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## The impact of education on personality: Evidence from a German high school reform

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# IAB-Discussion Paper

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Articles on labour market issues

## The impact of education on personality Evidence from a German high school reform

Sarah Dahmann  
Silke Anger

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# The impact of education on personality

## Evidence from a German high school reform

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Mit der Reihe „IAB-Discussion Paper“ will das Forschungsinstitut der Bundesagentur für Arbeit den Dialog mit der externen Wissenschaft intensivieren. Durch die rasche Verbreitung von Forschungsergebnissen über das Internet soll noch vor Drucklegung Kritik angeregt und Qualität gesichert werden.

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## Abstract

This paper investigates the short-term effects of a reduction in the length of high school on students' personality traits using a school reform carried out at the state level in Germany as a quasi-natural experiment. Starting in 2001, academic-track high school (*Gymnasium*) was reduced from nine to eight years in most of Germany's federal states, leaving the overall curriculum unchanged. This enabled students to obtain a university entrance qualification (*Abitur*) after a total of only 12 rather than 13 years of schooling. We exploit the variation in the length of academic-track high school over time and across states to identify the effect of schooling on students' Big Five personality traits and on their locus of control. Using rich data on adolescents and young adults from the German Socio-Economic Panel (SOEP) study, our estimates show that shortening high school caused students on average to be more extroverted and less emotionally stable. Our estimates point to important heterogeneous effects. In addition to differences between East and West Germany, we find that male students and students from disrupted families showed stronger personality changes following the reform: they became more agreeable and more extroverted, respectively. We conclude that the educational system plays an important role in shaping adolescents' personality traits.

## Zusammenfassung

Diese Studie untersucht die kurzfristigen Effekte der Verkürzung der Gymnasialzeit auf die Persönlichkeitsmerkmale von Schülern und verwendet dafür eine auf Bundeslandebene durchgeführte Schulreform als quasi-natürliches Experiment. Seit 2001 wurde in den meisten deutschen Bundesländern die Gymnasialzeit von neun auf acht Jahre unter Beibehaltung des Gesamtlehrplans reduziert. Dadurch konnten Abiturienten nach nur 12 anstatt 13 Schuljahren die Hochschulzugangsberechtigung erlangen. Wir nutzen die Variation in der Gymnasialdauer über die Zeit und zwischen Bundesländern, um den Effekt von Schule auf die „Big Five“ Persönlichkeitsmerkmale und die Kontrollüberzeugung von Schülern zu identifizieren. Auf Basis umfangreicher Daten zu Jugendlichen und jungen Erwachsenen aus der Längsschnittstudie Sozio-oekonomisches Panel (SOEP) zeigen unsere Schätzergebnisse, dass die Verkürzung der Gymnasialdauer dazu geführt hat, dass Gymnasiasten durchschnittlich extrovertierter und weniger emotional stabil sind als vor der Reform. Unsere Schätzungen deuten auf wichtige heterogene Effekte hin: zusätzlich zu Unterschieden zwischen Ost- und Westdeutschland finden wir, dass männliche Schüler und Schüler aus nicht-intakten Familien stärkere Persönlichkeitsveränderungen nach der Reform aufweisen; sie wurden sozial verträglicher beziehungsweise extrovertierter. Wir schlussfolgern, dass das Bildungssystem eine bedeutende Rolle bei der Entwicklung der Persönlichkeitsmerkmale von Jugendlichen spielt.

**JEL classification:** I21, I28, J24

**Keywords:** Non-cognitive Skills, Big Five, Locus of Control, Skill Formation, High School Reform

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# 1 Introduction

In recent years, a growing body of literature has emerged on the importance of personality traits as determinants of individual economic and social outcomes.<sup>1</sup> Studies investigating the impact of personality on labor market outcomes show that certain characteristics such as emotional stability are rewarded with higher wages, while characteristics such as agreeableness are penalized with lower wages (Heckman/Stixrud/Urzua, 2006; Nyhus/Pons, 2005; Heineck/Anger, 2010). Furthermore, personality has been shown to affect labor market success through occupational sorting (John/Thomsen, 2014) and job search behavior (Caliendo/Cobb-Clark/Uhlendorff, 2014). Not only has personality been linked to specific labor market outcomes; it has also been found to affect educational success, as shown by studies on academic performance (Piatek/Pinger, 2010; Duckworth/Seligman, 2005) and school dropout probability (Coneus/Gernandt/Saam, 2011). Moreover, research shows that personality traits are at least as important as cognitive skills in determining social outcomes such as criminal behavior, marital stability, and health and mortality (Heckman/Pinto/Savelyev, 2013; Roberts et al., 2007).

While the association between personality traits and economic and social outcomes is widely acknowledged, there is far less empirical economic research on the factors that affect the formation of these non-cognitive skills. The literature has identified two main channels that shape non-cognitive skill formation: *nature*, referring to the fact that personality is strongly heritable, and *nurture*, encompassing all environmental factors such as culture, social factors, family background, and individual or situational factors which may influence personality. In their model of skill formation, Cunha/Heckman (2007) argue that it is the interaction of these mechanisms – nature *and* nurture – that determines skill formation, but that the two channels cannot be disentangled. Their model suggests that the development of skills takes place especially during the early (pre-)educational period in life. This is consistent with the psychology literature, according to which personality traits develop mainly during childhood and adolescence, and remain relatively stable later in life (Costa/McCrae, 1994). As a nurturing factor, education during childhood and adolescence may therefore constitute a critical determinant in an individual's long-term formation of personality. Yet, there is little direct evidence on the effect of schooling on personality traits. Most of the research focuses on the United States and investigates interventions targeting children at a relatively young age, such as the Perry Preschool Program, which is aimed at three- to four-year-old preschoolers (Heckman/Pinto/Savelyev, 2013), and the Project STAR (Dee/West, 2008).

In the present paper, we focus on the impact of schooling on personality traits in adolescence. Our research question is threefold: First, we assess whether the educational system, and more specifically a reduction in the length of high school, affects adolescents' personalities. Second, we examine heterogeneous effects by analyzing which students are most likely to exhibit changes in personality following the changes in the educational system. And finally, we investigate the underlying mechanisms by disentangling various potential channels of impact.

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<sup>1</sup> For a detailed overview, see Almlund et al. (2011).

To address these questions, we use a nationwide educational reform carried out in Germany in the 2000s that shortened academic-track high school by one year, reducing the total number of years of school attendance from 13 to 12 years, leaving the overall curriculum unchanged, as an exogenous variation in schooling. We exploit the variation over time and across federal states to analyze causal effects of schooling on students' personality traits, which are measured by the dimensions of the Big Five personality inventory (Openness, Conscientiousness, Agreeableness, Extraversion, Neuroticism), and locus of control. Using data on adolescents and young adults from the German Socio-Economic Panel (SOEP) study, we find that the reduction in the length of high school by one year led to considerably higher extraversion and lower emotional stability among high school students. Moreover, our estimates point to important heterogeneous effects. While the increase in extraversion was driven by students from non-intact families, the decrease in emotional stability was more pronounced among students in East Germany. Furthermore, male students and students from disrupted families were more agreeable and more open, respectively, following the reform. Children with non-working mothers faced a decline in openness, while students with migration background experienced an increase in conscientiousness.

We find suggestive evidence that the reform effect is driven by the increased learning intensity, which adversely affects school performance and emotions, and by stronger student-teacher or student-student interactions as a result of longer school days, and not by a change in leisure-time activities. We conclude that the educational system plays an important role in shaping adolescents' personality traits.

Our paper adds to the existing literature in several ways. First, to the best of our knowledge, this is the first representative study that exploits a nationwide change in the educational system as quasi-natural experiment to analyze the causal effect of education on personality. In contrast to previous studies on the impact of schooling on the malleability of personality traits in young people, our treatment is large-scale and not locally restricted, as it affects students from almost an entire country. Second, to identify the causal effects of the educational reform, we exploit variation in schooling over time and across states. The high school reform has been gradually introduced in almost all of Germany's federal states. Hence, we are able to isolate the causal effect of the change in the educational system from any other potential influential factors or policy changes. Furthermore, we reduce the risk that potential unobserved effects bias our estimates by including students who graduated several years before and after the reform, which enables us to establish a long-lasting effect of the reform rather than an artifact of its implementation. Third, our data provide rich information on individuals' socio-economic backgrounds, which allows us to examine whether the personalities of particular groups of students were more malleable following the reform. Pre-reform characteristics of students and their families such as migration background, parental education, or household income may affect the ability to cope with reform-induced changes. As a consequence, different students may react differently to the high school reform in terms of both the likelihood of changes in personality traits and the type of personality traits affected. Fourth, by examining the malleability of personality in adolescence, we complement previous studies on skill formation that focused primarily



on young children. Evidence on whether personality is malleable even in adolescence is crucial for policy makers who may want to target individuals who are too old for childhood interventions. Furthermore, educational policy should take potential second-order effects on students into account when implementing school reforms. Finally, by investigating effects of education on personality in Germany, we complement the previous largely US-based evidence. Differences in institutional settings between the US and other countries could lead to different processes of skill formation, in which education, family factors, and other determinants of personality may play different roles. By comparing findings for Germany and the US, we are able to draw conclusions on the importance of educational settings for non-cognitive skills.

The next section presents the theoretical background on skill formation and gives an overview of previous research. Section 3 explains the reform and discusses potential effects on adolescents' personality traits. Section 4 describes the data and the empirical strategy, and Section 5 presents the results. Section 6 elaborates on several robustness checks. Section 7 concludes and discusses the implications of our findings.

## 2 Theoretical Background and Previous Literature

Personality traits are a significant part of an individual's non-cognitive skills.<sup>2</sup> Both cognitive abilities and non-cognitive skills constitute personal skills, which belong to an individual's overall human capital. A prominent approach to describe the formation of such skills has been developed by Cunha/Heckman (2007). They propose that an individual's present skill stock depends on his or her past skill stock, previous investments, and environmental characteristics, according to the following model:

$$\theta_{t+1} = f_t(\theta_t, I_t, h) \quad (1)$$

where a vector of skill stocks at age  $t + 1$ ,  $\theta_{t+1}$ , depends in some functional form  $f(\cdot)$  on the past vector of skill stocks (with initial endowment  $\theta_1$ ), on the investment in period  $t$ ,  $I_t$ , and on parental, or more generally environmental, characteristics  $h$ . In this model, Cunha and Heckman propose a multiplier effect driven by two mechanisms, *self-productivity* and *dynamic complementarity*. The former, self-productivity, occurs when skills persist such that higher skills in one period create higher skills in the subsequent period. This is not restricted to one and the same skill, but also applies to cross effects between different skills, and is the case whenever  $\partial f_t(\theta_t, I_t, h)/\partial \theta_t > 0$ . The latter, dynamic complementarity, manifests that the productivity of an investment is increasing with higher existing skills and occurs whenever  $\partial^2 f_t(\theta_t, I_t, h)/\partial \theta_t \partial I_t' > 0$ . Cunha/Heckman (2008) test and verify both propositions empirically. The resulting multiplier effect suggests that investments are most productive in early stages in life, which implies that childhood constitutes a bottleneck period for skill formation.

