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Facing the dropout crisis among PhD candidates: The role of supervisor support in emotional well-being and intended doctoral persistence among men and women

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Abstract

The number of PhD candidates who experience psychological problems has risen significantly over the past few years. Poor mental health can have numerous negative consequences for PhD candidates and their supervisors, as it may adversely affect their quality of life, attrition, and academic productivity. Despite these well-documented challenges, few studies have looked at how the supervisor–supervisee relationship can influence the emotional well-being of male and female doctoral candidates. The current work examined the role of the supervisor’s support in emotions and intended doctoral persistence among men ($n = 411$) and women ($n = 514$), in all disciplines at two large universities in Belgium. Results indicate that emotional well-being was low for all doctoral candidates but women experienced even more negative emotions (anxiety, stress, discouragement, demoralization, sadness and depression) and fewer positive emotions (confidence, optimism, happiness, fulfillment, satisfaction and content) than men. Interestingly, we also found that perceived structure and autonomy, two dimensions of supervisor support, have an effect on emotional well-being and intention of pursuing a PhD trajectory for both men and women. This paper makes a contribution to the higher education and research supervision literature by offering new directions for research and by providing guidelines for the training of research supervisors.

Keywords: mental health; well-being; higher education; PhD candidates; PhD students; supervisor; self-determination theory; doctoral persistence.

Facing the dropout crisis among PhD candidates: The role of supervisor support in emotional well-being and intended doctoral persistence among men and women

Although PhD candidates are recruited from among the brightest and most successful students, the rate of completion of doctoral studies, which is estimated at 40-50% in Western countries (e.g., Golde, 2005; Wollast et al., 2018), is the lowest compared to all other degrees (Ampaw & Jaeger, 2011). Doctoral attrition is often associated with the higher prevalence of psychological distress among doctoral candidates (Levecque et al., 2017). Many PhD candidates report being overworked and overstressed (e.g., constant demand for results, time pressure, uncertainty about doctoral processes, sense of belonging in scholarly communities and financial pressures; Cornwall et al., 2018), which negatively affects their mental health (for a review, see Schmidt & Hansson, 2018). Levecque and colleagues (2017) found that 51% of Flemish doctoral candidates had experienced at least two symptoms of poor mental health over the course of completing their research degree, 40% experienced three symptoms and 32% reported at least four symptoms. Furthermore, their results indicated that these symptoms were more prevalent among doctoral candidates than among highly educated employees and other higher education students. In the same vein, Evans et al. (2018) raised concerns about a mental health crisis in graduate education and showed that the risk of doctoral candidates experiencing such mental health challenges (e.g., depression, anxiety) is up to six times greater than for the general population.

According to the World Health Organization (2004), mental health is a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community. Considering that emotion regulation is an essential feature of mental health (Gross & John, 2003), dysregulated emotions are often used as indicators of low

psychological well-being (Houben et al., 2015). Based on this, a growing body of research has examined the mental health of doctoral candidates through the lenses of the emotional dimension (Cotterall, 2013), emotional competencies (O'Meara et al., 2013), emotional exhaustion (Devine & Hunter, 2017), and self-reported emotions (Evans et al., 2018; Van Der Heijde et al., 2019). In this context, Evans et al. (2018) highlighted a critical need for studies that investigate intervention strategies that could address the mental health crisis among PhD candidates. Thus, the present work investigates how PhD candidates' mental health and ultimately their intended doctoral persistence are determined by the dynamics around the supervisor–supervisee relationship. If some facets of doctoral supervision can influence the emotions of male and female candidates, interventions aimed at training supervisors could be an avenue for improving PhD candidates' emotional well-being.

Role of supervisor in terms of self-determination theory

Besides the candidates themselves (De Clercq et al., 2019), the doctoral supervisor is recognized as one of the most important and crucial protagonists in the doctoral journey; for this reason, a large body of research has focused on the supervisor–supervisee relationship (e.g., Andriopoulou & Prowse, 2020; Grant et al., 2014; Gruzdev et al., 2020; Jairam & Kahl, 2012). Many studies have found an association between different types of support from the supervisor and PhD candidates' research productivity, career commitment, self-efficacy (Paglis et al., 2006), research progress (Martinuso & Turkulainen, 2011), and satisfaction (Zhao et al., 2007).

As argued by Devos et al. (2015), a supervisor's support can be analyzed in light of the three basic human needs identified in self-determination theory (SDT; Ryan & Deci, 2017). According to Deci and Ryan (2000, 2002), feeling of competence, autonomy, and relatedness, are essential for ongoing psychological growth and integrity, as well as for constructive social development and personal well-being. Relatedness or affiliation, refers to

individuals' feelings of connection and closeness with others, having a sense of belongingness (see also Van den Broeck et al., 2010; Van der Linden et al., 2018). Competence refers to individuals' feelings of efficiency and experience of mastery. Third, the need for autonomy refers to individuals' feelings of volition (i.e., the power or ability to decide something by yourself), and experience of integration and freedom (cf. individual agency; McAlpine & Mitra, 2015).

According to Deci and Ryan (2002), the satisfaction of these needs can be supported (or thwarted) by the social context. The influence of the social context can manifest itself through three complementary dimensions: involvement versus rejection or neglect, structure versus chaos, and autonomy support versus control or coercion (Olivier et al., 2021; Stroet et al., 2013). In this paper, we aim to analyze these dimensions in the context of the supervisor–supervisee relationship (see Devos et al., 2015; Dupont et al., 2014; Van der Linden et al., 2018).

