve the generalizability of findings" [17: p. 199]*. Finally, we performed this research in a particular population which might be especially vulnerable to stimulant misuse, namely medical students.

This research study provides a strong basis for concrete prevention initiatives. The TTI indicates that the ultimate predictors of the model represent the *'root causes of behavior'* [11: 34]. Although they are the most difficult to change in prevention programs, they will have the most impact in the long run [11]. In this respect, increasing cooperation within competitive faculties could be a valuable approach (e.g., alternative ways to evaluate students, group collaboration). In addition, students reporting fear of failure or concentration problems, should be structurally guided in their study process by, for example, student counsellors, or medical doctors in case of an untreated ADHD diagnosis. It is important not to tackle only the ultimate predictors, as the TTI model assumes a multifaceted approach. In our research, attitude was found to be the strongest proximal predictor of intention to misuse. Preventing misuse thus also comes down to changing positive or neutral attitudes/expectancies into negative perceptions. Universities can play an important role in providing information on the risks of misuse. Also, with respect to peer influences, social norm campaigns to diminish alcohol use in college have already proven their effectivity [41, 42]. The current study can provide students with a correct perception of how many students misuse stimulants (i.e. 11.1% of students in this study have ever misused stimulants), and can thus help change the misconception that a large number of students misuse the medication [43]. With respect to the personal stream, more guidance in dealing with exams, helping to plan, and teaching students how to deal with academic stress in

a non-pharmaceutical way might be useful strategies. In this respect, adding academic skills to the curriculum, or including a more prominent role for student counsellors could be helpful, especially for first year students.

To conclude, together with the studies by Bavarian et al. [9, 17], this study provides a strong basis on which to build future research into stimulant misuse. As also suggested by Bavarian, longitudinal research could empirically clarify the suggested ordering of the variables. Moreover, testing the TTI model among students from several faculties would be interesting, in order to identify possible differences between faculties. Finally, future research should explore the influence of additional predictors in the TTI model. For example, our model indicated strong associations with the cultural stream variables. Further exploration of this stream, for example with respect to differences in study climate between faculties or the off-label prescribing behavior of physicians between different areas, would be valuable.

5 Declarations of interest

insert 'Declaration of interest' section here

6 References

1. Wilens, T.E., et al., *Misuse and diversion of stimulants prescribed for ADHD: a systematic review of the literature.* Journal of the American Academy of Child & Adolescent Psychiatry, 2008. **47**(1): p. 21-31.
2. Benson, K., et al., *Misuse of stimulant medication among college students: a comprehensive review and meta-analysis.* Clinical Child and Family Psychology Review, 2015. **18**(1): p. 50-76.
3. Coveney, C., J. Gabe, and S. Williams, *The sociology of cognitive enhancement: Medicalisation and beyond.* Health Sociology Review, 2011. **20**(4): p. 381-393.

4. White, B.P., K.A. Becker-Blease, and K. Grace-Bishop, *Stimulant medication use, misuse, and abuse in an undergraduate and graduate student sample.* Journal of American College Health, 2006. **54**(5): p. 261-268.

5. Dussault, C.L. and L.L. Weyandt, *An examination of prescription stimulant misuse and psychological variables among sorority and fraternity college populations.* Journal of Attention Disorders, 2013. **17**(2): p. 87-97.

6. Rabiner, D.L., et al., *Predictors of nonmedical ADHD medication use by college students.* Journal of Attention Disorders, 2010. **13**(6): p. 640-648.

7. Arria, A.M., et al., *Perceived harmfulness predicts nonmedical use of prescription drugs among college students: Interactions with sensation-seeking.* Prevention Science, 2008. **9**(3): p. 191.

8. Flay, B.R., F. Snyder, and J. Petraitis, *The theory of triadic influence.* Emerging Theories in Health Promotion Practice and Research, 2009. **2**: p. 451-510.

9. Bavarian, N., et al., *Development and psychometric properties of a theory-guided prescription stimulant misuse questionnaire for college students.* Substance Use & Misuse, 2013. **48**(6): p. 457-469.

10. France, A., *Towards a sociological understanding of youth and their risk-taking.* Journal of Youth Studies, 2000. **3**(3): p. 317-331.

11. Flay, B.R. and J. Pertraitis, *The Theory of Triadic Influence: A new theory of health behavior with implications for preventive interventions.* Advances in Medical Sociology, 1994. **4**: p. 19-44.