Several intervention studies have therefore been targeted at children of preschool age. Even though most of these do not focus primarily on improving personality traits, they make it possible to study the impact of education on personality. A prominent example is the Perry Preschool Program, which provided extra classes and teacher visits at home to three- to four-year-olds. The program led to large benefits in later-life outcomes, such as improved labor market outcomes and a reduction in criminal incidence (Schweinhart et al., 2005). Though the program did not focus primarily on improving personality traits, Heckman/Pinto/Savelyev (2013) show that the reported benefits are fully attributable to a permanent improvement in non-cognitive skills, while there has not been any lasting effect on cognitive abilities. The project STAR revealed similar results; children who were randomly assigned to small kindergarten classrooms showed positive changes in personality, assessed by teacher-reviews measured in fourth grade (Dee/West, 2008). Other interventions, such as the PATHS program, focused more explicitly on improving non-cognitive skills and showed that personality traits are malleable during childhood (Bierman et al., 2010).

While Cunha/Heckman (2008) find a strong multiplier effect of early investments, their empirical results also reveal that the critical period of investment lasts longer in life for

<sup>2</sup> Examples of further non-cognitive skills are trust and (e.g., time or risk) preferences (see, e.g., Almlund et al., 2011).

non-cognitive skills than for cognitive skills. Yet the evidence on malleability of personality traits in adolescence remains limited. Martins (2010) shows that a program targeted at 13- to 15-year-olds in Portugal improved student achievement by increasing motivation, self-esteem, and study skills. Furthermore, the National Guard Youth ChalleNGe program in the United States increased discipline and emotional stability among high school dropouts (Bloom/Gardenhire-Crooks/Mandsager, 2009). Exploiting changes in the compulsory minimum school leaving age in Australia, Li/Powdthavee (2014) find that an increased number of years of schooling raises individuals' conscientiousness and internal locus of control, based on data on adult respondents from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. Using data from the National Longitudinal Survey of Youth 1979 (NLSY79) Heckman/Stixrud/Urzua (2006) find that locus of control is affected primarily by high school attendance and not by college attendance, which points towards a potential point of exhaustion of malleability in late adolescence.

Thiel/Thomsen/Büttner (2014) exploit the same high school reform as we do – the reduction in the length of academic-track high school – in one East German federal state (Saxony-Anhalt).<sup>3</sup> They do not find any significant effect of increased learning intensity on adolescent personality development. Their analysis focuses, however, on only one of Germany's 16 federal states. Since this East German state prolonged high school by one year only shortly before the reform (following German reunification), the implementation and consequences of the reform may not be representative for the whole of Germany. Furthermore, since time and reform effects cannot be separated, their estimates might be biased by other factors affecting the region. Moreover, their analysis only takes into account the double cohort of graduates, that is, the last cohort graduating from high school with a total of 13 years of schooling and the first cohort graduating after 12 years. This double cohort of graduates undoubtedly features peculiarities that may lead to confounding effects and potentially offset true effects of the reform.<sup>4</sup>

Our study is unique in the sense that it uses a nationwide quasi-experiment and representative data to investigate the causal impact of education on personality. Furthermore, none of the previous studies investigated heterogeneous effects, distinguishing between subgroups of students that may have been affected differently by the educational reform. Finally, our rich information on individual characteristics and activities allow us to investigate potential mechanisms by which the reform affected personality traits.

<sup>3</sup> For a detailed description of the high school reform and the German education system in general, see Section 3.

<sup>4</sup> For example, increased competition due to a limited number of available jobs may lead students who graduate within 13 years to be worried or feel pressure because employers may prefer job candidates from the younger cohort given that they hold the same educational degree. As a consequence, any potential increase in stress among the younger cohort as a true effect of the reform, for example due to a higher workload, would therefore be offset and would not be measurable.

## 3 The German High School Reform

### 3.1 Institutional Background

In Germany, educational policy is the responsibility of the federal states (*Bundesländer*). In all of the states, children start elementary school at the age of six and continue to secondary school after four years in most cases.<sup>5</sup> The German educational system comprises three basic types of secondary school: *Hauptschule*, *Realschule*, and *Gymnasium*. These are listed in ascending order by the level of education provided; only successful completion of the *Gymnasium* (henceforth referred to as academic-track or simply high school) leads to the *Abitur* (henceforth referred to as high school diploma), the university entrance qualification. Some states also have comprehensive schools, which combine the aforementioned three secondary school types.

Until 2001, high school lasted nine years in almost all federal states (except for Saxony and Thuringia), resulting in a total of 13 years of schooling to obtain a high school diploma.<sup>6</sup> The relatively long time spent in the university preparatory track compared to most other industrialized countries was considered a disadvantage for German graduates, who therefore entered the labor market later than in other countries. Starting in 2001, most federal states introduced a school reform to shorten the length of high school from nine to eight years for newly entering students, reducing overall schooling from 13 to 12 years.<sup>7</sup> This reform allowed high school students earlier graduation and earlier labor market entry, which was attractive for several reasons.

First, the reform envisaged that graduating younger would help German school-leavers to be more competitive in the international labor market. Second, by shortening secondary school duration, the reform was to make the German education system less costly per student and hence more efficient. Finally, the reform was meant to address the challenges emerging in many Western countries due to demographic changes. By expanding the labor force by one birth cohort, the reform was designed not only to reduce the shortage of skilled workers but also to solve the problem of an increasing disparity between a reduced group of young workers contributing to the pension scheme and a rising share of an older population receiving pension benefits. In contrast, opponents of the reform feared that shortening the high school track would harm the quality of education.

The German high school reform was introduced in most of the federal states between 2001

<sup>5</sup> An exception are the states Berlin and Brandenburg, where elementary school encompasses the first six years of schooling. In Mecklenburg-West Pomerania, the four years of elementary school are followed by another two years of orientation phase. In these three states, the placement to different secondary school tracks thus takes place at grade seven, as opposed to grade five.

<sup>6</sup> In the former East, students finished secondary school after 12 years. Following reunification, the East German states of Brandenburg, Mecklenburg-West Pomerania, and Saxony-Anhalt adapted to West German standards and increased total years of schooling from 12 to 13 in the 1990s. In contrast, Saxony and Thuringia have kept 12 years of schooling.

<sup>7</sup> In the states of Berlin, Brandenburg, and Mecklenburg-West Pomerania, where tracking takes place in grade seven, the reform reduced high school from seven to six years. In the following, whenever we refer to the year of high school entry, we mean the year in which students began grade five and pursued the academic track. Analogously, high school refers to the last eight (or nine) years of school from grade five until graduation.

and 2007.<sup>8</sup> Exceptions are Rhineland-Palatinate, where the length of high school has been reduced only in selected schools so far, and Saxony and Thuringia, which have not reduced the length of high school. The educational reform was first implemented in the state of Saarland in the 2001/2002 school year. Other states followed up to 2007. Since the reform was mandatory for all high schools within a state, it was almost impossible for students to avoid the change in the educational system.<sup>9</sup> A detailed overview of the introduction of the reform and the first cohorts to be affected, broken down by federal state, is given in Table 1.

Table 1: Introduction of the Reform by State

State	Implementation of the reform	Graduation of first cohort affected
Saxony <sup>(*)</sup>	—	—
Thuringia <sup>(*)</sup>	—	—
Saarland	2001	2009
Hamburg	2002	2010
Saxony-Anhalt	2003	2007
Mecklenburg-West Pomerania	2004	2008
Bavaria	2004	2011
Lower Saxony	2004	2011
Baden-Wuerttemberg	2004	2012
Bremen	2004	2012
Hesse <sup>(**)</sup>	2004	2012, 2013, 2014
North Rhine-Westphalia	2005	2013
Berlin	2006	2012
Brandenburg	2006	2012
Schleswig-Holstein	2007	2016
Rhineland-Palatinate <sup>(***)</sup>	2007	—

(\*) Saxony and Thuringia kept the 12-year school system after reunification.

(\*\*) Gradual introduction: school year 2004/05 (10% of all schools); 2005/06 (60%); 2006/07 (30%).

(\*\*\*) In Rhineland-Palatinate, the reform has only been introduced in selected schools so far.

Source: Autorengruppe Bildungsberichterstattung (2010)

While it did reduce the total duration of schooling, the reform did *not* reduce the overall curriculum. The total number of hours required for graduation (265 year-week hours) between grade five and graduation were maintained (see KMK, 2013). The decision on how to distribute the total year-week hours over the remaining grades was left up to the individual schools, but the great majority of schools allocated the increase in hours to grades seven to nine, when students are aged 13 to 16. As a result, students attended up to 36 hours per week in school after the reform, compared to less than 30 before the reform.<sup>10</sup> This increase in workload per unit of time led to a higher learning intensity (per week), and prolonged school days.<sup>11</sup>

<sup>8</sup> Currently, schools in some states can choose (by parental vote) whether to return to 13 years of schooling. So far, however, almost no school decided to do so. In any case, this possibility has only been in existence for a very short time and therefore does not concern our sample of students described in Section 4.

<sup>9</sup> See Section 6.5 for a discussion on non-compliance with the reform.

<sup>10</sup> Note that an increase in class hours is accompanied by an increase in homework. Therefore, the true increase in workload per week is even higher than the pure increase in class hours.

<sup>11</sup> At the same time, there was a substantial increase in all-day high schools. By 2010, almost half of all

### 3.2 Anticipated Effects of the Reform on Personality

Since the overall curriculum and the requirements for the German high school diploma were left unchanged, the policy reform increased the learning intensity for students through a greater number of hours per school year. This might have had various unintended consequences such as an increase in grade repetition or a decrease in mental health due to a higher stress level.

A similar change in the German education system took place in the 1960s, moving the start of the academic year to an earlier date. In 1966 and 1967, the academic year was shortened, reducing the total amount of time in school by two-thirds of a year for students enrolled in school at that time, while the basic curriculum was left unchanged. Pischke (2007) finds that there were no adverse effects of shorter school duration on earnings and employment later in life, and concludes that the more recent high school reform (the reform used in this study), which reduced the length of high school by one year, may not compromise labor market success of affected students in general. However, according to Pischke (2007) the shorter school years increased grade repetition in elementary schools and led to fewer students attending higher secondary school tracks. This may point to important heterogeneous effects, as the most poorly performing students appear to be less likely to keep up with the increased learning intensity. Furthermore, Pischke (2007) notes that the shorter instructional time may induce costs by shifting students' time away from activities that are not directly linked to labor market outcomes such as voting or artistic pursuits.

