DISCUSSION PAPER SERIES

DP17241

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LABOUR ECONOMICS

ISSN 0265-8003

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Discussion Paper DP17241
Published 23 April 2022
Submitted 22 April 2022

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Abstract

Do the people around us influence our personality? To answer this question, we conduct an experiment with 543 university students who we randomly assign to study groups. Our results show that students become more similar to their peers along several dimensions. Students with more competitive peers become more competitive, students with more open-minded peers become more open-minded, and students with more conscientious peers become more conscientious. We see no significant effects of peers' extraversion, agreeableness, or neuroticism. To explain these results, we propose a simple model of personality development under the influence of peers. Consistent with the model's prediction, personality spillovers are concentrated in traits predictive of performance. Students adopt personality traits that are productive in the university context from their peers. Our findings highlight that socialization with peers can influence personality development.

JEL Classification: I21, I24, J24

Keywords: personality, malleability, peer effects, Experiment

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Acknowledgements
We received helpful comments from Jan Bietenbeck, Alexandra de Gendre, Bart Golsteyn, Jan Feld, Edwin Leuven, Nicolás Salamanca, and seminar participants at the CESifo Area Conference on Economics of Education and the University of Zurich. We thank Anna Valyogos, Matthew Bonci, and Timo Peer Haller for providing outstanding research assistance.

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1. Introduction

Humans are social beings, and peers are a key aspect of our social environment. The omnipresence of peers makes it easy to imagine that they influence who we are. This idea is captured by group socialization theory stating that our personality is formed through efforts of fitting into a group and competing with others (Harris, 1995). While peers are promising and seemingly obvious candidates for explaining personality development, causal evidence on their influence is absent. Surprisingly, the large literature on peer effects that is devoted to studying social spillovers has never directly investigated this question.

In this paper, we estimate how peers affect students' personality development. We conduct a field experiment with 543 undergraduate students who we randomly assign to small study groups of four students. In these groups, students solve problem sets, prepare tutorial sessions, discuss lectures, as well as meet for different social events. These interactions take place during the first months at university, a formative period in which students adjust to a new environment, make new friends, and form new habits. We measure students' Big Five personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism), which psychology considers the most important personality traits. We also measure students' competitiveness, which has recently emerged as an important predictor of education and labor market outcomes (Buser et al., 2021). We measure these six traits at the start of the course before students were assigned to their study groups (baseline). We then measure the same traits at the end of the course, just before their final exams (endline) and in a follow up survey one to three years after the end of the experiment (follow-up). We then estimate how the personality of randomly assigned peers measured at the baseline affects student personality at the endline and follow-up.

Our results show that students become more similar to their peers along several, but not all, dimensions. Being randomly assigned to peers who are one standard deviation (SD) more conscientious raises a student's own conscientiousness by 0.070 SD. Being assigned to peers who are one SD more competitive makes students 0.076 SD more competitive. These effects are long-lasting: peer spillovers for conscientiousness and competitiveness remain visible up to three years after the initial peer group assignment. We also see that being assigned to peers who are one SD more open to experiences raises a student's own openness by 0.061 SD in the short term, but this effect fades over time. We find no evidence that peer extraversion, agreeableness, or neuroticism affect students' own personality in the short or long term.

Are these results driven by the personality of peers or other characteristics correlated with peer personality? It is hard to make this distinction because peer personality cannot be independently randomized from other peer characteristics. From a policy perspective, this distinction is also less important. Knowing that exposure to conscientious peers increases students' conscientiousness is policy relevant, regardless of what drives these effects. In practice, we cannot assign students to more-conscientious peers without changing peer gender, achievement, and other unobserved peer characteristics correlated with conscientiousness. However, to be able to better place our findings in the academic literature, it is important to know whether peer personality is merely a proxy for other peer characteristics that have been shown to predict students' outcomes. We therefore test whether controlling for peer gender, achievement, and a large set of other peer characteristics affects our results. It does not. Having peers with different personalities generates distinct social spillovers.

We find suggestive evidence that peer personality also affects students' university performance. Having peers who are one SD more conscientious increases students' probability of passing the course by 3.4 percentage points. This result is only marginally significant but consistent with Golsteyn et al. (2021), who find that peer persistence—a facet of conscientiousness—raises students' performance. Having peers who are one SD more competitive also increases course performance by 0.04 SD. This effect is in line with descriptive evidence by Buser et al. (2014, 2021), who show that more-competitive students do better in school. These peer effects on performance may be driven by changes in students' own personality or through other spillovers from peers who are more conscientious and more competitive. While we cannot distinguish between these mechanisms, our key finding is that peers not only affect personality, but also "hard" academic outcomes associated with these traits.

Our results raise the question of why peers affect only some personality traits but leave others unaffected. To explain this pattern, we propose a simple model for personality development under the influence of peers. In this model, we assume that students can engage in self-directed personality change. Students adapt their personality to increase academic achievement. Peers affect the marginal cost of changing a student's personality by acting as role models and creating social pressure. Our model predicts that students adjust their personality for traits that affect their academic achievement. Consistent with this prediction, we find that personality spillovers are only visible for traits that predict educational success. Our framework and findings are consistent with the idea that students adopt those personality traits that are productive in the university context from their peers. Our model is also consistent

with recent evidence showing that people can engage in self-directed, effortful personality change (Hennecke et al., 2014; Stieger et al., 2021).

The large literature on peer effects has studied how peers' gender, race, or achievement affect performance and educational choices.[1] Only a few recent papers have explored peer personality as an input in the education production function. These studies show that peer personality affects students' performance. Hancock and Hill (2021) show that teammate conscientiousness raises team performance in university study groups. Golsteyn et al. (2021) show that exposure to peers who are more persistent raises university performance. Only one other peer effects paper looks at an outcome related to personality. Bietenbeck (2021) studies peer motivation using project STAR data and finds that having more motivated peers, while increasing reading test scores, has no significant impact on own motivation. Bietenbeck studies these effects in the primary school classroom. In contrast, we study peer effects in small university peer groups using six validated personality measures.

Our work also relates to several studies that also conduct experiments to study peer effects (Booij, Leuven, & Oosterbeek, 2017; Carrell, Sacerdote, & West, 2013; Duflo, Dupas, & Kremer, 2011; Oosterbeek and Van Ewijk, 2014). While these studies provide important insights into the nature of peer effects, they focus on performance and do not consider student personality as an input or output variable. Given the increasing returns to non-cognitive skills in education and the labor market (Deming, 2017; Edin et al., 2022) we think that changes in personality traits might be as important as changes in achievement.

Our paper underlines the malleability of personality in adolescence and relates to a series of recent papers showing that targeted interventions can have lasting impacts on personality development (Abeler et al., 2021; Alan et al., 2019; Alan et al., 2021; Kosse et al., 2020; Sorrenti et al., 2020; Roberts et al., 2017).

Our paper contributes to the literature by establishing a novel fact: peers influence students' personality development.

[1] For example, Hoxby (2005) shows that having more female peers raises both boys' and girls' test scores. Carell et al. (2013) highlight that low-achieving students perform worse when medium-achieving peers are replaced with high-achieving peers. Consistent with these results, Booij, Leuven, and Oosterbeek (2017) show that low- and medium-achieving students benefit from tracking of the same type of students. Figlio (2007) shows that boys with female-sounding names have more behavioral problems and a negative impact on their peers' test scores. Carrell and Hoekstra (2010) show that children who experienced domestic violence negatively affect their peers' reading and math test scores. Carrell, Hoekstra, and Kuka (2018) follow up on these results and highlight that having disruptive peers reduces earnings by 3%–4%. Sacerdote (2014) provides an excellent review of the existing literature on peer effects.

2. What is Personality and How Much Does it Change?

The American Psychological Association defines personality as "individual differences in characteristic patterns of thinking, feeling and behaving." Heckman and Kautz (2014) define personality traits as "personal attributes not thought to be measured by IQ tests or achievement tests" (p, 346). Both of these definitions are broad and include socio-emotional skills, soft skills, and what economists refer to as "non-cognitive" skills. Differentiating personality traits from behaviors, habits, or feelings is empirically not possible (Borghans et al., 2011). Because traits can only be inferred from their consequences such as observable behavior, there can be no direct measurement of an abstract trait. In this paper, we adopt the pragmatic definition by Pervin (1994), who defines personality traits as *observable* patterns of habits and behaviors that make a person unique. Because personality is always measured through questions about behavior, lasting changes in these behaviors represent changes in personality by definition.

What do we know about changes in personality? While there is a misconception among some economists that personality is fixed, a large literature in psychology has shown that personality is both malleable and reasonably stable over time (Roberts et al., 2001; Roberts et al., 2006; Borghuis et al., 2017). Within economics, a series of recent intervention studies has provided evidence on the malleability of personality during childhood. Kosse et al. (2020) show that children participating in the German "Balu und Du" mentoring program become more prosocial. Abeler et al. (2021) show that these children also become more honest, and Boneva et al. (2021) show they become more competitive. In related work, Alan and Ertac (2018) shows that children receiving a classroom-based intervention become more patient, and Alan et al. (2019) show that grit can be fostered through interventions. Alan et al. (2021) show that an intervention in perspective taking increases prosocial behavior. Cappelen et al. (2020) show that early childhood education affects children's social preferences for fairness and the importance children place on efficiency relative to fairness. Sorrenti et al. (2020) show that a socio-emotional skills intervention persistently reduces children's impulsiveness and disruptiveness.

We know substantially less about factors that affect personality in adolescence and adulthood. Dahmann and Anger (2018) study a German schooling reform and find that a one-year reduction in years of schooling increases openness and decreases emotional stability. Only two studies have investigated how schools and teachers affect outcomes related to personality. Jackson (2018) and Jackson et al. (2020) show that both schools and teachers shape socio-emotional development and non-cognitive outcomes like absences, suspensions, and on-time

grade progression. These results suggest that adolescence can be a formative period for socio-emotional skills.

Recent evidence further suggests that people can change their own personality. Stieger et al. (2021) show that access to a virtual personality coach can help people to persistently change their personality in the desired direction. Experimental participants who had access to such a coach became more conscientious, less neurotic, and more extraverted. Hennecke et al. (2014) propose a framework for self-directed personality development and three necessary conditions to change personality. Based on this framework people can change their personality if they (1) feel such a change is desirable or necessary, (2) consider the change to be feasible, and (3) make a habit of the initial changes.

3. Experimental Design

3.1. The Experiment

Our experiment took place in an introductory economics course which was offered from September until December.[2] It included students who took the course in three different academic years: 2018/2019, 2019/2020, and 2020/2021. Most of these students were in their first semester, 19 to 22 years old, and enrolled in a major or minor in economics, business, or informatics.

The structure of the course was identical for each of the three student cohorts. Students attended two lectures and one tutorial session per week and completed weekly ungraded problem sets. To pass the course, students needed to pass their final exam, which was the only determinant of their grade. The stakes for this exam were high. If a student failed the exam, it could only be retaken once. Failing the exam a second time meant the student would have to change majors or drop out of university.

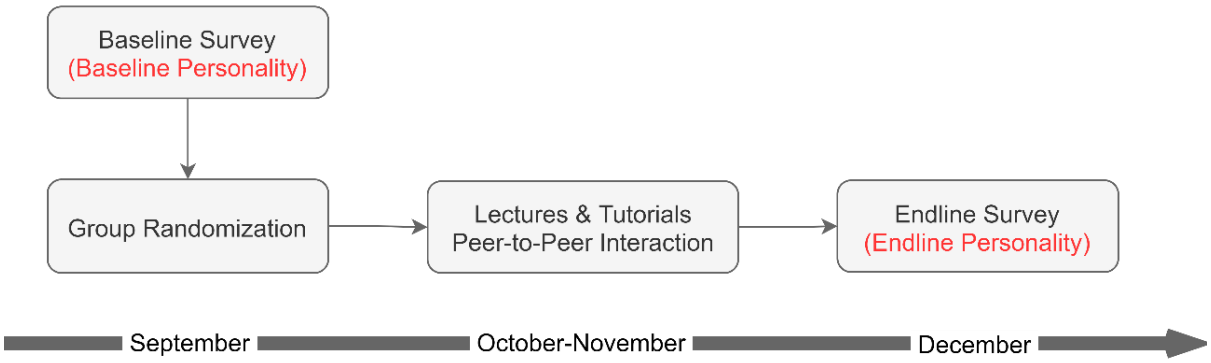
Figure 1 shows the timeline of our experiment. Before the start of the term, students received an invitation to complete a baseline survey. This survey contained measures of students' personality as well as other demographic and background questions. In the first lecture, we informed students about the possibility of signing up for study groups. While

[2] The experiment received IRB approval from the University of Zurich (OEC IRB # 2018-021). We pre-registered our experiment at the American Economic Association's registry for randomized controlled trials in the fall of 2018 before the start of the first wave (AEARCTR-0003255). In this pre-registration, we hypothesized that peer personality would affect performance, which our results support. However, at the time, we did not plan to investigate how peer personality affects students' own personality. After observing significant personality peer effects based on the 2018/19 and 2019/20 data, we replicated our experiment in 2020/21 and found similar results.

signing up had no direct effect on students' grades, we suggested that they might enjoy studying with other students. Of all enrolled students, 33% signed up to a study group.[3]

We assigned these students to study groups as follows: In each year, we grouped students into three study programs depending on whether they were enrolled in 1) a business or economics major, 2) an informatics major, or 3) any other major with a business or economics minor. Students who are enrolled in the same broad program typically follow the same curriculum. Within the program, we randomly assigned each student to a study group consisting of four students. Our study group assignment is therefore stratified at the program–cohort level. 65% of students in our sample were enrolled in business or economics majors: business administration, finance or economics.