12. Stoeber, J. and S. Hotham, *Perfectionism and attitudes toward cognitive enhancers ("smart drugs").* Personality and Individual Differences, 2016. **88**: p. 170-174.

13. Benson, K., et al., *Is ADHD, independent of ODD, associated with whether and why college students misuse stimulant medication?* Experimental and Clinical Psychopharmacology, 2018. **26**(5): p. 476.

14. Arria, A.M., et al., *Persistent nonmedical use of prescription stimulants among college students: possible association with ADHD symptoms.* Journal of Attention Disorders, 2011. **15**(5): p. 347-356.

15. Upadhyaya, H.P., et al., *Stimulant Formulation and Motivation for Nonmedical Use of Prescription Attention-Deficit/Hyperactivity Disorder Medications in a College-Aged Population.* The American Journal on Addictions, 2010. **19**(6): p. 569-577.

16. Jardin, B., A. Looby, and M. Earleywine, *Characteristics of college students with attention-deficit hyperactivity disorder symptoms who misuse their medications.* Journal of American College Health, 2011. **59**(5): p. 373-377.

17. Bavarian, N., et al., *Using structural equation modeling to understand prescription stimulant misuse: A test of the Theory of Triadic Influence.* Drug and Alcohol Dependence, 2014. **138**: p. 193-201.

18. Holt, L.J. and M.D. McCarthy, *Predictors of prescription stimulant misuse in US college graduates.* Substance Use & Misuse, 2020. **55**(4): p. 644-657.

19. Ponnet, K., et al., *Predicting students' intention to use stimulants for academic performance enhancement.* Substance Use & Misuse, 2015. **50**(3): p. 275-282.

20. De Bruyn, S., et al., *Popping smart pills in medical school: Are competition and stress associated with the misuse of prescription stimulants among students?* Substance Use & Misuse, 2019. **54**(7): p. 1191-1202.

21. Ajzen, I., *Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior 1.* Journal of Applied Social Psychology, 2002. **32**(4): p. 665-683.

22. Lueck, J.A., R. Costantini, and M. Knobloch, *The Making of an Addiction: Examining Psychological Determinants of Prescription Stimulant Abuse among College Students.* Health Communication, 2019: p. 1-9.

23. Emanuel, R.M., et al., *Cognitive enhancement drug use among future physicians: Findings from a multi-institutional census of medical students.* Journal of General Internal Medicine, 2013. **28**(8): p. 1028-1034.

24. Webb, J.R., J.W. Thomas, and M.A. Valasek, *Contemplating cognitive enhancement in medical students and residents.* Perspectives in Biology and Medicine, 2010. **53**(2): p. 200-214.

25. Lempp, H. and C. Seale, *The hidden curriculum in undergraduate medical education: qualitative study of medical students' perceptions of teaching.* BMJ, 2004. **329**(7469): p. 770-773.

26. Dahlin, M., N. Joneborg, and B. Runeson, *Stress and depression among medical students: A cross-sectional study.* Medical Education, 2005. **39**(6): p. 594-604.

27. Dyrbye, L.N., M.R. Thomas, and T.D. Shanafelt, *Systematic review of depression, anxiety, and other indicators of psychological distress among US and Canadian medical students.* Academic Medicine, 2006. **81**(4): p. 354-373.

28. Cohen, J.L., E. Ma, and A.J. Rogers, *Nonmedical use of prescription stimulants by medical students: a call to action.* Academic Medicine, 2017. **92**(7): p. 901.

29. Bavarian, N., et al., *Illicit use of prescription stimulants in a college student sample: a theory-guided analysis.* Drug and Alcohol Dependence, 2013. **132**(3): p. 665-673.

30. Bavarian, N., et al., *The illicit use of prescription stimulants on college campuses: A theory-guided systematic review.* Health Education & Behavior, 2015. **42**(6): p. 719-729.

31. Novak, S.P., et al., *The nonmedical use of prescription ADHD medications: results from a national Internet panel.* Substance Abuse Treatment, Prevention, and Policy, 2007. **2**(1): p. 32.

32. Van Damme, J., et al., *In hogere sferen?, Volume 4: Een onderzoek naar het middelengebruik bij Vlaamse studenten. [Head in the clouds?, Volume 4: A research study on the substance use among Flemish students]*. 2018, VAD, Vlaams expertisecentrum Alcohol en andere Drugs: Brussel.