Since the recent reduction in the length of high school by one year represented a much greater change than the shortened academic years of the 1960s, it may well be that it also impacted students' personalities. In this study, we focus on the personality concept of the Five Factor Model (McCrae/Costa, 1999), which comprises five psychological dimensions, also known as the *Big Five* – openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. Openness to experience describes an individual's creativity and imagination, while conscientiousness refers to the propensity to work effectively, efficiently, and thoroughly as opposed to being disorganized and lazy. Extraversion is defined as an individual's tendency to be outgoing, sociable, and communicative rather than being reserved. Agreeableness describes individuals who are polite, forgiving, and kind to others. Neuroticism measures emotional instability, that is, whether a person tends to worry and get nervous easily rather than coping well with stress and being relaxed. In addition to these Big Five personality traits, we also include the concept of locus of control, which refers to an individual's perception of control over his or her life (Rotter, 1966).

Each of these personality traits may be affected differently by the different consequences of the German high school reform. First, the higher workload may have increased the pressure on students, and hence decreased their emotional stability, that is, increased their neuroticism. At the same time, we hypothesize that the compression of the curriculum

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high schools had become all-day schools compared to only about 12% in 2002 (Autorengruppe Bildungsberichterstattung, 2012). In addition to the compulsory curriculum, most of these all-day schools offer further activities on a voluntary basis, which is, however, also the case for more traditional schools.

required a higher level of self-discipline, that is, it increased students' conscientiousness about performing well in school. The reform may have had ambiguous effects on agreeableness, since, on the one hand, more cooperation may be required to cope with the higher workload, and on the other hand, students may become more selfish in a more competitive environment. Likewise, the effect on locus of control may be positive or negative depending on whether students recognize that they are able to cope or not with the increased pressure induced by external factors. Second, spending more time in school and having less leisure-time may affect social skills, that is, the agreeableness, extraversion, and openness of students. Third, the exogenous enactment of the reform may have decreased students' perceived control over their lives, that is, it may have resulted in a lower locus of control. A detailed overview of these theoretical considerations with the potential mechanisms at work is given in Table 2. Moreover, we expect to find heterogeneous effects for students from different socio-economic backgrounds. For example, for students from non-intact families, longer school days following the reform may have created a more stable environment due to more frequent interactions with teachers, allowing the young people to build relationships to additional adults who they can turn to for advice and support. On the other hand, these students may receive less support at home to cope with the increased workload and may therefore experience higher stress levels due to the shortening and increased intensity of high school.

It remains an empirical question which personality traits are affected by the educational change and whether or not the reform's effects vary by student characteristics.

Table 2: Potential Mechanisms and Anticipated Effects

Consequences of the reform and potential mechanisms	Anticipated effects
<b>Higher requirements/ workload/ learning intensity</b>	
Increase in pressure and fear of failure <sup>(*)</sup>	N (+), LoC (–)
Increase in self-discipline required	C (+)
Increase in cooperation or selfish behavior	A (+/–)
Recognizing ability of coping/not coping <sup>(*)</sup>	LoC (+/–)
<b>More time spent in school</b>	
Increase in social interaction with students and teachers <sup>(*)</sup>	A (+), E (+)
<b>Less leisure-time</b>	
Reduction in leisure-time activities	O (–)
Reduction in time for social interaction outside school	A (–), E (–)
<b>Exogenous enactment of reform</b>	LoC (–)
<i>Notes:</i> Compare to Thiel/Thomsen/Büttner (2014); extensions denoted by <sup>(*)</sup> . + (–) denotes an anticipated increase (decrease) in terms of the score of the personality traits openness (O), conscientiousness (C), extraversion (E), agreeableness (A), neuroticism (N) and locus of control (LoC).	



## 4 Data and Methods

### 4.1 Data

Our analysis is based on data from the German Socio-Economic Panel (SOEP) study, which is a representative household panel survey (Wagner/Frick/Schupp, 2007) with more than 20,000 individuals in more than 11,000 households in the most recent wave. In addition to rich information on family background and childhood environment characteristics, the SOEP provides self-ratings of personality traits for 17-year-old adolescents and for adult respondents aged 18 and over in various waves since 2005. Hence, we use data from the years 2005 to 2012, and select all adolescents and young adult respondents up to the age of 21 who were attending high school at the time of the survey or had earned a high school diploma.<sup>12</sup> To identify whether an individual was affected by the high school reform, we use information on the year of school entry and on the state of residence or, in cases where school has been already completed, the state where the high school diploma was obtained. In case of missings, the year of school entry was imputed from the date of birth.<sup>13</sup> We exclude students from Saxony and Thuringia because both East German states were not affected by the reform, as they kept the eight-year high school track after reunification. Furthermore, we drop students from Rhineland-Palatinate from our sample because there the reform has been introduced only in selected schools to date. We also exclude individuals who we know repeated one or more grades to avoid noise from different levels of schooling experienced so far and from different learning intensities students were exposed to. Finally, we only include individuals who successfully answered the items from at least one of the personality dimensions<sup>14</sup> and provided valid information on family background and home environment. The final sample consists of 1,058 individuals, of whom 211 were affected by the reform.<sup>15</sup>

The SOEP provides self-ratings of personality traits in various waves since 2005 (Gerlitz/Schupp, 2005). These cover personality measures related to the Five Factor Model (McCrae/Costa, 1999), which comprises the dimensions of the *Big Five* – openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. Each of these dimensions is measured with three items, which are answered on seven-point Likert-type scales.<sup>16</sup> As a further personality concept we follow the approach by Specht/Egloff/Schmukle (2013) and construct a measure for internal locus of control from seven items, which reveal whether a person believes that events are the result of his or her own actions rather than of external factors. To construct measures for the respective personality trait, the items

<sup>12</sup> Students in the academic track at a comprehensive school are affected by the reform as well. However, we exclude these students since we cannot unambiguously identify which tracks they have been in since entering secondary school. Furthermore, these students' exposure to the reform would be difficult to identify since a transitional period has been provided for implementation of the reform and exceptions are allowed at comprehensive schools in some states. Compulsory schooling ends in Germany at age 16.

<sup>13</sup> The year of school entry is available for 36 percent of the full sample. For these students, the imputed year matched the actual year in 90 percent of all cases, and the assignment to treatment or control group was correct in 99 percent of all cases.

<sup>14</sup> These are more than 99 percent of all individuals in our sample of consideration.

<sup>15</sup> The average size of a birth cohort surveyed at age 17 is 269 in the years under observation; on average 41 percent of the individuals in a cohort are in the high school track.

<sup>16</sup> For details on all personality items, see Tables 7 and 8 in the appendix.



are averaged for each dimension and standardized separately by gender at mean zero and variance one. While for adolescents these personality measures are included in the Youth Questionnaire in every year between 2006 and 2012, adult respondents' Big Five personality traits were surveyed only in the waves 2005 and 2009 and their locus of control in the waves 2005 and 2010. If an individual's personality has been measured twice, we use the personality measures at the youngest age possible, between 17 and 21 years, to guarantee a largely homogeneous sample and to avoid biased estimates through possible age effects.

To account for potential age effects we include age and age squared at the point in time of measurement in all estimations. Additionally, we control for several pre-reform individual characteristics in our preferred specification. These include demographic and socio-economic variables, such as gender, migration background, and whether the student has lived primarily in a rural area during childhood. We incorporate students' previous educational performance based on the teacher's recommendation at the end of elementary school. Variables related to family circumstances capture whether students come from a non-intact family, that is, whether they lived with only one parent up to the age of 15, the number of siblings, and birth order. Furthermore, the model accounts for parental characteristics including education, religion, the occupational status of the father, and the employment status of the mother at the time when the individual was ten years old.<sup>17</sup> The summary statistics of the personality traits and the individual characteristics are shown in Tables 9 and 10 in the appendix.

## 4.2 Empirical Strategy

We exploit the German high school reform introduced in almost all federal states in the years 2001 to 2007 as a quasi-natural experiment to establish a causal effect of education on personality. The control group consists of students who entered high school prior to the reform and hence graduated after nine years of high school. Our treatment group, in contrast, consists of students who entered high school after the implementation of the reform and hence obtain their diploma after only eight years of high school. Individuals are assigned to the treatment and the control group based on their year of school entry and on either their state of residence or the state where their high school diploma was obtained. We exploit the variation in time and region to isolate the effect of the reform from other influential factors. To this end, we estimate the following model

$$y_{ist,17} = \alpha \text{REFORM}_{st} + X_i \beta + \sum_s \gamma_s \text{STATE}_s + \sum_t \delta_t \text{YEAR}_t + \varepsilon_{ist}, \quad (2)$$

where  $y_{ist,17}$  is the personality measure at age 17 (or slightly older, as described in Section 4.1) of person  $i$  in state  $s$  who has entered high school in year  $t$ . Our prime variable of interest,  $\text{REFORM}_{st}$ , equals 1 if in state  $s$  students entering high school in year  $t$  are affected by the reform, and 0 otherwise.  $\text{STATE}_s$  is a set of state dummies and  $\text{YEAR}_t$

<sup>17</sup> For a description of all variables, see Table 6 in the appendix.

dummies indicating the year of high school entry.  $X_i$  is a vector of individual characteristics, including age and age squared, gender, and a number of pre-reform characteristics, which may be correlated with personality. These include the occupational status of the father, parental education, childhood environment, a dummy for non-intact family, and the employment status of the mother when the individual was ten years old. Furthermore, we include indicator dummies for the different SOEP sub-samples and we cluster error terms at the state level.<sup>18</sup>

When estimating equation (2), our main parameter of interest is  $\alpha$ , which indicates the impact of the high school reform on the respective personality trait. The key identifying assumption is that, in the absence of a reform,  $\alpha$  will be zero, that is, the treated ( $REFORM_{st}=1$ ) and the non-treated ( $REFORM_{st}=0$ ) do not differ significantly in terms of their personality traits. Our analysis, which resembles an extended difference-in-differences (DID) setting, hence assumes that there are no other policy changes or regional shocks that coincide with the implementation of the high school reform and affect students' personality traits. Identification, therefore, requires that the outcome of interest, that is, the personality traits, of students affected by the reform and students not affected by the reform would have followed the same trend over time had the high school reform not been implemented. This *common trend assumption* boils down in our case to the assumption that the personality of high school students would have evolved similarly in the different federal states. While this is not testable, as the counterfactual observation in absence of the reform cannot be observed, we argue that the assumption is realistic and nonrestrictive. We exploit the variation in the introduction of the reform over time, as we compare high school students from different federal states in Germany and control for a potential time trend through year fixed effects. We believe this is the least restrictive possible comparison as the evolution of one student's personality is likely to most closely resemble that of another student in the same school track (high school) even if the two are from different states (as opposed to students from the same state but different school tracks). As we control for state fixed effects, students from different federal states are allowed to differ in their levels of personality traits.