Figure 1: Timeline of the Experiment



We informed students about their study group via email. This email included the names and email addresses of their study group peers, invited them to create a WhatsApp group, and suggested that they schedule their first group meeting.[4] To foster social interactions, we also offered each group a $20 voucher for drinks at the local university bar. Once students were assigned to groups, participation in group activities was voluntary. Although study groups were designed for studying economics, group members could also organize social activities. At the end of the semester, prior to the final exam, students received the endline survey. This survey elicited students' endline personality traits as well as information about academic and social interactions with their peers.

[3] Figure A1 in the Appendix provides evidence for the demand for peer groups and shows which student characteristics predict study group sign-up.
[4] According to our pre-experimental survey, more than 90% of students use WhatsApp to communicate with friends, which makes it a convenient tool to facilitate peer group interaction.

3.2. Data

We measure students' personality in the baseline survey and in the endline survey. Table 1 provides an overview of the included personality traits, the items used to measure them, and their answer scales. We measure the Big Five personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism) with the 15-item Big Five Inventory (BFI-S), which consists of three items per trait (Gerlitz and Schupp, 2005). This inventory is a short version of the original 44-item Big Five Inventory (John et al., 1991) and has been validated and used in different settings (Specht et al., 2011, Lang et al., 2011, Hahn et al., 2012). Students rate each item on a 7-point scale ranging from 1 = "does not apply to me at all" to 7 = "applies to me perfectly." Following Gerlitz and Schupp (2005), we measure each personality trait as the average of students' ratings on the three designated items. To measure students' competitiveness, we use the 1-item measure proposed and validated by Buser et al. (2020), which is, "In general, how competitive do you consider yourself?" Students answer this question on a 10-point scale ranging from 1 = "not at all competitive" to 10 = "very competitive."

Table 1: Measurement of Personality Traits (C-OCEAN)

Personality Trait	Question and Scale
Competitiveness	**In general, how competitive do you consider yourself?** *Scale: 0 (not competitive at all) to 10 (very competitive)*
	I see myself as someone who . . . *Scale: 1 (does not apply to me at all) to 7 (applies to me perfectly)*
Openness	is original, comes up with new ideas values artistic, aesthetic experiences has an active imagination
Conscientiousness	does a thorough job tends to be lazy [reversed] does things effectively and efficiently
Extraversion	is communicative, talkative is outgoing, sociable is reserved [reversed]
Agreeableness	is sometimes somewhat rude to others [reversed] has a forgiving nature is considerate and kind to others
Neuroticism	worries a lot gets nervous easily is relaxed, handles stress well [reversed]

Notes: Students could choose to fill out the survey in German or English. More than 80% of students answered the survey in German. The German version of the 15-item Big Five personality traits is taken from the German Socio-Economic Panel (G-SOEP). The single-item competitiveness scale is based on an early version of Buser et al. (2021).

Our estimation sample consists of 543 students for whom we have measures of all six personality traits in the baseline survey and the endline survey, as well as data from all six personality traits of their three study group peers from the baseline survey.[5] Table 2 shows descriptive statistics for this sample. In our sample, 46% of students are female, 86% of students attended a high school with German as the instruction language,[6] 65% were majoring in business or economics, 18% were majoring in informatics, and the remaining 17% were majoring in another subject but were enrolled in a business or economics minor.

Table 2: Descriptive Statistics

Panel A: Overall Sample Composition					
Experimental Cohort			Study Program		
Year 2018/19	17%		Business / Economics		65%
Year 2019/20	34%		Informatics		18%
Year 2020/21	49%		Other majors		17%
	N	mean	sd	min	max
Panel B: Student Background Characteristics					
Female	543	0.46	0.50	0	1
Retaking the Course	543	0.08	0.27	0	1
High School Math Grade	543	4.59	0.80	2	6
High School Language Grade	543	4.75	0.57	3	6
High School First Language was German	543	0.86	0.35	0	1
Panel C: Student Personality					
Baseline Competitiveness	543	6.86	1.91	1	10
(Peer leave-own-out mean)		(6.82)	(1.16)	(2.3)	(9.3)
Endline Competitiveness	543	6.60	2.05	1	10
Baseline Openness	543	4.90	1.14	1.3	7
(Peer leave-own-out mean)		(4.90)	(0.62)	(3.3)	(6.4)
Endline Openness	543	4.95	1.18	1.3	7
Baseline Conscientiousness	543	4.80	0.97	1.3	7
(Peer leave-own-out mean)		(4.76)	(0.53)	(3.2)	(6.3)
Endline Conscientiousness	543	4.56	1.07	1.7	7
Baseline Extraversion	543	4.81	1.25	1	7
(Peer leave-own-out mean)		(4.82)	(0.74)	(2.6)	(6.6)
Endline Extraversion	543	4.83	1.30	1	7
Baseline Agreeableness	543	5.52	0.87	3	7
(Peer leave-own-out mean)		(5.54)	(0.49)	(4.2)	(6.7)
Endline Agreeableness	543	5.31	0.88	2.7	7
Baseline Neuroticism	543	4.09	1.32	1	7
(Peer leave-own-out mean)		(4.07)	(0.74)	(1.7)	(6.6)
Endline Neuroticism	543	4.28	1.36	1	7
Panel D: Student Performance Indicators					
Grade for Microeconomics 1	543	4.21	1.04	1	6
Exam Attendance	543	0.96	0.20	0	1
Course Passing	543	0.70	0.46	0	1

Notes: This table is based on our estimation sample. The standard deviation is denoted by "sd." Summary statistics of the peer leave-own-out average personality traits at the baseline calculated within study groups are in parentheses.

[5] Panel B of Table A1 in the Appendix shows that peer personality at the baseline does not predict missing personality measures at the endline.

[6] The instruction language in our setting is German. We coded all our survey questions in both German and English so that students could freely choose the language throughout the survey.

Panel C of Table 2 shows the summary statistics of personality traits at the baseline and endline. From the beginning to the end of the first semester, we only see small changes in students' personality: the average student in our sample becomes slightly more open to new experiences, more extraverted, less competitive, less conscientious, less agreeable, and more neurotic. Appendix Figure A2 plots the distribution of the six personality traits at baseline and endline.

All six personality traits are empirically distinct from each other. Appendix Table A2 shows the pairwise correlations between personality traits at baseline never exceed 0.29 in absolute terms. Table A3 provides evidence on the reliability of our Big Five measures. The Cronbach's Alpha coefficients range from 0.41 to 0.85 and largely support the internal consistency of our personality measures. Table A4 provides evidence on the stability of personality over time. The within-trait correlations over time range between 0.6–0.8, which is reasonably stable and close to what is typically found in other studies over similar time horizons (Robins et al., 2001; Terracciano et al., 2010).

Panel D in Table 2 shows three key indicators of student performance from the course in which our experiment takes place. In this course, the final course grade is entirely based on students' final exam score. In our estimation sample, 96% of students attended the final exam. The average grade on this exam was 4.21 on a 1 to 6 scale. Students with a grade of 4 or higher successfully pass the course and earn the course credits. The course pass rate is 70%.

4. Empirical Strategy

Our aim is to estimate how peer personality measured at baseline affects students' own personality at endline. We estimate the following model separately for each personality trait T:

$$T_{ig,t} = \alpha + \beta \bar{T}_{-ig,t-1} + \gamma X_{ig,t-1} + \varepsilon_{igt}, \qquad (1)$$

where $T_{ig,t}$ is the trait level of student *i* in study group *g* measured in the endline survey at time *t*. $\bar{T}_{-ig,t-1}$ is the average trait level of students in group *g* (excluding student *i*) measured in the baseline survey at time *t−1*. In our main analysis, we estimate Equation (1) separately for each personality trait. For example, we estimate the effect of having more open peers on students' own openness.

The vector $X_{ig,t-1}$ includes control variables that differ by specification. In all specifications, $X_{ig,t-1}$ includes *randomization controls*, which are study program dummies (business or economics majors, informatics majors, base group: other majors) and two student

cohort dummies (2018/19, 2019/20, base group: 2021/21) and for the 2020/21 cohort, nine dummies for the last digit of students' ID number. The latter set of dummies accounts for the fact that for this cohort, the university assigned students to online or in-person lectures based on their student ID to facilitate social distancing during the COVID-19 pandemic. In all specifications, $X_{ig,t-1}$ also includes the baseline level of the personality trait in question. For example, we control for students' own openness at baseline when our dependent variable is students' openness at endline. This control implies that our estimates are econometrically equivalent to using the change in personality between baseline and endline as a dependent variable.

We estimate additional specifications where $X_{ig,t-1}$ includes students' other personality traits measured at baseline (*other own personality traits*), student's gender, age, group fixed effects, fixed effects for business-economics majors, high school math and language grades, and an indicator for whether German is the instruction language in high school (*other own characteristics*), as well as peer averages of these variables (*other peer personality traits* and *other peer characteristics*). To facilitate the interpretation of our estimates, we standardize each personality trait to have a mean of zero and a standard deviation of one across the estimation sample. The peer averages reported in our regression tables are based on those standardized personality measures.

The key identifying assumption for our approach is that the randomization of students into study groups was successful. To confirm that this is the case, we test how peer personality measured at baseline relates to students' own personality measured at the *baseline*, that is, before it could have been affected by the peer composition. We implement this test by estimating Equation (1) but use as the dependent variable students' baseline personality instead of their endline personality. Besides randomization controls, these regressions include a leave-out-mean of each personality trait at the program-by-cohort level to account for the mechanical relationship between own and peer characteristics (see Guryan et al., 2009).

Table 3 shows that peer personality at baseline does not significantly predict students' own personality at baseline. All six point estimates of interest are small and none are statistically significant. Table A5 in the Appendix provides an alternative balancing check in which we test whether study group dummies predict students' baseline characteristics. This is not the case. Both tests confirm that our randomization of students into study groups was successful.

Table 3: Randomization Test

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Own Personality Traits at Baseline					
	Competitiveness	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism
Peer Competitiveness	-0.020					
	(0.039)					
Peer Openness		0.002				
		(0.040)				
Peer Conscientiousness			-0.040			
			(0.037)			
Peer Extraversion				-0.017		
				(0.038)		
Peer Agreeableness					0.005	
					(0.032)	
Peer Neuroticism						-0.051
						(0.038)
Observations	543	543	543	543	543	543
R-squared	0.409	0.427	0.489	0.519	0.496	0.436

Notes: Each column represents one OLS regression. All regressions control for study program-by-cohort fixed effects and the leave-out-mean of each personality trait at the program-by-cohort level. All dependent and independent variables are standardized. Robust standard errors clustered at the study group level are in parentheses. Appendix Table A5 presents an alternative randomization test showing that study group dummies do not predict baseline characteristics. Panel A of Appendix Table A1 shows the balancing results using the full baseline sample (792 students in 198 groups).