The need for relatedness can be supported within a social environment that cultivates positive interpersonal relationships (Dupont et al., 2014). This can include a focus on empathy and the offer of comfort when the person experiences distress (Ryan & Deci, 2017). This implies being involved in the person's experiences, both positive and negative, which in the context of doctoral candidates' supervision can translate into reassuring students when needed, and showing respect and concern for the student not only as a researcher, but also as an individual. The need for competence is supported within a structured academic context providing clear expectations about the desirable goals to achieve and close guidance throughout the process (Hospel & Galand, 2016). For instance, supervisors can prescribe sequential patterns of activity to facilitate candidates' learning process and the achievement of desired outcomes. Furthermore, structured supervisors are attentive to maintaining candidates' motivation and effort by providing both leadership (in terms of communicating

clear directions) and support (e.g., constructive feedback), which will help candidates improve their skills and achieve a sense of competence (Jang et al., 2010).

Finally, an autonomy-supportive style nourishes candidates' volition by providing them with opportunities to make choices and take initiatives. Supervisors who promote candidates' autonomy take into account their perspectives and emotional experiences (Hospel & Galand, 2016). That is, they are open to listen to candidates' input, and acknowledge their entitlement to express negative emotions. On the opposite end of the spectrum, controlling supervisors prioritize their own perspective, going as far as demanding that candidates behave and think in a certain way. A supervisor may thus provide a solid structure while simultaneously adopting an autonomy-supportive style (Olivier et al., 2021).

To sum up, in this study, we analyze how the supervisor's support, in terms of involvement, structure, and autonomy, relates to PhD candidates' emotional well-being and intentions to persist in doctoral studies. Moreover, to increase our contribution to the effort of finding efficient solutions for the mental health crisis in the graduate trainee population, we adopt a gender-focused analysis. Indeed, efficient strategies to tackle this problem must first take into account the fact that male and female students do not encounter the same challenges. Additionally, it is possible that the same challenge may be perceived and handled differently among men and women.

A gender-focused analysis of the mental health crisis among PhD candidates

The issue of considerable dropout rate and poor mental health in doctoral programs has been the focus of extensive research highlighting psychological predictors, but also sociodemographic factors such as age, nationality, funding, and gender (Bair & Haworth, 2004; Spronken-Smith et al., 2018; Wollast et al., 2018). Specifically, regarding gender, some studies have shown that men are more likely to complete their PhD program than women

(Groenvynck et al., 2013; Visser et al., 2007). However, other studies did not find significant gender differences (e.g., Mastekaasa, 2005; Van der Haert et al., 2013; Wollast et al., 2018).

Is gender associated with PhD candidates' mental health? Although research is relatively scarce (for a review, see Schmidt & Hansson, 2018), a few studies have documented that women experience higher levels of emotional distress than men (e.g., Appel & Dahlgren, 2003; Fisher et al., 2019). This pattern is not surprising, given the prevalence of gender inequalities in higher education, particularly in highly selective and prestigious academic contexts, in which women often suffer psychological distress to a greater extent than men (Nerdrum et al., 2006; Verger et al., 2009). For instance, during their first year of medical school, women appear significantly more likely than men to have symptoms of depression and anxiety (Hardeman et al., 2015). Moreover, women may also experience higher uncertainty about belonging (e.g., impostor syndrome), higher anxiety, and lower self-efficacy in academic contexts than men (Aelenei et al., 2020; Bian et al., 2018; Harackiewicz et al., 2014; Harackiewicz et al., 2016; Sommet et al., 2013). The reasons for this discrepancy are manifold. One major factor relates to social identity threat, with women fearing that they may be devalued because of their gender, particularly in STEM fields (Murphy et al., 2007; for a review, see Cheryan et al., 2017). Recent research has documented that these deleterious gender-identity dynamics extend to other fields (including humanities and social sciences), in which the belief that success requires brilliance predominates (Leslie et al., 2015; Meyer et al., 2015). Explicitly linking success to brilliance (instead of dedication and effort, for instance) has a negative effect on female students, because, despite being as brilliant as men, they experience the burden of the stereotype associating brilliance more with men than with women (Bian et al., 2018).

Overview of the present work and hypotheses

Building on the theoretical framework developed by Devos et al. (2015) structuring PhD candidates' supervisory experiences through the three basic needs framework from SDT, and on the gender-focused research in academia (Bian et al., 2018; Cheryan et al., 2017), we aim to investigate the effects of a supervisor's support on emotional well-being (i.e., experience of positive and negative emotions) and intentions to persist in doctoral studies among men and women. Based on the literature discussed here, we formulate the following hypotheses:

Hypothesis 1. We expected men to report lower negative emotions (Hypothesis 1a), but greater positive emotions (Hypothesis 1b) and doctoral persistence (Hypothesis 1c) than women.

Hypothesis 2. To explore the role of the types of supervisor support in intended doctoral persistence, we examined a model including positive and negative emotions as mediators of this relation. We hypothesized that greater perception of structure is negatively linked with negative emotions (Hypothesis 2a) and positively associated with positive emotions (Hypothesis 2b) and doctoral persistence (Hypothesis 2c) for both men and women.

Hypothesis 3. We hypothesized that greater perception of autonomy is negatively associated with negative emotions (Hypothesis 3a) and positively associated with positive emotions (Hypothesis 3b) and doctoral persistence (Hypothesis 3c) for both men and women.

