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Dropout Intentions in PhD Studies: A Comprehensive Model Based on Interpersonal Relationships and Motivational Resources

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Abstract

The purpose of this study was to provide a better understanding of doctoral studies persistence and completion by developing and validating a predictive model of dropout intentions. Based on self-determination theory (SDT), the model posits that perceived competence decreases dropout intentions, and that perceived competence is explained by autonomous and controlled regulations, which are in turn predicted by perceived psychological needs support provided by the student's advisor, faculties as well as other graduate students. A two-pronged approach was used: 1) a retrospective comparison of completers and noncompleters ($N = 422$), and 2) a prospective examination of enrolled PhD students over two trimesters to assess dropout intentions ($N = 1060$). Overall, the findings of the two studies are similar and support the proposed model. Specifically, perceived competence appears to be the cornerstone of doctoral studies persistence (completion and dropout intentions) and is predicted mainly by autonomous and controlled regulations and advisor support. Both perceived support by advisor and by faculty have an indirect effect on dropout intentions through motivational processes.

Keywords*:* PhD studies persistence, self-determination theory, perceived competence, academic motivation

1. Introduction

In the United States and Canada, enrollment in doctoral programs rose by 64% and 57%, respectively, from 1998 to 2010 (OECD, 2013). A doctoral education confers many benefits, for both individuals (e.g., greater professional and personal mobility, better working conditions, higher income) and society (e.g., tax incomes, knowledge production and dissemination, innovation, social and economic development; AUCC, 2009; Auriol, 2010; Wendler et al., 2012). Nevertheless, doctoral attrition rates remain high in North America, at an estimated 40% to 50% (Berelson, 1960; CGS, 2009; MERS, 2013; Nettles & Millett, 2006). However, they vary across disciplines, being higher in the arts, humanities, and social sciences and lower in the natural sciences (Bowen & Rudenstine, 1992; CGS, 2009; Elgar, 2003; Nettles & Millett, 2006).

Although some students may have compelling personal reasons for leaving their PhD program, such as attractive job opportunities, financial difficulties, and family obligations, the consequences for these students, as well as for universities and society, can be costly. Students who drop out may have fewer employment opportunities and experience lower self-esteem (Lovitts, 2001; Statistics Canada & HRSDC, 2003). Moreover, the substantial time and energy they invested could have been directed to other areas of their lives. For the university, doctoral attrition reduces resources and at the same time incurs costs for faculty members who have invested considerable time in research projects that will never be completed. For society, doctoral program non-completion results in lower productivity and competitiveness (Wendler et al., 2010, 2012).

Despite the high and steady attrition rates and the negative consequences of dropping out, the media and policymakers show little interest in this issue. This disinterest is also reflected in a lack of research. In 1993, Tinto noted that very few empirical studies had addressed this topic, and those that had were usually not guided by a comprehensive model or theory. Twenty years later, the situation has not changed significantly (see Ampaw & Jaeger, 2012; Elgar, 2003; Golde, 2005; Tamburri, 2013).

Given the relevance of doctoral student persistence, the lack of research on this subject, and the dearth of adequate theoretical models, this study aimed to develop and test a model of doctoral dropout intentions based on self-determination theory (SDT; Deci & Ryan, 1985). The model posits that motivational resources and perceived psychological needs support provided by advisors, faculty, and other graduate students are strong predictors of doctoral dropout intentions. Below, we introduce SDT. We then present a brief literature review concerning the relationship of doctoral persistence to autonomous regulation, competence, and support by students, faculty, and the advisor. We also present the persistence determinants we used as control variables. We then describe our model in more detail and outline the two studies we conducted to validate it.

1.1 Theoretical Background: Self-determination Theory (SDT)

According to SDT, individuals possess a natural tendency for psychological growth and integration (Deci & Ryan, 2012b). This tendency is a function of the social context in which individuals evolve, and the capacity of that context to support and satisfy three innate psychological needs: *autonomy, competence*, and *relatedness* (Deci & Ryan, 1985, 2012a, 2012b). Autonomy refers to "the necessity of experiencing a sense of choice, willingness, and volition as one behaves" (Deci, Ryan, & Guay, 2013, p.113). Competence relates to the feeling of being effective in one's interactions with the environment and being able to exercise their capacities. Relatedness refers to the quality of interpersonal relationships, to the "need to be close to, trusting of, caring for, and cared for by others" (Deci & Ryan, 2012a, p. 421). The more the social environment satisfies psychological needs, the more positive the consequences (Deci & Ryan, 2012a). In this study, we assess psychological needs support provided by advisors, faculty,

and other graduate students as potential determinants of autonomous and controlled regulations (Deci & Ryan, 2012a; Vansteenkiste, Lens, & Deci, 2006).

Autonomous regulation takes place when individuals perceive that their behaviors and goals result from their own volition and choice. In contrast, controlled regulation refers to acting in order to obtain a reward or recognition by others, or to avoid punishment, feelings of guilt, or shame. Empirical evidence supports the argument that when psychological needs are satisfied, people experience greater autonomous motivation and lower controlled motivation (see Deci & Ryan, 2000, for a review). Moreover, autonomous regulation is associated with positive outcomes, whereas controlled motivation is associated with negative outcomes (Guay, Ratelle, & Chanal, 2008). In a study conducted to validate a scale of motivation toward completing a PhD (Litalien, Guay, & Morin, 2015), autonomous regulation was positively associated with satisfaction (university, program, and studies), positive affect, performance, and postdoctoral intentions, and negatively associated with test anxiety, negative affect, dropout intentions, and thesis problems. Conversely, controlled regulation was positively associated with the aforementioned negative outcomes but negatively with most of the positive outcomes.

Similarly, Losier (1994) demonstrated that academic persistence in graduate students was predicted mainly by autonomous regulation. Black and Deci (2000) found that undergraduate students who took a chemistry class for less autonomous reasons were more likely to drop out of the course. Autonomous regulation has also been associated with persistence in junior-college students (Vallerand & Bissonnette, 1992) and high school students (Vallerand, Fortier & Guay, 1997), whereas controlled regulation was negatively associated with persistence.

In addition to autonomous regulation, perceived competence is a central concept in SDT and in other theories (e.g., Ajzen, 1985; Bandura, 1993) that is associated with positive consequences. More precisely, competence beliefs have been associated with persistence in numerous studies using different samples, methodologies, and measures (Multon, Brown, & Lent, 1991). For example, Quiroga, Janosz, Bisset, and Morin (2013) found that perceptions of academic competence predicted school dropout in a sample of seventh-graders. College competence beliefs at the end of the first semester were also associated with persistence in the next semester, controlling for college competence beliefs on the first college day and other variables such as gender, ethnicity, first-generation status, and high school academic achievement (Wright, Jenkins-Guarnieri, & Murdock, 2012). In graduate students, perceived academic competence predicted later academic persistence (Losier, 1994), while in doctoral students, competence beliefs toward research have been associated with interest in the research (Bishop & Bieschke, 1998) and research productivity (e.g., number of submitted articles, conference presentations; Brown, Lent, Ryan, & McPartland, 1996; Hollingsworth & Fassinger, 2002).

1.1.1 Proposed sequence between theoretical constructs

When assessing both regulation types and perceived competence in a model, previous research based on SDT supported different sequences (e.g., autonomous regulation predicting perceived competence vs. perceived competence predicting autonomous regulation). The model proposed here favors the sequence in which autonomous and controlled regulations precede perceived competence. Two reasons lead us to propose such a sequence:

First, according to SDT, higher level of autonomous regulation could precede perceived competence because the educational tasks to master at the graduate level are complex and necessitate a high level of cognitive and behavioral engagement. Autonomous motivation toward PhD studies could help students to initiate and engage in a set of complex actions (e.g., trying to understand a given phenomenon by reading numerous scientific articles, synthetizing a literature, generating ideas that will contribute to existing knowledge, learning research methods, and

developing an expertise in analyzing qualitative or quantitative data). This willingness and involvement are thus likely to lead them to improve their skills and to perceive themselves as more competent in achieving these tasks. In other words, autonomous motivation facilitates the execution of those complex actions, which in turn mobilize perceptions of competence.

