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Deciding upon a career within the medical field

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CHAPTER 4

Benefits of Personality Characteristics and Self-Efficacy in the Academic Achievement of Medical Students³

³ A revised version is under review as: Guntern, S., Korpershoek, H., & van der Werf, G. Benefits of Personality Characteristics and Self-Efficacy in the Academic Achievement of Medical Students.

Abstract

This study investigates the joint impact of personality characteristics and self-efficacy on the academic achievement of medical students on top of their prior high school performance. The sample consisted of medical students in their pre-clinical years. The students' grade point average scores (GPA) at high school were included as control variable in our explanatory models. Based on previous findings in the literature, we selected self-discipline, social activity, and emotional stability from the Five Factor Model (FFM) of Personality as predictor variables. Furthermore, following the social cognitive theory of Bandura, we added self-efficacy (students' belief in their academic skills) as an additional predictor. The logistic regression analyses confirmed the importance of self-discipline (positively related) and social activity (negatively related) for these students' academic achievement. Additionally, we found a positive contribution of self-efficacy. The results of this study (as discussed in the final sections) have implications for support programs in the practical field.

Keywords: Self-efficacy – Social activity – Self-discipline – Medical students' academic achievement – Support programs

Introduction and Problem Statement

In the past few years, considerable research has been done on the prediction of academic success. The results of this research have demonstrated the importance of personality characteristics (Busato, Prins, Elshout, & Hamaker, 2000; Robbins, Lauver, Le, Davis, Langley, & Carlstrom, 2004; Trapmann, Hell, Hirn, & Schuler, 2007). The current study concentrates on the prediction of academic success of medical students in their pre-clinical years. In medical education, the focus on investigating the impact of personality characteristics using the Five Factor Model (FFM) of Personality has been far less extensive than in other areas. However, additional knowledge about the relevance of non-cognitive factors on outcome criteria (e.g., academic achievement, drop-out rates, study satisfaction, study length and clinical outcomes) would be valuable as regards, for example, the nature of future admission procedures for the medical studies. In our research, we added self-efficacy to the FFM-model's personality characteristics (self-discipline, social activity, and emotional stability) since self-efficacy has been reported to be positively associated with performance and study behavior (Pintrich, Smith, Garcia, & McKeachie, 1993; Robbins et al., 2004). Moreover, we were especially interested in the additional impact of these predictors after controlling for our sample students' prior performance at high school.

It is generally known that personality characteristics improve the prediction of students' academic achievement by approximately 8 to 10% compared to the impact of cognitive factors, which explain up to 25% of the variance in their future academic achievement (Robbins et al., 2004; Trapmann et al., 2007). Furthermore, in combination with knowledge of cognitive factors, information on personality characteristics could be used to better guide and support students with achievement problems or with higher risks of dropping out of education (Kyllonen, Walters, & Kaufman, 2005; Lievens, Coetsier, De Fruyt, & Maeseneer, 2002; Robbins et al., 2004; Trapmann et al., 2007).

Our study has expanded the earlier explanatory models by adding self-efficacy as predictor of academic achievement to the personality characteristics of the FFM of Personality. If this variable indeed makes a unique contribution to students' academic achievement, then students with a low degree of self-efficacy may profit from cognitive-behavioral interventions. Such programs have already shown to increase students' self-efficacy and enable them to develop alternative ways of dealing with stress, an element

often connected with poor academic achievement (Bresó, Schaufeli, & Salanova, 2011; Stewart, 1999).

Personality Characteristics as Predictors of Academic Achievement

We derived those variables from the FFM of Personality that have commonly been considered as related to academic achievement, namely conscientiousness, emotional stability, extraversion, agreeableness, and openness to experience (for a general review: De Raad & Schouwenburg, 1996; Trapmann et al., 2007; for a review in the medical field: Doherty & Nugent, 2011). It is generally acknowledged that conscientiousness, emotional stability and to some extent extraversion are stronger predictors of performance than agreeableness and openness to experience.

