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Refining the openness – performance relationship: Construct specificity, contextualization, social skill, and the combination of trait self- and other-ratings

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Abstract

Scholars have raised concerns that openness to experience has ambiguous relationships with performance. In the present study, we examine both openness and one of its more narrow dimensions, learning approach. In addition, the research context was made narrow (i.e., higher education academic performance in science), and social skill was interactively combined with peer- and self-rated personality in the prediction of academic performance (i.e., grades). We found that those high on learning approach, but not openness, one year later performed better academically than those lower on learning approach. Furthermore, for those high and average on social skill, increased peer-rated learning approach was associated with higher performance. Finally, the combination of self- and other-ratings of learning approach was a better predictor of academic performance than the combination of self- and other-ratings of openness. Openness' relationship with academic performance benefits from narrowing predictors and criteria, framing the study within a relevant context, accounting for social skill, and combining self- and other- trait ratings.

Key words: Openness to experience, learning approach, social skill, academic performance

Refining the openness – performance relationship: Construct specificity, contextualization, social skill, and the combination of trait self- and other-ratings

The personality – performance relationship has garnered a large amount of research attention over several decades, but many studies and meta-analyses have found small or modest, though significant, relationships with performance (e.g., Barrick, Mount, & Judge, 2001). To increase the validity of personality constructs, some suggested narrowing the conceptual bandwidth of the predictors and criteria, making them more relevant to each other (e.g., Paunonen, Rothstein, & Jackson, 1999), and others argued for the importance of context to the personality-performance association (e.g., Tett & Guterman, 2000). In addition, social skill plays a role in translating personality into performance (e.g., Hogan & Shelton, 1998).

The present study combines these theoretical approaches and prior research evidence to examine the relationship of openness to academic performance. Of the Five Factor Model (FFM) dimensions, openness to experience has the least known relationship with performance (Blickle, 1996; Penney, David, & Witt, 2011). However, some authors recently argued that openness is better represented by two aspects, rather than one factor (e.g., Connelly, Ones, & Chernyshenko, 2014). Our research assesses the interactive effects of a narrow aspect of openness to experience (i.e., learning approach) and social skill on academic performance in the context of scientific study in higher education. Moreover, we extend prior research by investigating the joint effects of self- and other-reported personality (i.e., learning approach and openness) on academic performance, as suggested by a recently developed model (i.e., McAbee, Connelly, & Oswald, 2014a); this joint factor of self- and other-reported personality is named the *Arena* factor (Luft & Ingham, 1955).

Learning Approach and Performance

As research has progressed on the FFM, scholars have connected these personality dimensions with performance, a construct involving the behaviors related to effectiveness, achievement, and success in a particular role (e.g., employee, student). Many of these studies

have focused on job and academic performance. Likely the least understood factor in relation to performance is openness to experience, as results show it to have the lowest levels correlations with performance., even when corrected for measurement error and range restriction (Barrick et al., 2001, p. 13).Individuals high on openness are described as intellectual, cultured, and imaginative.

Meta-analytic research has found that those high on openness have a greater tendency to be scientists (d = .11; Feist, 1998), and, of the FFM traits, it is the most consistently related to scientific interest (r = .26; Feist, 2012). Moreover, prior research found that the intellectual dimensions of openness related to being a scientist (Barton, Modgil, & Cattell, 1973) and to scientific creative accomplishments Kaufman, 2013)[i]. Also, a recent study found that openness was the strongest personality correlate of scientific creativity, as measured via journal publications (β = .21; Grosul & Feist, 2014). Given the connection between openness and science, it seems clear that openness is related to performance in a scientific environment.

Additionally, some studies have examined the relevance of openness to a learning context, including both work and academic environments. For example, among outcomes examined in their meta-analysis, Barrick et al. (2001) found openness to have its strongest relationship with training performance (r = .14). Also, openness consistently has been related to investigative interests (Connelly et al., 2014), and numerous studies have associated openness with academic performance (e.g., Connelly & Ones, 2010; Furnham, Rinaldelli-Tabaton, & Chamorro-Premuzic, 2011; McAbee & Oswald, 2013; O'Connor & Paunonen, 2007; Poropat, 2009; Richardson, Abraham, & Bond, 2012). However, in many of these studies and across measures, the effect sizes of these relationships have been small. In sum, evidence suggests that openness could have a relationship with performance in scientific academic pursuits, although the weak effects suggest that a more refined (i.e., narrower personality trait) and/or conditional (moderated) analysis could increase the strength of the relationship.

In recent years, scholars have begun to suggest that the openness domain might be better represented by two dimensions rather than one factor (Connelly, Ones, & Chernyshenko, 2014; DeYoung, Quilty, & Peterson, 2007; Woo et al., 2014). Unlike the NEO Personality Inventory (NEO-PI-R; Costa & McCrae, 1992) items for openness, the *Hogan Personality Inventory* (HPI; Hogan & Hogan, 2007) items have strong loadings on their two dimensions of openness (Woo et al., 2014). The HPI labels one of these as *inquisitive* and the other *learning approach*, reflecting intellectual engagement (Chernyshenko, Stark, & Drasgow, 2011; Kaiser & Hogan, 2011). Individuals high on learning approach are strongly oriented to academic achievement (Hogan & Blickle, 2013), indicating an appreciation of formal education, an ease of memory recall, and an enjoyment of reading. Given its focus on the intellect, we believe learning approach should have a greater relevance within the higher education environment.

Much like Barrick et al.'s (2001) finding regarding openness, Hogan and Holland's (2003) meta-analysis found learning approach to be associated with training-related performance criteria. Further, they suggested that with more aligned outcomes (e.g., continuous learning criteria), associations with learning approach should be improved. However, although aligning predictors and criteria improved validities, Hogan and Holland's meta-analytic results concerning learning approach still left over 66% of the variance unexplained.

How Personality Theoretically Relates to Performance

Much variance has remained unexplained in even the strongest of FFM and performance relationships. Consequently, scholars take different approaches to better account for these relationships. First, socioanalytic theory (Hogan & Blickle, 2013; Hogan & Shelton, 1998) contends that social skill transforms personality into performance. In support, studies found social skill constructs (e.g., political skill) to interact with personality in performance prediction (e.g., Blickle et al., 2008; Blickle et al., 2013; Witt & Ferris, 2003).