Hypothesis 4. We hypothesized that greater perception of involvement is negatively linked with negative emotions (Hypothesis 4a) and positively associated with positive emotions (Hypothesis 4b) and doctoral persistence (Hypothesis 4c) for both men and women.

Hypothesis 5. We postulated that doctoral persistence is positively associated with positive emotions (Hypothesis 5a) and negatively associated with negative emotions (Hypothesis 5b) among men and women.

Hypothesis 6. We expected indirect effects of the types of support on intended doctoral persistence through positive and negative emotions (Hypothesis 6). Ultimately, we do not have a priori hypotheses on the relative magnitude of indirect effects of involvement, structure and autonomy between men and women.

Method

Participants

We recruited PhD candidates in all disciplines at the two largest universities in the French-speaking community of Belgium, [Anonymized for review]. The questionnaire was sent by email to 3,230 PhD candidates registered in the two universities and was completed by 925 of them (for more information about our national doctoral context, see Wollast et al., 2018)¹. In total, 925 PhD candidates participated in this study. Of these, 411 were male and 514 were female. The participants completed an online questionnaire voluntarily and without compensation. Table 1 reports the distribution of men and women as a function of socio-demographic factors. In sum, men and women shared the same socio-demographic characteristics except for the field of research, with men outnumbering women in sciences and technologies, whereas the reverse occurred in social sciences and humanities.

[Insert Table 1 here]

Measures

The questionnaire was administered in French. All of the items in French and their English translations are available in the online supplementary material (<https://osf.io/y2znx>).

Doctorate-related Need Support Scale. Participants indicated on a Likert scale ranging from 1 (*Totally disagree*) to 5 (*Totally agree*) the extent to which they agreed with each of the 12 items of the validated Need Support Scale (Van der Linden et al., 2018).

¹ This study is part of a larger national research project across multiple universities in Belgium that aims at understanding the process of doctoral completion in the light of motivational theories, through qualitative, quantitative and longitudinal designs (for more information about the project, see Van der Linden et al., 2018).

Specifically, we used the three dimensions of this scale (four items per dimension), namely involvement (e.g., “My supervisor reassures me when I need it”), structure (e.g., “My supervisor gives me good advice on how I should plan and carry out my research”) and autonomy (e.g., “My supervisor encourages me to work in an independent way”).

To test whether the three dimensions were psychometrically distinct from each other, we performed confirmatory factor analyses (CFA) and compared several concurrent models (see Table 2). Model fit was assessed using multiple fit indices (Tanaka, 1993). The root mean square error of approximation (RMSEA) should be $\leq .08$, and the comparative fit index (CFI) should be $\geq .90$ (Byrne, 2004). Additionally, we used the Akaike information criterion (AIC) and Bayesian information criteria (BIC), with indices closer to zero indicating better model fit (Lin et al., 2017). The CFA model was based on maximum likelihood estimation. CFAs indicated that the model distinguishing the three dimensions demonstrated better model fit statistics. Importantly, all standardized factor loadings were significant and above the conventional threshold ($> .40$). The internal consistency was good for involvement ($\alpha_{\text{total}} = .85$; $\alpha_{\text{men}} = .84$; $\alpha_{\text{women}} = .85$) and structure ($\alpha_{\text{total}} = .85$; $\alpha_{\text{men}} = .84$; $\alpha_{\text{women}} = .86$) and suboptimal for autonomy ($\alpha_{\text{total}} = .61$; $\alpha_{\text{men}} = .60$; $\alpha_{\text{women}} = .62$), as in the original study (Van der Linden et al., 2018).

Emotional engagement. This scale assessed the emotions that participants experienced while they were working on their PhD (Baudoin & Galand, 2017; Dupont et al., 2014). Participants were asked to rate statements about nine emotions on a scale from 1 (*Strongly disagree*) to 5 (*Strongly agree*). Four items assessed positive emotions (e.g., “I feel confident/optimistic when I work on my PhD”) and five items assessed negative emotions (e.g., “I feel anxious/stressed when I work on my PhD”).

To test whether positive emotions and negative emotions were psychometrically distinct from each other, we performed CFA and compared two concurrent models (one factor

versus two factors, see Table 2). CFAs indicated that the model distinguishing positive emotions and negative emotions demonstrated better model fit statistics than when we combined them together. Importantly, all standardized factor loadings were significant and above the conventional threshold ($> .40$). The internal consistency was good for positive ($\alpha_{\text{total}} = .84$; $\alpha_{\text{men}} = .84$; $\alpha_{\text{women}} = .85$) and negative ($\alpha_{\text{total}} = .80$; $\alpha_{\text{men}} = .80$; $\alpha_{\text{women}} = .80$) emotions.

Intended doctoral persistence. Participants were required to respond to six items (e.g., “I am seriously considering quitting my PhD”; reversed) assessing intended doctoral persistence (Neuville et al., 2007; Van der Linden et al., 2018) on a scale from 1 (*Strongly disagree*) to 5 (*Strongly agree*). Internal consistency was good ($\alpha_{\text{total}} = .80$; $\alpha_{\text{men}} = .77$; $\alpha_{\text{women}} = .81$).