The positive impact of *conscientiousness* on academic achievement was confirmed in several studies conducted in the medical context (Chamberlain, Catano, & Cunningham, 2005; Ferguson, James, O’Hehir, & Sanders, 2003; Lievens, Ones, & Dilchert, 2009; Tyssen et al., 2007). Especially the facets self-discipline (e.g., not getting distracted), achievement striving (e.g., working hard to reach one’s goals) and competence (e.g., being convinced of succeeding) were found to predict academic achievement, whereas order, deliberation, and dutifulness were observed to be less influential factors (Lievens et al., 2002). Another meaningful predictor was *extraversion*, which was shown to be significantly related to medical students’ academic achievement (Lievens et al., 2002, 2009). As reported by Lievens et al. (2009), medical students with high scores on gregariousness and excitement-seeking appear to be less successful than students with lower scores on these facets. Except for excitement-seeking, whose influence on academic achievement remained negative, the other facets of extraversion had a positive impact on students’ achievement later in their education. Another study with dental students (Chamberlain et al., 2005), however, did not identify significant associations between extraversion facets and pre-clinical school performance measures. And regarding *emotional stability* (the inverse of neuroticism), it was shown that its influence on the achievement of medical students was trivial, which corresponds with findings outside the medical field (Ferguson et al., 2003; Lievens et al., 2002, 2009).

Self-Efficacy as Predictor of Academic Achievement

In the educational context, the importance of students' self-efficacy beliefs has often been investigated and used as a predictor of their academic achievement. According to Bandura (1977), self-efficacy is the confidence a person has in his/her own ability to solve problems and accomplish tasks. Bandura argued that "*perceived self-efficacy is concerned with judgments of how well one can execute courses of action required to deal with prospective situations*" (Bandura, 1982, p. 122). Self-efficacy is a construct linked to motivational aspects, aspects of persistence, and aspects of how much effort individuals put in their actions (e.g., Burgoon, Meece, & Granger, 2012). Students with higher levels of self-efficacy possess more of these qualities than students with lower degrees of self-efficacy.

Several studies have reported that self-efficacy is positively related to academic achievement (Chemers, Hu, & Garcia, 2001; Pintrich & De Groot, 1990; Pintrich et al., 1993; Robbins et al., 2004). This relationship is explained by the argument that self-confident students are more persistent, even in the case of achievement difficulties (Chemers et al., 2001; Robbins et al., 2004). It is in line with another finding that less confident students tend to avoid challenging situations (Fenollar, Román, & Cuestas, 2007). In the medical field, it has been suggested that self-efficacy involves an affective component. It was found that medical students' self-efficacy was negatively associated with achievement emotions, such as course-related anxiety and boredom, whereas it was positively related to course-related enjoyment (Artino, La Rochelle, & Durning, 2010). Another study with medical students showed that self-efficacy was significantly positively correlated with first year performance (Stegers-Jager, Cohen-Schotanus, & Themmen, 2012).

The Present Study

The present study has evaluated the joint impact of personality characteristics and self-efficacy on the academic achievement of medical students. To this end, we extended earlier models focused on the FFM personality factors by adding self-efficacy. Moreover, students' previous performance was taken into account as cognitive factor and included in our models as control variable. To the best of our knowledge, combining these two aspects

in investigating a sample of medical students in their pre-clinical years has not yet been done before.

As non-cognitive factors we focused on self-discipline, emotional stability, and social activity, components that measure students' personality on a more specific level than broader factor scales. Some authors (Ackerman, Chamorro-Premuzic, & Furnham, 2011; McCrae & Costa, 1997) have argued that measuring personality on a more specific level is presumably more suitable for an educational setting. Therefore, emotional stability was adjusted to situations in an educational context, in which elements such as stress and dealing with frustration are more applicable than, for example, clinical reactions to depression or anxiety. Particular interest was paid to the impact of self-efficacy, which was assumed to be an influential predictor of medical students' achievement.

Based on former study results we assumed that on top of cognitive factors as measured via high school grades, non-cognitive factors (self-discipline, social activity, emotional stability, and self-efficacy) would explain additional variance in medical students' pre-clinical achievement (hypothesis 1). Starting from the literature, we expected a rather small influence of emotional stability (hypothesis 2). Moreover, we expected a positive impact of self-efficacy (hypothesis 3) and of self-discipline (hypothesis 4) on our students' academic achievement. No concrete assumption was made about the influence of social activity on their academic achievement because the literature has been ambiguous as regards this topic.