Second, empirical evidence concurs with this sequence. In second year medical students, Williams and Deci (1996) found that autonomous motivation mediated the relationship between perceived autonomy support by instructors and subsequent perceived competence. Black and Deci (2000) also showed that undergraduate students with higher autonomous motivation at the beginning of term were more likely to perceive themselves as competent at the end of term. Although related to the health domain, other studies based on SDT also supported this sequence. Williams, Freedman, and Deci (1998) showed that perceived autonomy support by the health care provider increased patients' autonomous regulation, which led them to feel more competent. In turn, perceived competence predicted persistence of healthy behaviors in time. Moreover, Williams, McGregor, Zeldman, Freedman, and Deci (2004) found that perceived competence for engaging in healthy behaviors mediated the relationship between autonomous regulation and health behavior change.

We suggest that students who perceive their environment as more supportive will be more autonomously motivated toward their PhD studies. In turn, they will perceive themselves as more competent and will be less likely to quit their program. In contrast, students who perceive less support will be more likely to be regulated by controlled motivation and less likely to experience autonomous regulation. In turn, they will perceive themselves as less competent and will be more likely to quit the program.

1.2 Doctoral Studies Persistence and Support for Psychological Needs

SDT suggests that autonomous regulation flourishes when interactions with others support the satisfaction of the three psychological needs. In contrast, controlled regulation would be higher when the social context does not satisfy these needs. According to Tinto (1993), doctoral student persistence is largely shaped by social interactions with peers, faculty, and the advisor, which are particularly relevant for completing the doctoral dissertation. Defining learning as a social process, Baker and Lattuca (2010) also emphasized that relationships can either facilitate or hamper learning and identity development in graduate studies.

Previous empirical studies have confirmed the influence of personal relationships in shaping doctoral experience. For example, in their narrative review, Bair and Haworth (2005) concluded that completers were more likely than noncompleters to relate with their academic peers. Lovitts (2001) also found negative and significant correlations between integration opportunities (e.g., office sharing, dissertation support groups, departmental activities and committees) and attrition rates.

From 58 semistructured interviews with doctoral nonpersisters, Golde (2005) found that an incompatible relationship with the advisor and lack of supportive relationships with faculty and peers contributed to attrition. In their narrative review of doctoral student attrition and persistence, one of the most striking findings by Bair and Haworth (2005) was the association of PhD graduation with the quality of interactions between students and their advisors and other faculty members, irrespective of the research methodology adopted (i.e., quantitative, qualitative, or mixed).

Moreover, the quality of interactions with faculty was negatively associated with time to complete the PhD program and positively associated with expectations to enter a faculty or postdoctoral position (Nettles & Millett, 2006). Using different data sources (e.g., survey of completers and noncompleters, interviews with noncompleters, graduate program directors, and

faculty members), Lovitts (2001) concluded that the student–advisor relationship "is probably the single most critical factor in determining who stays and who leaves" (p.270). Moreover, from interviews with students and their supervisors, Buckley and Hooley (1988) concluded that supervision quality was the most significant problem associated with completing doctoral programs.

Albeit useful, the above research does not provide clear or common guidelines for assessing aspects of relationships that are determinant for sustaining motivation toward PhD studies. The present study extends the few attempts to understand PhD persistence through SDT (Overall, Deane & Peterson, 2011; Losier, 1994) by assessing the quality of support for psychological needs provided by certain significant sources that are most likely to be present in the academic social context and liable to shape the doctoral experience: advisors, faculty, and other graduate students.

1.3 Persistence Determinants Used as Control Variables

We also included as control variables other determinants of doctoral persistence proposed in previous studies. Although the results in the literature are inconsistent for some of these variables, we consider gender (CGS, 2008; Most, 2008; Nettles & Millett, 2006; see also Bair & Haworth, 2005 and Reamer, 1990, for a review), financial resources (Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; Girves & Wemmerus, 1988; Kim & Otts, 2010; Lovitts, 2001; Millett, 2003; Nettles & Millett, 2006), citizenship (CGS, 2008), research productivity (Nettles & Millett, 2006), and the number of completed semesters (Bowen & Rudenstine, 1992; Tinto, 1993).

1.4 The Present Study

The purpose of this study was to provide a better understanding of PhD completion by developing and validating a predictive model of dropout intentions. Based on SDT, the model (see Figure 1) proposes that higher perceived competence leads to lower dropout intentions. Furthermore, perceived competence should be positively predicted by autonomous regulation and negatively by controlled regulation. In turn, autonomous and controlled regulations should be predicted by perceived support for psychological needs by the advisor, faculty, and other graduate students. As suggested by SDT, an environment that provides psychological needs support should lead to autonomous regulation. These associations between variables are hypothesized while controlling for other significant PhD persistence determinants: students' presentation and publication rate, scholarships, income, indebtedness, gender, citizenship, program type, number of completed trimesters[1], and dropout intentions at the first measurement time (T1, see Figure 1).

We validated our model with two studies. First, we conducted a retrospective comparison of students who completed or did not complete a PhD program. The aim was to identify distinctive characteristics of completers and noncompleters that could provide support for the proposed model. More specifically, we proposed that compared to noncompleters, completers would present higher autonomous regulation, perceived competence, and perceived psychological needs support by their advisor, faculty, and other graduate students. Second, we conducted a prospective study to test the predictive value of the proposed model over a 6-month period. Due to the difficulty of capturing PhD dropout behavior in a relatively short time period (i.e., most students quit after the second year; Bowen & Rudenstine, 1992; MERS, 2013), we used dropout intentions as an indicator of dropout behavior. According to the theory of planned behavior (Ajzen, 1985), intention is assumed to be an immediate antecedent of action. In a meta-analysis

[1] In the present study, academic years for doctoral studies are divided in three terms.

of the relationship between intentions and behavior, Sheeran (2002) reported a mean correlation of .53 between these two constructs.

2. Study 1

2.1 Method

2.1.1 Participants and Procedure

In fall 2011, an email was sent to all PhD students (N = 2,167) of a large French-language university in Canada who had or had not completed a PhD program in 2007-2011 and who were no longer enrolled in any program at this university. They were invited to fill out an online questionnaire lasting about 40 minutes. The questionnaire asked them to recollect their perceptions of their relationships and motivational states when pursuing their PhD studies. A total of 522 former students participated in the study (24% of the population). However, 89 respondents were eliminated due to missing data on the item distinguishing between completers and noncompleters, and 11 respondents were excluded because they were currently enrolled in a PhD program at another university. Comparison analyses were therefore conducted on a reduced sample of 422 participants (mean age = 35.6 years, SD = 7.9, 54.5% males). Concerning citizenship, 76.3% were Canadian citizens, 10.7% were permanent residents, and 13.0 % held a temporary visa. Participants included 287 completers who graduated and 135 noncompleters who completed an average of 6.6 trimesters (SD = 4.7). Participants had enrolled in 66 different PhD programs, and 39.9 % had received a scholarship.

2.1.2 Measures

2.1.2.1 Completion

To distinguish completers from noncompleters, we first asked the participants, "Which of the following situations best corresponds to yours?" Possible choices were 1) "I completed my PhD program" (n = 287), 2) "I enrolled in a PhD program at another university" (n = 11), 3) "I enrolled in another type of program at another institution" (n = 8), 4) "I temporarily interrupted my PhD studies" (n = 50) and 5) "I definitely quit my PhD program" (n = 77). The first situation (1) applied to the completer group and the three last situations (3, 4 and 5) applied to the noncompleter group (n = 135). Because they were currently enrolled in PhD studies, students in the second situation (2) were considered as persisters and were excluded from this study. Participants who reported temporary interruption (situation 4) were considered as noncompleters as our dataset did not enable us to verify whether they continued their PhD studies at a later point in time. To ensure this merging was appropriate, we compared differences between the temporary and the definitive interruption groups on all variables. Except for the program type, no significant differences were observed. Students who mentioned having temporarily interrupted their studies were more likely to study in human sciences than in natural sciences, $\chi 2$ (1, N = 137) = 4.52, $p <$ .05.

2.1.2.2 Support for psychological needs

Using three different scales (Rochester Assessment Package for Schools, Connell & Wellborn, 1991; Learning Climate Questionnaire, Williams & Deci, 1996; Markland & Tobin, 2010), we measured the quality of support provided by three sources: the advisor, faculty, and other graduate students. For each source, we assessed the students' perceptions of the support they received for autonomy (e.g., "Overall, my advisor encouraged me to formulate my own ideas"), competence (e.g., "My advisor gave me confidence in my ability to succeed in my PhD studies"), and relatedness (e.g., "My advisor seemed to like me"). Within each source of support, strong correlations were found between support for competence, autonomy, and relatedness, ranging from r = .75 to r = .90. We therefore computed a general needs support score for the advisor (27 items), professors (18 items), and graduate students (15 items). Cronbach's alphas

were .98 for advisor support and .97 for both professor and graduate student support. Correlation between these sources of support range from $r = .32$ to $r = .51$ (see Table 2).