5. Results

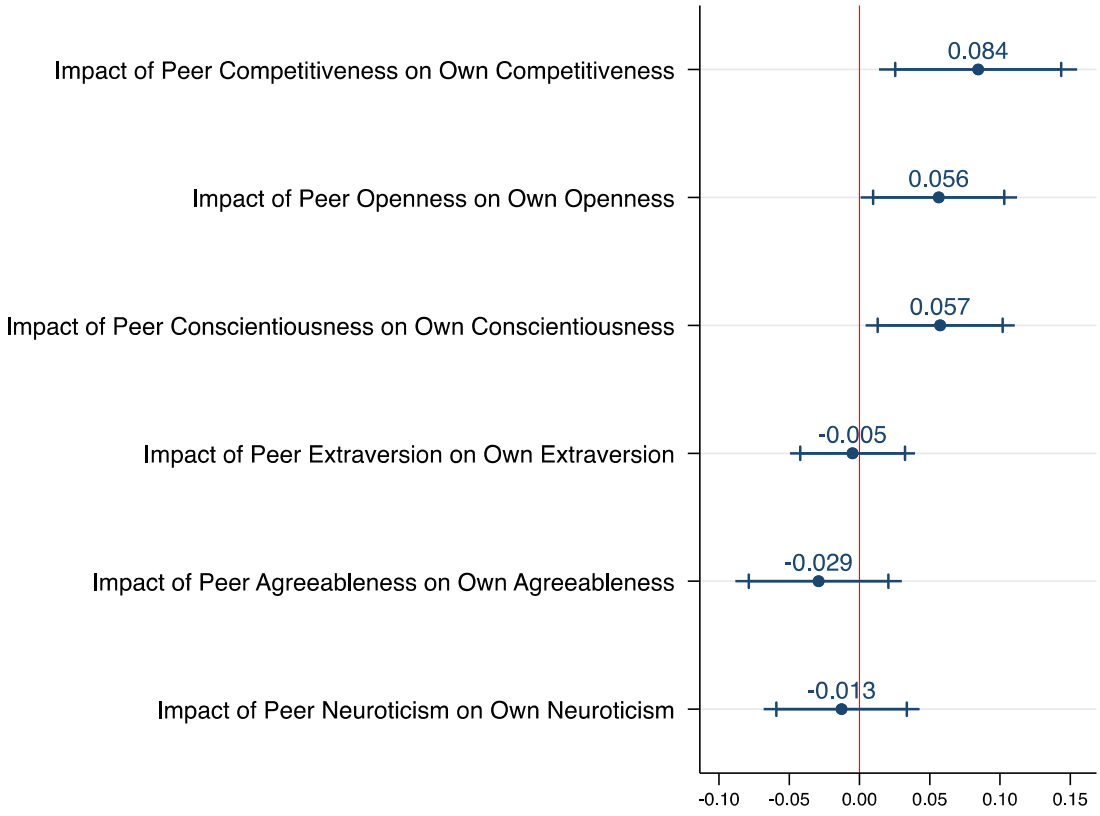
5.1. Personality Spillovers

Figure 2 shows that students become more similar to their randomly assigned peers for three out of six personality traits. Being assigned to peers who are one SD more competitive increases students' own competitiveness by 0.084 SD (*p*-value = 0.019). Being assigned to peers who are one SD more open to experiences increases students' own openness by 0.056 SD (*p*-value = 0.047). Similarly, being assigned to peers who are one SD more conscientious increases students' own conscientiousness by 0.057 SD (*p*-value = 0.034). We find no evidence that being assigned to more extraverted, agreeable, or neurotic peers affects students' own personality in these dimensions.[7]

[7] Figure A3 in the Appendix shows that our results are very similar when we construct each of the Big Five personality traits as follows: we first standardize each item, then we take the average of 3 normalized items, and standardize the average value again.

How large are these effects in their original scales? In terms of the 10-point scale used to measure competitiveness, being assigned to peers who are, on average, one point more competitive increases students' own competitiveness by 0.149 points. In terms of the 7-point scale used to measure the Big Five personality traits, we see that being assigned to three peers who are each 1 point more open increases own openness by 0.108 points, and being assigned to peers who are all 1 point more conscientious increases own conscientiousness by 0.115 points. These effects are modest but economically meaningful.

Figure 2: The Impact of Peer Personality at Baseline on Own Personality at Endline



Notes: Each point estimate represents one OLS regression as specified in column (1) of Table 4. For each regression, the outcome variable is a standardized own personality trait at endline, the independent variable of interest is a standardized peer personality trait at baseline, and the control variables include randomization controls as defined in the empirical strategy and students' own personality at baseline (i.e., the baseline level of the dependent variable). Standard errors are clustered at the study group level. Error bars indicate 95% and 90% confidence intervals.

We assess the robustness of these results by gradually adding student and peer level control variables. Column (1) of Table 4 shows our baseline estimates from Figure 2 for reference. Column (2) shows estimates from regressions in which we include all own

personality variables in the model, and in column (3) we additionally include all student background variables. As expected under random assignment, the inclusion of these variables does not affect our point estimates in any meaningful way.

Table 4: Peer Personality and Own Personality

	(1)	(2)	(3)	(4)	(5)
Panel A: Dependent Variable: Own Competitiveness at Endline					
Peer Competitiveness	0.084**	0.087**	0.076**	0.083**	0.082**
	(0.036)	(0.035)	(0.035)	(0.037)	(0.037)
Panel B: Dependent Variable: Own Openness at Endline					
Peer Openness	0.056**	0.061**	0.061**	0.072**	0.069**
	(0.028)	(0.028)	(0.029)	(0.032)	(0.032)
Panel C: Dependent Variable: Own Conscientiousness at Endline					
Peer Conscientiousness	0.057**	0.054**	0.070**	0.087***	0.101***
	(0.027)	(0.027)	(0.028)	(0.029)	(0.030)
Panel D: Dependent Variable: Own Extraversion at Endline					
Peer Extraversion	-0.005	-0.007	-0.012	-0.009	-0.001
	(0.023)	(0.023)	(0.023)	(0.024)	(0.025)
Panel E: Dependent Variable: Own Agreeableness at Endline					
Peer Agreeableness	-0.029	-0.028	-0.018	-0.005	-0.009
	(0.030)	(0.031)	(0.032)	(0.032)	(0.032)
Panel F: Dependent Variable: Own Neuroticism at Endline					
Peer Neuroticism	-0.013	-0.012	-0.009	-0.017	-0.013
	(0.028)	(0.028)	(0.027)	(0.028)	(0.029)
Observations	543	543	543	543	543
Control Variables:					
Other own personality traits	N	Y	Y	Y	Y
Other own characteristics	N	N	Y	Y	Y
Other peer personality traits	N	N	N	Y	Y
Other peer characteristics	N	N	N	N	Y

Notes: Each column in each panel shows one coefficient from a separate OLS regression. All regressions include the baseline level of the dependent variable as well as randomization controls as defined in the empirical strategy. *Other own personality traits* include five other personality traits at the baseline, except for the one trait being examined in each panel. *Other own characteristics* include gender, business-economics major fixed effects, high school math and language grades, an indicator for German as the instruction language, course-retaking status, and age fixed effects. *Other peer personality traits* are five other peer personality traits at the baseline, except for the one being analyzed. *Other peer characteristics* include peers' gender, high school math and language grades, and whether German is the instruction language. All dependent and independent variables are standardized. Robust standard errors clustered at the study group level are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Are these effects driven by peer personality? Or, do they show effects of characteristics correlated with peer personality? These questions are difficult to answer because we cannot randomly assign peer personality independently from other peer attributes. For policymakers, understanding what drives our observed effects is also less important. They can, for example, increase students' competitiveness by assigning them to more competitive peers *regardless of what drives these effects*.

To be able to better place our results in the literature, it is nevertheless important to know whether our peer personality spillovers merely capture effects associated with other peer variables, for example, peer gender and peer achievement, which are the two peer characteristics most frequently studied in the literature. We therefore test how our point estimates are affected by including other peer variables. In column (4) of Table 4 we include all peer personality variables in the model, and in column (5) we include peer gender, high school math and language grades, and whether German is the instruction language. The inclusion of these controls does not affect the point estimates of interest in any meaningful way. This result suggests that our measures of peer personality capture distinct components of students' personality traits. Column (5) shows that peer conscientiousness increases own conscientiousness (p-value = 0.001). Peer competitiveness increases own competitiveness (p-value = 0.028), and peer openness increases own openness (p-value = 0.031). Taken together, our estimates in Table 4 show that the impact of peer personality remains remarkably robust and is not sensitive to the inclusion of student- or peer-level control variables.

While our conclusions remain the same, it is not clear whether controlling for other peer characteristics is a good robustness check. The estimates from specifications that include these controls do not deliver policy-relevant parameters. In practice, we cannot assign students to more-conscientious peers without changing peer gender, achievement, and other correlated unobserved peer characteristics.

Cross-Trait Spillovers: So far, we have focused on within-trait spillovers. We have tested, for example, how peer conscientiousness affects students' own conscientiousness. However, there might also be across-trait spillovers. For example, having peers who are more conscientious may make students more competitive. To better understand such spillovers, we show all personality coefficients of the specification shown in column (5) of Table 4. More specifically, Table 5 provides a "cross-trait spillover matrix" and shows estimates for how each peer trait affects the six own traits. We find that spillovers are highly concentrated on the diagonal line, where a given own trait is regressed on the same peer trait. Only one out of the other 27

coefficients reaches significance at the 5% level: students exposed to smore open peers appear to become less competitive. This result could also be a chance finding. Taken together, we find little evidence for meaningful cross-trait spillovers.[8]

Table 5: Cross-Trait Spillover Matrix

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Own Personality Traits at Endline					
	Competitiveness	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism
Peer	**0.082****	0.012	0.009	-0.016	-0.017	0.001
Competitiveness	**(0.037)**	(0.032)	(0.028)	(0.028)	(0.033)	(0.027)
Peer	-0.072**	**0.069****	-0.013	0.022	-0.057*	0.023
Openness	(0.036)	**(0.032)**	(0.029)	(0.025)	(0.031)	(0.027)
Peer	-0.011	0.005	**0.101*****	-0.000	-0.017	0.049
Conscientiousness	(0.035)	(0.031)	**(0.030)**	(0.028)	(0.037)	(0.031)
Peer	0.008	-0.055*	-0.041	**-0.001**	-0.002	-0.055*
Extraversion	(0.035)	(0.029)	(0.034)	**(0.025)**	(0.035)	(0.031)
Peer	-0.001	0.011	-0.034	0.041	**-0.009**	-0.020
Agreeableness	(0.034)	(0.032)	(0.030)	(0.025)	**(0.032)**	(0.032)
Peer	-0.021	0.005	0.057*	0.030	-0.008	**-0.013**
Neuroticism	(0.035)	(0.029)	(0.030)	(0.025)	(0.029)	**(0.029)**

Notes: Each column represents one OLS regression in which the dependent variable is one of the six own personality traits at endline (standardized). The independent variables of interest are six peer personality traits at baseline (standardized). The specification of each regression is the same as in column (5) of Table 4. Robust standard errors clustered at the study group level are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Measurement error: One might be concerned that measurement error in the peer personality variables drives our results. If measurement error is random, this should not be a concern. Feld and Zölitz (2017) show that random measurement error will attenuate peer effect estimates in settings with random assignment. If peer personality measures true personality with random error, we would therefore expect our results to be a lower bound of the true effect.

To quantify bias from measurement error, we use the *obviously related instrumental variables* (ORIV) approach by Gillen et al. (2019) and exploit the fact that we have three items for each Big Five personality trait. Because competitiveness is measured with only one question, we cannot apply the ORIV approach to correct for measurement errors in

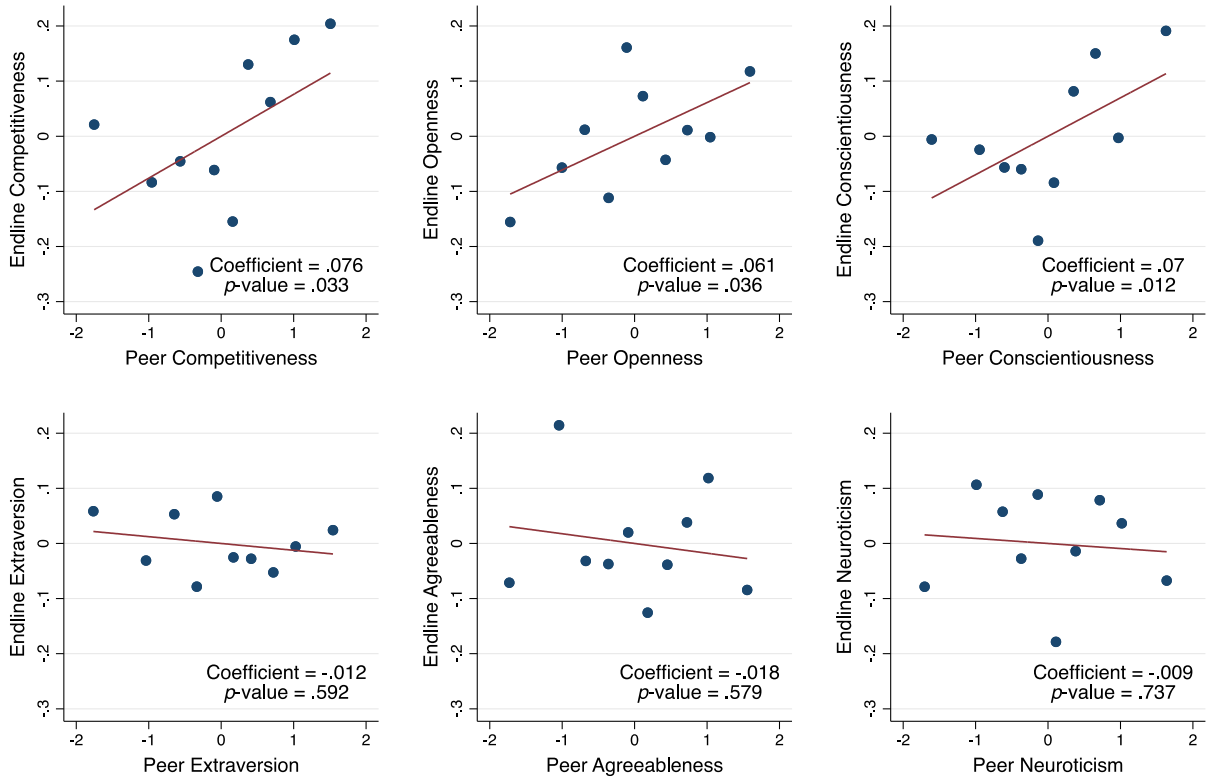
[8] In Appendix Table A6, we present the same results with original *p*-values and corrected *p*-values using a very conservative Bonferroni correction for all 36 hypotheses tested in Table 5. Effects for conscientiousness remain statically significant (*p*-value = 0.036).