Method

Participants

In total 863 medical students from Switzerland and Austria participated in this study. These students had achieved the highest scores on a selective admission test, aimed at choosing the 'best' applicants for the medical studies. At the time of the survey, the students were in their pre-clinical years. They were asked to fill out a questionnaire about study-relevant personality characteristics and self-efficacy (this was done voluntary while no rewards were offered for participation). We informed the students about the study's objective of supporting prospective applicants in their study decision. The answers of the

students were intended to be used for the development of a self-administered assessment for applicants to the medical study.

The participation rate was approximately 30% of all students to whom the assessment was offered. Based on the availability of students' high school grades (indicated by 34%), the final sample size consisted of 291 students. The main age of the students in the sample was 21 years ($SD = 2.8$), of which 54% was female ($n = 156$) and 46% male ($n = 135$). The majority of the students were in their second year ($n = 198$, 68%), and one third in their first year ($n = 93$, 32%). The first two years of medical education are usually considered to be the pre-clinical years with a main focus on natural sciences. In the higher study years clinical internships form an integrated part of the program.

Measuring Personality Characteristics and Self-Efficacy

The questionnaire employed to measure the personality characteristics was based on the well-documented Five Factor Model (FFM) of Personality (McCrae & Costa, 1997). The NEO-PI-R, a tool for measuring the FFM, served as standard instrument for our scale construction. We exclusively focused on study-relevant personality characteristics. Therefore, we constructed a new questionnaire (Table 1). Additionally, this questionnaire was adjusted to the medical context. Several steps were realized to build a reliable and valid questionnaire. First, a comprehensive literature research guided the selection of the FFM scales. We chose those FFM scales whose impact on study success was proven according to this literature. Second, the scales were formulated in the style of the NEO-PI-R item texts, after which experts evaluated their comprehensibility. Third, our definitive item selection was based on reliability and exploratory factor analyses.

The final questionnaire included the following personality characteristics: self-discipline (a facet of conscientiousness; 14 items, $\alpha = 0.91$), social activity (a facet of extraversion; 11 items, $\alpha = 0.89$), and emotional stability (12 items, $\alpha = 0.86$). Emotional stability focused on students' ability to cope with frustrations and stress, which we believed to be the most relevant component in the medical context where students are required to function in a highly demanding environment. We therefore measured emotional stability on a more specific level than done by the NEO-PI-R. Some scale item examples are the following: *I can put away disappointments*, *I start having self-doubts quickly* and *I easily get insecure*

(emotional stability); *I have difficulties to start working, I finish my tasks in time and I get easily distracted* (self-discipline); *I am not a shy person, I like to meet new people and I am open toward foreigners* (social-activity).

Furthermore, a self-efficacy scale (16 items, $\alpha = 0.88$) was added to the questionnaire to measure the students' self-confidence. The operationalization of this component was based on Bandura's social cognitive theory (2001). Again, we adjusted its items to the educational context of medical students. Some item examples are: *I am convinced to finish my studies successfully, I also tackle difficult tasks with confidence and I trust in my intellectual abilities*. The item responses for all scales ranged from (1) *not at all applicable* to (5) *entirely applicable*.

Table 1: Scale overview

Predictors	Items	α	Scale definitions
Self-discipline	14	0.91	The ability to start and finish tasks in time. Self-disciplined students do not get distract easily.
Emotional stability	12	0.86	Emotional stabile students are self-confident and can put frustrations away.
Social activity	11	0.89	Students with high scores are communicative and prefer being together with others.
Self-efficacy	16	0.88	Self-efficient students are convinced about their abilities also in times of difficulties.

α = Cronbach's alpha for 863 medical students.