Second, researchers argue that traits narrower than FFM dimensions yield greater explanatory value (Murphy & Dzieweczynski, 2005). In many studies, openness demonstrated small or non-significant relationships with performance-related outcomes, which suggests that different characteristics of openness could have differential relationships with performance (Neal, Yeo, Koy, & Xiao, 2012).

Finally, some scholars argue that personality traits are only expressed in relevant situations (Tett & Burnett, 2003; Tett & Guterman, 2000), and, in relation to performance, research has supported these arguments (e.g., Blickle et al., 2013; Kell, Rittmayer, Crook, & Motowidlo, 2010). Also, the relationship between personality and interest in science depends on discipline type (Feist, 2006), which could imply a change in personality's relationship with academic performance in science. Meta-analyses have demonstrated that openness was only sometimes positively associated with academic achievement, and that it had a weak correlation of .08 with GPA (McAbee & Oswald, 2013; O'Connor & Paunonen, 2007). These findings suggest that there are likely situational moderators in the openness - academic performance relationship.

Consequently, taking into account each of these three theoretical perspectives, we narrow both the predictor and criterion to match their bandwidth (Murphy & Dzieweczynski, 2005), especially since a consistent and criterion-matched frame of reference has been specifically recommended for openness (Pace & Brannick, 2010). We also place our predictors and criterion in a context relevant to each (i.e., scientific study). And finally, we take a socioanalytic approach (Hogan & Shelton, 1998), interactively combining learning approach with social skill in the prediction of academic performance in science, as explained below.

The Interaction of Learning Approach and Social Skill in Context

Research has shown social skill to be related to academic performance (e.g., $\beta = .46$, Seyfried, 1998; Henricsson & Rydell, 2006). Specific to our context, a scientist's number of

social ties has been related to creativity (i.e., Perry-Smith, 2006; Zhou, Shin, Brass, Choi, & Zhang, 2009). It could be that the new and potentially diverse information received from being socially skilled yields increased creativity (Perry-Smith & Shalley, 2003). In relation to openness to experience, research has associated it with social skill-related behaviors. Both openness and social politicking are similarly focused on information-seeking (Coleman, 1988; Wolff & Kim, 2012). Much like those high on openness generate ideas (Ashton & Lee, 2001), the socially skilled are better capable of sharing resources, such as ideas (Burt, 2004), information (Granovetter, 1973), and instrumental support (Blickle, Witzki, & Schneider, 2009). Also, openness has been positively related to developing new acquaintances (Cuperman & Ickes, 2009) and to internal and external social politicking via building, maintaining, and using social contacts (Wolf & Kim, 2012). For instance, Anderson (2008) found that managers high on need for cognition, conceptually similar to openness, benefitted from increased socializing.

However, we located only two published studies that investigated an interaction of openness with social skill (i.e., as measured via political skill) on performance, and both of these tended not to support the openness-social skill-performance relationship. Blickle, Wendel, and Ferris (2010) did not find an interaction of openness and political skill, but suggested this could be because openness is better measured as two dimensions. Further, another study found a three-way interaction of conscientiousness, learning approach, and political skill on job performance (i.e., Blickle et al., 2013), but did not demonstrate an interaction between openness and political skill. For both of these studies, however, the non-significant findings could be because the context of each of these studies did not elicit the expression of the openness trait when interactively combined with social skill (Hogan & Shelton, 1998; Tett & Burnett, 2003).

In summary, few studies have considered the joint impact of openness and social skill on performance, and no studies have narrowed the interactive predictors and criterion, and

placed them in a relevant context. Thus, based on socioanalytic theory (Hogan & Shelton, 1998), we suggest that those high on social skill will translate their openness personality traits (i.e., learning approach) into academic performance observed and evaluated positively by others. However, those not high on social skill will not improve academic performance through heightened learning approach. Further, we contend the narrower bandwidth personality construct of learning approach will demonstrate stronger relationships than that of the dimension of openness to experience.

To specify our hypotheses, we use the statistical concepts of mediation and moderation (Hayes, 2013). *Mediation* is when two variables are linked by a third variable, and *moderation* indicates that the relationship between two variables depends on a third variable, which affects the direction and strength of the relationship between these two variables.

Hypothesis 1. Other-ratings of learning approach will positively mediate the effect of self-ratings of learning approach on academic performance. Social skill will moderate the relationships between self- and other-ratings of learning approach and between other-rated learning approach and academic performance, such that these positive relationships will become stronger under heightened social skill. Thus, moderated mediation is expected to occur.

Hypothesis 2. The moderated mediation of learning approach on academic performance will be stronger than the moderated mediation of openness on academic performance, as moderated by social skill.

Moreover, scholars recently have begun to argue that analyses of the effect of personality on behavior move past the traditional approach of convergence across self- and other-reports of personality to consider, instead, the unique information supplied by each (e.g., Connelly & Ones, 2010; Oh, Wang, & Mount, 2011; Vazire, 2010). In response to these calls, some have used the Johari window (Luft & Ingham, 1955) to model the awareness that the self and others have of the self's traits (e.g., McAbee et al., 2014a; Vazire, 2010). McAbee

and colleagues (2014a) provided a structural equation framework for assessing the joint factor from both self- and other-reported personality on a trait (i.e., the *Arena* factor).

In relation to openness, its internal focus makes it one of the two least perceptible personality traits of the FFM (Connelly & Ones, 2010; Zillig, Hemenover, & Dienstbier, 2002). Moreover, given our prior suggestion that the use of traits narrower than dimensions provide more explanatory value (Murphy & Dzieweczynski, 2005; Paunonen et al., 1999), our third assertion is that the Arena factor effect of learning approach will be stronger than the Arena factor effect of openness. In other words, when self- and other-ratings of learning approach are combined (i.e., Arena factor), academic performance will be more accurately predicted than by the combination (i.e., Arena factor) of self- and other-ratings of openness.

Hypothesis 3. The positive effect of the Arena-factor of learning approach on academic performance will be stronger than the positive effect of the Arena-factor of openness on academic performance.