2.1.2.3 Motivation toward PhD Studies

To assess motivation, we used the Motivation for PhD Studies scale. This scale has good psychometric properties (Litalien et al., 2015) and was inspired by two other questionnaires (Self-Regulation Questionnaire, Ryan & Connell, 1989; Academic Motivation Scale, Vallerand, Blais, Brière, & Pelletier, 1989). It contains a total of 15 items that originally assessed five types of regulation proposed by SDT: intrinsic, integrated, identified, introjected, and external. Based on previous research (e.g., Vansteenkiste, Smeets, Soenens, Lens, Matos, & Deci, 2010), we combined the subscales into two broader regulation categories: autonomous (intrinsic, integrated, and identified) and controlled (introjected and external). This merging was made in order to significantly reduce the number of free parameters in the model and to preserve the richness of the multidimensional conception of motivation proposed by SDT. A general question asked participants to rate the extent to which each item corresponded to their reasons for persisting in their doctoral studies on a five-point Likert scale (1 = *does not correspond at all*, 5 = *corresponds exactly*). Nine items measured autonomous regulation (e.g., "For the fun I have conducting my research project") and six controlled regulation (e.g., "In order to get a better salary later on"). Cronbach's alphas were .79 for autonomous regulation and .68 for controlled regulation.

2.1.2.4 Perceived competence

We administrated the competence subscale of the Balanced Measure of Psychological Needs scale (BMPN; Sheldon & Hilpert, 2012). This subscale contains six items, three assessing satisfaction (e.g., "I was successfully completing difficult tasks and projects.") and three assessing dissatisfaction (e.g., "I struggled doing something I should be good at"). In the context of this scale, satisfaction and dissatisfaction respectively refer to the salient presence and absence of a specific experience (Sheldon & Hilpert, 2012). In our study, we used a 7-point Likert scale (1 = *does not correspond at all*, 7 = *corresponds exactly*) and Cronbach's alpha was .76.

2.1.2.5 Presentation rate

Participants reported how often they presented posters or gave oral presentations at conferences. For noncompleters, the number of presentations was divided by the number of trimesters for which they had enrolled. As data on the number of completed trimesters was not available for completers, we divided the number of their presentations by the average number of trimesters needed by previous students to graduate from the same program (based on institutional data).

2.1.2.6 Publication rate

Participants also reported how often they published articles, books, book chapters, book reviews, or work of art reviews as first author or coauthor. For noncompleters, the number of publications was divided by the number of trimesters in which they had enrolled. For completers, the number of publications was again divided by the average number of trimesters needed by previous cohorts for completing the program.

2.1.2.7 Scholarships

In Quebec, graduated students with Canadian citizenship or permanent resident status can obtain scholarships from federal or provincial granting agencies. A dichotomous variable was generated (0 = *no scholarship obtained*, 1 = *scholarship obtained*) to capture this variable.

2.1.2.8 Income and indebtedness

Students' income for the last year in their program was assessed by summing all scholarships, wages, and loans. Indebtedness refers to the total amount of debt accumulated by participants since the beginning of their postsecondary studies. Income and indebtedness were

then converted into categorical variables. Income was score from 1 to 10 (1 = *less than $10,000 per year*, 10 = *$90,000 or more per year*) and indebtedness scores ranged from 1 to 7 (1 = *less than $1,000*, 7 = *more than $50,000*).

2.1.2.9 Other control variables

Gender, citizenship status (1 = *citizen*, 2 = *non-citizen*), and program type were used as control variables, all measured dichotomously. As mentioned above, participants had enrolled in 66 programs. We constructed two broader program groups: 1) natural sciences, and 2) human sciences. The majority of our sample had enrolled in natural sciences programs (54.5%).

2.1.3 Statistical Analyses

2.1.3.1 Goodness of fit indices

We assessed the fit of all models using various indices embedded in Mplus 7.3 (Muthén & Muthén, 2012) in conjunction with the MLR estimator (Hu, & Bentler, 1999; Yu, 2002): the MLR Chi-square statistic (χ^2), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). Values greater than .90 for CFI and TLI indicate adequate model fit, although values approaching .95 are preferable. RMSEA values smaller than .08 or .06 indicate acceptable and good model fit, respectively. SRMR values smaller than .08 indicate adequate model fit.

2.1.3.2 Clustered nature of data

Students were nested within programs. This can lead to underestimation of standard errors, and thus to overly liberal tests of statistical significance (see Hox, 2010). To correct for this potential bias, all analyses take into account the clustered nature of the data by adjusting for standard errors (i.e., TYPE=COMPLEX option in Mplus; Muthén & Muthén, 2012).

2.1.3.3 Parcels

We used three parcels of items to measure each latent factor, as the scales contained several items (from 6 to 27). When scales contain many items, item parceling reduces the number of estimated parameters and is associated with more reliable and valid indicators (Marsh & Yeung, 1998). For each of these scales, parcels were created by averaging every third item, resulting in three item parcels (e.g., for a 10 items scale: items 1, 4, 7, and 10; items 2, 5, and 8; and items 3, 6, and 9). Percentages of item non-responses were acceptable, ranging from 0% for most variables to 5.8% for faculty support.

2.1.3.4 Analyses

We ran three types of analyses. First, we used confirmatory factor analysis (CFA) to 1) test model adequacy, 2) assess the magnitude of the relationships between latent variables and their indicators, and 3) estimate the correlations among the model variables. We then conducted a multiple indicators multiple causes (MIMIC) model analysis to investigate whether completion status (completers vs. noncompleters) predicts latent and observed variables. Gender, citizenship status, and program type were included as control variables to estimate the net effect of completion on latent and observed variables. In contrast to MANOVA and multiple regressions, MIMIC models are based on the underlying factor structure rather than scale scores, thus providing control for measurement error.

For each significant main effect at the multivariate level (i.e., MIMIC), we explored differences in the latent and observed variable means across predictive variables (completion, gender, citizenship status, and program type). We used four models, one for each predictive variable, and included only variables for which significant main effects were observed. For each model, we first used CFA to test for strong invariance of the measurement models across groups. Strong invariance holds when factor loadings and the intercepts of the manifest indicators are invariant across groups such that differences in average indicator scores reflect differences in

latent means. In the next step, we constrained the latent and observed means of the variables to be invariant across groups. When the constrained means model shows worse fit than the model in which means are allowed to be freely estimated, this reflects mean differences between groups. Models were compared with the chi-square difference test using a scaling correction factor obtained with the MLR estimator (Mplus: http://www.statmodel.com/chidiff.shtml). To facilitate interpretation of the latent means, we reparameterized the model using a nonarbitrary method to identify and set the scale of latent variables (see Little, Slegers, & Card, 2006). This method allows estimating latent means in a nonarbitrary metric that reflects the metric of the indicators measured.

2.2 Results

Results of the general CFA indicated an acceptable fit (see M1 in Table 1). Correlations between latent constructs and descriptive statistics are presented in Table 2. The MIMIC model also provided an acceptable fit (see M2 in Table 1). It assesses four predictive variables: completion (1 = noncompleters, 2 = completers), gender (1 = male, 2 = female), citizenship status (1 = Canadian citizenship, 2 = other citizenship), and program type (1 = natural sciences, 2 = human sciences). Results of the MIMIC model revealed six main effects for completion, five for citizenship status, four for gender, and three for program type (see Table 3).

Compared to noncompleters, completers perceived higher support by their advisor, faculty, and other graduate students. They also felt more competent, had a higher presentation per trimester rate, and were more likely to receive scholarships. Compared to men, women showed more autonomous and controlled motivation, perceived themselves as more competent, and felt more supported by peers. Canadian citizens showed less controlled regulation than non-citizens, but were more likely to receive a scholarship and had higher income and indebtedness. Students in natural sciences programs perceived more support by other graduate students, gave more presentations, and had lower indebtedness compared to students in human sciences programs.

To further explore the magnitude of these differences, we ran additional analyses to compare latent and observed means. We tested four models, one for each predictive variable (completion, gender, citizenship status, and program type), and included only factors with significant main effects in the MIMIC. For each model, constraining the construct means (latent and observed) to be invariant across groups resulted in a substantially worse fit (see M3 to M10 in Table 1). Mean differences between groups and Cohen's *d* are presented in Table 4. Overall, stronger mean differences were observed between completion and citizenship status (Cohen's $d > 0.40$). Completers perceived themselves as more competent than noncompleters, and non-citizens had less financial resources, although they also had less indebtedness.