Measuring Prior Performance and Academic Achievement of Medical Students

The prior academic accomplishments of the medical students were measured by asking them about their average high school grades (for students' prior performance) and their examination performance at university so far (for students' academic achievement). As aforementioned, the sample was reduced because of some students there was no information available about their high school grades. Analyses of variance, however, showed no significant differences for personality characteristics between the selected students ($n = 291$) and the non-selected students ($n = 572$). As regards self-efficacy, the selected students scored slightly lower than the non-selected students [$M_{\text{selected}} = 3.87$,

$SD_{\text{selected}} = 0.54$; $M_{\text{non-selected}} = 3.96$, $SD_{\text{non-elected}} = 0.53$; $F(1, 861) = 5.35$, $p = 0.021$, $\eta^2 = 0.006$]. As a result, self-efficacy was slightly underestimated in our sample.

Based on the students' university examinations passed so far, the students could be divided into three categories: (1) *the upper performance third*, (2) *the middle performance third* and (3) *the lower performance third*. Approximately half of the students (51.2%) could be placed in the upper third ($n = 149$), 43.6% in the middle third ($n = 127$), and 5.2% in the lower third ($n = 15$). Given that a relatively large number of better performing students participated in the survey, a selection bias may have occurred. But then, medical students are known as a highly performing group for which the lowest performance group will in fact be rather small. Moreover, the sample size of the lower performance group was too small for logistic regression analysis with study year as control variable. Therefore, the middle and lower performance groups were combined.

Control Variables

Since our study aim was to investigate – in addition to prior performance – to which degree personality characteristics and self-efficacy predict the academic achievement of medical students, we used the students' high school grades as control variable. Furthermore, to confirm the overall impact of our factors, we controlled for study year.

Data Analyses

We started our analyses by examining the correlations among the predictors self-discipline, social activity, emotional stability, and self-efficacy. In regression analysis, highly correlated scales should be excluded because they to some extent provide overlapping information. Subsequently, to determine the additional amount of explained variance in the academic achievement component, we conducted hierarchical regression models by entering the control variables prior to the predictor variables. Next, because our outcome variable was categorical while our predicting variables were continuous, logistic regression analyses were performed. If the outcome variable is dichotomous, a logit transformation is required to be better able to interpret the results (Peng, Lee, & Ingersoll, 2002).

To establish the relative predictive impact of the predictors we looked at their odds ratios. Odds ratios inform us about the change in the odds produced by a unit change in the predictive variable when all other predictors are held constant (Peng et al, 2002). Applied to our data, if the odds value of our predictors (self-discipline, social activity, self-efficacy) is larger (smaller) than 1, then the chance for being in the better performing group increases (decreases) by the factor of the odds ratio. Furthermore, to gain more insight into what the expected value of the predictors would be in the population, we also investigated the predictors' confidence intervals. A confidence interval of 95% means that if a series of identical studies were performed, 95% of these intervals would enclose the results (Gardner & Altman, 1986).

Results

Descriptive Results

As reported in Table 2, the correlations among the predictors were moderate, although the connection between emotional stability and self-efficacy was relatively high ($r = 0.67$, $p < 0.01$). Moreover, as shown in Table 3, emotional stability did not correlate with academic achievement ($r = -0.03$, $p > 0.05$), which is why it was excluded from our further analyses.

The other predictors did correlate with the medical students' academic achievement. High school grades ($r = 0.40$, $p < 0.01$), self-discipline ($r = 0.20$, $p < 0.01$), and self-efficacy ($r = 0.19$, $p < 0.01$) were positively related to their overall achievement. Furthermore, self-discipline significantly correlated with students' achievement in the first study year ($r = 0.34$, $p < 0.01$), but did not do so in the second study year ($r = 0.14$, $p > 0.05$). And whereas there was no correlation between social activity and academic achievement in the first study year ($r = 0.03$, $p > 0.05$), it was significant and negative in the second year ($r = -0.17$, $p < 0.05$).

Table 2: Means (M), standard deviation (SD) and correlations between predictors

Predictors	Range	M	SD	1)	2)	3)	4)
1) High school grades ^a	1-6 ^b	5.14	0.46	–			
2) Self-discipline	1-5	3.40	0.73	0.22**	–		
3) Emotional stability	1-5	3.39	0.64	–0.04	0.07	–	
4) Social activity	1-5	3.76	0.69	0.05	0.11	0.28**	–
5) Self-efficacy	1-5	3.87	0.54	0.27**	0.24**	0.67**	0.32**

Pearson correlations for 291 medical students with ** $p < 0.01$.