[Insert Table 2 here]

Multi-group measurement invariance

Prior to comparing participants’ responses to the survey, it was necessary to demonstrate that male and female participants interpreted the questions on our measures in a similar manner (Vandenberg & Lance, 2000). To do so, we estimated different levels of measurement invariance on the full structural model using AMOS (Byrne, 2004). The model fit was assessed using the cut-off criteria of CFI $> .90$ and RMSEA $< .08$ (Hu & Bentler, 1999). First, an unconstrained (i.e., configural) model verifies that the general factor structure of the measure is the same across different groups by freely estimating parameters in each of the groups (i.e., the same model without any invariance in both groups, but parameters may vary). This unconstrained model constitutes a basis for comparison to test for invariance. Second, a constrained metric model is run in which measurement weights of the latent variables are constrained to be equal. Third, an additional constrained scalar model is run in which the loadings and intercepts are constrained to be equal. Finally, a strict invariance model is tested in which factor loadings, intercepts and residuals are constrained to be equal

across groups (Putnick & Bornstein, 2016). However, strict invariance is not a prerequisite for testing mean group differences (Vandenberg & Lance, 2000). To determine whether measurement invariance was present, we tested metric invariance by comparing the metric model with constrained measurement weights to the unconstrained configural model, then tested scalar invariance by comparing the scalar model with constrained intercepts to the metric model with constrained measurement weights, and finally we tested strict invariance by comparing the scalar model with the residual model (Byrne, 2004). Changes in CFI $< .01$ and in RMSEA $< .015$ are considered indicators of invariance (Chen, 2007).

We first tested measurement invariance using the unconstrained full structural model, which revealed good model fit ($\chi^2 = 1419.740$, $df = 618$, CFI = .924, RMSEA = .037). Second, we compared this configural model with a constrained model ($\chi^2 = 1446.851$, $df = 639$, CFI = .924, RMSEA = .037), which confirmed that full metric invariance was achieved ($\Delta\text{CFI} = 0$, $\Delta\text{RMSEA} = 0$). Third, we created an additional constrained scalar model with constrained intercepts and loadings ($\chi^2 = 1539.433$, $df = 666$, CFI = .918, RMSEA = .038) and compared it with the metric model with constrained measurement weights ($\Delta\text{CFI} = .006$, $\Delta\text{RMSEA} = .001$), thus confirming that full scalar invariance was reached. Finally, we compared this scalar model with the residual (i.e., strict) model, where factor loadings, intercepts and residual variances were constrained to be equal ($\chi^2 = 1580.276$, $df = 693$, CFI = .916, RMSEA = .037) and found that strict invariance was achieved ($\Delta\text{CFI} = .002$, $\Delta\text{RMSEA} = .001$).

Results

Correlations and latent mean differences

Table 3 reports the correlations, means and standard deviations of all variables for men and women, and also testing differences between means. As expected, all correlations were significant ($p < .001$) and in the expected direction. Independent-samples t -tests were

conducted to compare the different variables for men and women respondents. Following the recommendations on statistical practice made by Delacre et al. (2017), we relied only on Welch's *t*-test, instead of a student's *t*-test, when comparing our two independent groups. Furthermore, Bonferroni corrections for multiple testing were introduced. Specifically, we compared each of the *p*-values to the alpha threshold divided by the number of dependent variables. In sum, significance was reached when $p < .05/6 = .008$. Given the large sample size in this study, the risk of type 1 error was relatively limited. This significance level allowed us to detect a *d* of .23 with 80% power. However, to fully inform the reader, in Table 3 we report the 95% CI for the differences between the means for the two groups.

[Insert Table 3 here]

First, there was no main effect of gender on the three dimensions of the Need Support Scale (involvement, structure and autonomy). Second, in line with hypotheses 1a and 1b, we observed a main effect of gender on positive and negative emotions. In fact, women reported significantly stronger negative emotions and weaker positive emotions than men did. Third and in line with hypothesis 1c, we found a main effect of gender on intended doctoral persistence, with men reporting higher persistence than women.

To go further, we looked at each positive and negative emotion individually. Table 4 reports the means and standard deviations of all emotions for men and women. Results indicated that women reported feeling more anxious/stressed (especially), more discouraged/demoralized, less confident/optimistic, less happy/fulfilled and less satisfied/contented, than men (ranked by effect size). Furthermore, women reported feeling more sad/depressed than men, but this difference was marginally significant. Finally, we did not find gender differences for angry/revolted, ridiculous/ashamed and curious/captivated.

[Insert Table 4 here]

Multi-group modeling

Before testing our mediation model, we analyzed two more parsimonious models in which we were interested in the direct effects of the types of support on doctoral persistence (Figure 1s and Figure 2s) and emotions (Figure 3s and Figure 4s) separately (see Online Supplementary Material).

Mediation model. The structural equation model provided excellent fit in terms of the RMSEA (.037) and adequate fit in terms of the CFI (.924). Standardized path coefficients for men and women are shown in Figures 1 and 2, respectively. Additionally, we tested the equality of correlations and standardized regression coefficients between men and women using a series of Wald χ^2 tests (Klopp, 2019). Specifically, we assessed constraints on statistical parameters (i.e., correlations and regression paths individually and independently) based on the weighted distance between the unrestricted estimate and its hypothesized value under the null hypothesis, where the weight is the precision of the estimate (Fahrmeir et al., 2013; Ward & Ahlquist, 2018).