Studying scientific subjects within a university setting poses complex cognitive demands and requires continuous learning. Therefore, in order to align our personality construct (i.e., learning approach) with the context of our study (Tett & Burnett, 2003), we sampled university students enrolled in scientific fields of study such as agriculture, biochemistry, biology, chemistry, computer science, geology, mathematics, medicine, pharmacy, physics, and other related subjects. One year after the first assessment, we invited the targets to provide information about their current academic performance.

The variance approach taken by our study examines the antecedents and consequences of a specific relationship (i.e., regression method). As Van de Ven and Huber (1990, p. 213) argued, the variance study specifies the identification of "input factors (independent variables) that statistically explain variations in some outcome criteria (dependent variables)." In addition, Podsakoff, McKenzie, Lee, and Podsakoff (2003) recommend the assessment of predictors and criterion at two different measurement occasions to reduce potential biases in

the response process (i.e., easier retrieval of information and avoidance of using previous answers). Therefore, to reduce the chance for common source and common method bias, we chose a separate time point for our criterion.

Method

Participants and procedure

Students were recruited through personal contact during lectures in western Germany universities, and through websites of natural science student groups at various German universities. They were informed about the purpose of the investigation and the necessity of a fellow student as rater for a short evaluation of the targets. Each person could only participate as either target or rater, and no one could participate twice. Further, target students and raters had to know each other at the university for at least 18 months. To stimulate participation, a lottery for 20 gift coupons of a popular online store was conducted.

Consequently, 346 students received an e-mail invitation, which included a personal code and a link to an online questionnaire. Targets could invite a fellow student via e-mail in the online questionnaire. The invitee was automatically invited to participate as a rater. The invitation requested that ratings be completed as soon as possible. Thus, all fellow student ratings were completed at the first measurement (t1), before assessing the grades. We were able to associate the different sets of target and rater by using an identical code for those who formed a specific target-rater set. One year after the initial invitation, we invited the targets via email to a second online questionnaire to provide information about their current academic performance. At that time, another lottery for 10 gift coupons was conducted. Of the targets initially contacted by e-mail, 154, constituting a 44.5% response rate, provided self-reports of personality at t1 and met the study criteria. Of those, 130 (84.4%) targets took part in the second online questionnaire (t2) and, therefore, provided complete data. Finally, 116 students (75.3%) had also been rated on personality by a fellow student at t1.

The sample consisted of 76 (65.5%) female and 40 (34.5%) male students. Ages ranged from 17 to 32 years (M = 22.77, SD = 2.20 years). Fifty-three (45.6%) took part in a bachelor's degree program, 11 (9.5%) in a master's degree program, 2 (1.8%) in a diploma program, and 50 (43.1%) in a state examination program. At t1, targets had been, on average, studying at university for 5.66 semesters (SD = 1.80) and reported spending 37.93 hours a week for their studies (SD = 17.89). The raters and targets knew each other for an average of 2.74 years (SD = 1.93). At the second measurement occasion (t2), 58 targets (50.0%) had already finished their academic program. Of those, 45 (38.8%) finished a bachelor program, 1 (0.9%) completed a diploma program, and 10 (8.6%) finished a state examination program. Fifty-six targets (48.2%) were continuing the same study programs as in t1. Two targets (1.7%) had changed the subject of their program, but were still in similar scientific program, so these targets were kept in our sample.

Measures

Learning approach. The NEO Personality Inventory (Costa & McCrae, 1992) facet items of openness do not have strong loadings on the learning approach (i.e., Intellect) aspect of openness, but the Hogan Personality Inventory (HPI; Hogan & Hogan, 2007) items do (see Woo et al., 2014). Therefore, we chose to use the IPIP equivalent (Goldberg, 1999) of the HPI Scale Learning approach / School success (Hogan & Hogan, 1992) to assess learning approach and the NEO-FFI (Costa & McCrae, 1992) to measure the openness factor. The equivalence of the IPIP and HPI scales has been established by high correlations between the two (Learning approach: r = .64; overall HPI: r = .70). Prior research has shown that the HPI Learning Approach Scale has convergent validity with cognitive ability tests (General Aptitude Test Battery, r = .30, p < .01) and with other personality inventories (Hogan & Hogan, 2007). It correlates with the Reasoning subscale of the 16-PF (r = .38, p < .01), the Intellectual Efficiency subscale of the California Personality Inventory (r = .48, p < .01), and the Complexity subscale of the Jackson Personality Inventory (r = .30, p < .01) (Hogan &

Hogan, 2007). Learning Approach also correlates with the Investigative dimension (r = .34, p < .01) of Holland's (1997) occupational characteristics and job demands.

The Learning Approach Scale consists of ten items on a five-point Likert-type scale, ranging from 1 (*Very inaccurate)* to 5 (*Very accurate).* The German version of the scale has been validated in a previous study (Blickle et al., 2013). Sample items are "*I can handle a lot of information*" and "*I have a rich vocabulary*". In the present study, the Cronbach's alpha internal consistency reliability estimate was .76. For the personality rating of learning approach by fellow students, we used the same items from the third-person perspective (e.g. "*He/She can handle a lot of information*"). For the learning approach peer rating, Cronbach's alpha internal reliability estimate was .77.

Openness to experience. We measured openness to experience (self- and peer-ratings) by using the German version (Borkenau & Ostendorf, 1993) of the NEO-FFI (Costa & McCrae, 1992). The scale comprises of 12 items, answered on a 5-point Likert-type scale from 1 (*Very inaccurate)* to 5 (*Very accurate)*. Cronbach's alpha internal consistency for self-ratings in the present study was .71. For the personality rating of openness to experience by fellow students, we used the same items from the third-person-perspective. Other-ratings of openness were also conducted at t1. Cronbach's alpha internal consistency for peer-ratings in the present study was .65.