2.3 Discussion

This retrospective study was conducted to explore differences (and their relative strength) between completers and noncompleters on selected determinants embedded in our persistence model, while considering gender, citizenship, and program type. Six of the 11 selected determinants distinguished completers from noncompleters. First, the strongest difference between the two groups was observed for perceived competence. In line with past research (Losier, 1994; Multon et al., 1991; Quiroga et al., 2013: Wright et al., 2012), students who perceived themselves as more competent were more likely to complete their PhD program.

Second, our results reinforce previous studies on the relevance of relationship quality with advisor and faculty (e.g., Bair & Haworth, 2005; Lovitts, 2001). Specifically, the results suggest that completers perceived greater support for their psychological needs by their advisor, faculty, and other graduate students. Additionally, our findings suggest that perceived support by peers might be relevant.

Third, completers and noncompleters showed similar levels of autonomous and controlled regulations, even though persistence has been positively associated with autonomous regulation and negatively with controlled regulation in high school (Vallerand et al., 1997), junior-college (Vallerand & Bissonette, 1992), and graduate studies (Losier, 1994). Because the present study was retrospective, it is possible that previous motivational states were difficult to remember. Moreover, as proposed in our model, and according to past results (Black & Deci, 2000; Williams & Deci, 1996; Williams et al, 1998, 2004), autonomous and controlled regulations might instead affect persistence through perceived competence.

Fourth, obtaining a scholarship appears to play a role in completion over and above financial aspects, given that income and indebtedness did not differ across completers and noncompleters. Although scholarships often release students from having to support themselves while studying, thus allowing them to enroll full-time, they might also be perceived as an indicator of competence and integration in research. Another sign of integration in research could be research productivity. The presentation rate is higher for completers, although no differences were found in the publication rate.

As mentioned in the results section, we also found differences by gender, citizenships status, and program type, mainly in favor of natural sciences students, as expected (Bowen & Rudenstine, 1992; Bair & Haworth, 2005; Elgar, 2003, Lovitts, 2001). Differences in citizenship status were mostly related to financial aspects, probably because non-residents are not eligible for federal or provincial scholarships, and therefore might come from wealthier families. Non-citizens also showed higher controlled regulation. Compared to citizens, international students might feel additional pressure to succeed in their studies, given that they often take on a greater commitment by leaving their country and family, and given that they usually need a student visa to be allowed to remain in the host country. Although previous research on doctoral persistence suggests either no gender effect (Bowen & Rudenstine, 1992; Most, 2008; Nettles & Millett, 2006) or some in favor of men (CGS, 2008), our results are slightly more favorable to women.

A significant limitation of this study is attributable to the retrospective design. Although the results are informative about indicators that distinguish completers from noncompleters, the data were based on memories, and the temporal sequence could not be examined. We therefore conducted a prospective study to address this limitation.

3. Study 2

3.1 Method

3.1.1 Participants and Procedure

In October 2011, an email was sent to all the PhD students enrolled at the above-mentioned French-speaking university (N = 2,266) to invite them to participate in a study on determinants of doctoral persistence. We asked them to complete an online questionnaire lasting about 40 minutes. We subsequently used different reminder strategies to solicit students: an email to faculty members to ask for their help in recruiting, two personalized emails, phone calls, and finally, a letter. A total of 1,060 PhD students participated in this first wave of data collection. Mean age of participants was 31.9 years (SD = 8.1) and 52.1% were female. Participants were enrolled in 71 programs and 17 faculties. Half the participants were in natural sciences programs (50.7%) and the other half in human sciences (49.3). Overall, they completed 7.1 trimesters (SD = 5.5), 98.5% had a research advisor, and 45.6% had received a scholarship. With respect to citizenship, 67.4% were Canadian citizens, 9.1% were permanent residents, and 23.5% held temporary visas.

In March 2012, an email invitation was sent to each student who agreed to participate at the second measurement time (N = 1000). They were asked to fill out an online questionnaire

lasting approximately five minutes. Respondents were eligible for a draw prize of two iPads. At T2, 914 respondents completed the questionnaire (13.7% attrition). Mean age of participants was 31.7 years (SD = 7.7) and 53.7 % were female. At T2, 866 students were still enrolled in the same program. Of the participants who were no longer studying in their original program (N = 48), 29 had obtained a PhD, three had enrolled in a PhD program at another university, two had enrolled in a program at another education level or at another institution, 11 had temporarily interrupted their PhD, and only three had definitely dropped out of the PhD program. To test for attrition effects, we compared students who participated at both time points with students who participated in the first wave only on the model variables and age (18 variables). Significant differences were found for only four variables. Continuers had higher indebtedness (M = 2.64 vs. M = 2.11; SD = 1.76 vs. SD = 1.63; d = 0.31), perceived more support by other graduate students (M = 4.73 vs. M = 4.22; SD = 1.23 vs. SD = 1.03; d = 0.46), and were more likely to be female, χ^2 (1, N = 906) = 8.1, p < .001 and a Canadian citizen χ^2(1, N = 906) = 17.9, p < .001.

3.1.2 Measures

Study 2 includes all measures used in Study 1 except for persistence. Cronbach's alpha values were .97 for advisor support, .96 for both professor and graduate student support, .81 for autonomous regulation, and .71 for both controlled regulation and perceived competence. In contrast to Study 1, students' income was estimated by summing all scholarships, wages, and loans for the current academic year (using the same scale). All these variables were assessed at T1 only. Additionally, we included a new variable at both time measurements: dropout intentions.

3.1.2.1 Dropout intentions

Participants answered two items on a 5-point Likert scale (1 = *not at all likely*, 5 = *very likely*): "Is it likely that you will give up your studies in the next year?" and "Is it likely that you will give up your studies before graduation?". As the scale only includes two items, the Spearman-Brown formula was used to assess it reliability (Eisinga, Grotenhuis, & Pelzer, 2012). The Spearman-Brown coefficient for this scale was .91 at both time measurements. The correlation between T1 and T2 dropout intentions was high (r = .73).

3.1.3 Statistical Analyses

We used the same analyses as in Study 1, with the additional control variable number of trimesters. Furthermore, we used structural equation modeling (SEM) to validate the model (Kaplan, 2000) and we tested indirect effects with bias-corrected bootstrap analyses (Shrout & Bolger, 2002).

We conducted analyses on all students who participated at T1, and we estimated missing data. Depending on the scale, non-response on T1 items ranged from 0% for regulation types and perceived competence to 15.1% for indebtedness and dropout intentions. Dropout intentions at T2 accounted for 18.4% of the missing data (including the 13.7% attrition and the 48 participants who were no longer enrolled in the program). We used a model-based approach to estimate missing data (see Allison, 2001) called full information maximum likelihood (FIML) with the MLR estimator implemented in Mplus 7.3 (Muthén & Muthén, 2012).

3.2 Results

Results from the CFA indicated an acceptable fit (see M1 in Table 5). Correlations between latent constructs and descriptive statistics are presented in Table 6. The MIMIC models assessing four predictive variables, gender (1 = male, 2 = female), citizenship status (1 = Canadian citizenship, 2 = other citizenship), program type (1 = natural sciences, 2 = human sciences), and number of completed trimesters also provided acceptable fit (see M2 in Table 5)

and revealed four main effects for gender, 10 for citizenship status, six for program type, and nine for completed trimesters (see Table 7).

Overall, women showed more autonomous and controlled motivations, but lower perceived competence and publication rate. Canadian citizens showed less controlled regulation than non-citizens, felt more supported by other graduate students, perceived themselves as more competent, were more likely to have dropout intentions (at T1 and T2) and to obtain scholarships, and had higher presentation and publication rates, higher income, and indebtedness. Students in natural sciences programs showed higher controlled regulation than students in human sciences, as well as a higher presentation and scholarship rates. They were less likely to think about dropping out (at T1 and T2) and had lower indebtedness. The number of completed trimesters positively predicted presentation rate, scholarships, income, and controlled regulation, and negatively predicted support by advisor, faculty, and other graduate students as well as autonomous regulation and dropout intentions at T2.

To further explore the magnitude of these differences, we ran additional analyses to compare latent and observed means between groups formed according to the dichotomous predictive variables (gender, citizenship status, and program type). For each of these three variables, we tested one model including factors with significant main effects. For each model, constraining construct means (latent and observed) to be invariant across groups resulted in a substantially worse fit (see M5 to M10 in Table 5). Mean differences between groups and Cohen's *d* are presented in Table 8. Several mean differences were observed between citizenship statuses. Non-citizens felt less supported by other graduates students and had fewer financial resources, although they had less indebtedness.