In line with our hypotheses, the three dimensions of the Need Support Scale were strongly and positively intercorrelated with each other among men and women. Turning now to regressions, in line with our hypotheses (2a, 2b, 2c), the structure dimension was positively associated with positive emotions and intended doctoral persistence and negatively associated with negative emotions among men and women. Second, the autonomy dimension was negatively associated with negative emotions among men and women (Hypothesis 3a). Furthermore, this dimension also positively predicted positive emotions and intended doctoral persistence among women, but not among men (3b, 3c). Third, and contrary to our expectations, the involvement dimension was found to be *negatively* associated with intended doctoral persistence among women (Hypothesis 4c). Remarkably, this path coefficient was not significant for men. Ultimately, Wald χ^2 tests revealed that only two coefficient paths differed significantly (and marginally) between men and women: the paths from autonomy

($\Delta\chi^2 = 4.114, p = .043$) and positive emotions ($\Delta\chi^2 = 3.445, p = .063$) to intended doctoral persistence were stronger among women than among men. All other path coefficients did not differ significantly between gender groups ($p > .063$) for each χ^2 difference for all other regressions).

Furthermore, and as expected, positive emotions were positively associated with intended doctoral persistence (Hypothesis 5a), whereas negative emotions were negatively associated with intended doctoral persistence (Hypothesis 5b), for men and women. Importantly, Wald χ^2 tests revealed that the magnitude of the correlations did not differ significantly between men and women ($p > .05$ for each χ^2 difference for all correlations).

To complement our statistical analysis, we explored indirect effects (Hypothesis 6). Table 5 reports the magnitude and significance of indirect effects of the types of support on doctoral persistence by way of positive and negative emotions for men and women. When comparing all indirect effects, findings differed depending on gender. For women, the path through positive emotions explained the effect of structure and autonomy on doctoral persistence most strongly. For men, this was true of the path through negative emotions. Indirect effects through involvement were not significant for either men or women.

Ultimately, the high value of the coefficients of determination (R^2 , see Figure 1 and Figure 2) indicates that an important proportion of the variance in the dependent variables was explained by the independent variables for both men and women. This suggests that the regression models fit the observed data reasonably well.

Discussion

Research examining the mental health of PhD candidates is flourishing; however, little is known about the associations between the supervisor–supervisee relationship and emotional well-being. Rooted in the framework of self-determination theory and adopting a perspective sensitive to the gender differences documented in academia, the current work examined the

role of the supervisor's support as a predictor of emotions and intended doctoral persistence among male and female PhD candidates from all disciplines at the two largest universities of the French-speaking Community of Belgium. In line with a growing body of research (e.g., Evans et al., 2018; Levecque et al., 2017), we found that poor levels of emotional well-being are present among doctoral candidates (e.g., anxiety and stress), particularly among female candidates. Indeed, we found that women experience stronger negative emotions (anxiety, stress, discourage, demoralization, sadness and depression) and weaker positive emotions (confidence, optimism, happiness, fulfillment, satisfaction and content) than men do. Moreover, women reported weaker intended doctoral persistence. This is consistent with previous findings documenting that women may have a more challenging academic experience than their male counterparts, particularly in highly selective and prestigious academic settings (Cheryan et al., 2017; Hardeman et al., 2015), such as PhD programs. However, in appraising such effects, it is important to keep in mind that gender inequality often results from the accumulation of small effects that can ultimately tip the balance (cf. Martell et al., 1996). Similarly, it is well-established that dropout from a PhD program also results from the accumulation of individual risk factors (see Wollast et al., 2018). Ultimately, in light of self-determination theory, our research provides evidence that several dimensions of supervisor support are related to emotional well-being and intended persistence in the PhD trajectory.

The role of the supervisor's support

Building on and extending the findings of Devos et al. (2015) on doctoral supervisors' styles as viewed through self-determination theory, we demonstrated that the supervisor's provision of structure, involvement, and autonomy support is strongly associated with the way candidates feel and anticipate their future. Specifically, we focused on the role of the supervisor's support, not as a cause of gender differences in academia, but as a way to

improve the emotional experience for both genders. Indeed, there were no gender differences in the perceived support from the supervisor. Thus, in this context, one cannot argue that women experienced stronger negative emotions because they perceived weaker support.

Importantly, our results indicate that the need-satisfaction dimensions of supervision play a beneficial role in how male and female doctoral candidates feel and perceive their doctoral trajectory. Whereas the three dimensions were positively associated with mental health outcomes for both genders, the dimension of structure was found to be the most important (Hospel & Galand, 2016). This suggests that both male and female candidates need a structured academic environment that provides clear expectations and communication, constructive feedback, close guidance, and attention to maintaining the candidate's motivation and effort (Olivier et al., 2021). This is consistent with research showing that perceiving a lack of meaning and low progress are strong predictors of doctoral dropout (Declercq et al., 2021; Devos et al., 2016). Finally, although both genders benefit from well-articulated supervision, the positive effect of structure could particularly help to mitigate the emotional distress among women in STEM PhD programs, as suggested by a recent study (Fisher et al., 2019). Furthermore, the autonomy dimension was found to be directly associated with positive emotions and intended doctoral persistence only among women. Thus, an autonomy-supportive style as opposed to a controlling one may particularly benefit women. This may be the case because supervisors who promote candidates' autonomy are actively taking into account candidates' perspective and input, which may give female candidates the empowerment and the confidence that would be diminished by different negative stereotypes. In the same vein, as a potential way to mitigate negative effects of identity threat for women in PhD programs, specifically in STEM fields, other research has found that greater autonomy support from the supervisor was associated with higher research self-efficacy (Overall et al., 2011). Finally, autonomy support for female PhD candidates may have a particularly strong

positive effect on their emotional well-being, because that will allow them to pursue more freely community-oriented research goals (e.g., serving the community, connecting with others), which are more important for women than men (Diekmann et al., 2011).