^a. High school grades (GPA) ranged from 1 to 6. All study participants though had at least a grade of 4, because such a grade is required to pass an examination. ^b. Higher numbers indicate better grades.

Table 3: Zero order correlations with the examination performance

Predictors	Performance group ^a		
	Overall (n = 291)	Year 1 (n = 93)	Year 2 (n = 198)
High school grades	0.40**	0.27**	0.47**
Self-discipline	0.20**	0.34**	0.14
Emotional stability	–0.03	0.01	–0.05
Social activity	–0.10	0.03	–0.17*
Self-efficacy	0.19**	0.21*	0.18*

Spearman’s rho for 291 medical students with * $p < 0.05$; ** $p < 0.01$.

^a. Lower performance group is coded with 1 and better performance group with 2.

Hierarchical Logistic Regression Analyses

Hierarchic logistic regression analyses were performed using study year and high school grades as control variables, and self-discipline, social activity, and self-efficacy as predictors of academic achievement (Table 4). The high school grades explained 20% of the variance in examination performance after controlling for study year ($\chi^2(1) = 47.97$, $p < 0.001$). Personality characteristics and self-efficacy accounted for an additional amount of 7% of the variance in academic achievement ($\chi^2(3) = 17.88$, $p < 0.001$) after controlling for study year and students’ prior performance at high school.

All predictors included in the model were significantly related to academic achievement. The high school grades had the largest impact on examination performance

(OR = 2.32, 95% CI [1.72, 3.13]). Furthermore, the odds ratios for self-efficacy (OR = 1.43, 95% CI [1.07, 1.91]) and self-discipline (OR = 1.39, 95% CI [1.07, 1.79]) both indicated that the odds of belonging to the better performance group was 1.43, resp. 1.39 times greater for each unit of increase in the score on these scales. Thus, the percent change in the odds of the better performing group was 43%, resp. 39% corresponding to a one unit increase while holding the other predictors fixed. The relationship between social activity and performance group was negative. If the social activity of students increased by one unit, the odds of belonging to the better performance group decreased (OR = 0.65, 95% CI [0.48, 0.87]). Since the confidence intervals of all predictors did not include 1, there is relative strong evidence that self-efficacy and self-discipline affect students' achievement positively, while social activity has a negative impact on that outcome variable.

Table 4: Hierarchical logistic regression analyses for the examination performance

	OR	95% CI	p-value
Step 1, $R^2 < 0.001$			
Study year	0.96	0.59–1.57	0.88
Step 2, $R^2 = 0.20$			
Study year	0.84	0.49–1.44	0.53
High school grades	2.49	1.87–3.31	< 0.01
Step 3, $R^2 = 0.27$			
Study year	0.88	0.51–1.55	0.67
High school grades	2.32	1.72–3.13	< 0.01
Self-discipline	1.39	1.07–1.79	0.01
Social activity	0.65	0.48–0.87	< 0.01
Self-efficacy	1.43	1.07–1.91	0.02

OR = Odds ratios; 95% CI = 95% Confidence interval.
All predictor scores are standardized into z-values.

Discussion

Our study aim was to investigate to which degree personality characteristics (self-discipline, social activity, and emotional stability) and self-efficacy predict the pre-clinical academic achievement of medical students on top of their prior performance at high school. Therefore, we included students' pre-university performance as control variable. Furthermore, we also controlled for the study year to investigate the overall impact of our factors. This was necessary to do because the correlations of the factors with students' academic achievement were different for the first and second study year. In literature, it was reported that a varying impact of cognitive and non-cognitive factors on the same outcome variable across the study years is not unusual (Lievens et al., 2009; McManus, Woolf, Dacre, Paice, & Dewberry, 2013). One explanation for an increased impact of cognitive factors is that achieving the current learning goals depends on the learning outcome of earlier years (McManus et al., 2013). However, other researchers have argued that the impact of cognitive factors presumably decrease in higher education (Ackerman et al., 2011; Furnham, Chamorro-Premuzic, & McDougall, 2003), whereas the one of non-cognitive factors increase in higher education. For example, Lievens et al. (2009) showed that conscientiousness and extraversion of medical students became more important in clinical years. Generally speaking, the impact of the factors seems to depend on the predicted variable (Lievens et al., 2009).