33. Vrecko, S., *Everyday drug diversions: A qualitative study of the illicit exchange and non-medical use of prescription stimulants on a university campus.* Social Science & Medicine, 2015. **131**: p. 297-304.

34. De Bruyn, S., et al., *Off-label prescribing of stimulant medication to students: a qualitative study on the general practitioner perspective.* Sociology of Health & Illness, 2020.

35. NICE, *Attention deficit hyperactivity disorder: diagnosis and management*. 2018.

36. Hoge Gezondheidsraad, *Good clinical practice in de herkenning, diagnose en behandeling - ADHD (Good clinical practice in the recognition, diagnosis and treatment - ADHD)*. 2013: Brussel.

37. Muthén, L.K. and B.O. Muthén, *Mplus User's Guide. Eight Edition.* 1998-2017: Los Angeles, CA.

38. Hu, L.t. and P.M. Bentler, *Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives.* Structural Equation Modeling: a Multidisciplinary Journal, 1999. **6**(1): p. 1-55.

39. Browne, M.W. and R. Cudeck, *Alternative ways of assessing model fit.* Sociological Methods & Research, 1992. **21**(2): p. 230-258.

40. Brown, T., *Confirmatory factor analysis for applied research*. 2006, New York: The Guilford Press.

41. Fitzpatrick, B.G., et al., *On the effectiveness of social norms intervention in college drinking: the roles of identity verification and peer influence.* Alcoholism: Clinical and Experimental Research, 2016. **40**(1): p. 141-151.

42. Scribner, R.A., et al., *Alcohol prevention on college campuses: The moderating effect of the alcohol environment on the effectiveness of social norms marketing campaigns.* Journal of Studies on Alcohol and Drugs, 2011. **72**(2): p. 232-239.

43. Helmer, S.M., et al., *Personal and perceived peer nonmedical use of prescription medicines to improve academic performance among university students in seven European countries.* Drug & Alcohol Dependence., 2016. **168**: p. 128-134.

44. Hoyle, R.H., et al., *Reliability and validity of a brief measure of sensation seeking.* Personality and Individual Differences, 2002. **32**(3): p. 401-414.

45. Tuckman, B.W., *The development and concurrent validity of the procrastination scale.* Educational and Psychological Measurement, 1991. **51**(2): p. 473-480.

46. Frost, R.O., et al., *The dimensions of perfectionism.* Cognitive Therapy and Research, 1990. **14**(5): p. 449-468.

Appendix 1

Measurement model: Standardized factor loadings

	Standardized factor loadings
PERSONAL STREAM	
Sensation-seeking *(1 = strongly disagree to 5 = strongly agree)*	
I choose friends who do exciting and unpredictable things	0.746
I like to do exciting things	0.695
I like wild parties	0.690
I would love to have new and exciting experiences, even if they are illegal	0.745
Procrastination *(1 = strongly disagree to 5 = strongly agree)*	
I needlessly delay finishing jobs, even when they are important	0.934
When I have a deadline, I wait until the last minute	0.878
I am an incurable time waster	0.653
Fear of failure *(1 = strongly disagree to 5 = strongly agree)*	
If someone does a task at work/school better than I, then I feel like I failed the whole task	0.636
If I do not do as well as other people, it means I am an inferior human being	0.802
If I do not do well all the time, people will not respect me	0.820
The fewer mistakes I make, the more people will like me.	0.573
Academic stress *(1 = Totally not stressful to 7 = totally stressful)*	
Stress about external expectations	0.622
Stress not to meet the expectations of my parents.	0.741
Stress not to meet the expectations of my friends.	0.762
Stress about the study material	0.751
Stress about the amount of study material.	0.912
Stress of having too little time to process all the study material.	0.889
Stress about not passing	0.921
Stress not to pass one or more course(s)	0.827
Stress not to graduate.	0.626
Controllability *(1 = strongly disagree to 5 = strongly agree)*	
I decide for myself to take stimulant medication to study better.	0.862
It is my choice if I take stimulant medication to study better.	0.768
SOCIAL STREAM	