Moreover, crucial for the causal interpretation of the reform effect is that the variation in schooling is truly exogenous to serve as a quasi-natural experiment. This assumption would be violated if there were self-selection into either the treatment or the control group or if the assignment were not random. In this analysis, neither should be an issue. Since the reform was introduced in an entire state at one time, the only possibility to avoid the reform, that is, to self-select into the control group, would have been to move to a different state.<sup>19</sup> Given the high costs associated with moving a whole family to another state, this

<sup>18</sup> To account for the small number of clusters, it may be necessary to use wild cluster bootstrapped standard errors (see Cameron/Gelbach/Miller, 2008). Our estimations, however, show that the wild cluster bootstrap rather leads to even slightly lower standard errors if different at all. We therefore report the usual standard errors without bootstrapping, as it is the more conservative estimation method in our case.

<sup>19</sup> The only exception to this is Hesse, where there are double graduating cohorts in three consecutive years, 2012, 2013, and 2014. We therefore only include students from Hesse who were not affected by the reform and who graduated in 2012 or earlier and students who graduate in 2014 or later and were affected by the reform.

seems highly unlikely.<sup>20</sup> This is also confirmed by the descriptive statistics on individual characteristics of the control group and the treatment group, which are provided in Table 10 in the appendix. Mean comparisons of the treatment and control groups show that no (pre-reform) variables exhibit severe differences on average, apart from *age* and *East*. These differences can be explained by the composition of the sample and the earlier introduction of the reform in the East German states.

The timing of the high school reform may be related to specific state characteristics. Since we control for state fixed effects in our analysis, it is not necessary that the timing of state reforms be unrelated to state characteristics (see Black/Devereux/Salvanes, 2005). Nevertheless, we investigate whether the timing of the implementation of the new education system followed some pattern. For this purpose, we ran OLS and ordered probit regressions of the timing of state school reforms (late implementation, year in which the reform was implemented) on various pre-reform state characteristics (see Table 11). The analysis shows that there is no such pattern, as the timing of the reform is not related to the percentage of high school students in a state's population, to whether the state government is conservative, to whether the next state elections were scheduled for 2001/2002, or to the state's GDP per capita. There is some evidence that states with a higher median age of residents adopted the high school reform slightly earlier, which is an artifact caused by the older population in East German states.

Next, we have to address the exact treatment of the high school reform effect that we are able to measure. Since the majority of our sample was surveyed the year they turned 17 and in most cases were still enrolled in high school, we do not measure the effect of a decrease in years of overall school duration per se. Instead, the focus of our study is the compression of learning achievement and how this shapes personality traits during adolescence. Hence, the treatment implied by the reform is a higher workload in school, especially between ages of 13 and 16. Affected students therefore experienced a higher learning intensity during these years, spent more time per day in school, and had a higher level of learning achievement by age 17 because of more cumulative hours of school.

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<sup>20</sup> See Section 6.5 for a more extensive discussion of selectivity and robustness checks.

## 5 Results

The results of our OLS estimates of equation (2) are provided in Table 3.<sup>21</sup> The first specification does not control for any individual characteristics apart from age and age squared to account for any potential age effects, while the second specification additionally controls for gender and other individual pre-reform characteristics. The parameter estimates of the reform effect are almost identical in both specifications. This manifests the validation of using the high school reform as a quasi-natural experiment, as individual characteristics which may be correlated with personality do not appear to be correlated with the reform, and their omission does not bias the estimated impact.

Table 3: Effects of the Reform

	Outcome Variables: Personality Traits					
	Open.	Consc.	Extrav.	Agree.	Neurot.	LoC
Reform	-0.162 (0.143)	-0.107 (0.187)	0.193* (0.104)	0.223 (0.154)	0.268* (0.142)	-0.016 (0.129)
R <sup>2</sup>	0.025	0.047	0.046	0.032	0.050	0.039
Reform	-0.144 (0.145)	-0.113 (0.185)	0.209* (0.099)	0.214 (0.147)	0.282* (0.135)	-0.014 (0.118)
Female	-0.004 (0.059)	-0.018 (0.092)	-0.013 (0.073)	-0.007 (0.075)	0.024 (0.064)	-0.017 (0.072)
Rural area	-0.012 (0.070)	-0.096 (0.096)	0.071 (0.078)	-0.028 (0.062)	0.066 (0.059)	-0.046 (0.059)
Non-intact family	0.064 (0.053)	-0.066 (0.091)	0.087 (0.088)	-0.069 (0.069)	0.112 (0.077)	-0.096 (0.073)
Work.-class father	-0.250** (0.101)	0.081 (0.082)	-0.065 (0.082)	-0.019 (0.046)	0.140 (0.116)	-0.003 (0.077)
High parental educ.	0.019 (0.074)	-0.227*** (0.054)	-0.142 (0.087)	-0.046 (0.059)	-0.018 (0.053)	0.036 (0.048)
Working mother	0.093 (0.076)	-0.076 (0.064)	0.132* (0.063)	-0.030 (0.045)	-0.121** (0.043)	-0.033 (0.075)
Christian parents	0.082 (0.065)	0.121 (0.070)	-0.041 (0.060)	-0.062 (0.061)	0.067 (0.077)	-0.021 (0.058)
Migration backgr.	0.045 (0.113)	-0.180*** (0.051)	-0.023 (0.086)	-0.103 (0.092)	-0.035 (0.086)	0.046 (0.060)
Low-perf. student	-0.001 (0.058)	-0.072 (0.049)	-0.126 (0.084)	0.012 (0.063)	0.030 (0.081)	-0.122 (0.081)
R <sup>2</sup>	0.037	0.067	0.058	0.035	0.059	0.044
Observations	1047	1054	1055	1056	1052	1015

Notes: SOEPv29 waves 2005 to 2012. OLS regressions. Age, age squared and a maximum set of state dummies, year of school entry dummies, dummies for the different SOEP samples, and a constant are included. Standard errors, reported in parentheses, are clustered at the state level. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

While there is no clear impact of the reform on openness, conscientiousness, and locus of

<sup>21</sup> Table 3 provides results from unweighted regressions. However, weighted regressions deliver virtually the same estimated coefficients.

control in the overall population of high school students, the estimates show that the reform significantly increased students' extraversion and neuroticism. The effects are substantial in that extraversion is on average increased by a fifth of a standard deviation, while students' emotional stability is even altered by more than a quarter of a standard deviation on average. Following the reform, agreeableness increases as well by more than a fifth of a standard deviation. In terms of conventional statistical significance levels, this effect is however at the edge and marginally insignificant.<sup>22</sup>

Considered together, these findings suggest that the change in the educational system may impact different facets of personality, possibly via different channels. A potential increase in agreeableness and in particular an increase in extraversion may stem from changes in the type and intensity of social interactions between students. In contrast, an increase in neuroticism may reflect the impact of the higher workload, which may have increased stress and pressure on students.<sup>23</sup>

With respect to the individual characteristics, we find only few meaningful driving forces, which include having a father with a working-class occupation, parents with a low level of education, a working mother, and for some of the personality outcomes, having a migration background.<sup>24</sup> Students with a lower socio-economic background, that is, students from working-class or less-educated families, are on average less open and more conscientious than students with higher socio-economic backgrounds.<sup>25</sup> On average, less-educated parents with blue-collar jobs tend to be characterized by hard work and social conformity rather than creativity, which may be associated with less openness and more conscientiousness. Children might either inherit these traits from their parents or be socialized in a particular way, for example, by learning from their parents as role models throughout life. Students with a working mother are on average significantly more extroverted and less neurotic than students whose mother did not work when they were ten years old. This could be due to the fact that children of working mothers learn independence and social interaction relatively early through increased exposure to day care. They may therefore be more outgoing and settled in life, leading to a higher extraversion and emotional stability.

Students with a migration background display a lower level of conscientiousness than students without a migration background, but do not exhibit further significant differences in traits.

Moreover, living in a non-intact family appears to be related to personality. We observe

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<sup>22</sup> Note in general, that due to the relatively small number of observations, we pick the 10% level of significance to be relevant. Given this small sample size, the fact that some of the coefficients appear to be statistically significant at this, or even more conservative levels, makes our findings even stronger. For the interpretation of any other coefficient, one should keep in mind that statistical insignificance does not prove that there is no effect, but only that we fail to reject it, which may be an artifact of the sample size.

<sup>23</sup> For a more extensive discussion on the potential mechanisms at work, see Section 5.2.

<sup>24</sup> Note that due to the standardization separately by gender, all differences in absolute levels of the scores on personality traits between male and female students are erased. We therefore expect the coefficient of *female* to be small and insignificant in the estimation, which is indeed the case. However, this does therefore not imply that there are no significant differences by gender in the original scores on personality.

<sup>25</sup> Note that our sample is special in the sense that it only comprises high school students. As these students are in a presumably more advantaged situation than students enrolled in other school tracks, the effects of the individual characteristics on personality may not be representative for the average adolescent in Germany.

a higher level of neuroticism and a lower level of perceived control, both by about 0.1 of a standard deviation. Although these effects are (marginally) not statistically significant, their signs are in line with the general expectation of a disrupted family causing emotional stress in children and making them feel that they can do little to change the status quo. However, a more alarming finding is that the change in the educational system has an even larger impact on neuroticism than does a disrupted family, both in terms of magnitude and significance: the high school reform increases neuroticism by more than twice as much as being raised in a non-intact family.<sup>26</sup>

In an extended specification, we further include family characteristics related to the number of siblings and birth order for a subsample of students with the relevant information (see Table 12 in the appendix). While the reform effects prove to be stable, these estimates reveal that students without any siblings are less agreeable and that first-born individuals are more open and conscientious. In an additional specification, we include the respective parental personality trait in each regression for a subsample of our students.<sup>27</sup> The respective coefficients stand out in both magnitude and significance, pointing to a strong intergenerational transmission of personality.<sup>28</sup> However, their inclusion makes little difference concerning the reform coefficients other than a small loss in significance due to a reduction in sample size.

## 5.1 Heterogeneous Effects

So far, the estimates show average effects for the overall population of high school students. Following the high school reform, students tend to be more extroverted and possibly more agreeable, but also less emotionally stable. To truly shed light on the effects of the reform, however, it is important to consider how the policy change has affected particular subgroups of students differently. This may not only reveal which students' personality traits are especially susceptible to a change in the educational system, but possibly also illustrate the different mechanisms by which the reform impacts personality. A natural distinction here is by *gender*, since boys and girls of a given age not only differ in their stage of physical and mental development but also in their behavior. As shown in Table 4, the increase in agreeableness is driven by male students, for whom this effect is statistically significant and economically large, amounting to one-third of a standard deviation in magnitude. In contrast, the estimates reveal that there is hardly any increase in agreeableness for female students. Since boys are usually observed to be more competitive and less agreeable than girls, the exogenous variation in social interaction or necessity for cooperation may have forced boys in particular to become more sociable and cooperative. This finding therefore illustrates how a change in the educational system also could mitigate gender differences in personality or behavior and bring initially different levels of development into closer alignment across genders.

<sup>26</sup> Note that this applies to the sample of high school students. Being raised in a non-intact family may have larger effects on neuroticism in the overall population.