We found that the students' high school grades accounted for 20% of the variance in their academic achievement. When adding self-discipline, social activity, and self-efficacy, the explained variance increased to 27%. Thus, hypothesis 1 was confirmed, while our results regarding this premise are in line with previous findings in both the educational (Robbins et al., 2004; Trapmann et al., 2007) and medical context (Ferguson et al., 2003). Hence, non-cognitive factors accounted for an increased amount of explained variance of approximately 7% in our students' academic achievement on top of their prior performance at high school. In highly selective fields such as, for example, medical education, relatively weak associations between predictors and outcome variables can already be considered useful (Adam, Bore, McKendree, Munro, & Powis, 2012). Additionally, non-cognitive factors provide valuable information on the cognitive factors. Personality characteristics,

for example, inform about students' behavior in a specific situation (Kyllonen et al., 2005; Lievens et al., 2009; Robbins et al., 2004; Trapmann et al., 2007).

Second, we tested the relative predictive impact of the personality characteristics and self-efficacy on the students' pre-clinical academic achievement. All of our predictors, self-discipline, social activity, and self-efficacy, had a significant impact on the academic achievement of our sample of medical students. Particular attention was paid to the influence of self-efficacy, a variable which we assumed to be more valuable than students' emotional stability in the educational context. This assumption was based on findings that emotional stability is generally not a significant predictor of academic achievement (Chamberlain et al., 2005; Lievens et al., 2002, 2009). In this respect, we agree with the argumentation of other authors that self-efficacy reflects emotional stability in an academic setting (Judge & Bono, 2001; Robbins et al., 2004). Although we expected the impact of emotional stability to be rather small, our results did show a (non-significant) correlation between this factor and our students' overall performance ($r = -0.03$, $p > 0.05$). Therefore, hypothesis 2 was not confirmed. Furthermore, our results revealed that *self-efficacy* was a significant predictor of academic achievement, thereby confirming hypothesis 3. The most likely explanation of the positive impact of self-efficacy is that self-confident students work harder and are more persistent than unconfident students (Chemers et al., 2001). It is assumed that self-efficacy is susceptible to change through cognitive-behavioral interventions (Bresó et al., 2011; Robbins et al., 2004). On the other hand, also the way in which teachers, practitioners and others give feedback has an influence on this variable. Fenollar et al. (2007), for example, reported that accurate, timely, and specific feedback has a positive influence on students' confidence.

Our findings also indicated a positive impact of *self-discipline* on our medical students' pre-clinical academic achievement (confirming hypothesis 4). In our questionnaire, we measured the students' ability to start and finish tasks in time. It seems that students who performed better were less deflectable and better able to stick to their schedule than less self-disciplined students. In general, the positive impact of conscientiousness (a factor of self-discipline) on study success has been well confirmed in the literature (for non-medical samples: e.g., Robbins et al., 2004; for medical samples: e.g., Lievens et al., 2009).

To continue, better performing students scored lower on *social activity* (a facet of extraversion), implying that, on average, they were less outgoing and presumably spent