competitiveness. For all other measures, we use each item as an instrumental variable for the other two items and re-estimate the effect of peer personality on own personality using two-stage least-squares (2SLS) regressions. As expected, this procedure leads to larger point estimates in absolute terms (see Figure A4 in the Appendix). The estimated effect of a one SD increase in peer openness on students' own openness is 0.104 SD (compared to a 0.069 SD in our main specification). The estimated effect of a one SD increase in peer conscientiousness on own contentiousness is 0.136 SD (compared to 0.07 SD in our main specification). Both estimates are statistically significant at the 5% level.

5.2. Heterogeneity

Figure 3 shows binned scatter plots illustrating the impact of peer personality on own personality at the endline. The figure suggests that the impact of peer personality is fairly linear.

Figure 3: Non-linear Effects? Impact of Peer Personality on Own Personality



Notes: Binned scatter plots showing the relationship between own personality traits at endline (y-axis) and peers' personality traits at baseline (x-axis). All measurements of own and peer personality traits are standardized. Each plot uses the same specification as in column (3) of Table 4.

We further test for whether our effects differ for students with above and below median values of a given trait at the baseline. Figure A5 shows results from these subgroup regressions that suggest this is not the case.

To provide more-detailed evidence on possible non-linear effects, we test whether the impact of peer personality differs by both own *and* peer personality. We implement this in three steps. First, we classify students for each personality trait as low, middle, or high based on whether their trait at the baseline is in the bottom, middle, or top third of the distribution of that trait among all students in our estimation sample. Second, we calculate the proportion of low- and high-type peers in each study group. Third, we regress students' own personality at the endline on the proportion of low-type peers and high-type peers of that same trait separately for low-, middle-, and high-type students. For example, we limit our sample to low-openness students and regress their own openness at endline on the proportion of high-openness peers and the proportion of low-openness peers. In this regression, the high-openness peers coefficient shows how low-openness students are affected if one replaced middle-openness peers (the reference group) with high-openness peers. In all regressions, we additionally include randomization controls and students' own personality measured at baseline. Table A7 in the Appendix shows that this exercise reveals little systematic heterogeneity. Taken together, we find little evidence that there is important student- or peer-level heterogeneity in the impact of peer personality on own personality. Overall, the linear-in-means model is a good approximation to describe spillovers in our setting.

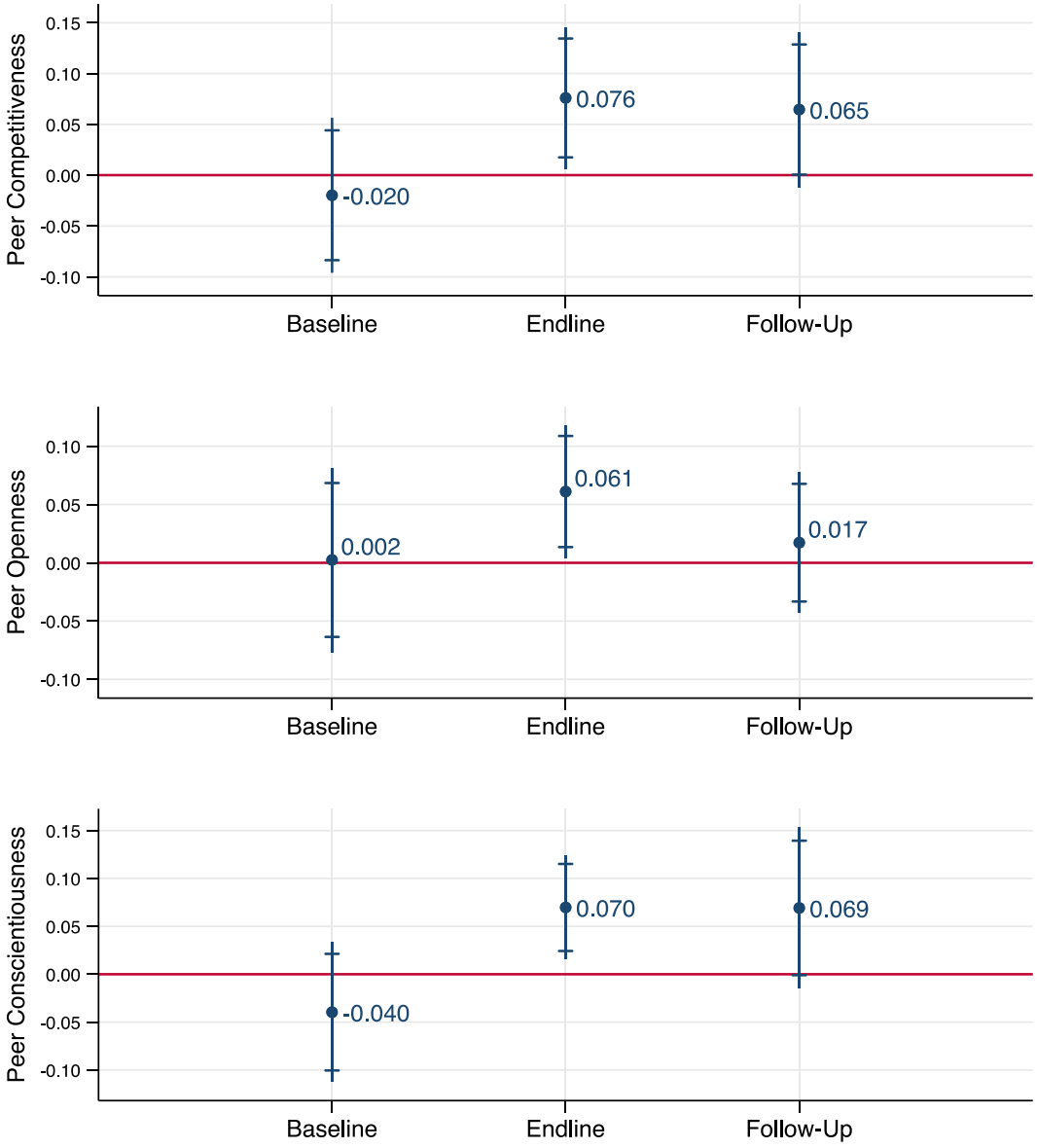
5.3. Persistence of Personality Changes

We have shown that peers have affected students' personality at the time of the endline survey, which was three months after the study group assignment. It is not clear what happens after that. Personality peer effects may fade out and students may revert to their old selves once they are no longer exposed to their study group peers. Or peer effects may persist if students have formed new habits or continue to interact with their peers after the end of the course.

To provide evidence on the persistence of peer personality effects, we conducted a follow-up survey in the summer of 2021 and measure students' personality. Depending on their cohort, students were surveyed one to three years after the end of the experiment. 326 out of

the 543 students in our estimation sample completed the follow-up survey. Peer traits predictive of spillovers are unrelated to the probability of responding to this survey.[9]

Figure 4: Balance, Short and Longer-Term Effects of Peer Personality



Notes: The figure shows estimated effects of peer personality on students' own personality measured at baseline, in the endline survey, and in the follow-up survey in 2021—up to three years after the experiment. Openness and conscientiousness in the follow-up survey are measured with six items (rather than three items) from the 44-item Big-Five Inventory to increase measurement precision. Baseline estimates are based on Table 3. The endline and follow-up estimates are based on the model reported in column (3) of Table 4. We standardize the dependent variables in a way that makes the magnitude of the point estimates comparable across the three specifications. More specifically, the units of individual personality at baseline, endline, and follow-up consist of one standard deviation of the endline personality among all students in our estimation sample. Error bars indicate 95% and 90% confidence intervals based on robust standard errors clustered at the study group level.

[9] Table A8 tests whether baseline peer personality predicts follow-up survey participation. Peer extraversion shows a small negative effect on the response rate, significant at the 10% level. Other peer personality traits do not predict the response rate.

Figure 4 shows how peer personality relates to own personality at the baseline, endline, and follow-up. The baseline estimates show that peer and own traits are not significantly correlated, confirming that peers are randomly assigned to study groups. The endline estimates restate our main results from column (3) of Table 4 for reference.

Overall, the follow-up estimates suggest persistence of some personality peer effects. We cannot reject the null hypothesis that effects are significantly different at endline for any of the three traits we consider. While follow-up estimates are less precise than our endline estimates, we see almost identical effect sizes for competitiveness and conscientiousness. Up to three years after being assigned to a study group, students who had peers who were one SD more competitive are still 0.065 SD more competitive (compared to 0.076 SD at the endline). Similarly, students who had peers who were one SD more conscientious peers are 0.069 SD more conscientious (compared to 0.070 SD at the endline). The effect on conscientiousness even reaches statistical significance at the follow-up (p-value = 0.05). We do see somewhat lower point estimates at the follow-up for openness (0.017 SD vs. 0.061 SD), but the 95% confidence interval includes the endline effect size. Taken together, we see these results as suggestive evidence that conscientiousness and competitiveness persist. Peers appear to have effects on personality that remain visible a long time after students have finished their course.

While effects for the follow-up survey are less precisely estimated and therefore are more suggestive, they give us confidence that our main results are not driven by short-lived behavioral changes. Our results suggest that peers can induce lasting changes in behavior that remain visible in personality measures.

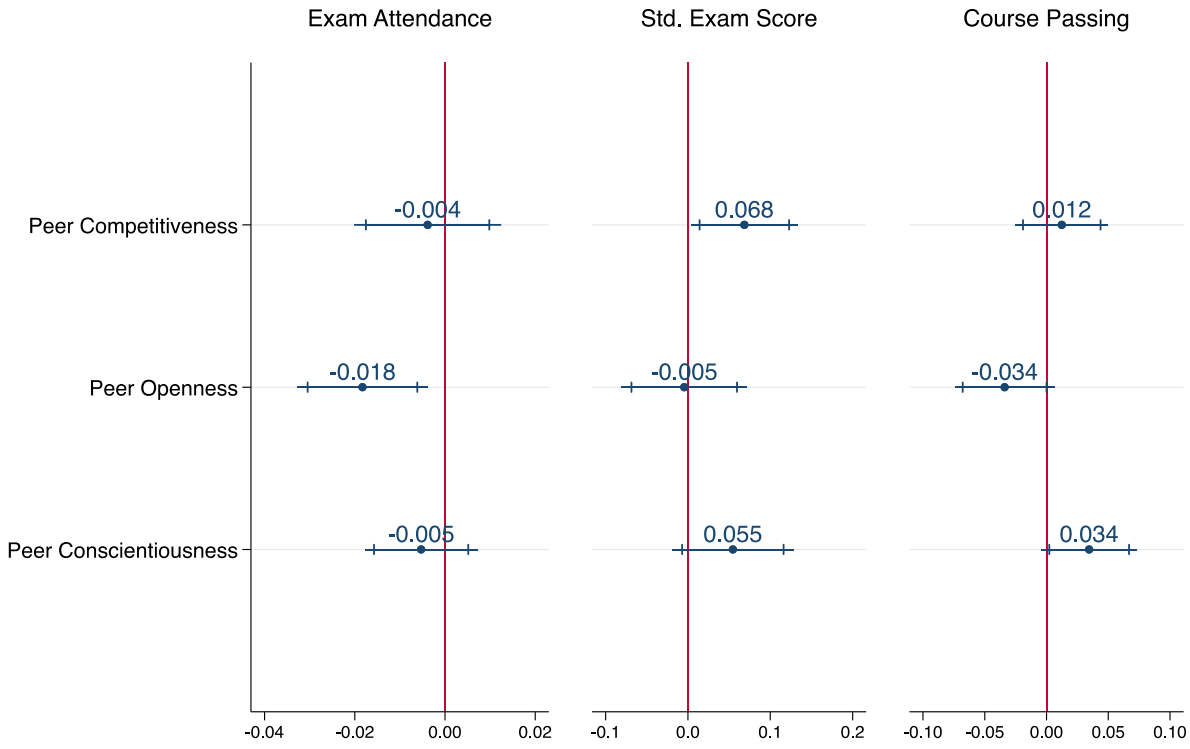
5.4 Impact of Peer Personality on Performance

Does peer personality also affect students' educational outcomes? Such effects could be a result of peer-induced changes in students' own personality, direct effects of peer personality on performance, or both.