<sup>27</sup> The results are available from the authors upon request.

<sup>28</sup> The intergenerational effects are between 0.104 and 0.173 for the Big Five personality traits and 0.248 for locus of control. These results are largely in line with the intergenerational correlation coefficients reported by Anger (2012) for children of all school types.

Table 4: Heterogeneous Effects of the Reform

	Outcome Variables: Personality Traits					
	Open.	Consc.	Extrav.	Agree.	Neurot.	LoC
<b>Female</b>						
Reform	-0.068 (0.170)	-0.063 (0.188)	0.209 (0.119)	0.340* (0.165)	0.254* (0.142)	0.118 (0.137)
Interaction	-0.165 (0.168)	-0.110 (0.105)	-0.002 (0.176)	-0.276* (0.154)	0.060 (0.078)	-0.287 (0.189)
<b>East</b>						
Reform	-0.181 (0.192)	-0.011 (0.201)	0.324** (0.122)	0.329** (0.141)	0.155 (0.127)	-0.040 (0.126)
Interaction	0.111 (0.140)	-0.308 (0.256)	-0.348 (0.197)	-0.347* (0.161)	0.382*** (0.057)	0.078 (0.148)
<b>Non-intact family</b>						
Reform	-0.229 (0.169)	-0.070 (0.168)	0.074 (0.104)	0.184 (0.169)	0.282* (0.144)	0.024 (0.115)
Interaction	0.399*** (0.126)	-0.200 (0.243)	0.630*** (0.180)	0.138 (0.161)	-0.001 (0.208)	-0.180 (0.256)
<b>Working-class father</b>						
Reform	-0.176 (0.144)	-0.105 (0.174)	0.177 (0.115)	0.211 (0.156)	0.315* (0.148)	-0.001 (0.128)
Interaction	0.157 (0.205)	-0.041 (0.161)	0.154 (0.186)	0.015 (0.132)	-0.164 (0.163)	-0.063 (0.255)
<b>High parental education</b>						
Reform	-0.100 (0.174)	-0.111 (0.145)	0.320** (0.139)	0.109 (0.154)	0.290** (0.122)	-0.095 (0.168)
Interaction	-0.078 (0.192)	-0.004 (0.190)	-0.198 (0.150)	0.185 (0.115)	-0.014 (0.115)	0.148 (0.184)
<b>Working mother</b>						
Reform	-0.411*** (0.091)	-0.241 (0.183)	0.275* (0.150)	0.262 (0.187)	0.258 (0.203)	-0.016 (0.161)
Interaction	0.356* (0.191)	0.171 (0.294)	-0.088 (0.164)	-0.065 (0.193)	0.032 (0.127)	0.003 (0.156)
<b>Migration background</b>						
Reform	-0.170 (0.148)	-0.183 (0.196)	0.219** (0.084)	0.227 (0.182)	0.262* (0.145)	0.012 (0.132)
Interaction	0.191 (0.120)	0.505** (0.215)	-0.077 (0.209)	-0.095 (0.323)	0.141 (0.227)	-0.184 (0.230)



Low-performing student						
Reform	-0.049 (0.182)	-0.105 (0.187)	0.232* (0.111)	0.197 (0.152)	0.223 (0.138)	-0.078 (0.169)
Interaction	-0.307 (0.193)	-0.026 (0.093)	-0.078 (0.242)	0.054 (0.206)	0.191 (0.232)	0.210 (0.246)
Observations	1047	1054	1055	1056	1052	1015

*Notes:* SOEPv29 waves 2005 to 2012. OLS regressions, separately for each interaction considered. Only the coefficients of *REFORM* and the respective interaction with *REFORM* are presented. Age, age squared, female, rural area, non-intact family, working-class father, high parental education, working mother, Christian parents, migration background, low-performing student and a maximum set of state dummies, year of school entry dummies, dummies for the different SOEP samples, and a constant are included. Standard errors, reported in parentheses, are clustered at the state level. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Additionally, we investigate differential impacts of the high school reform in former *East* and *West Germany*, as there are not only persistent differences with respect to the socio-economic environment, but also differences in educational policies between the two parts of Germany. Especially the long-standing tradition of the former 13-year school system is not present in the former East. Those Eastern states that reduced high school by one year in the 2000s prolonged high school by one year just a decade before. This could mitigate any changes induced by the recent high school reform, which may be perceived as less dramatic by the affected population. In line with these expectations, the estimates in Table 4 reveal that the increases in extraversion and agreeableness are entirely driven by students in West Germany. Contrary to this intuition, however, the increase in neuroticism is significantly more pronounced among students in East Germany. The only reasonable explanation we can think of is that in Eastern states, where students normally attend elementary school for their first six years of schooling, seventh-grade students were confronted with the transition to high school and with a higher workload at the same time. In contrast, West German seventh-graders already had two years to acclimatize themselves to high school before being confronted with the higher workload. Hence, this finding may demonstrate the importance of gradually changing the learning environment of students who may feel stressed if several features are altered at the same time.

In the next step, we look into heterogeneous effects by family structure. For students from *non-intact families*, the increase in time spent at school may have created a more stable environment with stronger interactions with teachers as additional adult reference persons. In contrast, these students may also receive less support at home to cope with the increased learning. The estimates provide suggestive evidence for the former hypothesis; students who did not live with both parents during their entire childhood benefit from the educational change in terms of openness, and particularly drive the overall increase in extraversion. In contrast, there is no evidence to support the hypothesis that these students have an even higher increase in neuroticism due to a potential lack of support at home: the increase in neuroticism is identical for students of all family circumstances.<sup>29</sup> We hypothesized that children with a large *number of siblings* and with a high *birth order* may

<sup>29</sup> It would, however, be interesting in a next step to compare the absolute levels of the score on neuroticism in both groups before and after the reform. Due to the censored structure of the Likert scale, there is less scope for increases in individuals who already scored high on a personality trait before the reform.



have greater difficulties coping with the higher workload after the reform as they may not receive the same amount of parental support as a first child or only child. However, we do not find any significant differences between the respective groups in their responses to the reform.<sup>30</sup>

Furthermore, it is of interest how students from different socio-economic backgrounds respond to educational changes. To this end, we investigate heterogeneous effects by the *occupational status of the father* as well as by *parental education*. It is conceivable that students with a lower socio-economic status are less likely to receive (adequate) support from their parents to meet the increased demands at school. Hence, the higher workload induced by the reform may lead to a higher stress level for this group. However, we do not find any significant differences in the impact of the reform on neuroticism, neither by occupational status of the father nor by parental education. The estimates even indicate a smaller albeit insignificant increase in emotional instability for students with a working-class father.

Moreover, we investigate whether students with a *working mother* respond differently to the high school reform. Since the reform led to longer school days and thus to a better infrastructure for organized afternoon activities, students with working mothers may benefit from having improved supervision in the afternoon. However, we do not find such differences in the impact of the reform by the employment status of the mother, except for the effect on openness. While there is no clear impact of the educational change on openness of students with a working mother, the estimates reveal that students with a non-working mother showed a significant decrease in openness by more than 0.4 of a standard deviation. This may be a result of the reduction in time spent at home and in the time available for extracurricular or family activities after the reform.

Furthermore, students with a *migration background* may respond differently to the reform than students from non-migrant families. One could hypothesize that the former benefit from longer school days by becoming better integrated into their peer groups and by improving their language skills. If so, this reform could help to reduce initial and persistent differences between these two groups and foster integration and educational performance of students from migrant families. However, we only find differential effects of the reform for one personality trait: students with a migration background appear to show increased conscientiousness. Migrant and non-migrant students appear to respond similarly to the reform in all other personality traits.

A general concern is that *low-performing* students are particularly vulnerable to the educational reform as they are most at risk of being ‘the first to be left behind’ by the higher requirements at school. Hence, we investigate whether students with low performance prior to high school show differential effects. Though the increase in neuroticism following the reform is indeed even higher for this group, we fail to find a statistically significant difference.<sup>31</sup>

<sup>30</sup> Results are available from the authors upon request.

<sup>31</sup> Note, however, that the share of low-performing students, identified through the teacher's recommendation at the end of elementary school, is naturally very low among high school students, making it difficult to

## 5.2 Potential Mechanisms

So far, we find evidence of a causal effect of the high school reform on adolescents' personality traits, in particular on emotional stability, extraversion, and agreeableness. However, the effect of the reform on students' personalities still remains largely a black box because the compression of schooling had a number of implications. Affected students faced a higher learning intensity especially between ages 13 and 16, spent more time per day in school, and were expected to achieve a higher level of learning achievement by age 17 due to the higher number of cumulative school hours. Hence, the reform could have impacted students' personalities through various distinct channels.

First, the increase in learning intensity due to the compressed curriculum may have led to higher pressure on students, leading to adverse health effects. Previous research on working conditions and health has shown that an increase in workload negatively affects health related outcomes (Proctor et al., 1996), which may be related to an individual's emotional stability.<sup>32</sup> To shed more light on this potential mechanism, we investigate whether the reform has impacted students' health related characteristics. We find that the reform had no adverse effects on the perceived health status of the students (see Table 5). This holds true regardless of whether we investigate a change in the binary variable (very good or good health, as opposed to satisfactory, not so good, or bad health), or a change in the categorical variable by means of an ordered probit model. We find, however, that shortening the high school track increases feelings of sadness. Following the reform, the probability of being sad at least sometimes (as opposed to seldom or very seldom) rose by ten percentage points among affected students. The lack of statistical significance may be at least in part attributable to the small number of observations.<sup>33</sup> We take this result as suggestive evidence that emotions are a relevant transmission channel.

Moreover, the high learning intensity may have directly affected students' performance. As shown by Proctor et al. (1996), an increase in workload is in some cases significantly associated with impaired performance on tests of attention and executive function. In the educational context, an increase in learning intensity may therefore also decrease attention and cognitive functioning among students, resulting in inferior school performance. Büttner/Thomsen (2014) show for the double cohort in the state of Saxony-Anhalt that an increase in learning intensity indeed negatively affected students' grades in Mathematics and English.<sup>34</sup> This in turn may have increased the feeling of pressure and stress due to fear of failure among students who were affected by the reform. In additional regressions, we actually find that the high school reform decreased students' satisfaction with their school performance. The share of students who were very satisfied with their performance in the subjects German literature and first foreign language decreased by about

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clearly interpret our results.

<sup>32</sup> Taking automotive workers as an example, Proctor et al. (1996) find overtime work to be associated with increased feelings of depression, fatigue, and confusion.

<sup>33</sup> The information of the frequency of being sad in the past four weeks is only available for half of our original sample, as the question was not part of the survey every year.

<sup>34</sup> Unfortunately, we cannot investigate reform effects on school performance, as the students' school grades are not comparable across our sample. While the grades of students in our control group only counted on their annual school report card, the grades of students in our treatment group were already counted into their final high school grades and hence were much more relevant.