No latent variables	
CULTURAL STREAM	
Negative expectancies *(1 = never tot 5 = always)*	
I would feel anxious.	0.788
I would feel dizzy/lightheaded.	0.819
My heart would race	0.645
Positive expectancies *(1 = never tot 5 = always)*	
I would get better grades	0.819
I would find studying more enjoyable	0.690
Attitudes	
To what extent do you find taking prescription stimulants to study is … (Scale from 1 to 7)	
Irresponsible – responsible	0.878
Harmful – harmless	0.737
Bad – good	0.845
Intention *(1 = strongly disagree to 5 = strongly agree)*	
I intend to take stimulant medication to improve my study performances.	0.924
I want to take stimulant medication during the exam period to study better.	0.921
It is my intention to take stimulant medication during the exam period to study better.	0.907

Tables and figures

Table 1. Sample descriptives

Variable	**Response categories**	**N = 2,938**
Sex (n (%))	Male	1,095 (37.3)
	Female	1,843 (62.7)
Age (mean (SD))	/	22.55 (2.9)
Living situation (n (%))	At home	800 (27.2)
	Alone in student residence/studio/apartment	979 (33.3)
	Shared student residence/studio/apartment	1,115 (38.0)
	Other living situation	44 (1.5)
Study progress (n (%))	Bachelor	1,455 (49.5)
	Master	1,483 (50.5)
Academic trajectory (n (%))	Standard	2,604 (88.6)
	Individualized (i.e., attending courses across multiple years)	334 (11.4)
Grades out of 20 (mean (SD))	/	14.2 (2.0)
Member of student association (n (%))	No	1,424 (48.5)
	Yes	1,514 (51.5)

Table 2. Description of the indicators (n =2740)

	Mean (SD) or %	Reliability (α)	Source
PERSONAL STREAM			
Ultimate underlying causes			
Self-perceived ADHD *(0= no; 1 = yes)*		NA	/
Do you believe you have ADHD?	No: 94.7% ; yes: 5.3%		
Sensation-seeking *(1 = strongly disagree to 5 = strongly agree)*		0.81	[44]
I choose friends who do exciting and unpredictable things	2.60 (1.03)		
I like to do exciting things	3.30 (1.05)		
I like wild parties	2.92 (1.19)		
I would love to have new and exciting experiences, even if they are illegal	2.37 (1.07)		
Procrastination[a] *(1 = strongly disagree to 5 = strongly agree)*		0.86	[45]
I needlessly delay finishing jobs, even when they are important	2.81 (1.23)		
When I have a deadline, I wait until the last minute	2.54 (1.20)		
I am an incurable time waster	3.01 (1.20)		
Fear of failure[b] *(1 = strongly disagree to 5 = strongly agree)*		0.82	[46]
If someone does a task at work/school better than I, then I feel like I failed the whole task.	2.72 (1.07)		
If I do not do as well as other people, it means I am an inferior human being.	2.26 (1.04)		
If I do not do well all the time, people will not respect me.	2.45 (1.06)		
The fewer mistakes I make, the more people will like me.	2.62 (1.12)		
Distal predisposing influences			
Academic stress – second order construct *(1 = Totally not stressful to 7 = totally stressful)*		0.79	[20]
Stress about external expectations		0.72	
Stress not to meet the expectations of my parents.	4.22 (1.71)		
Stress not to meet the expectations of my friends.	3.80 (1.64)		
Stress about the study material		0.90	
Stress about the amount of study material.	5.58 (1.31)		
Stress of having too little time to process all the study material.	5.73 (1.35)		
Stress about not passing		0.66	
Stress not to pass one or more course(s)	5.47 (1.52)		
Stress not to graduate.	3.86 (2.04)		
Proximal immediate predictors			
Controllability *(1 = strongly disagree to 5 = strongly agree)*		0.80	/