In the next step, we tested the hypothetical model and an alternative model (see Figure 1) using SEM. In addition to the hypothetical model, the alternative model posits that dropout intentions are also positively predicted by autonomous regulation and support by advisor, faculty, and other students, and negatively by controlled regulation. We tested these additional associations because autonomous regulation has been directly associated with persistence in previous studies (e.g., Losier, 1994) and to ensure that perceived support has an effect through motivational processes (motivation, competence), as suggested by SDT.

The hypothetical and alternative models provided excellent fit to the data (see M3 and M4 in Table 5). The hypothetical model, Model 3, was retained as the final model, because the additional paths in Model 4 were not significant[2] and did not improve the fit. Structural relationships between constructs are presented in Table 9. Dropout intentions were relatively stable from T1 to T2. Despite this stability, dropout intentions at T2 are negatively predicted by perceived competence, number of completed trimesters, and presentation rate at T1. In turn, perceived competence is positively predicted by autonomous regulation, advisor support, and scholarships, and negatively by controlled regulation, gender, citizenship, and T1 dropout intentions. Autonomous regulation is positively predicted by faculty support and scholarships, and negatively by number of completed trimesters and T1 dropout intentions. Controlled regulation is positively predicted by scholarship, indebtedness, gender, citizenship, and completed trimesters, and negatively by advisor support and program type.[3]

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[2] In the alternative model, dropout intentions were not directly predicted by autonomous regulation ($\beta = .00$, $p = .95$), controlled regulation ($\beta = -.05$, $p = .22$), support by advisor ($\beta = .00$, $p = .94$), support by faculty ($\beta = .01$, $p = .86$), or support by other students ($\beta = .01$, $p = .76$).

[3] As the average time to complete a PhD differs between disciplines, we tested another model in which we estimated a direct path connecting the average number of trimesters needed for program completion to dropout intentions at T2. This additional path was not significant ($\beta = .01$, $p = .56$) and other results remained the same.

In order to ensure the effects of autonomous and controlled regulations on dropout intentions were mediated by perceived competence, we conducted mediation analysis with these four variables using the bootstrap methodology and the sequence suggested by Shrout and Bolger (2002). Based on 5000 bootstrapping samples, indirect effects through perceived competence were both significant for autonomous regulation (standardised coefficient, β = -.15, *SE* = .03, bias corrected [BC] 95% CI [-.20, -.10]) and controlled regulation (β = .12, *SE* = .02, BC 95% CI [.08, .17]). The direct effect of autonomous regulation on dropout intentions was no longer significant in the mediation model (β = -.06, *SE* = .05, *p* = .17 vs. β = -.20, *SE* = .04, *p* < .01 in the total effect model). Moreover, the direct effect of controlled regulation was not significant either in the mediation model (β = -.06, *SE* = .04, *p* = .20) or the total effect model (β = -.07, *SE* = .04, *p* = .08).

Another mediation analysis was conducted to estimate other relevant indirect effects suggested by the hypothetical model. In addition to the relationships proposed in the model (excluding control variables), we estimated five additional indirect effects: three for support by advisor and two for support by faculty. The indirect effect of support by advisor to dropout intentions through perceived competence was significant (β = -.11, *SE* = .02, BC 95% CI [-.15, -.07]), but not through both controlled regulation and perceived competence (β = -.01, *SE* = .01, BC 95% CI [-.02, -.01]). However, the indirect effect from support by advisor to perceived competence via controlled regulation was significant (β = .04, *SE* = .01, BC 95% CI [.01, .06]). Regarding support by faculty, the indirect effect on dropout intentions through autonomous regulation and perceived competence was significant (β = -.03, *SE* = .01, BC 95% CI [-.04, -.01]), as the indirect effect on perceived competence via autonomous regulation (β = .07, *SE* = .02, BC 95% CI [.04, .10]).

3.3 Discussion

The purpose of Study 2 was to provide a better understanding of PhD studies persistence by validating our model of dropout intentions. Overall, the findings provide good support for the model and reinforce those obtained in Study 1. First, of the selected determinants, the strongest predictor of dropout intentions at T2 was perceived competence. This finding confirms the results of Study 1 and concurs with previous research with students of different ages (Losier, 1994; Multon et al., 1991; Quiroga et al., 2013: Wright et al., 2012). Surprisingly, only two other variables significantly predicted dropout intentions: number of completed trimesters and presentation rate. The greater the progress they make in their PhD program, and the more often they present at research conferences and related events, the less likely students are to consider quitting their program. None of the remaining variables had a direct effect on dropout intentions. Interestingly, as in Study 1, financial resources at the PhD level did not affect intentions to drop out, although it has frequently been proposed as a persistence determinant in previous studies (Bowen & Rudenstine, 1992; Ehrenberg & Mavros, 1995; Nettles & Millett, 2006, Tinto, 1993). However, it is important to keep in mind that the tuition fees at the university where we collected the data were relatively low (i.e., US$4,000 per year). It is possible that financial resources would better predict dropout intentions when tuitions fees are much higher.

Second, our findings indicated that both regulation types predicted perceived competence. Thus, when doctoral students felt more volition and were less pressured by internal impetuses (e.g., guilt, shame, and pride) or external incentives, the more they perceived themselves effective and capable in their studies. These relationships have been previously found in the education (Black & Deci, 2000, Williams & Deci, 1996) and health fields (Williams et al., 1998, 2004).

Third, although perceived support by advisor and by faculty did not directly predict dropout intentions, our results showed indirect effects of these sources of support through the

motivational processes. Perceived support by the advisor negatively predicted dropout intentions by enhancing student' perceived competence. This support has both a direct positive effect on perceived competence, as shown by Overall et al. (2011), and an indirect positive effect by reducing students' controlled regulation, which is detrimental to feelings of competence. Moreover, students who perceived their faculty as more supportive are more likely to feel autonomously motivated. This type of motivation subsequently enhances their perception of competence, which in turn reduces their dropout intentions. By affecting types of regulation and feelings of competence that students might experience, both advisor and faculty seem to have complementary roles in students' dropout intentions.

Interestingly, our results suggest that perceived support by advisor lessens students' controlled regulation, but does not increase their autonomous regulation. Conversely, perceived support by faculty increases students' autonomous regulation but does not lessen their controlled regulation. On the one hand, the advisor role may include more responsibilities that could be perceived as controlling (e.g., criticizing and assessing students' dissertation or drafts, fixing deadlines, advising on various choices students are facing, etc.). Perceiving adequate support from this mentor might reduce the feeling of external pressures to complete PhD studies. On the other hand, because interactions with faculty members take place mostly during classes (e.g., teaching) and extracurricular projects (e.g., collaborations, assistantships, committees), they are less formal than interactions with the advisor and might be less related to controlled regulation. Nevertheless, they remain influential in creating a favorable climate for autonomous regulation. Further research could shed light on this distinctive effect of the perceived support by advisor and faculty on regulation types.

Contrary to expectations, perceived support by students was not associated with any other variables although isolation has been posited as a prime attrition factor for many students (Lovitts, 2001). Because our model takes many variables into account, it is possible that support by other students is not as important as other types of support. It is also plausible that operationalizing the interactions with other graduate students via the support they offer for basic psychological needs was not optimal to capture their role on students' motivational processes and dropout intentions. For instance, the frequency of the interactions and the level of involvement with the academic peers (Bair & Haworth, 2005) could be more relevant.

As in Study 1, we found differences in the model variables by gender, citizenship status, and program type. Dropout intentions at both measurement times were higher for citizens and for students in human sciences programs. Although they were less likely to think about quitting their program and had lower indebtedness, non-citizens scored lower on every other variable (except for autonomous regulation). These findings suggest that the doctoral experience is more difficult for students from abroad. Again, all differences observed between programs were in favor of natural sciences students. In Study 2, women enrolled in PhD studies perceived themselves as less competent than men did, although the opposite situation was observed in the retrospective study. This contradiction might be due to the characteristics of the samples or to gender differences in recalling information about perceived competence. This question remains unanswered and further research should address this inconsistency. Additional analyses showed that this finding was significant only in the natural sciences programs, in which fewer women than men are enrolled. Surprisingly, in the retrospective study, women felt more competent in their studies than men, irrespective of program type. Terminating a PhD program (completed or not) might have given women a feeling of relief, because they recalled their past perceived competence more positively.