Social skill. We used the Social Skills facet (Nowack & Kammer, 1987) of the Self-Monitoring Scale (Snyder, 1974) to assess targets' social skill. This scale assesses the ability to adaptively and adequately present oneself in social interactions. Prior research has shown that social skill explains more variance in personality and performance ratings than the overall self-monitoring construct (Scholz & Schuler, 1993). It correlates positively with personality traits related to well-being and negatively with social anxiety and neuroticism (Nowack & Kammer, 1987). The construct validity of the Social Skill Scale was tested and supported in a study by Wolf, Spinath, Riemann, and Angleitner (2009). In an additional multi-source, multi-

method validation study, we tested the relationship of the Social Skill scale with an objective test of 203 targets' emotion recognition ability from faces and voices (Momm, Blickle, Liu, Wihler, Kholin, & Menges, 2015) and with two peer-ratings for each target of targets' social astuteness and interpersonal influence (Wihler, Blickle, Ellen, Hochwarter, & Ferris, 2014). Emotion recognition ability from faces (r (202) = .19, $p < .01$) and voices (r (202) = .21, $p < .01$), peer-ratings of social astuteness (r (202) = .20, $p < .01$), and peer-ratings of interpersonal influence (r (202) = .18, $p < .05$) positively associated with the Social Skill facet of self-monitoring, additionally supporting its validity. The Social Skill Scale consists of nine true-false-items. Sample items are: "*I would probably make a good actor*", "*I have considered being an entertainer*", and "*I can make impromptu speeches even on topics which I have almost no information*". Cronbach's alpha was .70.

Academic performance. To assess academic performance, we asked target participants one year after having provided personality self-assessments to report their grades (see Appendix). Previous American (Kirk & Sereda, 1969, $.93 \leq r \leq 1$) and German (Dickhäuser & Plenter, 2005, $.88 \leq r \leq .90$) studies have found that self-reported grades and grades from an objective source highly correlate. Specifically for college grade point average, Kuncel, Credé, and Thomas (2005), based on a meta-analysis, reported an average mean observed correlation of $r = .90$. These findings underscore the validity of self-reported grade data.

Of the targets who finished their program at t2, we assessed the grade point average (GPA) of their final degree. For those who were still studying in their program at t2, we asked for their current GPA (mean grade of completed exams). We also asked for the grade of their last exam, because we anticipated that not everyone knew their current GPA. In total, we assessed the final GPA of 66 targets (56.9%), the current GPA of 45 targets (38.8%), and the exam grades of 5 targets (4.3%). Grades cannot be easily compared among different study subjects, because subjects differ in the mean computation of their GPA. Therefore, we

standardized each grade with the mean GPA and standard deviation of the respective study subject, degree, and university for 94 targets (81.0%). We took this information from the latest broad report about GPA in different subject programs in Germany (Wissenschaftsrat, 2012).We scored the grades so that higher scores indicate better grades.

Control variables. We controlled for *gender* and *age* of the target students because these variables have been shown to be related to academic performance (Richardson, Abraham, & Bond, 2012). Additionally, to assess the targets' *study effort*, we asked students to report hours studied per week, because effort as a proxy for conscientiousness is associated with grades (Connelly & Ones, 2010).

We also asked targets to assess their *study performance demands* based on items adapted from Hogan and Holland (2003), e.g. capitalize on training, correctly analyze problems, exhibit technical skill, and possess subject knowledge. Therefore, using eight items, we asked targets to rate the importance of these performance demands for success in their studies (Tett, Simonet, Walser, & Brown, 2013). Items were presented on a five-point Likert-scale ranging from 1 (*Not at all important)* to 5 (*Very important)*; Cronbach's alpha was .88. Finally, we controlled for the *type of grade* (i.e., final GPA, current GPA, exam grades) targets reported. We built two effect-coded variables (Hardy, 1993), with final GPA as reference variable, namely *Exam Grade vs. Final GPA* and *Current vs. Final GPA.*

Data analyses

To test Hypothesis 1 and 2, we conducted multiple hierarchical regression analyses (Cohen, Cohen, West & Aiken, 2003) either with peer-rated learning approach /openness (mediator) or grades as dependent variables. In order to test the moderation by social skill, we followed Edwards and Lambert's (2007) general path analytic framework (see also Zhang, Kwan, Zhang & Wu, 2012). We tested for all three possible interaction effects (i.e., first-stage, second-stage, and direct moderation). Thus, if we find moderated mediation and no direct moderation, as hypothesized, we can exclude direct moderation from the explanation of

the results. The study variables were normally distributed, and, thus, our data met necessary assumptions for the analyses conducted.

In Step 1, peer-rated learning approach served as the dependent variable. We entered self-rated learning approach, social skill, and the self-rated learning approach x social skill interaction. Based on Cortina (1993) we further controlled for quadratic effects because learning approach and social skill were not completely statistically independent, but correlated at r =.38 (p < .001, Table 1). We also added the control variables gender, age, study effort, and performance demands. In Step 2, we used peer-rated openness as the dependent variable. We entered self-rated openness, social skill, and the self-rated openness x social skill interaction, and we also controlled for gender, age, study effort, performance demands, quadratic effects, and type of grade.

In Steps 3 and 4, grades served as the dependent variable. In Step 3, we entered self-rated and peer-rated learning approach, social skill, the self-rated learning approach x social skill interaction, the peer-rated learning approach x social skill interaction, quadratic effects, type of grade, and control variables. In Step 4, we entered self-rated and peer-rated openness, social skill, the self-rated openness x social skill interaction, the peer-rated openness x social skill interaction, quadratic effects, type of grade, and control variables.

To avoid multicollinearity, predictors and moderators were mean centered prior to analysis in all models (Cohen et al., 2003). In order to test the moderated mediation hypothesis, we calculated the conditional indirect effects of self-ratings of learning approach /openness on grades via peer-ratings at one standard deviation above and below the mean of social skills with PROCESS (Hayes, 2013).

Hypothesis 1 would be confirmed if the indirect effects for learning approach are positive and the corresponding confidence intervals do not include zero – which would confirm mediation, but only for high and medium social skill, and indicates moderated mediation. There should be either a significant, positive effect of the self-rated learning

approach x social skill in Step 1 and/or a significant, positive effect of the peer-rated learning approach x social skill in Step 3. We did not expect to find a direct interaction of self-rated learning approach x social skill on performance in Step 2.

Hypothesis 2 would be confirmed if the indirect effects for learning approach are positive and significant, and the indirect effects for openness are non-significant. It is also necessary for the first and/or second stage interaction for Step 1 and 3 to be positive and significant and for these effects to be non-significant for the openness Step 2 and 4.