more time on studying than students with higher social activity scores. Other studies using extraversion as a predictor have shown ambivalent results. Some have reported a significant negative association between extraversion and academic achievement in pre-clinical years (Lievens et al., 2002, 2009), whereas other studies have not shown this association (Chamberlain et al., 2005; Ferguson et al., 2003). Here, however, the operationalization of extraversion may play a role. In our study we restricted extraversion to the aspect of social activity, ignoring its other facets, such as warmth, gregariousness, assertiveness, excitement seeking, and positive emotions. The results correspond with those of a study of Chamorro-Premuzic and Furnham (2003), in which only facets which measure the need to meet with others were significantly related to the total examination grades of the students (activity: $r = -0.24, p < 0.01$; gregariousness: $r = -0.20, p < 0.01$). However, the negative impact of social activity (odds ratios smaller than 1) does not imply that social contacts are per se a threat to being successful at university. It has been shown that a social network can certainly be beneficial for students in completing their study successfully (Eggen, van der Werf, & Bosker, 2008). The impact of extraversion seems further to depend on the selected prediction criteria. For example, extraversion was not an important predictor for the academic achievement in medical students' pre-clinical years, but the impact of extraversion increased over time (Lievens et al., 2009). For study purposes in higher education it may be advisable to not be too extraverted and spend enough time on studying. For practical training or tasks involving social interaction, on the other hand, a dynamic network of contacts may be helpful (for non-medical samples: De Raad & Schouwenberg, 1996; for medical studies: Lievens et al., 2009).

A possible explanation for the joint influence of self-discipline, social activity, and self-efficacy is that the predictors in our study were especially conceptualized for the medical context. Our scales particularly focused on students' working behaviors. As pointed out by other authors (e.g., Dudley, Orvis, Lebiecki, & Cortina, 2006), for prediction purposes it has seemed more valuable to concentrate on narrow personality characteristics within specific contexts than on broader measurements. Therefore, instead of broader factor scales, our questionnaire specifically included NEO-PI-R facets.

Practical Implications

The knowledge that personality characteristics and self-efficacy in addition to prior performance at high school have an influence on medical students' pre-clinical educational achievements can be put to use in helping struggling students. The value of self-efficacy is that it may be more easily influenced than the other personality characteristics (e.g., Stewart, 1999). Cognitive-behavioral interventions, for example, can help students to deal with stress in a more effective manner (Bresó et al., 2011; Stewart, 1999). Increasing one's self-efficacy may therefore also be of importance in the work as a physician, which is known to be demanding, especially in terms of social involvement skills, such as being empathic and interacting with patients in times of stress.

Medical studies are known to be highly demanding with different study requirements in the clinical and pre-clinical study years. In the pre-clinical years medical students need to acquire the scientific knowledge, whereas the focus in the clinical study years lies more on the application of the acquired knowledge in practice. With regard to the selection process of medical students, our research provides useful knowledge about the additional impact of non-cognitive factors (on top of cognitive factors). As argued in the literature (Benbassat & Bauml, 2007; Lambe & Bristow, 2011; O'Neill, Hartvigsen, Wallstedt, Korsholm, & Eika, 2011), the assessment of non-cognitive factors may lead to a better self-selection of the medical applicants. Therefore, a self-administered assessment containing non-cognitive factors is expected to be beneficial to this group. O'Neill et al. (2011), for example, showed that students who were selected based on a non-grade admission dropped out of medical school less frequently than those admitted based on their highest pre-university grade point average. In our opinion, a combination of a voluntary assessment of non-cognitive factors and an obligatory, selective performance test may successfully identify those applicants most suitable for the medical studies.

Limitations

First, since the participation in the self-administered assessment was voluntary, our research may have been subjective to selection bias. It is possible that the group of better performing students, for example with higher scores on self-discipline, was larger than the group with lower scores on this scale. Although this might be the case, students had no

reason to present themselves in a better light. The students were informed that the data were needed to be better able to inform upcoming students.

Second, the unequal distribution of the outcome variable (51% in the upper performance third, 44% in the middle performance third and 5% in the lower performance third) needs some further explanation. There are several reasons that the outcome variable is, in fact, unequally distributed for our sample of medical students. Medical students are a highly performing group for which the lowest performance group will always be rather small. At the beginning of their studies, these students have already passed a highly selective admission procedure and proven to be very successful. Another reason may lie in the formulation of the question "*In which performance third (of passed university examinations) were you so far?*", which included a comparison with a reference value. Since medical students are known as a highly performing group, the lowest performance group was perhaps 'disproportionally' smaller than the other groups. We assume that receiving bad grades presumably did not apply to the students in our sample. However, the restricted range of the outcome variable (upper versus middle/lower performing third) resulted in underestimated rather than in overestimated associations. This was because the variance in the outcome variable was smaller than it actually would be considering more categories (Robbins et al., 2004; Schmidt & Hunter, 1977). This circumstance might have limited the generalizability of our results, although we do not believe it did so substantially.