4. Summary and Concluding Discussion

The purpose of this study was to provide a better understanding of doctoral studies persistence and completion by developing and validating a model that could be used to guide further research and interventions. The main aim was to assess the relative influence of various determinants considered in previous studies. Two studies were used to achieve this goal: 1) a retrospective study to compare completers and noncompleters, and 2) a prospective study to follow students enrolled in a PhD program over two trimesters in order to assess dropout intentions. Overall, results of the two studies concur in support of the proposed model.

Three major findings merit attention. First, perceived competence appears to be the cornerstone of doctoral studies persistence. This determinant was the strongest distinguisher between completers and noncompleters, being the strongest predictor of dropout intentions in enrolled students. Whereas the decision to quit PhD studies can be attributed to various factors and circumstances, it could be particularly influenced by a perceived "crisis" in competence. It is important to note that this perception might be more relevant than competence per se, which could be estimated by more objective indicators such as receiving a scholarship (or not) and higher presentation and publication rates. To our knowledge, previous research on PhD students' persistence did not propose perceived competence as a major determinant, although this association has been investigated and documented with students from various educational levels (Losier, 1994; Multon et al., 1991; Quiroga et al., 2013: Wright et al., 2012). In their review, Bair and Haworth (2005) reported only a few studies—with diverging findings—on related concepts (i.e., self-concept and self-image). Even when students are enrolled in the most advanced programs that target top candidates, the feeling of competence in their studies varies across students, and appears to be crucial for persistence. This could be particularly relevant, given that PhD training requires more autonomy and involves less structured indicators of progression as well as fewer courses.

Second, our results confirmed the importance of the quality of the student–advisor relationship (Bair & Haworth, 2005; Buckley & Hooley, 1988; Lovitts, 2001). In Study 1, higher perceived support by the advisor distinguished completers from noncompleters. In Study 2, this construct indirectly predicted dropout intentions via perceived competence and directly predicted both perceived competence and controlled regulation (negatively). In other words, students who completed their PhD were more likely to perceive previous interactions with their advisors as supportive of their psychological needs (autonomy, competence, and relatedness). Additionally, perceiving higher support by advisors helped currently enrolled PhD students feel more effective in their studies, both directly and indirectly by reducing the amount of motivation driven by external rewards or internal impetuses such as guilt or shame. By enhancing feelings of competence, this specific support also reduces the likelihood that students develop the intention to quit their program. Although many studies have suggested that the advisor plays a role as a determinant of PhD persistence, the mechanism by which it affects program completion has not be examined.

Third, although they might be less formal than the relationship with the advisor, interactions with other faculty also play a role in students' persistence. Support by faculty was positively associated with program completion in Study 1 and it indirectly predicted dropout intentions through autonomous regulation and perceived competence in Study 2.

Some other results also merit attention. Support by other students was associated with program completion in Study 1. However, when assessing many determinants together, peer support neither predicted motivational processes or dropout intentions (Study 2).

Surprisingly, autonomous and controlled regulations were similar between completers and noncompleters (Study 1), and neither regulation type directly predicted dropout intentions (Study 2), whereas they have been associated with persistence in previous studies (Losier, 1994; Vallerand & Bissonette, 1992; Vallerand et al., 1997). Nevertheless, our findings support the hypothesized indirect effect of these regulations on dropout intentions through a substantial association with perceived competence, which is consistent with other studies (Black & Deci, 2000; Williams & Deci, 1996; Williams et al, 1998, 2004). PhD students who are driven more by motives reflecting their will and volition and who feel less pressured by internal and external impetuses might be more prone to initiate behaviors that lead them to perceive themselves as more competent in their studies.

It is also noteworthy that income and indebtedness were not associated with completion and did not predict most of the variables, although they have often been proposed as persistence determinants. Nevertheless, having a scholarship distinguished completers from noncompleters and positively predicted perceived competence as well as autonomous and controlled regulations. Obtaining a substantial government scholarship could help students concentrate on their research and allow them more latitude, thus fostering academic motivation. However, it would also increase controlled regulation, because it could potentially act as an external motive.

4.1 Theoretical and practical implications

In order to fill a gap in the literature on PhD students, this study aimed to develop and empirically validate a persistence model based on SDT. From two studies, one retrospective and one prospective, with relatively large samples, the results 1) support the applicability of SDT' constructs (support for basic psychological needs, autonomous and controlled regulations, perceived competence) to the retention of PhD students, 2) shed light on the relative importance of persistence determinants mentioned in previous studies, and 3) propose a potential factor as the cornerstone of PhD completion, namely perceived competence. The results could help guide future research as well as interventions for promoting academic persistence.

According to our findings, in order to prevent PhD students from developing dropout intentions and subsequently leaving their program, interventions should aim to foster perceived competence. Our model suggests that this could be achieved by enhancing students' autonomous regulation and support by their advisor and reducing students' controlled regulation. Increasing support by faculty could also improve autonomous regulation. For instance, advisors and faculty could be informed on students' psychological needs and encouraged to support them, a role that goes beyond traditional classroom teaching and research project supervision. Although the advisory relationship usually concerns only the advisor and the student, institutions seeking to increase their completion rate could take a closer look at this relationship. Advisors could be trained and supported in their role by departments.

Additionally, our supplementary analyses revealed that non-citizen students might be a disadvantaged group with a particular need for additional support and closer follow-up. Because they account for a large part of the PhD enrollment and a substantial source of income for universities, appropriate efforts should be made to facilitate their integration throughout their training. Advisors and faculty should also be informed on how to provide international students with the support they need.

4.2 Limitations and further studies

PhD studies constitute a lengthy process that requires an average of five years to complete (MERS, 2013). Capturing this trajectory in a relatively short period incurs some limitations. First, Study 1 collected recalled information about situations that could have happened four years previously. Second, Study 1 participants who reported having temporarily interrupted their

studies were considered as noncompleters. Although additional analyses did not underscore significant differences between temporary and definitive interruption groups (except for program type), an unknown proportion of noncompleters might have continued their PhD studies at a later time. Third, although Study 2 used a prospective design, only five to seven months separated the two measurement times. As this period span on the same academic year, we decided not to reassess several variables at T2, including perceived support, motivation, and competence. This decision was made to reduce potential T2 measurement attrition and missing data and because we expected high stability between both time measurement. Nonetheless, as the predictor and mediator variables were measured at the same time, further longitudinal studies would be needed to support the proposed sequence.

Fourth, in Study 2 we used dropout intentions as a proxy for persistence as only three participants reported having definitely dropped out of their PhD program at T2. Although the two studies used different persistence indicators, they led to similar results.

Fifth, both studies were based on self-reported data, increasing the likelihood of common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Sixth, the magnitude of the predictive association between perceived competence and dropout intentions was small (e.g., β = .13). However, these effects were still substantial, because they were observed across a five-to-seven-month period while controlling for dropout intentions at T1 and several other variables. Seventh, although the proposed dropout intentions model assesses several determinants, other potential variables have not been included and could also play a relevant role in doctoral studies persistence. Moreover, to avoid redundancy with other constructs and be parsimonious, we did not include autonomy and relatedness needs satisfaction in the model.

In order to address these limitations, further research should be conducted over longer periods and following students from the beginning of the PhD program to graduation. Moreover, self-report measures should be combined with objective measures. Conducting research in collaboration with universities would facilitate such investigations. Additional variables such as program satisfaction, external support (e.g., partner, children, employer, etc.), parenting, perceived career prospects, perceived value of PhD studies, and professional aspirations could also be considered in future studies.

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Table 1

Study 1: Summary of Fit Statistics for All Models and Model Comparisons

Tested models	$\chi 2$	*df*	CFI	TLI	RMSEA	SRMR	H0 scaling correction factor	Model comparisons
All variables								
M1. CFA	410.678	228	.965	.946	.044	.031	1.419	
M2. MIMIC	412.678	228	.964	.946	.044	.031	1.419	
Persistence Model								
M3. Means free	262.355	144	.966	.957	.062	.041	1.232	
M4. Means constrained	348.210	150	.943	.931	.079	.089	1.247	M4 vs. M3**
Gender Model								
M5. Means free	163.958	112	.979	.975	.047	.070	1.201	
M6. Means constrained	180.491	116	.974	.970	.051	.078	1.218	M6 vs. M5**
Citizenship Model								
M7. Means free	31.666	20	.972	.942	.053	.039	1.168	
M8. Means constrained	117.286	24	.777	.610	.136	.119	1.144	M8 vs. M7**
Program Model								
M9. Means free	8.765	12	1.000	1.005	.000	.025	1.325	
M10. Means constrained	35.892	15	.981	.975	.082	.078	1.365	M10 vs. M9**

Note. Model comparisons are based on a robust chi-squared test for MLR estimator. * = $p < .05$. ** = $p < .01$.