I decide for myself to take stimulant medication to study better.	2.61 (1.51)		
It is my choice if I take stimulant medication to study better.	3.21 (1.44)		
SOCIAL STREAM			
Ultimate underlying causes			
Living situation		NA	/
Where do you live during weekdays? *(At home, student housing alone, student housing with friends, other)*	Respectively 27.5%; 33.0%; 38.1%; 1.4%		
Distal predisposing influences			
Endorsement friends *(*1 = strongly disagree to 5 = strongly agree)		NA	/
My fellow students/friends would approve of me taking stimulant medication, to improve my study performances.	2.22 (0.98)		
Proximal immediate predictors			
Social norm *(%)*		NA	/
What percentage of students at your faculty do you think has ever used stimulant medication to improve their study performances?	26.23 (18.83)		
CULTURAL STREAM			
Ultimate underlying causes			
Perceived competition within the faculty *(1 = strongly disagree to 5 = strongly agree)*		NA	[9]
Students from this faculty compete with each other for the best grades.	4.24 (0.83)		
Financial worries *(1= never to 5 = always)*		NA	/
How often have you worried about your financial situation during your studies at the university.	1.82 (1.09)		
Distal predisposing influences			
Negative expectancies[c] *(1 = never to 5 = always)*		0.79	[9]
I would feel anxious.	2.83 (1.05)		
I would feel dizzy/lightheaded.	2.80 (1.01)		
My heart would race	3.55 (0.94)		
Positive expectancies[ac] *(1 = never to 5 = always)*		0.72	[9]
I would get better grades	2.90 (0.95)		
I would find studying more enjoyable	2.22 (1.03)		
Proximal immediate predictors			
Attitudes[a]		0.86	
To what extent do you find taking prescription stimulants to study is … (Scale from 1 to 7)			
Irresponsible – responsible	2.49 (1.41)		
Harmful – harmless	2.50 (1.28)		
Bad – good	2.40 (1.27)		

Intention *(1 = strongly disagree to 5 = strongly agree)*		0.94	/
I intend to take stimulant medication to improve my study performance.	1.40 (0.83)		
I want to take stimulant medication during the exam period to study better.	1.52 (0.97)		
It is my intention to take stimulant medication during the exam period to study better.	1.36 (0.80)		

Notes: abbreviations: SD (standard deviation); NA (not applicable)

a: This latent construct originally consisted of an additional item, but this was removed due to low loading/cross-loading.

b: The error terms of the first two items and the last two items were allowed to correlate due to methodological reasons, i.e., similar wording.

c: Students who have misused the medication in the past at the time of the survey were asked the following question: *"Before you used prescription stimulants for the first time, to what extent did you think these stimulants had the following effects?".* Students who had not misused the medication in the past at the time of the survey were asked the following question: "To what extent do you think prescription stimulants have the following effects?" Answer categories were combined in order to create one variable to include in the model.