To test Hypothesis 3, we conducted structural equations modeling (SEM) analyses using the SEM model suggested by McAbee et al. (2014a). The model uses three uncorrelated latent predictors built on the trait self- and other-ratings and a manifest dependent variable. Additionally, we used the same manifest control variables as employed in the previous moderated mediation analyses in this paper. We used maximum-likelihood estimates with Mplus 7 (Muthén & Muthén, 2012). We had not used SEM to test Hypotheses 1 and 2, because Mplus cannot calculate goodness of fit-indices for moderated mediation analyses with latent predictors (Muthén & Muthén, 2012).

In order to directly compare learning approach and openness, we tested one model. For both learning approach and openness, we built three latent factors as predictors, namely Arena (i.e., joint personality information between self- and other-ratings), Façade (i.e., self-ratings beyond the Arena factor), and Blind-spot (i.e., other -ratings beyond the Arena factor). The correlations between all latent predictors in the McAbee et al. (2014a) model were set to zero. The Façade-factor consisted of three parcels (Moshagen, 2012), each containing one third of the items of self-rated learning approach or openness. The items were split on the basis of their order in the questionnaire. The Blind-spot-factor was equivalently built with three parcels of the peer-rated learning approach / openness items. The Arena-factor contained all six parcels (self-ratings and peer-ratings). Correlations between the different factors (Blind-spot, Façade, and Arena) were all set to zero. However, we allowed correlations between

corresponding factors of openness and learning approach (e.g. Arena-learning approach and Arena-openness). This kind of SEM model is called a bifactor model: “A bifactor structural model specifies that the covariance among a set of item responses can be accounted for by a single general factor that reflects the common variance running among all scale items, and group factors that reflect additional common variance among clusters of items, typically, with highly similar content.” (Reise, 2012, p. 667).

We set the residual variance for three parcels to zero to avoid Heywood cases (Heywood, 1931). Apart from the effects of the three latent factors on grades, we additionally controlled for gender, age, study effort, performance demands, and the two effect-coded variables for type of grade.

Following the procedure by McAbee, Oswald, and Connelly (2014b), the bifactor model was further compared to an alternative higher-order SEM model. Therefore, we built a factor for self-ratings and a second factor for peer-ratings for both learning approach and openness, with the same parcels as in the bifactor model. Then, each of those two factors together comprised a higher-order factor, which was used to predict student GPA. According to McAbee et al. (2014b), higher-order models can be seen as a less constrained version of bifactor models. We compared the model fit of the bifactor model with the higher-order model using the χ^2 difference test (Yun, Thissen & McLeod, 1999).

Hypothesis 3 would be confirmed if the effect of the Arena-factor of self- and other-ratings of learning approach on grades is significant and positive, and the effect of the Arena-factor of self- and other-ratings of openness on grades is non-significant. Also, a significantly better statistical fit for the bifactor model than the higher-order-factor model would support the use of the bifactor model of personality as appropriate measurement for reputation.

Results

Table 1 shows the means, standard deviations, correlations, and internal reliability estimates of the variables. As expected, targets generally rated the performance demands as

important (*M* = 4.23, *SD* = .53). Self- and peer-rated learning approach correlated positively, as well as self- and peer-rated openness . Social skill associated with self-rated learning approach , self-rated openness , and peer-rated openness , but not with peer-rated learning approach. Grades marginally correlated with self-rated (*r* = .17, *p* = .073) and positively with peer-rated learning approach , but not with self- or peer-rated openness. Control variables were not associated with any study variables apart from performance demands, which correlated positively with self-rated learning approach.

Table 2 shows the regression analyses with self-rated learning approach as predictor, and either peer-rated learning approach or grades as dependent variable (Step 1 and 3). In Step 1, there was a significant and positive effect of self-rated learning approach on peer-rated learning approach. But, there was no significant effect of the first-stage self-rated learning approach x social skill interaction (β = -.08, *p* = .489). In Step 3, there was a significant and positive effect of the second-stage peer-rated learning approach x social skill interaction , but no effect by the direct interaction of self-rated learning approach x social skill (β = -.13, *p* = .318). Further, there was an effect of the effect-coded control variables for both exam grades and current GPA.

Hypothesis 1 predicted that there is a positive mediation of self-ratings of learning approach on grades via other-ratings of learning approach moderated by social skill. The conditional indirect effect of self-rated learning approach on grades for low social skill values was -.03 (*SE* = .15; $CI_{99\%}$ based on 1000 bootstrap samples = [-.37; .23]), the conditional indirect effect for medium social skill was .20 (*SE* = .10; $CI_{99\%}$ based on 1000 bootstrap samples = [.02; .44]), and for high social skill was .36 (*SE* = .20; $CI_{99\%}$ based on 1000 bootstrap samples = [.07; .95]). Thus, these results support Hypothesis 1.

Figure 1 shows the plot of the significant peer-rated learning approach x social skill interaction in Step 3, with levels of peer-rated learning approach plotted at one standard deviation below the mean, at the mean, and at one standard deviation above the mean (Cohen

et al., 2003). For high social skill, higher levels of peer-rated learning approach (i.e., 1 *SD* above mean) were positively associated with grades (β = .43, *p* = .006). When social skill was medium, higher levels of peer-rated learning approach were also positively associated with grades (β = .21, *p* = .062), but to a flatter gradient. When social skill was low, increases in peer-rated learning approach resulted in a non-significant relationship with grades (β = -.02, *p* = .888) Thus, Hypothesis 1 was confirmed by our results.

The regression analyses with self-rated openness as predictor and either peer-rated openness or grades as dependent variable are shown in Table 2, Step 2 and 4. In Step 2, there was a significant and positive effect of self-rated openness on peer-rated openness (β = .56, *p* < .001). There was no significant effect of the first-stage self-rated openness x social skill interaction in Model 2 (β = .02, *p* = .867). In Step 4, we also found an effect of the effect-coded control variables for type of grade (β = .43, *p* = .029 for exam grades and β = -.45, *p* = .016 for current GPA). However, none of the other control variables, predictors, and interactions had a significant effect on grades.