Table 5: Effects of the Reform: Mechanisms

	Outcome Variables					
	Health & Emotions		Satisfaction with School performance		Leisure-time Activities	
	Health	Sadness	Literature	Language	Music	Sport
Reform	0.008 (0.051)	0.107 (0.089)	-0.087* (0.048)	-0.077 (0.046)	0.013 (0.065)	0.012 (0.035)
Female	-0.040** (0.014)	0.198*** (0.045)	0.116*** (0.030)	0.063 (0.060)	0.045 (0.032)	-0.052** (0.020)
Rural area	0.034 (0.028)	0.056* (0.026)	0.028 (0.027)	0.049 (0.052)	-0.037 (0.052)	0.029 (0.039)
Non-intact family	-0.002 (0.014)	0.021 (0.058)	-0.030 (0.048)	-0.016 (0.042)	0.023 (0.044)	0.059 (0.044)
Work.-class father	-0.003 (0.028)	0.043 (0.038)	-0.087 (0.050)	0.018 (0.046)	-0.077 (0.051)	-0.059 (0.061)
High parental educ.	0.007 (0.036)	0.043 (0.035)	-0.026 (0.034)	-0.046 (0.043)	0.135*** (0.037)	0.049* (0.023)
Working mother	-0.033* (0.015)	0.043 (0.044)	-0.029 (0.030)	-0.054 (0.069)	0.026 (0.034)	0.053* (0.029)
Christian parents	-0.004 (0.022)	-0.015 (0.077)	0.008 (0.048)	0.035 (0.054)	0.046 (0.048)	-0.013 (0.040)
Migration backgr.	0.009 (0.032)	0.034 (0.044)	0.021 (0.056)	0.084 (0.050)	-0.106*** (0.033)	0.029 (0.045)
Low-perf. student	0.008 (0.018)	-0.004 (0.059)	-0.097 (0.055)	-0.131*** (0.042)	-0.077** (0.029)	-0.081* (0.039)
Observations	1059	565	592	590	705	704

*Notes:* SOEPv29 waves 2005 to 2012. OLS regressions. A maximum set of state dummies, year of school entry dummies, dummies for the different SOEP samples, and a constant are included. Standard errors, reported in parentheses, are clustered at the state level. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

eight percentage points (see Table 5), although the latter effect barely fails to attain statistical significance at conventional levels.<sup>35</sup> Unreported regressions show that this decrease is considerably larger in East Germany, which is in line with the decrease in emotional stability being much more pronounced in the East. In addition, we find suggestive evidence that the high school reform increased students' need for paid tutor lessons (not reported).<sup>36</sup> Overall, we conclude that the increase in workload following the high school reform caused lower school performance and emotional difficulties among students, which explains the decrease in emotional stability particularly among East German students.

Second, the change in the institutional framework may have affected students through the change in time allocation, as those who were affected by the reform spent more time

<sup>35</sup> We define students as being very satisfied with their educational performance if they rate their satisfaction either 9 or 10 on a scale from 0 (low) to 10 (high). Among the control group, 23 percent reported very high satisfaction with literature and 26 percent with the first foreign language. Levels of satisfaction with the subject Maths was not significantly affected by the reform.

<sup>36</sup> Following the reform, the percentage of students attending paid tutor lessons in addition to their regular school attendance increased by almost six percentage points, though we fail to prove statistical significance at conventional levels.

per week in school. They not only attended additional classes, which often took place in the afternoon, but also spent lunch together, which in most schools was introduced with the reform. Hence, the reform led to more social interactions with teachers and other students and fostered independence from the parents. This stimulation of interpersonal behavior may positively affect extraversion and agreeableness. At the same time, however, students have less leisure-time, which could adversely affect personality traits related to social behavior. Furthermore, openness could be reduced through less diversity in the activities students engage in. To examine whether and how students' time allocation was affected by the reform, we investigate their participation in two leisure-time activities: music and sports (see Table 5). We do not find any evidence of the reform having affected participation in either of these activities.<sup>37</sup> Both the treatment and the control group seem to engage equally in both. These findings suggest that our results are more likely driven by the stronger student-teacher or student-student interactions as a result of longer school days and not by the change in time allocation away from non-academic activities.

Third, the higher level of learning achievement by age 17 due to more cumulative school hours may have impacted personality traits through changes in cognition. Since the great majority of schools increased hours between grades seven and nine (ages 13-16), the adolescents in our treatment group have typically accumulated a full year of additional learning over the control group. The earlier learning may increase cognitive skills at a younger age. This in turn may improve non-cognitive skills through the dynamic complementarity and the cross-effects suggested by Cunha/Heckman (2007) in their skill formation model. It would therefore be of high interest in further research to investigate this reform's effects on cognitive skills.

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<sup>37</sup> This holds true not only for *whether* students participate in these activities at all, but also for the *frequency* of participating in these activities.

## 6 Sensitivity Analyses

For a causal interpretation of the high school reform effect we have to rule out that any other factors than the ones considered might drive our estimates. This section discusses several sensitivity analyses that we carried out. The corresponding tables are provided in the Appendix.

### 6.1 Age Effects

To account for potential age effects in personality, we so far include age and age squared in all estimations. An alternative way is to regress the original score of each personality trait (without standardization) on age and age squared, next to gender (Nyhus/Pons, 2005). The resulting residuals are then age-free and can be used in the second stage as outcome measures. Our results are robust to this procedure (see Table 13). To completely rule out potential age effects, we additionally restrict our sample to adolescents aged 17. The increase in neuroticism is slightly reduced (see Table 13) but the other relevant coefficients are not altered much. Due to the substantial loss of observations, the precision of the estimates largely decreases.

### 6.2 Measurement Issues

A major concern when analyzing personality traits is potential measurement error. In particular when including personality traits as *independent* variables, estimated coefficients are biased if the measure of personality traits suffers from a lack of precision. Therefore, existing studies usually correct for potential measurement error (see for example, Heckman/Pinto/Savellyev, 2013; Heineck/Anger, 2010; Zumbühl/Dohmen/Pfann, 2013). However, in this study the *dependent* variable may suffer from measurement error. In this case, estimates are still unbiased as long as the error occurs randomly, but the variance may increase. We argue that in our study it is reasonable to assume that potential measurement error is random and hence uncorrelated with the assignment of students to the treatment or control group. We do not expect students who are affected by the reform to systematically differ in their self-reporting of personality other than differences induced by true reform effects.

One objection may be that after shortening the high school track, students face a closer proximity to the date of graduation when being interviewed at age 17. At the time of the interview students affected by the reform may hence face more temporary stress compared to their counterparts of the control group, which would bias our estimates. However, Bleidorn (2012) shows based on German data that the Big Five personality traits are stable over the two ultimate years of high school, and change only after graduation. Using our sample of adolescents, we investigate whether proximity to the date of graduation may be a source of non-random measurement error by including the time of the interview (measured in quarters of the year) interacted with the reform effect (see Table 14).<sup>38</sup> Some of

<sup>38</sup> Including the time of the interview in a larger sample of adults (who already graduated from school) shows

the reform effects are reduced after the inclusion of the interview quarter dummies and interaction variables. However, we attribute this to the small sample size and to the large number of covariates. Most important, we find no differential effects of the interview timing on personality for the control group and the treatment group. Furthermore, the coefficients of the quarter dummies are mostly insignificant and do not follow a clear pattern. Hence, we conclude that there is no measurement error induced by the timing of the interview.

To take into account changes in personality after graduation, we re-estimate the impact of the reform while controlling for individuals having graduated or not (see Table 14).<sup>39</sup> While the coefficients point to changes in personality after high school graduation, these effects are not precisely estimated. The effects of the high school reform on the personality traits do not differ from the baseline specification.

Another measurement issue is that adolescents in the SOEP are interviewed via a youth questionnaire, which differs from the adult questionnaire. The youth questionnaire has a much larger focus on (current) secondary education and conditions with respect to school, effort and parents' involvement. The presence of these questions in the youth questionnaire should be kept in mind as a potential source of bias when constructing a sample of adolescents *and* adults from the SOEP. To purge our estimates from potential survey-related effects, we restrict our subsample to adolescents. Indeed, the estimation results are comparable to the results from the entire sample, although precision and statistical significance decrease due to the substantial loss of observations (see Table 14).

Finally, the construction of personality measures by simply averaging item scores along each dimension may imply measurement error. Although we do not expect that this is correlated with the assignment of students to the treatment or control group, we conduct a factor analysis to validate this approach. We in fact find that the items which we use to measure personality in our analysis load on specific factors, which correspond to the dimensions of the Five Factor model and to locus of control.<sup>40</sup>

In sum, we conclude that our study does not suffer from bias due to measurement error. Even in the presence of measurement error, the reform effects we find are unbiased and inference is still valid, as the estimated standard errors provide an upper bound in this case.

### 6.3 Stability of Personality

Another concern is that the personality measures of the students in our sample may be a mere snapshot and not persist over time. To investigate this, we exploit the panel character of the dataset and use a subsample of students for whom a second self-rating of personality is available in the 2013 survey<sup>41</sup> to compare the two measurements: the rank-order

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hardly any effects and no systematic pattern of the interview month. Hence, we can exclude seasonal variation in personality self-ratings

<sup>39</sup> Only 20 percent of the individuals in our sample have already graduated.

<sup>40</sup> Results are available from the authors upon request.

<sup>41</sup> This is the case for half of our original sample.

correlation coefficients range from 0.41 to 0.59 for the Big Five dimensions.<sup>42</sup> These results are perfectly in line with Specht/Egloff/Schmukle (2011) for this age group, and only slightly below the rank-order correlations found for adults between 0.64 and 0.75 depending on the trait (Specht/Egloff/Schmukle, 2011). Hence, we have no reason to suspect that the personality of our sample of high school students is exceptionally unstable.

## 6.4 Estimation Model

As the Likert-type scale for the assessment of personality is an ordinal scale, an ordered probit model may be more appropriate than OLS regressions. This is true if changes of one unit have different implications depending on their location on the scale, that is, if the scale is non-linear. Therefore, we run an ordered probit regression, with the outcome categories being the standardized measures of each personality trait (see Table 14). This yields very similar results, confirming our earlier findings.

## 6.5 Selectivity

As outlined in Section 4.2, we consider selection from the treatment into the control group or vice versa highly unlikely due to relatively high moving costs involved. Indeed, for more than 92.3% of the individuals in our sample, we know that they have not changed residence since their childhood.

Still, we consider the possibility that individuals living close to a state border choose to attend school in a different state to avoid the reform. Hence, we define a subset of late-adopter states whose neighboring states have all adopted the reform already.<sup>43</sup> In these states, any self-selection from the treatment into the control group by moving to a neighboring state (or by attending school in the neighboring state if living at the border) to avoid the reform is thus ruled out. We still find positive coefficients on agreeableness, extraversion, and neuroticism (see Table 15), which are not, however, statistically significant, as can be expected given the sharp reduction of the sample size.