Figure 5 shows estimates of peer personality on students' probability of attending the exam, students' exam grade, and students' probability of passing the course. Overall, we see some evidence of peer personality effects on performance. Out of nine estimates, two are statistically significant at the 5% level. Students who had peers who were one SD more competitive perform 0.068 SD better on the final exam (p-value = 0.039). Students who had peers who were one SD more open become 1.8 percentage points less likely to attend the final exam (p-value = 0.014). We further see that students with peers who were one SD more

conscientious become 3.4 percentage points more likely to pass the final exam, although this estimate is only marginally significant (p-value = 0.079).

Figure 5: Impact of Peer Personality on Educational Outcomes



Notes: The figure shows how peer personality affects three educational outcomes: an indicator for attending the exam, students' standardized exam score, and an indicator for passing the course. All specifications include the same controls as column (3) of Table 4. Error bars indicate 95% and 90% confidence intervals based on robust standard errors clustered at the study group level.

Taken together, these results are consistent with two studies that have shown the benefits of having conscientious peers. Hancock and Hill (2021) show that having more-conscientious teammates in university study groups raises performance on team tests taken jointly in class. Similarly, Golsteyn et al. (2021) show that exposure to peers who are more persistent—which is a facet of conscientiousness—raises university performance. In addition to confirming those findings, we add to the literature by showing that students can also benefit from having peers who are more competitive and less open.

6. Why Does Personality Change?

Peers impact students' personality development. We find spillovers for conscientiousness and competitiveness that persist and spillovers for openness that are more short-lived. These results

raise the question of why peers affect some personality traits but not others. To explain these results, we develop a simple model in which students choose their optimal trait level depending on the costs and benefits of personality traits.

6.1 Modeling Personality Development

Consider a student who starts university education with a vector of K personality traits $\mathbb{T}_0 = [T_0^1, T_0^2, T_0^3, \dots, T_0^K]$. Personality is malleable and the student can change their traits from the baseline level to a new level $\mathbb{T} = [T^1, T^2, T^3, \dots, T^K]$. For simplicity we assume all trait levels to be strictly positive: $T_0^k, T^k > 0, \forall k \in 1,2, \dots, K$. Changes in traits are costly and the student obtains utility from academic achievement. Personality traits may affect achievement.

Our key modeling assumption is that peers affect the *costs* of personality change, for example, through social learning or social pressure. In the following, we will derive students' optimal personality vector ($\mathbb{T}^*$) in the absence of peers. After that, we will derive students' optional personality with peers who have higher, lower, or the same trait level.

No peers: As a benchmark, we first examine optimal personality development without peer influences. The student chooses their optimal personality vector ($\mathbb{T}^*$) by solving the following maximization problem:

$$\max_{\mathbb{T}=[T^1,T^2,\dots,T^K]} F(\mathbb{T}) - C(\mathbb{T};\mathbb{T}_0) = \sum_{k=1}^{K} f(T^k) - c\left(T^k; T_0^k\right), \tag{2}$$

where $f(T^k)$ denotes the production function of academic achievement that depends on trait T^k. $c\left(T^k; T_0^k\right)$ denotes the costs of adjusting the trait from the baseline level T_0^k to T^k. $f(T^k)$ allows for personality traits to have different effects on achievement.

For simplicity, we assume that traits (T^k) are substitutes—academic achievement is a linear function of each trait—$F(\mathbb{T}) = \sum_{k=1}^{K} f(T^k) = \sum_{k=1}^{K} \alpha^k T^k$, where α^k denotes the marginal benefit of raising T^k. We label traits as *productive* if higher levels of these traits lead to higher achievement: $\alpha^k > 0$. Other traits may have a negative or no impact on academic achievement: $\alpha^k \leq 0$.

We assume that students find changing their personality costly (McCrae and Costa, 1994). The costs of changing personality increase with the distance from the baseline level of the given trait:

$$\mathrm{c}\left(T^k; T_0^k\right) = \begin{cases} \left(T^k - T_0^k\right)^{\gamma}, & \text{if } T^k \geq T_0^k \\ \left(T_0^k - T^k\right)^{\gamma}, & \text{if } T^k < T_0^k \end{cases} \tag{3}$$

with $\gamma > 1$ capturing that it is increasingly costly to move further away from the initial level. Without loss of generality, we assume $\gamma = 2$ and that costs are identical for all traits. These simplifying assumptions about the cost structure and γ are not necessary to arrive at the model's qualitative predictions. Figure 6 provides a simple illustration of the cost function and the marginal benefit and marginal cost curves. The black solid line illustrates the scenario without peers. In equilibrium, the optimal level of a personality trait is determined by marginal benefit and marginal cost:

$$\alpha^k = 2(T^{k*} - T_0^k), \ k \in \{1,2,\dots,K\}. \quad (4)$$

The left-hand side of the equation is the marginal benefit, and the right-hand side is the marginal cost. Equation (4) shows that the optimal level of a productive trait is always above the baseline level: $T^{k*} > T_0^k$. For traits that are not relevant for academic achievement, students' optimal strategy is to avoid any costly changes: $T^{k*} = T_0^k$.

Peer Influences: We next consider how the presence of peers affects personality development. Suppose that the student is exposed to one peer or a group of peers whose baseline personality also consists of a vector of traits $\mathbb{T}_p = \left[T_p^1, T_p^2, T_p^3, \dots, T_p^K\right]$. For each trait, peer levels can be lower, higher, or equal to the student's initial level: $T_p^k \gtreqless T_0^k$. Peers may affect the costs of molding personality by acting as an example, providing a reference point, or creating peer pressure.[10] Through these mechanisms, it becomes less costly to converge toward, and more costly to deviate from, peer levels.

The dashed red line in Figure 6(a) illustrates how the cost function changes when the student is exposed to peers with higher levels of a trait ($T_p^k > T_0^k$). The dashed blue line shows how the cost function changes when the student is exposed to peers with lower levels of a trait ($T_p^k < T_0^k$). We assume that the cost function remains centered at T_0^k under the influence of peers—the costs are always the lowest and equal to zero when personality change is not initiated. This assumption highlights that changing personality is difficult and requires effort,

[10] Academic literature provides three possible channels for why this may happen. The role model or *social learning channel* captures the idea that students can learn from peers' characteristics, behaviors, and outcomes, and adapt their own personalities (Bandura & Walters, 1963; Bandura & McClelland, 1977; Moretti, 2011, Bursztyn et al., 2014). The *social comparison channel* states that students use peers as reference points to compare themselves to and become more similar to their peers' personalities (Suls et al., 2002; Rayo & Becker, 2007; Chen et al., 2010). The *group socialization channel* states that group members' personalities become more like each other due to within-group assimilation or the pressure of group norms (Harris, 1995; Rubin et al., 2006; Reitz et al., 2014).

and this aversion to change is stronger than the conforming effect of peers. Without loss of generality, we can formalize the cost function in the presence of peers as:

$$c\left(T^k; T_0^k, T_p^k\right) = \begin{cases} \frac{T_0^k}{T_p^k}\left(T^k - T_0^k\right)^2 \text{ , if } T^k \geq T_0^k \\ \frac{T_p^k}{T_0^k}\left(T_0^k - T^k\right)^2 \text{ , if } T^k < T_0^k \end{cases} \quad (5)$$

Equation (5) shows that when exposed to peers with the same trait level, $T_p^k = T_0^k$, costs are identical to the scenario without peers. Based on Equation (5) we can derive marginal costs.[11] As illustrated in Panel (b) of Figure 6, the MC is positive when $T^k > T_0^k$ and negative when $T^k < T_0^k$. Finally, we can derive the optimal trait levels as follows:

$$T^{k*}\left(T_0^k, T_p^k\right) = \begin{cases} \frac{T_p^k}{2T_0^k}\alpha^k + T_0^k \text{ , if } \alpha^k \geq 0 \\ \frac{T_0^k}{2T_p^k}\alpha^k + T_0^k \text{ , if } \alpha^k < 0 \end{cases} . \quad (6)$$

Prediction: The key prediction of this framework is that peer personality will only create spillover effects for traits that affect academic achievement, that is, when α^k is unequal to zero. Put differently, optimal trait levels increase in peer levels if a trait is relevant for academic performance. For traits that do not affect achievement, where $\alpha^k = 0$, baseline trait levels are optimal trait levels (i.e., the student has no incentive to change personality) and there will be no personality spillovers.

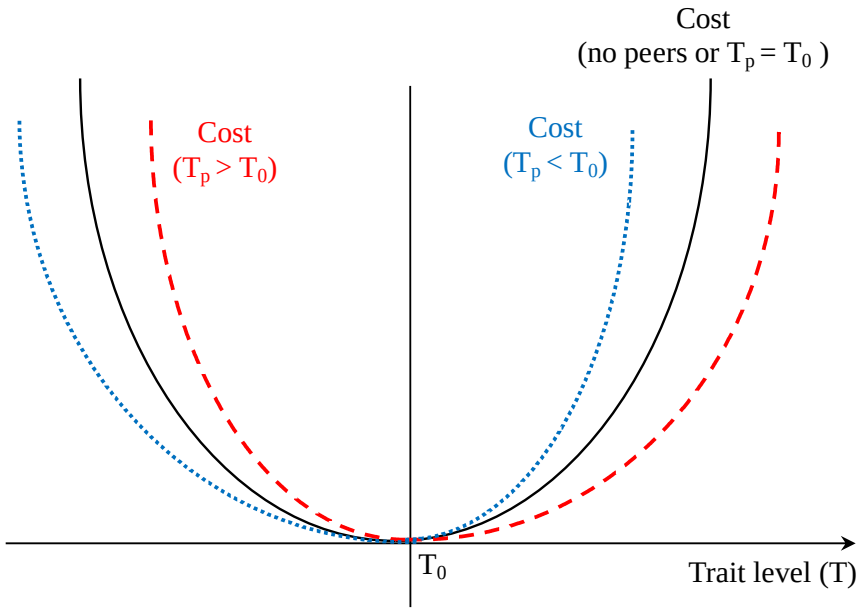
Figure 6(b) illustrates how peer trait levels affect own optimal trait levels. The presence of peers moves the optimal personality toward peers' personality. The optimal levels of these traits also move with the peers' levels: as T_p^k increases, T^{k*} increases.[12]

[11] $MC = \frac{2T_0^k}{T_p^k}(T^k - T_0^k)$ when $T^k \geq T_0^k$ and $MC = \frac{2T_p^k}{T_0^k}(T^k - T_0^k)$ when $T^k < T_0^k$.