Hypothesis 2 predicted that the moderated mediation of learning approach on grades is stronger than the mediation of self-rating of openness on grades via other-ratings of openness moderated by social skill. The conditional indirect effect of self-rated openness on grades for low social skill was .33 (*SE* = .17 $CI_{99\%}$ based on 1000 bootstrap samples = [-.025; .94]), the conditional indirect effect for medium social skill was .12 (*SE* = .11; $CI_{99\%}$ based on 1000 bootstrap samples = [-.17; .48]), and for high social skill was -.12 (*SE* = .21; $CI_{99\%}$ based on 1000 bootstrap samples = [-.10; .41]). All confidence intervals included zero, thus supporting Hypothesis 2.

Hypothesis 3 predicted that the positive effect of the Arena-factor of learning approach on grades is stronger than the positive effect of the Arena-factor of openness on grades. Figure 2 shows the model fit statistics and standardized path estimates for the bifactor model. The model had good model fit indices ($X^2_{(120)}$ = 163.72, *p* = .005; *CFI* = .913; *RMSEA* = .056;

SRMR = .079) and explained 51% of the variance in grades. There was a positive and significant standardized path estimate for the Learning Approach Arena-Factor (β = .59, *p* = .002), but not for Learning Approach Façade (β = -.16, *p* = .324) Learning Approach Blind-Spot (β = -.27, *p* = .206), Openness Arena-Factor (β = -.24, *p* = .053), Openness Façade (β = -.06, *p* = .587), and Openness Blind-Spot (β = .21, *p* = .248). Thus, the results provide support for Hypothesis 3.

The higher-order model of learning approach did not show satisfactory model fit indices ($X^2_{(89)}$ = 305.99, *p* <.001; *CFI* = .554; *RMSEA* = .145; *SRMR* = .136). The difference to the X^2 value of the bifactor model was statistically significant (*p* < .001). Thus, the bifactor model showed better model fit indices than the less constrained higher-order model.

Discussion

The findings fully confirmed our hypotheses: Both the zero-order correlation and the regression results found learning approach, but not openness, to be positively related to academic performance. Moreover, our results demonstrated an interaction between learning approach, but not openness, and social skill on grades in the academic science context. At one standard deviation above the mean of social skill, learning approach predicted 18% of the variance in grades compared to 7% by zero-order bivariate other-rated learning approach. Specifically, the findings indicated both that the effect of self-ratings of learning approach on academic performance was positively mediated by peer-ratings of learning approach and that social skill moderated this mediation, particularly the association between peer-rated learning approach and academic performance.

The stronger effects of peer-rated learning approach in contrast to self-ratings of learning approach could stem from a clearer, more behaviorally-related view by observers, in contrast to self-raters. Other-ratings of an individual's personality trait "rely on that individual's actions along with trace artifacts of those actions (e.g. a highly organized desk, word of mouth, and so on)" (Kluemper, Larty, & Bing, 2015, p. 238). Thus, in our study, for

those with peer-ratings of high learning approach, having heightened or even average, but not low, social skill was associated with increased academic performance one year later in scientific fields of study. Lastly, when examining the joint effect of trait self- and other-ratings (i.e., the Arena factor, McAbee et al., 2014) on academic performance, the learning approach Arena factor explained 35% of variance in grades, thus, demonstrating a much stronger positive effect than that of openness (R^2 = .06). In conclusion, as previous studies have suggested, learning approach, a narrow aspect of openness to experience, is a much stronger predictor of (academic) performance.

Following the guidance of scholars (e.g., Paunonen et al., 1999), we narrowed our predictors and criterion, and placed them in a context relevant to each. In addition, taking a socioanalytic (Hogan & Shelton, 1998) approach, we interactively paired learning approach with social skill in the prediction of performance. Finally, we combined trait self- and other-ratings in the prediction of performance as suggested by McAbee et al. (2014). Our study contributes to these growing bodies of literature regarding the personality – performance relationship by demonstrating an association with one-year-later academic performance. Moreover, our findings regarding the Arena factor (i.e., joint personality information between self- and other-ratings) of learning approach supports the importance of personality reputation, as individuals' self-knowledge of this intellectual aspect of openness was related to other-perceptions of the focal individual, even after controlling for other factors (i.e., age, gender, study effort, performance demands, and type of grade), and reputation was related to performance. Also, many scholars (e.g., Penney et al., 2011) have noted that we still know little about openness to experience. Our study augments literature suggesting a two-aspect approach to openness and it links one of these aspects to academic performance, particularly when paired with a social skill construct in the presence of scientific academic study.

The findings not only have relevance for personality and socioanalytic theories, but, in practice, they can assist in promoting careers among graduates in STEM (science, technology,

engineering, and mathematics) subjects. Reputation among one's peers contributes to marketability and career success (Blickle et al., 2011). Teaching students how to create a positive reputation of performance will not only yield beneficial social relationships, but, when combined with social skill, will improve performance and long-term career trajectory.

Strengths, Limitations, and Future Research

A strength of our study is the use of objective academic performance (i.e., grades) collected one year later, at a separate time point from our predictor variables. Additionally, we controlled for the effects of gender, age, study effort, performance demands, and type of grade on our outcomes, providing a more rigorous test of our hypotheses. Finally, narrowing the predictors, criterion, and context of our study provided greater explanatory value to our results (Schneider, Hough, & Dunnette, 1996). One limitation is that we collected our data from students in Germany. Thus, the generalizability to students in scientific disciplines in other cultural contexts is uncertain. Also, although our outcome variable was collected one year after our predictor variables, we cannot make conclusions about causality. Future research could better address the cause-and-effect relationships among our variables of interest using a cross-lagged panel design. Lastly, given the academic science focus of our research, it could be that the main effect of learning approach on academic performance is partly the result of the increased scientific interest (Feist, 1998) and creativity (Grosul & Feist, 2014) of those high on openness, but we were unable to test this possibility. Another limitation might be the use of the IPIP measure of learning approach. Although widely used, IPIP measures are rarely validated against the original measure due to copyright protection (Goldberg, 1999). Thus, studies could use the HPI measure of learning approach to further test these relationships.

Although social skill did not moderate the relationship between self-rated and other-rated personality in our study, it did influence the relationship between reputation (i.e., other-rated personality) and academic performance. Thus, future research could examine whether social skill's moderation figures into the personality - outcomes relationship between one's

reputation (e.g., other-rated personality) and the outcomes achieved (e.g., academic performance), as evidenced in our study, or if social skill moderates the relationship between self- and other-rated personality, as some have suggested (Hogan & Holland, 2003). Also, either or both of these could be the case, depending on the context and outcome(s) of a study. Moreover, scholars could examine whether constructs other than social skill (e.g., a second personality trait) moderate the relationship between self-rated and other-rated personality.