Table 2

Study 1: CFA Correlations among Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Advisor support	—														
2. Faculty support	.47**	—													
3. Student support	.32**	.51**	—												
4. Presentation rate	.20**	.10*	.09*	—											
5. Publication rate	.22**	.13**	.06	.47**	—										
6. Scholarships	.14**	.10*	.13**	.28**	.24**	—									
7. Income	.12	.10*	-.05	.02	.09	.08	—								
8. Indebtedness	.09	.03	-.06	.02	.03	.05	.18**	—							
9. Gender	.03	.07	.13*	-.04	-.07	.04	-.02	-.01	—						
10. Citizenship	-.03	-.06	-.05	-.05	-.03	-.26**	-.20**	-.32**	-.04	—					
11. Program type	.01	-.08	-.13*	-.19**	-.03	-.09	.15	.16**	.16*	-.14	—				
12. Autonomous regulation	.13**	.16**	.20**	.13**	.15**	.03	-.07	-.06	.10	.03	-.04	—			
13. Controlled regulation	-.13*	-.05	.02	.03	.02	.07	-.14**	-.02	.12*	.13*	-.08	.20**	—		
14. Perceived competence	.48**	.29**	.25**	.25**	.17**	.12**	.14**	-.06	.12*	.02	-.04	.19**	-.23**	—	
15. Completion	.23**	.15**	.22**	.23**	.01	.24**	-.02	-.04	-.01	.05	-.23**	.05	-.04	-.46**	—
M	5.09	4.92	5.18	0.36	0.36	0.41	4.05	2.62	1.45	1.24	1.45	3.62	2.28	5.48	1.68
SD	1.41	1.26	1.24	0.35	0.52	0.49	2.59	1.70	0.50	0.43	0.50	0.71	0.77	1.04	0.47

Note. * = $p < .05$. ** = $p < .01$.

Table 3

Study 1: Unstandardized and Standardized Significances for the MIMIC Model

	Completion →		Gender →		Citizenship status →		Program type →	
Variable	*Unst.*	*St.*	*Unst.*	*St.*	*Unst.*	*St.*	*Unst.*	*St.*
Advisor support	0.73 (0.15)	0.24**	0.06 (0.12)	0.02	-0.12 (0.15)	-0.04	0.15 (0.19)	0.05
Faculty support	0.34 (0.11)	0.14**	0.18 (0.12)	0.08	-0.19 (0.14)	-0.07	-0.15 (0.14)	-0.07
Student support	0.44 (0.12)	0.20**	0.30 (0.10)	0.15**	-0.17 (0.15)	-0.07	-0.25 (0.11)	-0.12*
Presentation rate	0.15 (0.04)	0.19**	-0.01 (0.03)	-0.02	-0.07 (0.03)	-0.08*	-0.11 (0.04)	-0.15**
Publication rate	0.02 (0.07)	0.02	-0.08 (0.04)	-0.07	-0.05 (0.08)	-0.04	-0.02 (0.08)	-0.02
Scholarships	0.25 (0.04)	0.24**	0.05 (0.04)	0.05	-0.32 (0.04)	-0.28**	-0.08 (0.05)	-0.08
Income	0.10 (0.25)	0.02	-0.25 (0.26)	-0.05	-1.15 (0.27)	-0.19**	0.70 (0.42)	0.13
Indebtedness	0.01 (0.21)	0.00	-0.08 (0.15)	-0.02	-1.22 (0.12)	-0.31**	0.42 (0.21)	0.12*
Autonomous regulation	0.04 (0.06)	0.04	0.12 (0.06)	0.11*	0.04 (0.06)	0.03	-0.05 (0.07)	-0.05
Controlled regulation	-0.07 (0.06)	-0.07	0.12 (0.05)	0.14**	0.12 (0.06)	0.12*	-0.09 (0.06)	-0.10
Perceived competence	0.99 (0.13)	0.48**	0.21 (0.09)	0.11*	0.01 (0.09)	0.00	0.11 (0.10)	0.06

Note. Standard errors in parentheses. Unst. = unstandardized; St.= standardized. * = $p < .05$. ** = $p < .01$.

Table 4

Study 1: Mean Differences and Effect Sizes between Groups

Variable	Non-completers (*n*= 135)	Completers (*n* = 287)	Male (*n*= 230)	Female (*n*= 192)	Citizens (*n*= 322)	Non-citizens (*n*= 100)	Natural sciences (*n* = 230)	Human sciences (*n* = 185)
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
	Cohen's *d*		Cohen's *d*		Cohen's *d*		Cohen's *d*	
Advisor support	4.67 (1.49)	5.33 (1.23)						
	0.49**							
Faculty support	4.67 (1.28)	5.06 (1.12)						
	0.33**							
Student support	4.73 (1.28)	5.32 (1.17)	4.97 (1.21)	5.29 (1.25)			5.28 (1.13)	4.96 (1.31)
	0.48**		0.26**				-0.26*	
Presentation rate	0.25 (0.37)	0.42 (0.33)			0.37 (0.36)	0.34 (0.30)	0.43 (0.34)	0.29 (0.35)
	0.49**				-.11		-0.38**	
Scholarships	0.23 (0.42)	0.49 (0.50)			0.48 (0.50)	0.18 (0.38)		
	0.55**				-0.67**			
Income					4.35 (2.58)	3.11 (2.37)		
					-0.50**			
Indebtedness					2.93 (1.72)	1.65 (1.13)	2.37 (1.56)	2.91 (1.78)
					-0.88**		0.32**	
Autonomous regulation			3.57 (0.63)	3.70 (0.66)				
			0.21					
Controlled regulation			2.21 (.60)	2.37 (0.76)	2.24 (0.67)	2.43 (0.70)		
			0.24*		0.28			
Perceived competence	4.83 (1.13)	5.79 (0.70)	5.38 (.97)	5.60 (.95)				
	1.02**		0.23*					

Note. Means are shown only for variables that were significant in the MIMIC model. * = $p < .05$. ** = $p < .01$.

Table 5

Study 2: Summary of Fit Statistics for All Models and Model Comparisons

Tested models	$\chi 2$	*df*	CFI	TLI	RMSEA	SRMR	H0 scaling correction factor	Model comparison
All variables								
M1. CFA	827.226	307	.959	.938	.040	.026	1.878	
M2. MIMIC	827.225	307	.959	.939	.040	.026	1.878	
M3. (1) SEM	824.863	312	.959	.943	.039	.026	1.888	NS
M4. (2) SEM	827.226	307	.958	.942	.040	.026	1.878	NS
Gender Model								
M5. Means free	112.377	72	.986	.983	.035	.034	2.162	
M6. Means constrained	129.417	76	.982	.979	.039	.042	2.224	M6 vs. M5*
Citizenship Model								
M7. Means free	340.072	204	.978	.967	.038	.030	1.879	
M8. Means constrained	727.706	214	.917	.882	.073	.096	1.932	M8 vs. M7**
Program Model								
M9. Means free	181.588	54	.964	.940	.072	.029	1.575	
M10. Means constrained	248.624	60	.947	.920	.083	.052	1.604	M10 vs. M9**

Note. Model comparisons are based on a robust chi-squared test for MLR estimator. * = $p < .05$. ** = $p < .01$.