Table 3. Structural model – standardized coefficients

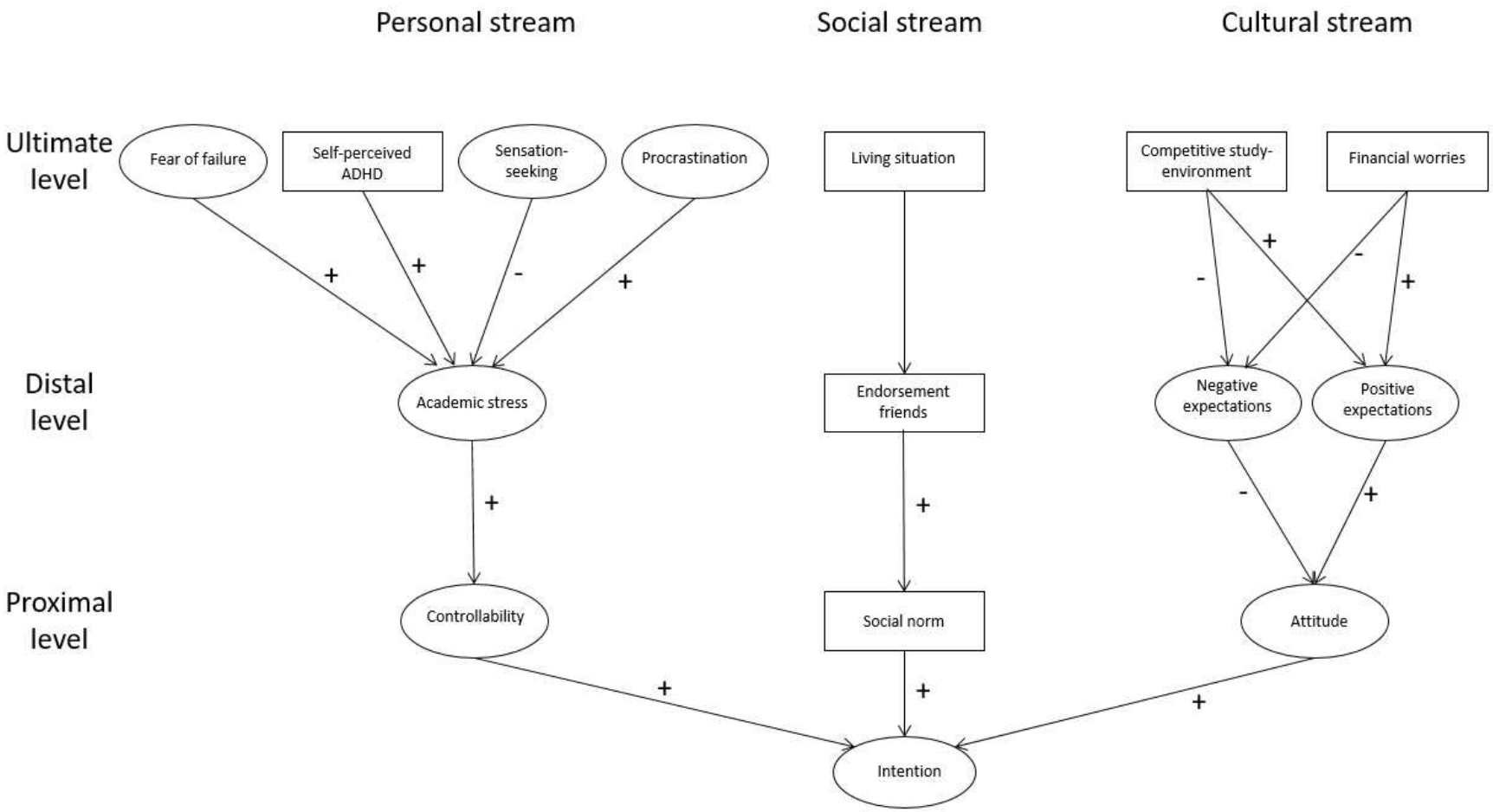
Paths	Standardized coefficients
Self-perceived ADHD → academic stress	0.192
Self-perceived ADHD → endorsement	0.340**
Self-perceived ADHD → negative expectancies	-0.405***
Self-perceived ADHD → positive expectancies	0.660***
Sensation-seeking → academic stress	-0.092**
Sensation-seeking → endorsement	0.207***
Sensation-seeking → negative expectancies	-0.217***
Sensation-seeking → positive expectancies	0.213***
Procrastination → academic stress	0.152***
Procrastination → endorsement	0.033
Procrastination → negative expectancies	-0.022
Procrastination → positive expectancies	0.130***
Fear of failure → academic stress	0.292***
Fear of failure → endorsement	0.063**
Fear of failure → negative expectancies	0.040
Fear of failure → positive expectancies	0.175***
Living situation → academic stress	0.105 ; 0.082 ; 0.025[a]
Living situation → endorsement	0.001 ; -0.002 ; 0.236 [a]
Living situation → negative expectations	-0.135* ; -0.093 ; -0.009 [a]
Living situation → positive expectations	0.189** ; 0.092 ; 0.102 [a]
Perception of competition → academic stress	0.068**
Perception of competition → endorsement	0.056**
Perception of competition → negative expectancies	0.063**
Perception of competition → positive expectancies	0.069**
Financial worries → academic stress	0.061**
Financial worries → endorsement	0.058**
Financial worries → negative expectancies	0.008
Financial worries → positive expectancies	0.060*
Academic stress → controllability	0.093**
Academic stress → social norm	0.039
Academic stress → attitudes	0.068**
Endorsement → controllability	0.158***
Endorsement → social norm	0.236***
Endorsement → attitudes	0.292***
Negative expectancies → controllability	-0.143***
Negative expectancies → social norm	-0.011
Negative expectancies → attitudes	-0.388***
Positive expectancies → controllability	0.152***
Positive expectancies → social norm	0.038
Positive expectancies → attitudes	0.375***
Controllability → intention	0.193***
Social norm → intention	0.058**
Attitudes → intention	0.585***
Sex → academic stress	0.679***
Sex → endorsement	-0.187***
Sex → negative expectancies	0.367***
Sex → positive expectancies	0.002
Sex → controllability	-0.192***
Sex → social norm	0.201***