The results of one study (i.e., Hwang, Kessler, & Francesco, 2004) indicated that student vertical networking (i.e., with teachers) was a better predictor of academic performance than student horizontal networking (i.e., with peers). Similarly, future research could examine the differential moderation by social skill of the peer-rated vs. teacher-rated personality - performance relationship. In addition, studies can utilize measures of social skill aside from the one used in the present study (see Wihler et al., 2015). We compared the NEO-FFI Openness factor with the HPI learning approach facet. Future studies could test these relationships using HPI-Openness instead of the NEO-FFI factor. Lastly, future studies could longitudinally track the development of scientific interest and subsequent academic and career performance to test the mechanisms link learning approach to long-term scientific output.

Conclusion

Our aim was to bring improved understanding to the relationship between openness and performance through the narrowing of personality, the activation of personality through a relevant contextualization in an academic performance setting, the use of social skill, and the combination of trait self- and other-ratings. We found that the academic performance of those in scientific disciplines was heightened at increased levels of the intellectual aspect of openness (i.e., learning approach) and social skill, and that the combined self- and other-ratings of learning approach were a strong predictor of academic performance. We believe future studies should consider taking a similar approach when relating personality to performance outcomes.

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Table 1

Means, standard deviations, coefficient α reliabilities, and correlation of variables

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1 Gender	1.34	.48	(−)											
2 Age	22.77	2.20	.07	(−)										
3 Study effort	37.93	17.89	.13	.01	(−)									
4 Performance demands	4.23	.53	-.05	-.01	.11	(.88)								
5 Exam vs. Final GPA	-.53	.58	-.19*	.03	-.08	.23*	(−)							
6 Current vs. Final GPA	-.18	.97	-.13	.03	-.09	.13	.85**	(−)						
7 Learning approach (SR)[a]	3.65	.57	.06	-.16	.03	.19**	.02	-.04	(.76)					
8 Learning approach (PR)[b]	3.96	.53	-.07	-.10	-.07	.07	.04	.01	.46**	(.77)				
9 NEO-FFI Openness (SR)[a]	3.64	.53	-.01	-.04	.12	.08	-.04	.01	.22*	.13	(.71)			
10 NEO-FFI Openness (PR)[b]	3.40	.48	-.01	-.05	-.01	.02	-.03	.02	.19*	.40**	.55**	(.65)		
11 Social skill	1.47	.25	.16	-.08	.09	-.02	.08	.08	.38**	.11	.21*	.23*	(.70)	
12 Academic Performance	.09	1.06	-.12	-.09	.01	-.01	.09	-.05	.17^{+}	.26**	-.10	.03	.07	(−)

Note. Gender: 1 = female, 2 = male. N = 116; Cronbach's alpha reliabilities are in the diagonal.
[a]SR = self-rating, [b]PR = peer-rating; $^{+}$ $p < .10$, * $p < .05$, ** $p < .01$.

Table 2

Moderated Mediation Model: Learning approach, NEO-FFI-Openness, Social skill, and Academic Performance

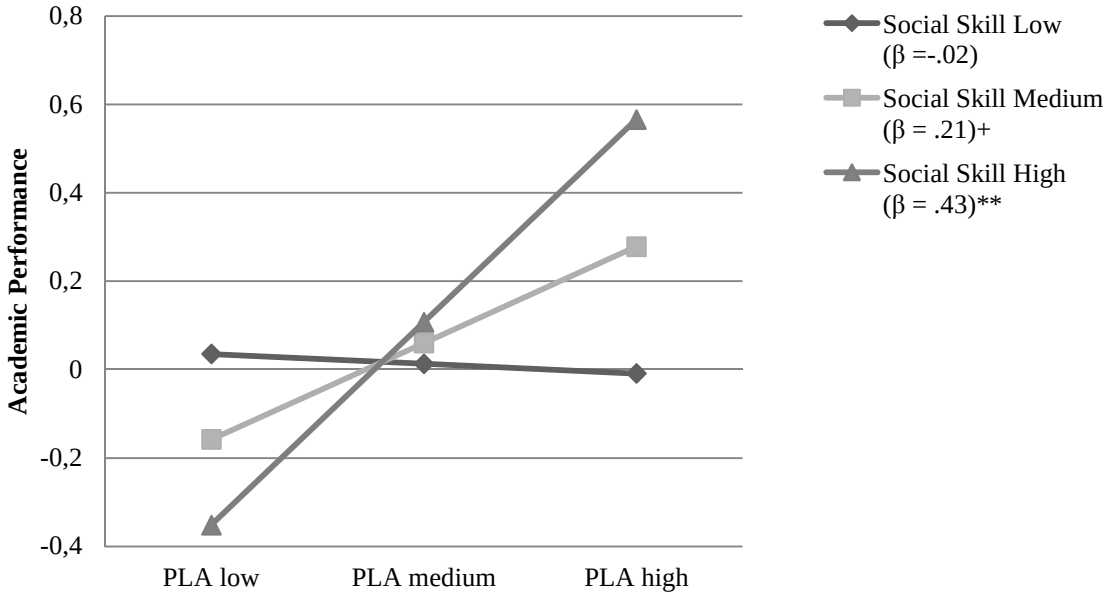
	Dependent Variables			
	Peer-rated Learning approach	***Peer-rated NEO-FFI-Openness***	***Academic Performance***	
	Step 1	Step 2	Step 3	Step 4
Predictors	β	β	β	β
Gender	-.09	.01	-.06	-.11
Age	.00	.00	-.07	-.07
Study effort	-.09	-.09	.02	.05
Performance demands	-.03	.00	-.07	-.04
Type of Grade: Exam Grade vs. Final GPA			.45*	.43*
Type of Grade: Current GPA vs. Final GPA			-.42*	-.45*
Social skill	-.06	.13	.04	.08
Social skill *x* Social skill	-.04	-.06	-.03	-.04
Self-rated Learning approach (SLA)	51***	.56***	.04	
Peer-rated Learning approach (PLA)			.21^{+}	
SLA *x* SLA	.16^{+}		-.03	
PLA *x* PLA			-.05	
SLA x Social skill	-.08		-.13	
PLA x Social skill			.23*	
Self-rated NEO-FFI-Openness (SNO)				-.13
Peer-rated NEO-FFI-Openness (PNO)				.19
SNO *x* SNO		.13		-.02
PNO *x* PNO				-.10
SNO x Social skill		.02		.12
PNO x Social skill				-.18
R^2	.25***	.34***	.19^{+}	.18