Third, because for some students there was no information available about their high school grades, the sample had to be reduced. However, in our opinion this reduction has not caused unreliable data, since students could skip this item if they considered this information as too sensitive. We preferred lacking data over unreliable data. If we had not given them the option to skip the question, we would have risked socially desirable answers. Additional analyses of variance showed that the personal characteristics of the selected students were comparable to those of the non-selected students, except for self-efficacy (lower scale score for selected students than for non-selected students). However, the scale difference for self-efficacy was not considered to be crucial with respect to the goals of the current study. Additionally, selected students did not significantly differ from the not select students in terms of the self-reported performance at university ($\chi^2(1) = 3.54$; $p = 0.06$). Thus, the selection of the students, based on their high school grades, did not result in considerable differences between the groups.

Finally, the high school grades of medical students were based on students' self-reports. A meta-analysis of Kuncel, Credé, and Thomas (2005) showed that "*self-reported grades are reasonably good reflections of actual grades for students with high ability and good point averages*" (p. 74). Our sample of medical students can be regarded as highly performing group with good high school grades. Additional arguments for the validity of the self-reported grades are that they explained most variance in students' performance at university and the correlation between the high school grades and the performance at university ($r = 0.40$, $n = 291$) corresponded with other studies (see McManus et al., 2013; Sawyer, 2013). Moreover, the impact of the non-cognitive predictors on the pre-university performance was in the expected direction. Nevertheless, a replication of this study is certainly desirable to support the current findings.

Further Research

Several research questions remain to be addressed. Our study focused on the prediction of academic achievement. However, the predictive impact of the personality characteristics and self-efficacy on outcome criteria other than student academic achievement (e.g., drop-out rates, study satisfaction, study length and clinical outcomes) still needs to be investigated.

Furthermore, the introduction of more sophisticated models which distinguish, for example, between female and male students, or between pre-clinical and clinical study years, would further enhance our knowledge. Our results showed a negative impact of social activity in the pre-clinical years. One assumption is that social activity may have a positive influence on the students' achievement in the clinical years, in which practical training with patient interactions becomes more influential. Moreover, additional research should also investigate the *differential* impact of non-cognitive factors on the outcome variables. Factors such as communication skills, social skills and empathy may have a bigger influence on clinical outcome variables than on academic variables, resp. become more important in higher years of medical education (Adam et al., 2012). Medical studies are known to be highly demanding in that they combine cognitive and non-cognitive requirements. In this respect, we agree with O'Neill et al. (2011) that assessing non-cognitive factors in a selection process would improve the self-selection of students.

Further research is also needed to investigate the influence of the study year. Is the impact of the personality characteristics and self-efficacy, for example, different in the pre-clinical years compared to the clinical years? Lievens et al. (2009) reported that factors such as extraversion and conscientiousness became more important during the clinical years as compared to the first study years. In a similar vein, we assume self-efficacy to have a positive effect on students' clinical work. Referring to some practical implications, we suggest conducting an intervention study about the effectiveness of support programs. Can students' self-efficacy actually improve through cognitive-behavioral interventions? We pointed out that students at risk of failing their examinations may profit from such interventions. In this respect, the value of self-efficacy partly lies in its vulnerability to intervention programs. The investigation of this research question would imply ongoing measurements of students' study performance. The challenge here would be to identify students at risk of failing their examinations at an early stage during their education.

Conclusion

We have contributed to the literature on relevant success factors in the medical studies, where the admission procedures are more selective than in other study fields, by presenting two sources of measurements, namely personality characteristics and self-efficacy for the prediction of academic achievement on top of students' pre-university achievement. A consideration of these variables – already during the admission process and later during the medical studies – offers additional information about students' working behavior. The value of this information can be seen in its influence on the academic achievement of students and its vulnerability to support programs for students with performance difficulties.