A more severe concern of selectivity is self-selection *out* of the sample, that is, students who would have originally attended high school but because of the reform chose to follow a different secondary school track.<sup>44</sup> This type of selection may occur in two distinct ways: either directly through a different school choice after elementary school, or through a change

<sup>42</sup> These computations are based on the SOEP waves 2005 to 2013 (forthcoming as SOEPv30) and use the non-standardized measures of personality. Rank-order correlation coefficients are measured by Spearman's Rho. Note that information on locus of control is not surveyed in the wave 2013.

<sup>43</sup> This group contains all states where the first students affected by the reform graduate in 2012 or later: Baden-Wuerttemberg, Bremen, Hesse, North Rhine-Westphalia, Berlin, Schleswig-Holstein, and Brandenburg.

<sup>44</sup> Note, however, that if self-selection out of high school based on personality traits were an issue, we would expect especially those students to leave or not enter high school who are most worried about the increase in the pace of learning and who fear not being able to cope with the higher workload after the reform. This implies that we would underestimate the true negative effects of the reform in terms of stress and emotional instability among high school students, given that the least emotionally stable students have left the treatment group. Our finding of an increase in neuroticism as depicted in Section 5 may in this case represent only a lower bound and a conservative estimate of the true impact of the educational reform on personality.



in high school dropout rates at a later stage. The former in particular concerns attendance of the comprehensive school (*Gesamtschule*) instead, as this allows students to still obtain the same university entrance qualification. However, the restriction of our sample to states where comprehensive schools typically do not exist<sup>45</sup> reveal virtually the same coefficients (see Table 15). There is no significant difference between the increase in neuroticism in states with and without comprehensive schools. However, the increases in extraversion and agreeableness are even stronger in the states without comprehensive schools than the average effects, which points to a weakening of the reform effects if students find a way to avoid the new system.

Lastly, both possible channels of self-selection, either through a change in school choice or a change in high school dropout rates, would not only change the composition of high school students, but also the composition of students enrolled in the other types of secondary schools, which these students would have to attend when opting out of high school. However, findings in Section 6.9 on reform effects for students from other school types support the assumption that there are no such changes in the composition of students.

## 6.6 Announcement Effects and Double Cohort

Since in some states the high school reform was a subject of public discussion prior to its implementation and was hence anticipated, one may raise concerns about announcement effects among cohorts of students around the date of implementation. Post-reform students may have tried to skip one grade to switch to the control group. However, this is highly unlikely as skipping a grade is nearly impossible and students would end up graduating in the same year as they would have originally. Likewise, it is very unlikely that pre-reform students repeat a grade on purpose and switch to the treatment group just to catch up with their original cohort at the time of the high school diploma. In turn, it is more plausible that pre-reform high school students who were at risk of repeating a grade may have tried to evade the reform by putting more effort in staying in their original grade, that is, to remain in the control group.

However, these concerns only apply to the last cohort graduating from high school with 13 total years of schooling and the first cohort graduating with 12 years. This double cohort could feature further peculiarities that may lead to confounding effects or may offset true effects of the reform. Therefore, we exclude this double cohort of graduates in an additional model (see Table 15). This estimation reveals an even stronger increase in extraversion and a comparable increase in neuroticism, and hence supports the notion that reform effects are to some extent offset in the double cohort of graduates.<sup>46</sup>

<sup>45</sup> States where comprehensive schools typically do not exist are Baden-Wuerttemberg, Bavaria, Mecklenburg-West Pomerania, Saarland, and Saxony-Anhalt.

<sup>46</sup> This finding provides a possible explanation why Thiel/Thomsen/Büttner (2014) do not find any effects in their analysis, which is only based on the double cohort of graduates.



## 6.7 Implementation Effects

For the evaluation of the new high school regulation, it is of interest whether the effects are persistent even among cohorts entering high school several years after the implementation of the reform. In many states, the reform has been implemented ad-hoc, for example, relevant books and subject matter were not yet adapted to the increased pace of learning. Any effects on students' personality traits could therefore also stem from the chaotic implementation of the reform.<sup>47</sup> To investigate whether the effects vanish with time that elapsed since the implementation of the reform, we add dummies for the second cohort affected by the reform, and for cohorts three and higher (see Table 15). The results reveal that for both groups – the second cohort affected, as well as students affected even three or more years after the implementation of the reform – the effects of the reform are not significantly different from those for students in the first cohort affected, which serve as the reference category in this estimation. Still, it seems that extraversion increased by more among the later cohorts, while there is tentative evidence that the magnitude of the increase in neuroticism decreased slightly with the time that elapsed since the introduction of the reform. Note that these results should be handled with caution due to the small sample size,<sup>48</sup> which makes it difficult to clearly interpret our results. However, they illustrate that the reform effects we find are not driven solely by the cohorts immediately affected by the reform but instead can be expected to persist.

## 6.8 Other Institutional Changes

Another aspect of the German high school system that has been the subject of substantial recent interest is the existence of standardized exit examinations (*Zentralabitur*). While these examinations have been in place in some federal states since the 1990s or even earlier, most of the remaining states introduced these standardized exams between 2005 and 2008. Since our empirical strategy exploits the variation over time and region, the effects of the high school reform should be isolated from any other policy changes that occur at different times, which is the case for the introduction of central exit examinations. Furthermore, central exit examinations, if newly introduced, affected both earlier cohorts and the later cohorts that were affected by the high school reform. As a consequence, almost the entire sample under consideration has been subjected to central exit examinations. Nonetheless, it may be that the introduction of standardized exit examinations affects students exposed to the high school reform and those not affected by the reform differently. To rule out that this is driving our results, we consider a subsample of states with standardized exit examinations that have been in place for some time.<sup>49</sup> The results (see Table 16) confirm that the increase in extraversion, agreeableness, and neuroticism as a consequence of the reform

<sup>47</sup> Note however, that this would not contradict our findings that personality traits *are malleable* in adolescence and that secondary schooling plays a role in shaping them.

<sup>48</sup> There are only few individuals in each cell, and as such gender balance, for example, is not guaranteed anymore, neither is the East-West distribution similar among the different years elapsed since implementation of the reform.

<sup>49</sup> States with standardized exit examinations in place for some time are Baden-Wuerttemberg, Bavaria, Mecklenburg-West Pomerania, Saarland, and Saxony-Anhalt (and Saxony and Thuringia, which are excluded from our entire analysis, however).

are indeed not driven by the introduction of central exit examinations, as the respective coefficients are very similar in magnitude.

## 6.9 Placebo Estimation

Finally, we run a Placebo regression to rule out that our results are driven by any other factors influencing students' personalities that are unrelated to the high school reform. Hence, we estimate the effect of the high school reform on the personality measures of students of other school types in the exact same manner. As students who attend the lower secondary school (*Hauptschule*) or the intermediate secondary school (*Realschule*) were not exposed to the high school reform, there should not be any measurable effects of the reform on these students' personality traits.<sup>50</sup> Perfectly in line with this expectation, our Placebo estimation shows no reform effects (see Table 17). Not only are the estimated effects clearly negligible in terms of magnitude, but they are also estimated quite precisely.

Furthermore, these findings refute the concern of out-of-sample selectivity following the reform: If there was selectivity out of the sample of high school students based on personality after the reform, we would expect to find a change in average personality among students of other school types. As this is clearly not the case, we can rule out that students who were originally aiming to attend high school selected themselves into alternative school types due to the reform.

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<sup>50</sup> Of course, these students could be indirectly affected by the reform, e.g., by facing increased competition for apprenticeship positions as their age advantage over the more highly qualified high school graduates was reduced substantially after the reform. However, these effects should not be as strong as direct effects.

## 7 Conclusion

There is a growing body of literature on the importance of personality traits as determinants of diverse economic and social outcomes. In studies dealing with the development of personality, there exists a consensus that the interaction of nature *and* nurture determines skill formation and that skills are shaped early in life. Nevertheless, little evidence exists on the impact of important nurturing factors such as education beyond pre-school age.

We provide first evidence on the malleability of personality traits in adolescence through schooling in Germany, and thus add to the scarce and mostly US-focused literature on the impact of education on non-cognitive skills. Using data on adolescents and young adults from the SOEP, we exploit the German high school reform as a quasi-natural experiment and use the variation over time and across states to establish a causal effect of the compression of the curriculum on the Big Five personality measures and on the locus of control.

Our estimates show that shortening the high school track, which was associated with a compression of the curriculum, caused students on average to be more extroverted and less emotionally stable. These effects were not only statistically significant but also economically meaningful, as extraversion increased by a fifth of a standard deviation and neuroticism even by more than a quarter of a standard deviation following the reform. The latter effect corresponds to an increase of roughly 0.3 points on the seven-point Likert scale and is robust across model specifications and different groups of students, though it is significantly more pronounced among students in East Germany. The increase in extraversion was in turn particularly driven by students from non-intact families. Moreover, our estimates point to additional heterogeneous effects of the change in the educational system on other personality traits. The results suggest a significant increase in openness among students from disrupted families. Additionally, male students and students in the West German states in particular experience a significant increase in agreeableness of more than one-third of a standard deviation, again corresponding to about 0.3 points on the seven-point Likert scale. Children whose mother is not working face a decline in openness, while the conscientiousness of students from migrant families increases.

Generally speaking, however, it should be noted that the treatment is restricted to students enrolled in academic-track high school. Those in this school track may be assumed to possess more favorable personality traits than others. While this calls the external validity of the precise estimated effects into question, it does not alter our conclusion that personality traits are malleable through schooling in adolescence. The recent introduction of the reform however, has only allowed us to investigate short-term effects so far.<sup>51</sup>

Nevertheless, our findings indicate that, at least in the short-run, the educational system plays a role in shaping adolescents' personality traits. Since the high school reform was

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<sup>51</sup> These personality traits have proven to be rather stable once entering adulthood. However, it would be an interesting topic for future research to see if the impact of the increase in learning intensity indeed leads to persistent differences in personality of students affected and students not affected by the reform in later life.

designed in a way that did not affect the overall curriculum, potential mechanisms underlying this influence could include the higher annual workload and increased learning intensity of students, the higher accumulated knowledge at the same age, stronger student-teacher or student-student interactions as a result of longer school days, or the change in time allocation away from non-academic activities. We investigated which of these potential mechanisms were at work in shaping adolescents' personalities through schooling by comparing how further outcomes changed with the reform. Our results point to no effects on health following the reform, but to adverse effects on school performance and emotions. We find tentative evidence that the higher workload and the stronger student-teacher or student-student interactions due to longer schools days are the driving forces, as there appears to be no effect on leisure-time activities.

We conclude that personality traits remain malleable in adolescence and that their formation is affected by the educational system, most likely through various channels. Hence, despite different institutional frameworks in the US and Germany, which may imply different skill formation processes, the educational setting is important for non-cognitive skills in both countries. The German high school reform was intended to improve students' competitiveness in the international labor market. The deterioration of some non-cognitive skills and the improvement of others may constitute a potentially substantial source of hidden costs and additional benefits. Put differently, our findings may therefore point to the necessity for educational policies to take the impact of educational changes on personality traits into consideration.