Turning now to the perceived involvement of the supervisor, our results showed that this dimension is important when considered independently from the other dimensions (see bivariate correlations), but becomes secondary when all dimensions are introduced in the same model (Dupont et al., 2014). In other words, candidates' need for relatedness through involvement by the supervisor appeared less crucial when the other dimensions are taken into account. If a doctoral candidate works in a well-articulated academic environment (i.e., structure) with opportunities to make choices and take initiatives (i.e., autonomy), the need for a highly involved supervision style becomes less salient for his or her own emotional well-being and doctoral trajectory. For women specifically, the results showed that after partialing out the effects of structure and autonomy, the perceived supervisor involvement negatively predicted intended doctoral persistence. This may be explained by the fact that the meaning left within the involvement dimension after taking out what this dimension shares with structure and autonomy may be in fact harmful for women, potentially perceived as personally invasive, since this involvement might not happen within the context of the PhD project and might lack autonomy. Further studies analyzing the interactive effects of these dimensions would be helpful to clarify this point.

Limitations and future directions

Although this study expands our understanding of how the role of the supervisor shapes PhD candidates' emotional well-being, this study is not without its limitations. First, we only consider the perception of the doctoral candidate; the supervisor's perspective is not taken into account. Future studies should analyze both perspectives and identify if there is congruence between the support perceived to be given and received, in the sense of a style-fit

between the supervisor and supervisee. For instance, studies have shown that a research match, which implies working on a doctoral project closely related to the supervisor's own research, increases satisfaction and intended doctoral persistence (van Rooij et al., 2021).

Second, we did not include the gender of the supervisor in the analysis, which could have an effect and possibly interact with the gender of the PhD candidate. Exploratory analyses revealed that the supervisor gender did not have a main effect and did not interact with the mentee's gender. However, we did not present these results, as some of the categories (e.g., female supervisor supervising female candidate) did not contain enough participants to reach adequate power. We encourage scholars to consider the gender of the supervisor in further studies with larger sample sizes. For instance, research on related topics found that male PhD candidates in STEM programs were more likely than their female counterparts to receive mentorship and sponsorship (i.e., supervisors using their influence to advance the career of their protégé) from senior male academics (O'Connor et al., 2020). Another limitation is that the design is cross-sectional and that claims about causality cannot be established. Furthermore, there may be a selection bias in the sample: If women in our sample have dropped out more than men, as our results suggests (see also Wollast et al., 2018), the size of the difference observed in our study may underestimate true differences at the start of the PhD.

The present study suggests that supervisor-based training that builds structure, autonomy and involvement may have a positive impact on doctoral candidates' emotional well-being. In this context, both [Anonymized for review] offer PhD training programs that provide courses on university policies, procedures for effective supervision, shared experiences and challenges with peers, psychological support, and resources to find further help and guidance. These programs are designed for supervisors as well as for PhD candidates. Importantly, our results may provide insight in the way in which these

interventions and training programs can best be implemented. For women, these interventions may require greater attention to autonomy and structure to overcome poorer mental health and additional gender inequalities in higher education. The results of this study suggest that the doctoral candidate is dependent on the his/her supervisor, who has a significant role in his/her doctoral trajectory. Interventions should therefore target both the supervisor and the supervisee, with a specific emphasis on structure and autonomy. Additionally, these interventions could include self-compassion components (Neff, 2003) which have been found to be associated with less negative emotions (Wollast et al., 2020a; Wollast et al., 2020b; Wollast et al., 2023) and more positive emotions (Wollast et al., 2019).

Conclusion

Researchers have called for evidence of a mental health crisis in graduate education. Poor emotional well-being is the result of pressure that manifests in several ways, including constant demand for results, increasingly marketized publications systems, financial pressures, uncertainty about doctoral processes, sense of belonging in scholarly communities and so on. In this context, social environment is a key factor that supposedly helps both male and female doctoral candidates to better cope with these demands and uncertainties. The current study found that the perceived provision of structure and autonomy support by the supervisor can make a significant difference in how male and female candidates think, feel and perceive their future in such a challenging environment.

Electronic Supplementary Material. Raw data, syntax, questionnaires, and additional elements can be found in the online supplementary material (<https://osf.io/uetrw/>).

Conflict of Interest. The authors declare that they have no conflict of interest.

Ethics Statement. This study complies with the APA ethical regulations for research on human subjects and all participants gave informed consent, as approved by the institutional review boards of the principal investigators.

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Table 1. *Distribution of men (n = 411) and women (n = 514) as a function of socio-demographic factors*

	Men	Women		Men	Women
<i>Nationality</i>			<i>Age</i>		
Belgian nationals	70%	73%	Younger than 26 years old	55%	58%
Nationals from another EU country	16%	18%	Between 26 and 40 years old	40%	38%
Non-EU nationals	14%	9%	Older than 40 years old	5%	4%
<i>Number of children</i>					
None	81%	77%	2 children	6%	7%
0 but I am or my partner is pregnant	2%	2%	3 children	2%	2%
1 child	7%	11%	4 children or more	2%	1%
<i>Final evaluation in master's degree program</i>			<i>Marital status</i>		
Highest distinction	20%	24%	Single	42%	34%
High distinction	44%	51%	Engaged in a committed relationship	32%	34%
Distinction	31%	22%	Married	26%	31%
Satisfaction	5%	3%	Widowed	0%	1%
<i>Position</i>			<i>Research field</i>		
Non-university funding or research project (grant or contract)	62%	64%	Sciences and technologies	44%	24%
Assistant lectureship	25%	23%	Health sciences	19%	24%
Two types of funding (e.g., grant and assistant)	2%	3%	Social sciences	28%	34%
No funding or unknown funding	11%	10%	Human sciences	8%	18%