Table 6

Study 2: CFA Correlations among Study Variables

Variable	AS	FS	SS	CR	PR	SC	IC	ID	GE	CI	PT	CS	D1	AU	CO	PC	D2
AS	—																
FS	.46**	—															
SS	.35**	.46**	—														
CR	.06*	.07*	.11**	—													
PR	.10**	-07**	.03	.31**	—												
SC	.10*	.09*	.17**	.20**	.09*	—											
IC	.07	.03	-.05	.05	.10*	.11**	—										
ID	-.03	-.01	.03	.02	-.02	-.03	.20**	—									
GE	.02	.05	.04	.03	-.07*	.07	.01	.05	—								
CI	-.02	-.01	-.07	-.08*	-.09**	-.33**	-.33**	-.36**	-.10*	—							
PT	.02	.03	-.08	-.11*	.05	-.03	.22**	.22**	.22**	-.21**	—						
CS	-.15**	-.09**	-.06	.14**	.04	.16**	.10**	.10**	.04	-.18**	.07	—					
D1	-.30**	-.22**	-.24**	-.12**	-.05*	-.03	.04	.10**	.01	-.10**	.13*	-.04	—				
AU	.28**	.35**	.25**	.08**	.02	.12**	.06	.05	.11*	-.03	.04	-.09*	-.21**	—			
CO	-.08**	.04	.05	.02	-.07	.11**	.00	.01	.08*	.11**	-.08*	.08*	.04	.26**	—		
PC	.42**	.29**	.20**	.10*	.09	.15**	.15**	.08*	-.06	-.18**	.07	-.01	-.35**	.33**	-.24**	—	
D2	-.24**	-.18**	-.18**	-.14**	-.04	-.05	.04	.10*	.03	-.10**	.12*	-.09*	.73**	-.19**	-.01	-.35**	—
M	5.39	5.02	5.08	0.36	0.26	0.46	3.58	2.59	1.52	1.33	1.49	7.14	1.57	3.76	2.45	5.32	1.57
SD	1.12	1.10	1.20	0.47	0.57	0.50	2.37	1.76	0.50	0.47	0.50	5.51	0.77	0.70	0.79	0.87	0.71

Note. AS = advisor support; FS = faculty support; SS = student support; CR = presentation rate; PR = publication rate; SC = scholarships; IC – income; ID = indebtedness; GE = gender; CI = citizenship; PT = program type; CS = completed semesters; D1 = dropout intentions at T1; AU = autonomous regulation; CO = controlled regulation; PC = perceived competence; D2 = dropout intentions at T2. * = $p < .05$. ** = $p < .01$.

Table 7

Study 2: Unstandardized and Standardized Significances for the MIMIC Model

	Gender →		Citizenship status →		Program type →		Completed semesters →	
Variable	*Unst.*	*St.*	*Unst.*	*St.*	*Unst.*	*St.*	*Unst.*	*St.*
Advisor support	0.04 (0.07)	0.02	-0.09 (0.08)	-0.04	0.03 (0.10)	0.01	-0.03 (0.01)	-0.16**
Faculty support	0.10 (0.06)	0.05	-0.04 (0.07)	-0.02	0.03 (0.08)	0.02	-0.02 (0.01)	-0.10**
Student support	0.11 (0.09)	0.06	-0.22 (0.07)	-0.10**	-0.22 (0.12)	-0.11	-0.01 (0.01)	-0.07*
Presentation rate	0.05 (0.04)	0.05	-0.08 (0.03)	-0.08*	-0.14 (0.05)	-0.14**	0.01 (0.00)	0.13**
Publication rate	-0.10 (0.05)	-0.09**	-0.10 (0.04)	-0.08**	0.06 (0.05)	0.05	0.00 (0.00)	0.02
Scholarships	0.06 (0.04)	0.06	-0.35 (0.03)	-0.33**	-0.11 (0.04)	-0.11*	0.01 (0.00)	0.10**
Income	-0.15 (0.16)	-0.03	-1,59 (0.19)	-0.32**	0.10 (0.23)	0.02	0.04 (0.02)	0.09*
Indebtedness	-0.07 (0.10)	-0.02	-1,19 (0.12)	-0.32**	0.55 (0.10)	0.16**	0.01 (0.01)	0.04
T1 dropout intentions	-0.04 (0.06)	-0.02	-0.15 (0.07)	-0.09*	0.18 (0.08)	0.12*	-0.01 (0.01)	-0.06
Autonomous regulation	0.12 (0.05)	0.11*	-0.04 (0.06)	-0.04	0.01 (0.06)	0.01	-0.01 (0.00)	-0.10**
Controlled regulation	0.11 (0.04)	0.10**	0.14 (0.04)	0.12**	-0.08 (0.03)	-0.08*	0.01 (0.00)	0.11**
Perceived competence	-0.13 (0.06)	-0.09*	-0.30 (0.07)	-0.19**	0.08 (0.06)	0.05	-0.01 (0.01)	-0.04
T2 dropout intentions	0.00 (0.06)	0.00	-0.16 (0.06)	-0.10**	0.15 (0.07)	0.10*	-0.02 (0.01)	-0.11*

Note. Standard errors in parentheses. Unst. = unstandardized; St. = standardized. * = $p < .05$. ** = $p < .01$.

Table 8

Study 2: Mean Differences and Effect Sizes between Groups

Variable	Male (*n*= 434)	Female (*n*= 472)	Citizens (*n*= 611)	Non-Citizens (*n*= 295)	Natural sciences (*n* = 459)	Human sciences (*n* = 447)
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
	Cohen's *d*		Cohen's *d*		Cohen's *d*	
Student support			5.09 (1.25)	3.97 (0.89)		
			-1.04**			
Presentation rate			0.40 (0.50)	0.32 (0.41)	0.42 (0.52)	0.32 (0.42)
			-0.18*		-0.22*	
Publication rate	0.31 (0.75)	0.23 (0.34)	0.30 (0.65)	0.19 (0.38)		
	-0.14**		-0.22**			
Scholarships			0.57 (0.49)	0.22 (0.41)	0.47 (0.50)	0.44 (0.50)
			-0.76**		-0.05	
Income			4.13 (2.46)	2.45 (1.65)		
			-0.80**			
Indebtedness			3.02 (1.75)	1.69 (1.40)	2.20 (1.66)	2.98 (1.76)
			-0.84**		0.46**	
T1 dropout intentions			1.62 (0.75)	1.46 (0.67)	1.48 (0.67)	1.66 (0.78)
			-0.22**		0.25*	
Autonomous regulation	3.70 (0.63)	3.84 (0.66)				
	0.22*					
Controlled regulation	2.39 (0.68)	2.49 (0.71)	2.40 (0.69)	2.55 (0.70)	2.50 (0.69)	2.39 (0.70)
	0.14		0.22**		-0.15*	
Perceived competence	5.36 (0.69)	5.27 (0.87)	5.42 (0.76)	5.11 (0.79)		
	-0.12		-0.40**			
T2 dropout intentions			1.61 (0.67)	1.48 (0.69)	1.50 (0.65)	1.65 (0.70)
			-0.20**		0.22*	

Note. Means are shown only for variables that were significant in the MIMIC model. * = $p < .05$. ** = $p < .01$.

Table 9

S*tudy 2: Unstandardized and Standardized Significances for the Structural Model in Figure 1*

	→ Autonomous regulation		→ Controlled regulation		→ Perceived competence		→ T2 dropout intention	
Variable	*Unst.*	*St.*	*Unst.*	*St.*	*Unst.*	*St.*	*Unst.*	*St.*
Advisor's support	.05 (.03)	.09	-.06 (.02)	-.12**	.17 (.04)	.23**	—	—
Faculties' support	.13 (.02)	.23**	.04 (.02)	.08	.04 (.03)	.05	—	—
Students' support	.03 (.02)	.06	.03 (.02)	.06	-.02 (.03)	-.02	—	—
Presentation rate	.04 (.04)	.04	-.01 (.06)	-.01	.03 (.07)	.02	-.06 (.03)	-.04*
Publication rate	-.03 (.04)	-.03	-.05 (.04)	-.05	-.02 (.06)	-.02	-.01 (.02)	.01
Scholarships	.10 (.04)	.09*	.16 (.04)	.16**	.13 (.05)	.08*	-.02 (.03)	-.01
Incomes	.01 (.01)	.05	.01 (.01)	.05	.02 (.01)	.07	.01 (.01)	.02
Indebtedness	.02 (.01)	.06	.02 (.01)	.08*	.02 (.02)	.05	.01 (.01)	.03
Gender	.09 (.05)	.08	.09 (.04)	.09*	-.15 (.05)	-.10**	.01 (.04)	.00
Citizenship	.04 (.06)	.03	.24 (.05)	.22**	-.15 (.07)	-.09*	-.08 (.04)	-.06
Program type	.04 (.07)	.03	-.08 (.04)	-.08*	.07 (.06)	.05	.02 (.04)	.02
Completed semesters	-.01 (.00)	-.09**	.01 (.00)	.08*	.00 (.00)	.03	-.01 (.00)	-.07*
T1 dropout intentions	-.10 (.05)	-.12*	.04 (.03)	.05	-.25 (.05)	-.23**	.64 (.06)	.67**
Autonomous regulation	—	—	—	—	.35 (.05)	.27**	—	—
Controlled regulation	—	—	—	—	-.40 (.06)	-.27**	—	—
Perceived competence	—	—	—	—	—	—	-.11 (.04)	-.13**

Note. Standard errors in parentheses. Unst. = unstandardized; St. = standardized. * = $p < .05$. ** = $p < .01$.