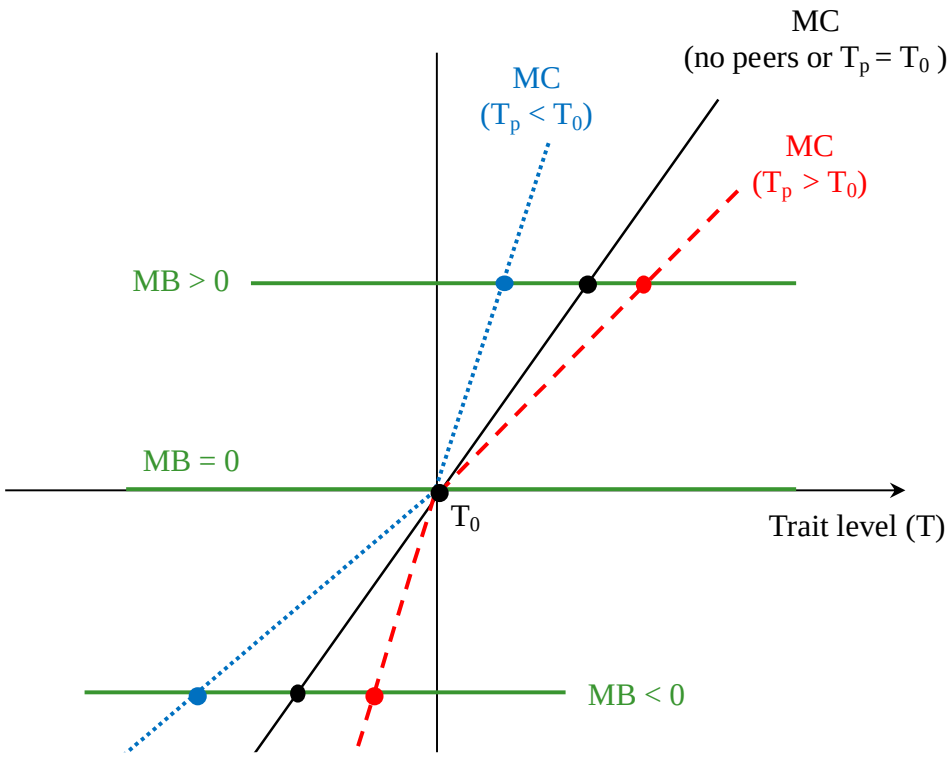
[12] Another way of interpreting the comparative statics or the positive spillover effect is that the student's own personality converges to peer personality. Our estimation of spillover effects uses this specification: $T = \beta_0 + \beta_1 T_p + \beta_2 T_0 + \varepsilon$, which is in essence a linear transformation of the following: $T - T_p = \delta_0 + \delta_1\left(T_0 - T_p\right) + \delta_2 T_0 + \eta$. Identifying $\beta_1 > 0$ is equal to identifying $\delta_1 < 1$. And $\delta_1 < 1$ means that the endline distance between one's own level of a trait and peers' level is smaller than the baseline distance. That is, personality converges to peer personality. Appendix Figure A6 shows that $\delta_1 < 1$ for competitiveness, openness, and conscientiousness in our setting.

Figure 6: Peers' Influence on Personality Development

(a) The Cost of Personality Change



(b) Marginal Costs and Benefits Determine the Optimal Personality Trait Level

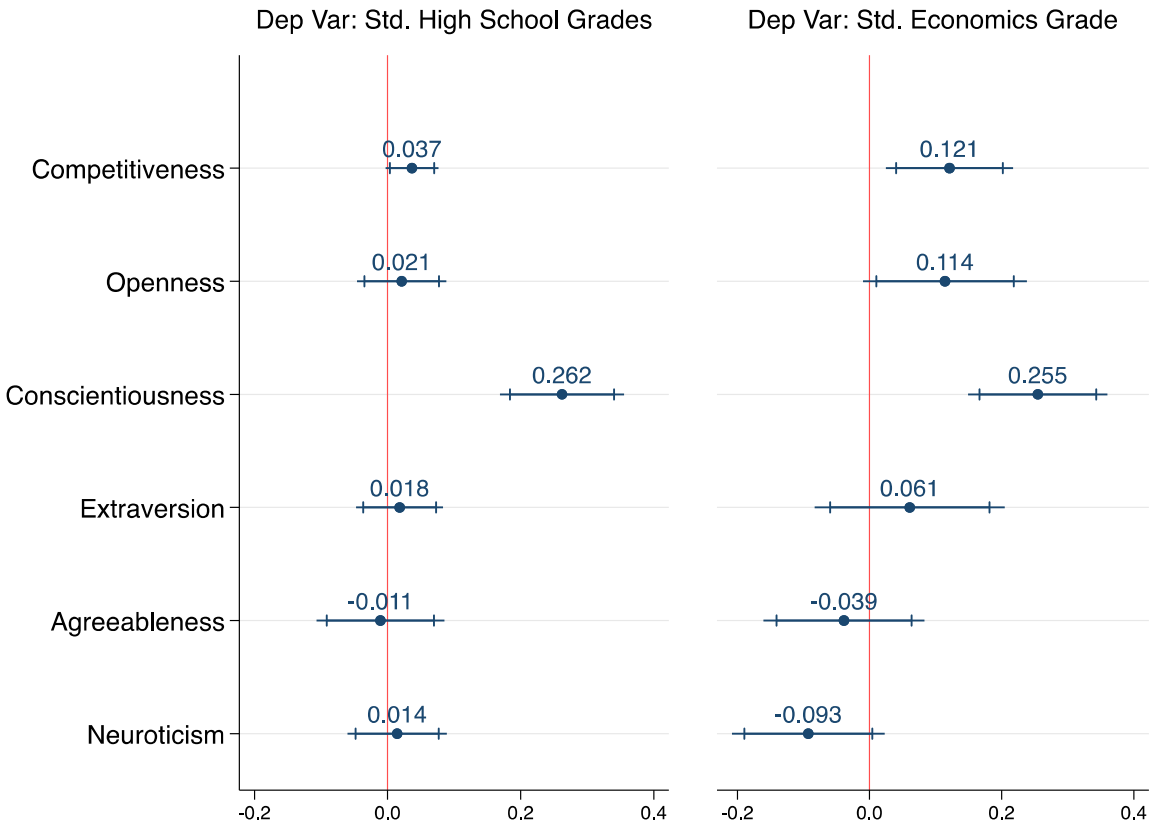


Notes: T_0 denotes the baseline level of a personality trait, and T_p denotes peers' baseline level of this trait. MC is the marginal cost and MB is the marginal benefit (in green). MB is negative when it is harmful to increase the level of a trait; MC is negative when the costs decrease with the level of a trait. We can think about these cases from the reverse direction: the marginal benefit and cost of lowering the level of trait are positive.

6.2 Empirical Evidence on the Academic Returns to Personality

The key prediction of our simple framework in the previous section is that we should only observe spillovers for traits that affect academic achievement. We therefore explore how different personality traits predict academic achievement. These apparent academic returns might motivate students to adopt the traits of their successful peers. Seeing that peers who are more competitive also perform better academically, might motivate students to become more competitive.

Figure 7: Correlation Between Personality and Academic Achievement



Notes: The figure shows how baseline personality traits predict the average standardized high school achievement and the first-year economics course grade. Estimates are based on 12 separate regressions controlling for all baseline characteristics except other personality traits. Standard errors are clustered at the study group level. Error bars indicate the 95% and 90% confidence intervals.

Figure 7 shows that conscientiousness and competitiveness are the only traits that significantly predict past and future achievement. A one SD increase in own conscientiousness predicts a 0.26 SD increase in high school grades and the economics grade (p-value < 0.001 for both). Similarly, a one SD increase in competitiveness predicts a 0.037 SD increase in high

school grades (p-value = 0.071) and a 0.12 SD increase in the economics grade (p-value = 0.014).

Results for openness are less clear. While we see that openness predicts higher grades in the economics course, this point estimate is only significant at the 10% level (p-value = 0.071). Openness does not significantly predict students' high school achievement. Extraversion, agreeableness, and neuroticism do not significantly predict either measure of student performance. Taken together, Figure 7 highlights that the persistent personality spillovers we document in Section 5 are only visible for traits that predict performance. Our evidence is consistent with the idea that students only adopt *productive* peer traits.

In summary, our model predicts that students change their personality to be more similar to their peers' for traits that affect academic achievement. In contrast, for traits that do affect academic achievement, students have no incentive to change their personality. Our evidence on the academic returns to personality is consistent with this model. We have shown that competitiveness, openness, and conscientiousness predict higher performance and create peer spillovers. Agreeableness, extraversion, and neuroticism do not predict higher performance nor do they create peer spillovers.

7. Conclusion

Attending university is formative for students. They socialize with their peers and adapt to their new environment. This paper represents the first systematic study on how the peer environment shapes students' personality. To identify the causal impact of peer personality, we conduct a field experiment that randomizes undergraduate students into study groups that have frequent social interactions.

We find that the peers students meet at the beginning of their studies have a lasting impact on their personality development. These spillovers are trait-specific. Students increase their competitiveness, openness, and conscientiousness if their study group consists of peers who score higher on these traits. Extraversion, agreeableness, and neuroticism appear unaffected by peer personality. Consistent with previous studies, we provide suggestive evidence that peer personality also influences student performance.

In order to reconcile why peers affect some traits but not others, we propose a simple model for peer-induced personality changes. In this model, students adjust their personality to increase their academic performance. Peers affect this process by acting as role models or by exercising peer pressure. For example, exposure to peers who are more conscientious makes it

easier for students to become more conscientious themselves. Whether students adopt peer traits, however, depends on the returns to different traits. Consistent with the predictions of our simple economic framework, we find that personality spillovers are limited to traits that are predictive of educational success. For these traits, students become more similar to their peers.

Our paper establishes that personality is malleable and shaped through socialization with peers. It provides the first causal link between the peer environment and personality development. The existence of these personality spillovers is important for both policymakers and practitioners in education who assign students to classes. Given the growing returns to non-cognitive skills in education and the labor market (Deming, 2017; Edin et al., 2022) it is becoming increasingly important to understand the causal determinants of personality change and to consider it as an explicit policy target.

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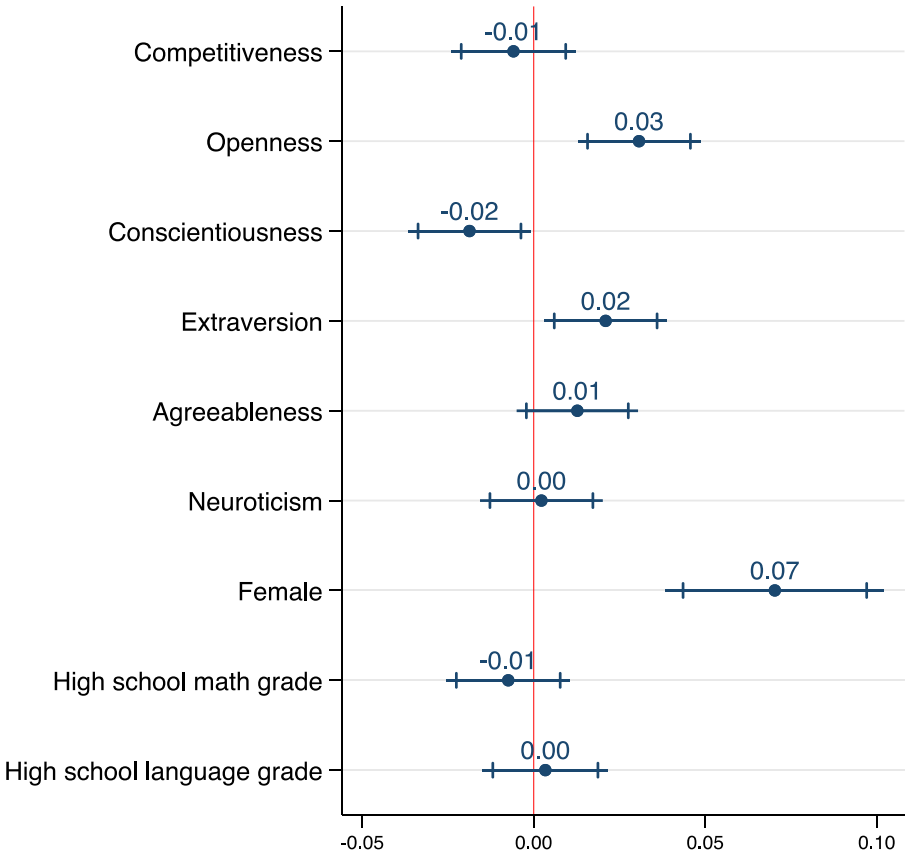
ONLINE APPENDIX