Note. $N = 116$;

$^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 1

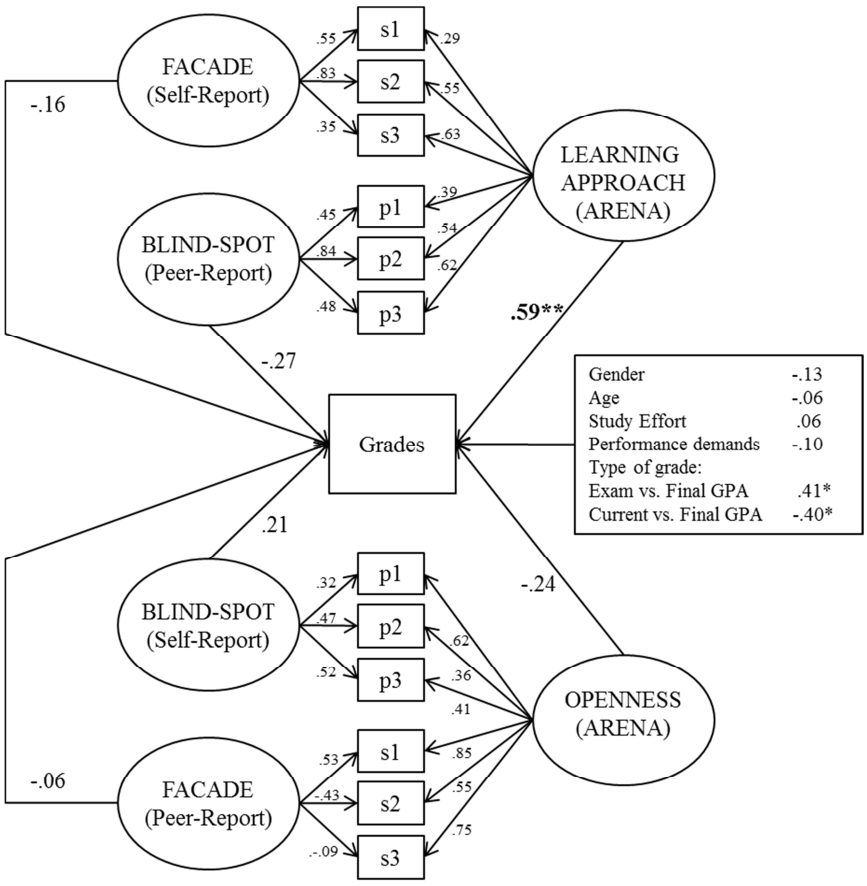
Interaction of peer-rated Learning approach (PLA) and Social Skill on Academic Performance



Note. N = 116; regression slope for medium and high Social Skill. $^{+}p < .10$, $*p < .05$ $^{**}p < .01$.

Figure 2

Standardized path estimates and mean factor loadings for the Bi-Factor-Model



Note. N = 116; Variance explained in Performance: R^2 = .51; factor-loadings above |.10| were significant; correlation between both Arena-factors: r = .26, p < .05, between both Blind-spot-factors: r = .47, p < .01, between both Façade-factors: r = .03, *ns.*; paths: * p < .05, ** p < .01.

Appendix

We standardized each grade with the mean GPA and standard deviation of the respective study subject and degree as you can see in Table 1. For 94 targets (81%) we were further able to standardize to the specific university, too. In those cases, in which we had no information about the target's university, we used the mean GPA for study subject and degree in Germany ('all German universities' in the table below). We took the information from the latest broad report about GPA in different subject programs in Germany (Wissenschaftsrat, 2012). We then centered the grades and scored them so that higher scores indicate better grades. *Original mean GPA for study subjects, degrees and universities in Germany.*

subject	university	mean GPA	SD
Agricultural science (B.Sc)	Bonn	2.10	0.5
Nutritional science (B.Sc)	Bonn	2.00	0.4
Nutritional science (M.Sc)	all German universities	2.00	0.4
Nutritional science (B.Sc)	all German universities	1.70	0.4
Geodesie (B.Sc.)	all German universities	2.60	0.5
Geography (B.Sc.)	Bonn	1.90	0.3
Medicine (state examination)	Bonn	2.30	0.6
	Bochum	2.30	0.6
	Munich	1.90	0.4
	all German universities	2.40	0.6
Dentistry (state examination)	Bonn	2.00	0.5
	Munich	1.90	0.4
Mathematics (B.Sc)	Bonn	1.80	0.5
	Freiburg	1.80	0.5
	all German universities	2.00	0.6
Nutritional chemistry (M.Sc)	all German universities	1.60	0.5
Chemistry (B.Sc)	Bonn	1.90	0.5
	all German universities	2.10	0.6
Meteorology(B.Sc.)	Bonn	2.20	0.6
Biology (B.sSc.)	Duesseldorf	2.20	0.5
	Cologne	2.00	0.6
Molecular life science (B.Sc.)	Bonn	1.80	0.4
	all German universities	1.30	0.2
Molecular life science (M.Sc.)	all German universities	1.50	0.4
Physics (B.Sc.)	Bonn	2.00	0.6
	Cologne	2.00	0.7
Physics (M.Sc.)	all German universities	1.70	0.5
Veterinary medicine (state examination)	Munich	2.20	0.5
Pharmacy (state examination)	Bonn	2.40	0.7
	all German universities	2.40	0.7
Geoscience (B.Sc.)	Bonn	2.00	0.5
Geoscience (MSc.)	Bonn	2.00	0.5
Aerospace engineering (diploma)	Stuttgart	2.00	0.5

Note. Grades in German universities vary from 1 (*Very good*) to 5 (*Unsatisfactory*).

[i] Based on Peterson and Brown (2005), here and below, we use zero-order correlations and standardized beta coefficients as effect-size estimates.