Table 2. Comparisons of concurrent models

	Model	χ^2	df	CFI	RMSEA	AIC	BIC	Factor loadings
Men	3 factors (IN vs AU vs ST)	134.25	51	.953	.063	188.25	296.76	.44–.80
	2 factors (IN vs AU and ST)	336.05	53	.839	.114	386.05	486.51	.25–.78
	2 factors (IN and AU vs ST)	240.45	53	.893	.093	290.45	390.91	.26–.80
	2 factors (IN and ST vs AU)	363.71	53	.823	.120	413.71	514.18	.42–.79
	1 factor (IN and AU and ST)	492.85	54	.750	.141	540.85	637.29	.19–.79
Women	3 factors (IN vs AU vs ST)	154.62	51	.960	.063	208.62	323.16	.48–.84
	2 factors (IN vs AU and ST)	415.35	53	.859	.115	465.35	571.40	.18–.83
	2 factors (IN and AU vs ST)	308.35	53	.900	.097	358.35	464.41	.28–.83
	2 factors (IN and ST vs AU)	401.78	53	.864	.113	451.78	557.84	.48–.78
	1 factor (IN and AU and ST)	567.75	54	.800	.136	615.75	717.57	.24–.79
Men	2 factors (Pos vs Neg)	75.55	26	.968	.068	113.55	189.90	.56–.88
	1 factor (Pos and Neg)	269.21	27	.843	.148	305.21	377.55	.52–.82
Women	2 factors (Pos vs Neg)	68.86	26	.978	.057	106.86	187.46	.51–.84
	1 factor (Pos and Neg)	228.94	27	.899	.121	264.94	341.30	.47–.79

Note: IN = Involvement; AU = Autonomy; ST = Structure; Pos = Positive emotions; Neg = Negative emotions.

Table 3. *Correlation matrix with women (n = 514) above the diagonal and men (n = 411) below the diagonal and means (standard deviations) differences as a function of gender*

	Involvement	Structure	Autonomy	Positive emotions	Negative emotions	Doctoral persistence
Involvement	1	.66**	.42**	.34**	-.35**	.28**
Structure	.56**	1	.23**	.37**	-.36**	.35**
Autonomy	.41**	.17**	1	.28**	-.30**	.26**
Positive emotions	.27**	.42**	.14**	1	-.65**	.58**
Negative emotions	-.24**	-.27**	-.27**	-.60**	1	-.54**
Doctoral persistence	.26**	.39**	.15**	.56**	-.54**	1
Men	3.99 (0.85)	3.61 (0.90)	4.07 (0.69)	3.53 (0.78)	2.25 (0.84)	4.18 (0.74)
Women	3.98 (0.92)	3.57 (0.98)	4.09 (0.73)	3.29 (0.86)	2.43 (0.88)	4.01 (0.84)
Total	3.98 (0.89)	3.59 (0.94)	4.08 (0.71)	3.40 (0.83)	2.35 (0.86)	4.09 (0.80)
Welch's <i>t</i>	0.04	0.65	0.38	4.47	-3.22	3.21
<i>df</i>	902.875	903.165	894.366	906.981	891.209	911.448
<i>p</i>	> .05	> .05	> .05	< .001	= .001	= .002
95% <i>CI</i>	[-.109; .122]	[-.082; .163]	[-.111; .075]	[.136; .348]	[-.294; -.071]	[.065; .269]
Cohen's <i>d</i>	.01	.04	.03	.29	-.21	.21

*Note: The scales vary between 1 and 5. ** = Correlation is significant at the 0.008 level.*

Confidence intervals that do not contain zero are considered significant (Mallinckrodt et al., 2006).

Table 4. Means (standard deviations) differences of all emotions for men ($n = 411$) and women ($n = 514$)

	Anxious Stressed	Angry Revolted	Sad Depressed	Ridiculous Ashamed	Discouraged Demoralized	Confident Optimistic	Curious Captivated	Happy Fulfilled	Satisfied Contented
Men	3.19 (1.24)	1.83 (1.11)	2.16 (1.19)	1.64 (0.94)	2.41 (1.13)	3.47 (0.95)	3.87 (0.90)	3.40 (1.00)	3.40 (0.97)
Women	3.61 (1.19)	1.77 (1.11)	2.33 (1.26)	1.70 (1.05)	2.74 (1.25)	3.09 (1.06)	3.80 (0.95)	3.11 (1.09)	3.17 (1.07)
Total	3.43 (1.23)	1.80 (1.11)	2.25 (1.23)	1.68 (1.00)	2.59 (1.21)	3.26 (1.03)	3.83 (0.93)	3.24 (1.06)	3.27 (1.03)
Welch's t	-5.24	-0.86	-2.14	-0.92	-4.10	5.76	1.14	4.19	3.40
df	860.867	874.664	898.037	910.798	909.001	907.939	893.950	905.074	908.354
p	< .001	> .05	= .033	> .05	< .001	< .001	> .05	< .001	= .001
95% CI	[-.576; -.261]	[-.081; .208]	[-.331; -.014]	[-.191; .070]	[-.474; -.167]	[.250; .513]	[-.051; .190]	[.152; .425]	[.095; .362]
Cohen's d	-.35	-.05	-.14	-.06	-.28	.08	.01	.28	.23

Note: Standard deviations are presented in parentheses. The scale varies between 1 and 5. Confidence intervals that do not contain zero are considered significant (Mallinckrodt et al., 2006).