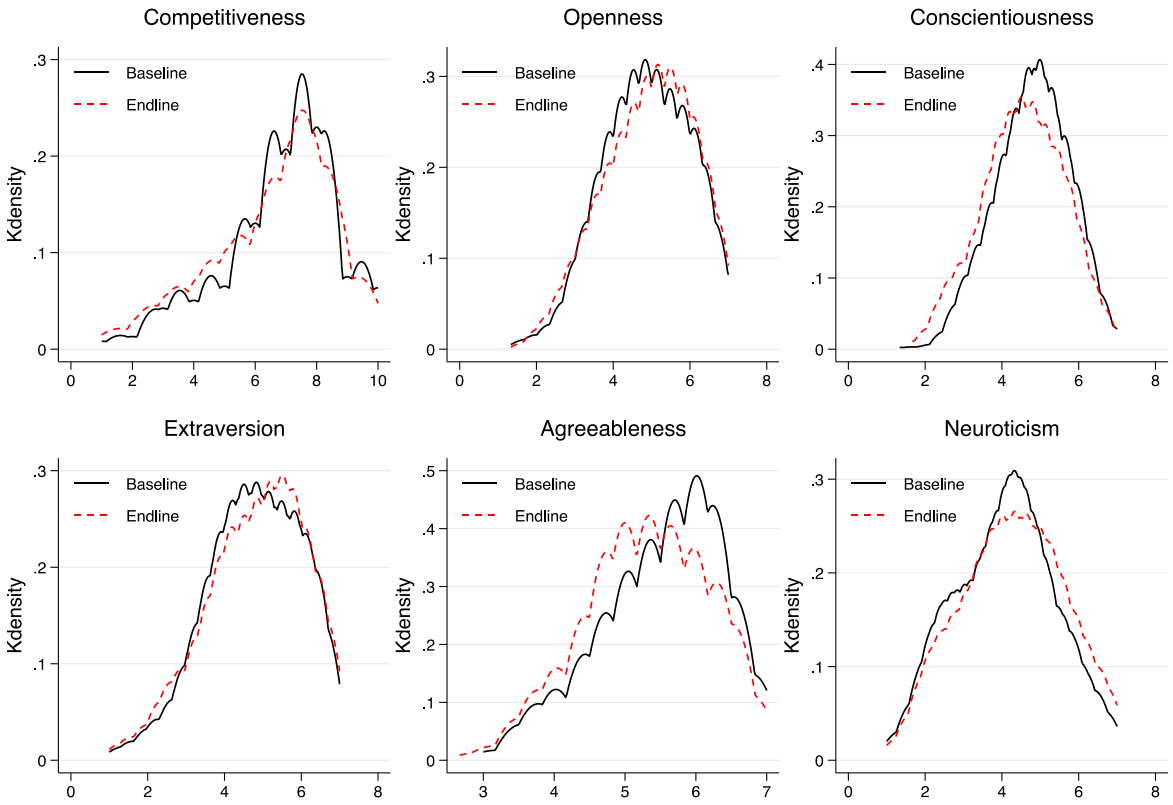
Appendix A: Additional Tables and Figures

Figure A1: Interest in Group Work – Who Registers for Small Study Groups?



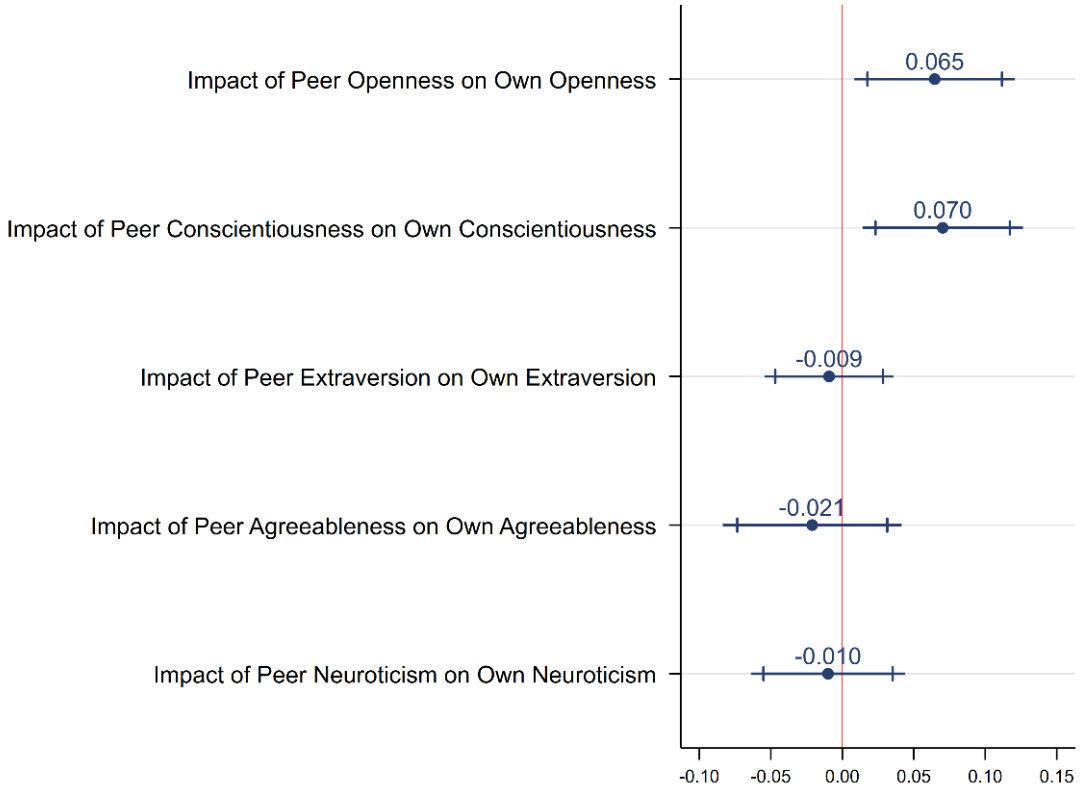
Notes: The figure shows how different student characteristics at baseline predict the sign-up decision for study groups. Each point estimate is derived from one OLS regression in which the dependent variable is an indicator for group registration and the independent variable is a baseline characteristic. Except for gender, all baseline characteristics are standardized. All regressions control for cohort and major fixed effects. Error bars indicate 95% and 90% confidence intervals based on robust standard errors.

Figure A2: The Distribution of Personality Traits at Baseline and Endline



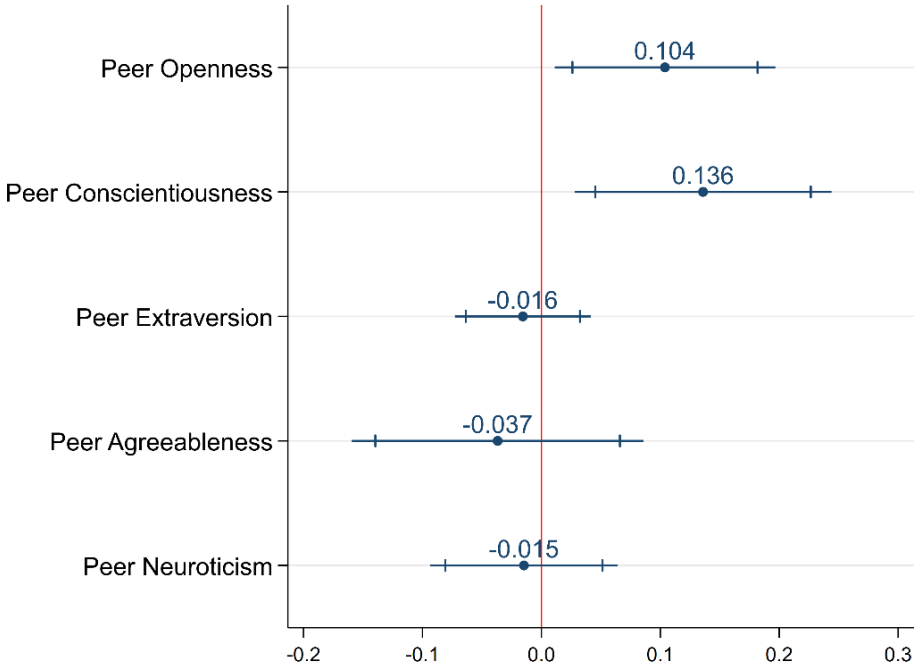
Notes: The figure shows the distribution of six personality traits at baseline and endline (the raw scores) for the estimation sample (N = 543).

Figure A3: Main Results Using Alternative Construction of Big Five Personality Measures



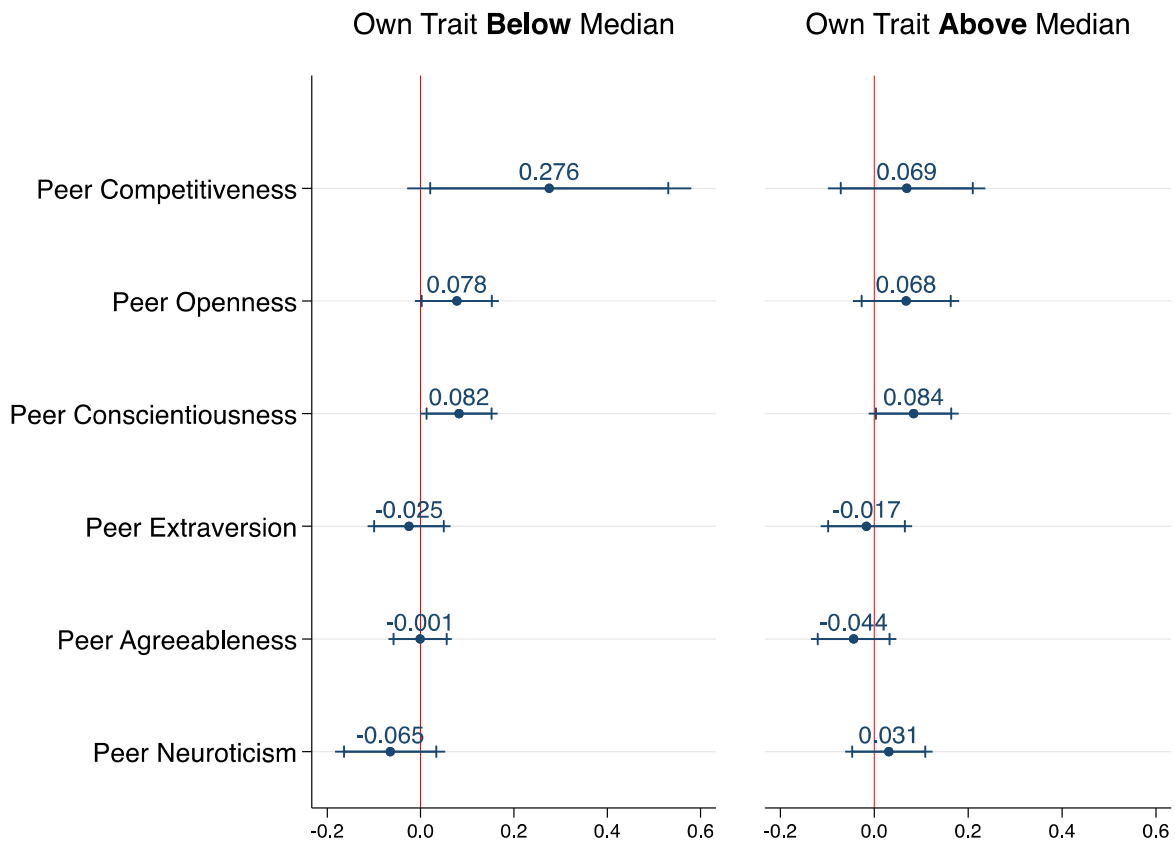
Notes: The table shows how peer personality affects own personality at endline when we construct each Big Five personality dimension as follows: we separately standardize the values of all items, then take the average of the three items capturing one trait, and then standardize this average again. Standard errors are clustered at the study group level. Error bars indicate 95% and 90% confidence intervals.