Sex → attitudes	-0.050
Sex → intention	0.072

* : p < 0.05; ** : p < 0.01 ; *** : p < 0.001

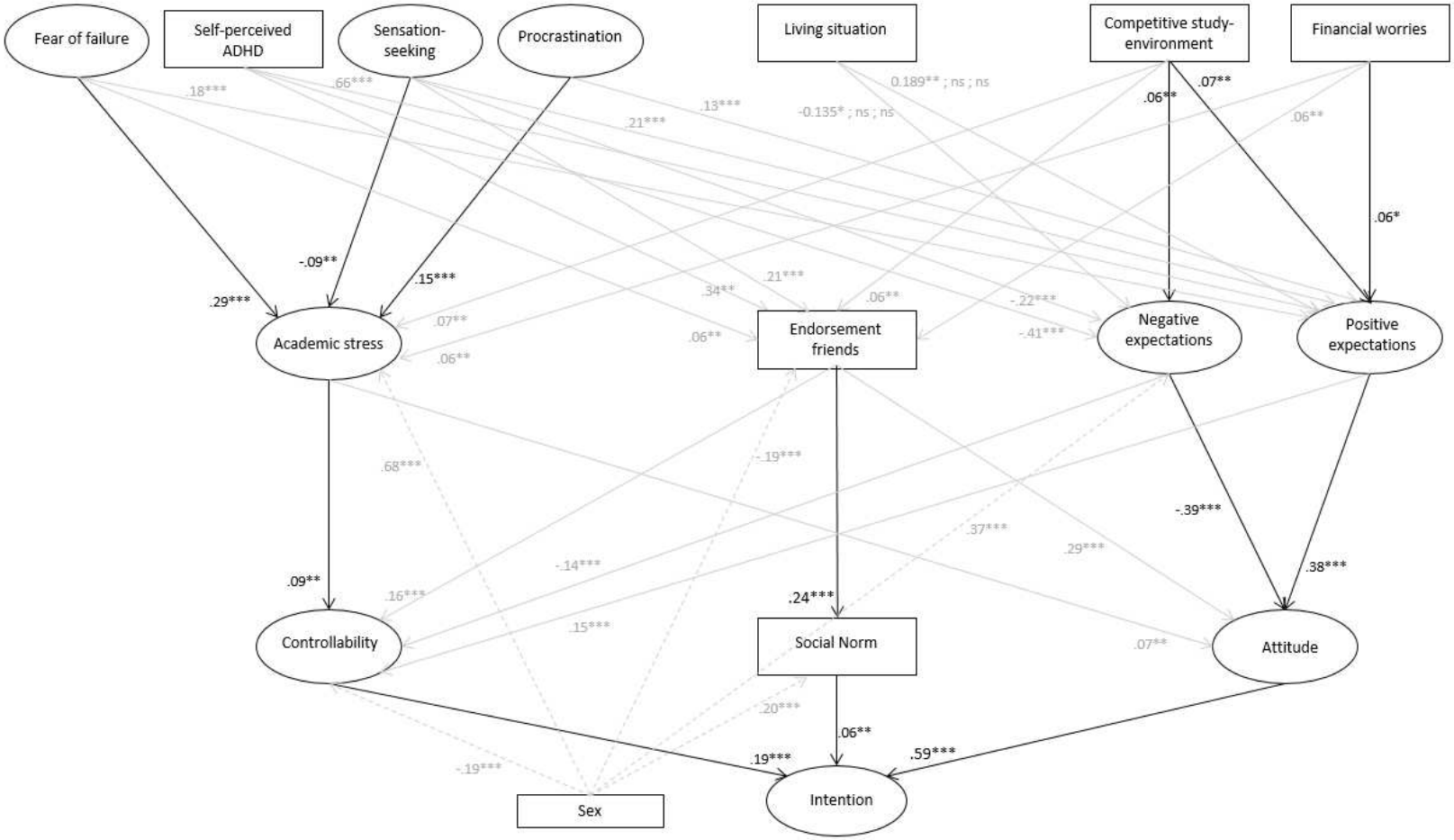
a: Three results are reported since living situation is included with three dummy variables in the model. The three results thus represent, respectively, student housing alone, student housing with friends, other; living at home is the reference category.

Figure 1. Hypothesized TTI model.



Notes: Inter-stream pathways are not hypothesized or drawn in the model for clarity reasons, but they were estimated in the structural model. Rectangles represent manifest variables, ellipses represent latent constructs.

Figure 2. Hypothesized TTI model with significant pathways.



Notes: Reported estimates are standardized values. Only significant pathways are included in this figure for clarity reasons. Indicators of latent constructs are also not shown for clarity reasons. Full black lines represent significant associations of the main variables within each stream; Grey lines represent significant inter-stream associations; Dashed grey lines represent significant associations of the covariate sex. More details are provided in Table 3.; * : $p < 0.05$; ** : $p < 0.01$; *** : $p < 0.001$