Table 5. *Magnitude and significance of indirect effects of the types of support on doctoral persistence by positive and negative emotions as a function of gender*

Gender	Predictor	Mediator	<i>B</i>	<i>SE</i>	95% CI
Male	Involvement	Positive emotions	-.015	.022	[-.073; .006]
		Negative emotions	-.030	.051	[-.122; .047]
Female	Involvement	Positive emotions	.006	.022	[-.073; .090]
		Negative emotions	-.005	.051	[-.064; .034]
Male	Structure	Positive emotions	.078	.053	[-.002; .172]
		Negative emotions	.116	.047	 [.051; .203]
Female	Structure	Positive emotions	.127	.048	 [.063; .223]
		Negative emotions	.079	.041	 [.027; .165]
Male	Autonomy	Positive emotions	.025	.026	[-.001; .093]
		Negative emotions	.147	.057	 [.073; .264]
Female	Autonomy	Positive emotions	.103	.044	 [.046; .195]
		Negative emotions	.081	.043	 [.029; .179]

Note: Confidence intervals that do not contain zero are considered significant (Mallinckrodt et al., 2006) and are highlighted in bold.

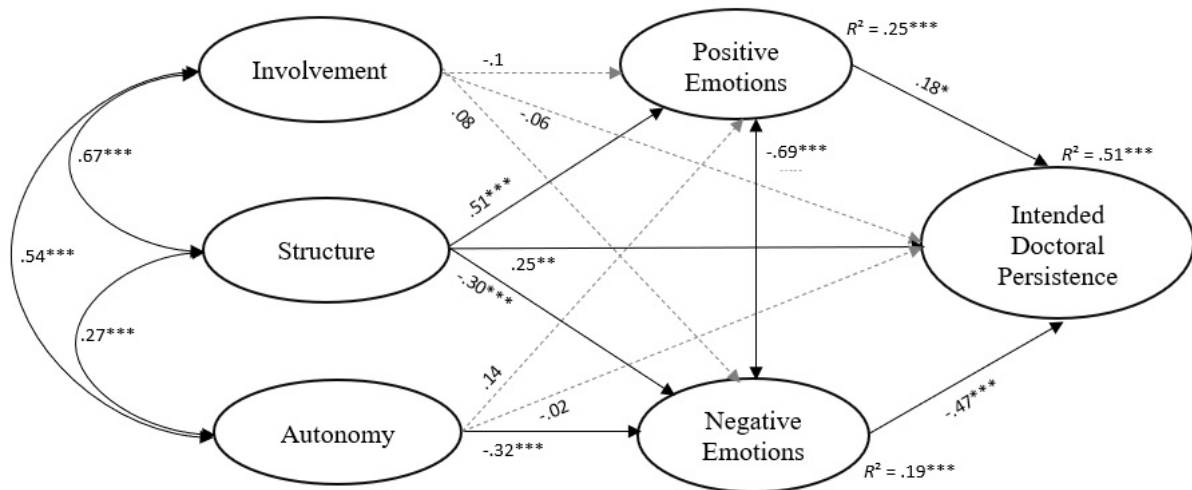


Figure 1. Standardized path coefficients for men ($n = 411$). Solid, black paths are significant whereas grey, dashed pathways are not ($p > .05$). * $p < .05$. ** $p < .01$. *** $p < .001$.

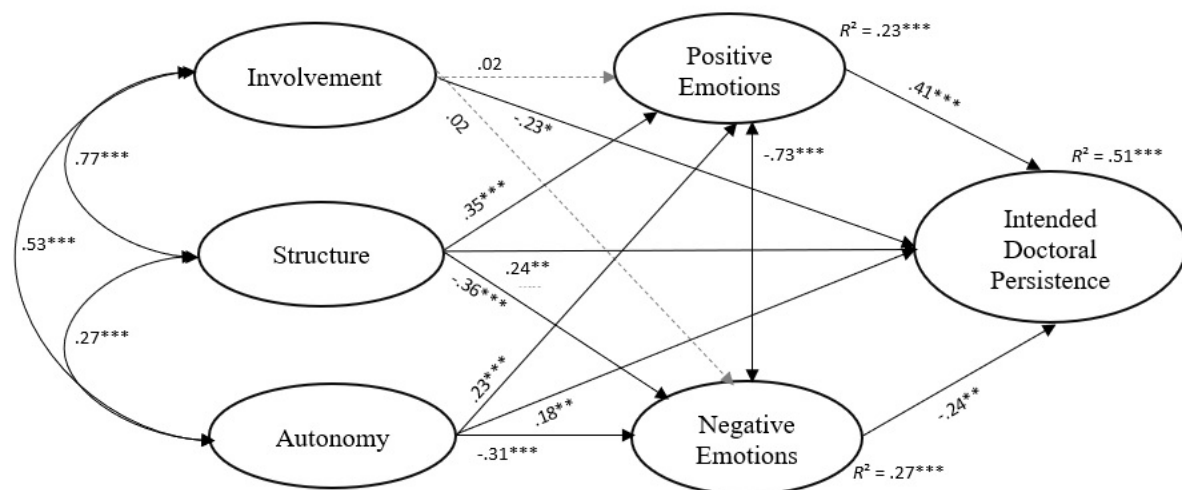


Figure 2. Standardized path coefficients for women ($n = 514$). Solid, black paths are significant whereas grey, dashed pathways are not ($p > .05$). * $p < .05$. ** $p < .01$. *** $p < .001$.