Figure A4: Main Results after Correction for Measurement Error using Obviously Related Instrumental Variables (ORIV)



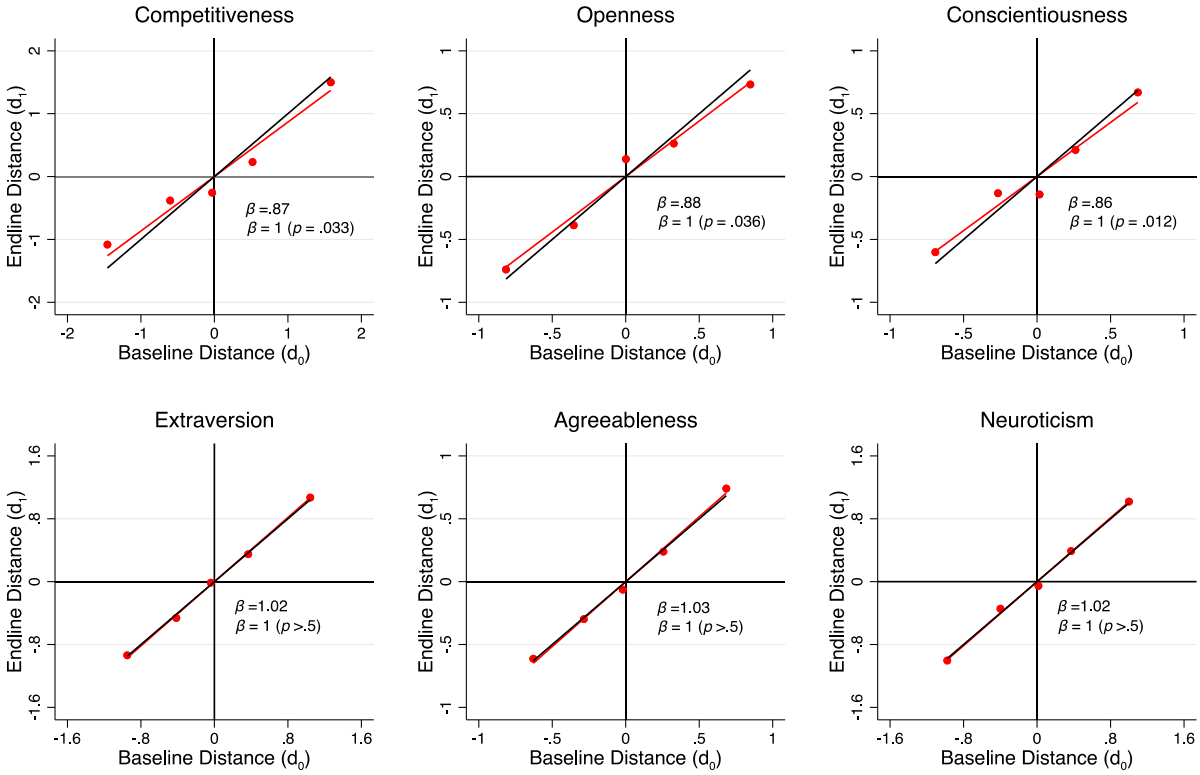
Notes: The figure shows the effects of peer personality on own personality estimated with 2SLS regressions based on the obviously related instrumental variables (ORIV) approach from Gillen et al. (2019). Each of the Big Five personality traits is measured with the mean of three questions. To employ the ORIV method, we duplicate observations six times and use one item as the IV for the other two items. More specifically, suppose we have three items of conscientiousness—consc1, consc2, and consc3. The independent variable is constructed as [consc1, consc1, consc2, consc2, consc3, consc3, …] and the IV is constructed as [consc2, consc3, consc3, consc1, consc1, consc2, …]. In the 2SLS regressions, we control for all the characteristics as listed in column (3) of Table 4 and cluster standard errors at the group level. Error bars indicate 95% and 90% confidence intervals.

Figure A5: Heterogeneous Effects: Own Trait Below Versus Above Median



Notes: The figure shows heterogeneous effects by the level of own personality at baseline. For each trait, we divide students into two subgroups: those with below-median and above-median levels of the trait. Then we estimate the impact of the peer trait on own trait for the two subgroups, respectively. All regressions control for all individual characteristics at baseline, as in column (3) of Table 4. None of the between-group differences in impacts reach significance at the 5% level. Error bars indicate 95% and 90% confidence intervals based on robust standard errors clustered at the study group level.

Figure A6: Trait-Specific Convergence to Peer Personality



Notes: The baseline distance (d_0) is the difference between a student's own level of a personality trait and peers' average level of this trait at baseline; the endline distance (d_1) is the difference between a student's own level at endline and peers' level at baseline. All baseline and endline distances are the residuals after controlling for all individual characteristics observed at baseline. The 45° line is a reference line representing the case of no convergence to peer personality: $d_1 = d_0$. The graph also plots the fitted linear lines and the slopes (β). We also test whether the estimated slopes are significantly different from one.

Table A1: Test for Balancing and Selective Attrition:
Impact of Baseline Peer Personality on Own Personality and Observing Endline Personality

	(1) Competitiveness	(2) Openness	(3) Conscientiousness	(4) Extraversion	(5) Agreeableness	(6) Neuroticism
Panel A: Dependent Variable: Own Personality at Baseline						
Peer Competitiveness	-0.076					
	(0.064)					
Peer Openness		-0.006				
		(0.057)				
Peer Conscientiousness			-0.099			
			(0.062)			
Peer Extraversion				0.030		
				(0.062)		
Peer Agreeableness					0.034	
					(0.045)	
Peer Neuroticism						-0.046
						(0.064)
Observations	792	792	792	792	792	792
R-squared	0.469	0.472	0.505	0.521	0.473	0.444
Panel B: Dependent Variable: Endline Response						
Peer Competitiveness	0.025					
	(0.017)					
Peer Openness		0.006				
		(0.018)				
Peer Conscientiousness			0.009			
			(0.018)			
Peer Extraversion				0.012		
				(0.016)		
Peer Agreeableness					0.007	
					(0.016)	
Peer Neuroticism						-0.013
						(0.016)
Observations	792	792	792	792	792	792
R-squared	0.013	0.011	0.011	0.011	0.011	0.011

Notes: Panel A examines whether peer personality predicts own personality at baseline; Panel B tests whether peer personality at baseline affects observing own personality at endline. Each column represents one OLS regression. The sample used for analysis is 792 students in 198 groups, where all students report their baseline personality traits. Out of the 792 students, 543 students (68.6%) report their endline personality. The independent variables of interest are standardized peer personality traits at baseline. All models control for cohort-by-program fixed effects. Results in Panel B are very similar even if we control for all individual characteristics at baseline. Panel A uses robust standard errors, and Panel B uses clustered standard errors (shown in parentheses).

Table A2: Pairwise Correlations Between Personality Traits

	(1) Competitiveness	(2) Openness	(3) Conscientiousness	(4) Extraversion	(5) Agreeableness	(6) Neuroticism
Competitiveness	1					
Openness	0.063	1				
	[0.141]					
Conscientiousness	0.289	0.035	1			
	[0.000]	[0.415]				
Extraversion	0.133	0.235	0.084	1		
	[0.002]	[0.000]	[0.051]			
Agreeableness	-0.025	0.088	0.211	0.064	1	
	[0.566]	[0.040]	[0.000]	[0.139]		
Neuroticism	-0.196	-0.012	-0.113	-0.245	0.011	1
	[0.000]	[0.774]	[0.009]	[0.000]	[0.795]	

Notes: Pairwise correlations at baseline (n = 543). *p*-values in brackets.

Table A3: Cronbach's Alpha Coefficient of Reliability

	(1) Baseline	(2) Endline	(3) Follow-Up
Openness	0.650	0.656	0.747
Conscientiousness	0.568	0.607	0.768
Extraversion	0.813	0.816	0.846
Agreeableness	0.488	0.410	0.550
Neuroticism	0.776	0.796	0.817

Notes: Each cell reports the Cronbach Alpha for each trait (measured with three items) at baseline, endline, and follow-up survey. In the follow-up survey, we have six items measuring openness and conscientiousness; thus, the alpha coefficients improved substantially. When we use the same three items as in the baseline and endline, the alpha coefficients are 0.624 and 0.589 for openness and conscientiousness.

Table A4: Stability of Personality – Within-Trait Correlation Across Time

	(1) Competitiveness	(2) Openness	(3) Conscientiousness	(4) Extraversion	(5) Agreeableness	(6) Neuroticism
Baseline & Endline	0.616	0.765	0.691	0.803	0.707	0.746
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Baseline & Follow-Up	0.620	0.705	0.634	0.793	0.651	0.731
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: The table shows the correlation between a trait's level at baseline and its level at endline or follow-up. *p*-values are in brackets.

Table A5: Edwin Leuven Test of Randomization

	F-statistic	*p*-value
Competitiveness	1.089	0.225
Openness	1.110	0.178
Conscientiousness	0.849	0.915
Extraversion	1.195	0.058
Agreeableness	0.976	0.574
Neuroticism	0.917	0.765
Female	1.050	0.328
High School Math Grade	1.034	0.381
High School Language Grade	1.075	0.260

Notes: We regress each baseline characteristic on study group dummies and test the joint significance of group dummies. The table reports the *F*-statistic and *p*-value separately for each baseline characteristic.

Table A6: Cross-Trait Spillover Matrix with Bonferroni Correction

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Own Personality Trait at Endline					
	Competitiveness	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism
Peer Competitiveness	**0.082**	0.012	0.009	-0.016	-0.017	0.001
	[0.028]	[0.715]	[0.741]	[0.569]	[0.601]	[0.963]
	{0.983}	{1.000}	{1.000}	{1.000}	{1.000}	{1.000}
Peer Openness	-0.072	**0.069**	-0.013	0.022	-0.057	0.023
	[0.047]	**[0.031]**	[0.667]	[0.393]	[0.071]	[0.388]
	{1.000}	**{1.000}**	{1.000}	{1.000}	{1.000}	{1.000}
Peer Conscientiousness	-0.011	0.005	**0.101**	-0.000	-0.017	0.049
	[0.765]	[0.872]	**[0.001]**	[0.998]	[0.639]	[0.121]
	{1.000}	{1.000}	**{0.036}**	{1.000}	{1.000}	{1.000}
Peer Extraversion	0.008	-0.055	-0.041	**-0.001**	-0.002	-0.055
	[0.809]	[0.063]	[0.229]	**[0.963]**	[0.955]	[0.072]
	{1.000}	{1.000}	{1.000}	**{1.000}**	{1.000}	{1.000}
Peer Agreeableness	-0.001	0.011	-0.034	0.041	**-0.009**	-0.020
	[0.970]	[0.738]	[0.260]	[0.102]	**[0.778]**	[0.523]
	{1.000}	{1.000}	{1.000}	{1.000}	**{1.000}**	{1.000}
Peer Neuroticism	-0.021	0.005	0.057	0.030	-0.008	**-0.013**
	[0.541]	[0.850]	[0.057]	[0.217]	[0.789]	**[0.654]**
	{1.000}	{1.000}	{1.000}	{1.000}	{1.000}	**{1.000}**

Notes: Each column represents one OLS regression in which the dependent variable is one of the six own personality traits at the endline (standardized). The independent variables of interest are six peer personality traits at the baseline (standardized). The specification of each regression is the same as in column (5) of Table 4. *p*-values based on clustered standard errors are in brackets, and Bonferroni-corrected *p*-values are in braces.

Table A7: Heterogeneous Impacts of Peer Personality on Own Personality

	(1)	(2)	(3)	(4)	(5)	(6)
	Own Type of Trait			Own Type of Trait		
	Low	Middle	High	Low	Middle	High
	Panel A: Competitiveness			**Panel B: Openness**		
Share of Low-Type Peers	-0.481*	-0.189	-0.226	-0.056	-0.491**	0.009
	(0.252)	(0.185)	(0.244)	(0.194)	(0.198)	(0.239)
Share of High-Type Peers	0.116	-0.038	-0.315	0.105	-0.299	0.061
	(0.330)	(0.245)	(0.288)	(0.210)	(0.229)	(0.227)
	Panel C: Conscientiousness			**Panel D: Extraversion**		
Share of Low-Type Peers	-0.095	0.254	0.381	0.089	-0.139	-0.068
	(0.227)	(0.244)	(0.259)	(0.168)	(0.248)	(0.171)
Share of High-Type Peers	-0.038	0.579**	0.573*	-0.368	0.060	-0.090
	(0.310)	(0.233)	(0.320)	(0.255)	(0.225)	(0.164)
	Panel E: Agreeableness			**Panel F: Neuroticism**		
Share of Low-Type Peers	-0.116	0.197	0.070	0.417*	0.210	0.090
	(0.173)	(0.231)	(0.305)	(0.214)	(0.232)	(0.229)
Share of High-Type Peers	-0.537**	-0.082	0.014	0.152	0.272	-0.088
	(0.211)	(0.281)	(0.355)	(0.205)	(0.217)	(0.282)

Notes: The table shows how the proportions of low- and high-type peers in the study group affect own personality separately for students with low, middle, and high levels of a personality trait. Each column in each panel represents one OLS regression. For each panel, the outcome variable is the own standardized personality trait at endline and the independent variables are the proportion of peers with low and high levels of a personality trait at baseline. All models control for all individual characteristics at baseline, as in column (3) of Table 4. Robust standard errors clustered at the study group level are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A8: The Impact of Peer Personality on Follow-Up Survey Response

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable: Follow-Up Survey Response						
Peer Competitiveness	0.014					
	(0.022)					
Peer Openness		0.019				
		(0.022)				
Peer Conscientiousness			0.004			
			(0.024)			
Peer Extraversion				-0.035*		
				(0.021)		
Peer Agreeableness					0.019	
					(0.020)	
Peer Neuroticism						-0.004
						(0.023)
Observations	543	543	543	543	543	543
R-squared	0.059	0.059	0.058	0.063	0.059	0.058

Notes: Each column represents one OLS regression in which the dependent variable is an indicator for whether a student reports personality in the follow-up survey. All models use the same specification of column (3) of Table 4. Robust standard errors clustered at the study group level are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.