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## A Variables

Table 6: Description of Variables

Variable	Description
Openness	Standardized Big Five measure for openness to experience
Conscientiousness	Standardized Big Five measure for conscientiousness
Extraversion	Standardized Big Five measure for extraversion
Agreeableness	Standardized Big Five measure for agreeableness
Neuroticism	Standardized Big Five measure for neuroticism
Locus of control	Standardized measure for internal locus of control
Age	Age (in years)
Female	Dummy for female
East	Dummy for East German states
Rural area	Dummy for having lived most of the childhood until age 15 in rural area
Non-intact family	Dummy for not having lived with <i>both</i> parents for the entire time up to age 15
Working-class father	Dummy for father having blue-collar occupation when student is aged 15, reference category encompasses <i>all</i> others
High parental education	Dummy for at least one of an individual's parents having an upper secondary school degree or higher
Working mother	Dummy for working mother (both full-time and part-time) when student is aged 10
Christian parents	Dummy for at least one of the parents being either catholic or protestant
Migration background	Dummy for student with migration background
Low-performing student	Dummy for not having received a recommendation for high school after the fourth grade
Only child	Dummy for being only child (of the mother)
Oldest child	Dummy for being oldest child (of the mother)
High school diploma	Dummy for having graduated from high school
Health	Dummy for health status being good or very good (as opposed to satisfactory, not so good, bad)
Sadness	Dummy for frequency of being sad in the past 4 weeks being sometimes, often, or very often (as opposed to seldom or very seldom)
Satisfaction Literature/ Language	Dummy for satisfaction with school performance in the subjects German literature and first foreign language, respectively, of at least 9 (on scale from 0, low, to 10, high)
Music	Dummy for being musically active
Sport	Dummy for doing sports

Notes: SOEPv29 waves 2005 to 2012.



Table 7: Big Five Personality Traits

<b>I see myself as someone who...</b>	
is original, comes up with new ideas	Openness to experience
values artistic experiences	Openness to experience
has an active imagination	Openness to experience
does a thorough job	Conscientiousness
does things effectively and efficiently	Conscientiousness
tends to be lazy (reversed)	Conscientiousness
is communicative, talkative	Extraversion
is outgoing, sociable	Extraversion
is reserved (reversed)	Extraversion
is sometimes somewhat rude to others (reversed)	Agreeableness
has a forgiving nature	Agreeableness
is considerate and kind to others	Agreeableness
worries a lot	Neuroticism
gets nervous easily	Neuroticism
is relaxed, handles stress well (reversed)	Neuroticism

*Notes:* SOEPv29 waves 2005 to 2012, youth and adult questionnaires.

Table 8: Internal Locus of Control

How my life goes depends on me.
If I run up against difficulties in life, I often doubt my own abilities (reversed).
Compared to other people, I have not achieved what I deserve (reversed).
What a person achieves in life is above all a question of fate or luck (reversed).
I frequently have the experience that other people have a controlling influence over my life (reversed).
The opportunities that I have in life are determined by the social conditions (reversed).
I have little control over the things that happen in my life (reversed).

*Notes:* SOEPv29 waves 2005 to 2012, youth and adult questionnaires.

## B Summary Statistics

Table 9: Summary Statistics of (non-standardized) Personality Traits

	Observations	Mean	Std. Dev.	Minimum	Maximum
Openness	1047	4.886	1.103	1	7
Conscientiousness	1054	4.959	1.122	1.333	7
Extraversion	1055	5.009	1.209	1	7
Agreeableness	1056	5.404	0.900	2	7
Neuroticism	1052	3.731	1.191	1	7
Locus of Control	1015	5.018	0.809	2.143	7

Notes: SOEPv29 waves 2005 to 2012, sample: adolescents and young adults aged 17 to 21 attending high school or with a high school diploma.

Table 10: Summary Statistics of Individual Characteristics

	Mean		Equality of Means t-stat
	Control	Treatment	
Age	18.030	17.090	9.271
Female	0.543	0.507	0.937
East	0.100	0.280	-6.941
Rural area	0.261	0.284	-0.689
Non-intact family	0.190	0.190	0.017
Working-class father	0.198	0.175	0.756
High parental education	0.584	0.583	0.039
Working mother	0.681	0.768	-2.456
Christian parents	0.645	0.687	-1.162
Migration background	0.175	0.175	-0.021
Low-performing student	0.313	0.218	2.713
Only child*	0.130	0.146	-0.625
Oldest child*	0.390	0.390	0.005
Observations	847	211	

Notes: SOEPv29 waves 2005 to 2012, sample: adolescents and young adults aged 17 to 21 attending high school or with a high school diploma. For variables marked with (\*), less observations than stated are available. For this reason these variables are excluded in the estimation; they are depicted here however to illustrate that they do not differ on average between treatment and control group and their exclusion should therefore not bias our estimates.

## C Estimation Results

Table 11: Timing of reform implementation and state characteristics

	Late Implementation <sup>1</sup> (OLS)	Year of Implementation <sup>2</sup> (Ordered Probit)
Proportion of high school students	-0.027 (0.037)	-0.051 (0.066)
Conservative government	0.164 (0.392)	-0.688 (0.694)
Next Election in 2001 or 2002	-0.164 (0.376)	-0.603 (0.667)
Median population age	-0.037 (0.213)	-0.934** (0.452)
GDP per capita	0.000 (0.000)	-0.000 (0.000)
Constant	2.545 (8.824)	
R <sup>2</sup>	0.132	
Pseudo R <sup>2</sup>		0.173
Observations	13	13

*Notes:* The regressors are pre-reform state characteristics in the year 2000 from administrative data sources. Proportion of high school students (in percentage points)/median population age (in years)/GDP per capita (in euros): Federal Statistical Office; governing party/election dates: [www.election.de](http://www.election.de). OLS, respectively ordered probit regressions. The indicator variable conservative government equals one if a state's prime minister is from the Christian Democratic Union (CDU), and zero otherwise. Standard errors in parentheses. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

<sup>1</sup>Dummy variable for late adopter state (as defined in Section 6.5), that is, first cohort affected graduating in 2011 or later.

<sup>2</sup>Year of implementation of the reform ranging from 1 (2001) to 7 (2007).

Table 12: Effects of the Reform (Extended Control Variables)

	Outcome Variables: Personality Traits					
	Open.	Consc.	Extrav.	Agree.	Neurot.	LoC
Reform	-0.137 (0.160)	-0.105 (0.173)	0.227** (0.090)	0.198 (0.144)	0.235* (0.121)	-0.037 (0.132)
Female	0.032 (0.070)	-0.018 (0.090)	0.009 (0.078)	-0.016 (0.075)	0.036 (0.063)	-0.031 (0.070)
Rural area	0.004 (0.056)	-0.091 (0.093)	0.058 (0.079)	-0.027 (0.063)	0.072 (0.064)	-0.056 (0.062)
Non-intact family	0.059 (0.051)	-0.036 (0.110)	0.065 (0.107)	-0.082 (0.067)	0.133* (0.065)	-0.125* (0.069)
Work.-class father	-0.270** (0.091)	0.063 (0.098)	-0.064 (0.086)	-0.019 (0.058)	0.137 (0.116)	-0.012 (0.070)
High parental educ.	0.006 (0.064)	-0.244*** (0.057)	-0.145 (0.087)	-0.084 (0.064)	-0.026 (0.052)	0.012 (0.049)
Working mother	0.075 (0.075)	-0.089 (0.065)	0.137* (0.074)	0.004 (0.042)	-0.138** (0.049)	-0.001 (0.072)
Christian parents	0.047 (0.071)	0.103 (0.071)	-0.039 (0.066)	-0.060 (0.050)	0.093 (0.083)	-0.012 (0.055)
Migration backgr.	0.091 (0.104)	-0.156** (0.056)	-0.026 (0.075)	-0.141 (0.114)	-0.040 (0.091)	0.033 (0.065)
Low-perf. student	0.008 (0.044)	-0.063 (0.050)	-0.136 (0.079)	-0.014 (0.067)	0.061 (0.073)	-0.157* (0.080)
Only child	0.100 (0.093)	-0.043 (0.046)	0.144 (0.090)	-0.157* (0.078)	0.020 (0.084)	0.016 (0.085)
Oldest child	0.111** (0.039)	0.106** (0.047)	0.070 (0.042)	-0.049 (0.051)	0.031 (0.073)	-0.059 (0.051)
R <sup>2</sup>	0.041	0.071	0.059	0.042	0.058	0.050
Observations	1011	1018	1020	1020	1016	986

Notes: SOEPv29 waves 2005 to 2012. OLS regressions. Age, age squared and a maximum set of state dummies, year of school entry dummies, dummies for the different SOEP samples, and a constant are included. Standard errors, reported in parentheses, are clustered at the state level. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

Table 13: Sensitivity Analyses 6.1: Age Effects

	Outcome Variables: Personality Traits					
	Open.	Consc.	Extrav.	Agree.	Neurot.	LoC
<b>Outcome Variables: Age-free residuals of Personality Traits</b>						
Reform	-0.157 (0.158)	-0.124 (0.202)	0.252* (0.120)	0.194 (0.132)	0.329* (0.156)	-0.011 (0.096)
Observations	1047	1054	1055	1056	1052	1015
<b>Subsample: Age 17</b>						
Reform	-0.157 (0.168)	0.003 (0.173)	0.216* (0.105)	0.279** (0.113)	0.126 (0.173)	-0.046 (0.154)
Observations	693	698	697	699	697	684

Notes: SOEPv29 waves 2005 to 2012. OLS regressions. Only the coefficients of *REFORM* and the respective number of observations are presented. Age, age squared, female, rural area, non-intact family, working-class father, high parental education, working mother, Christian parents, migration background, low-performing student and a maximum set of state dummies, year of school entry dummies, dummies for the different SOEP samples, and a constant are included. Standard errors, reported in parentheses, are clustered at the state level.\* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

Table 14: Sensitivity Analyses 6.2 - 6.4: Measurement Issues and Estimation Model

	Outcome Variables: Personality Traits					
	Open.	Consc.	Extrav.	Agree.	Neurot.	LoC
<b>Subsample: Age 17, Heterogeneous Effects by time of the interview<sup>1</sup></b>						
Reform	-0.186 (0.164)	0.048 (0.170)	0.273* (0.132)	0.196 (0.139)	0.035 (0.224)	-0.004 (0.163)
Reform*Quarter 2	0.038 (0.231)	-0.132 (0.168)	-0.134 (0.217)	0.139 (0.138)	0.214 (0.193)	-0.138 (0.213)
Reform*Quarter 3	-0.103 (0.297)	0.242 (0.279)	-0.000 (0.273)	0.277 (0.418)	0.044 (0.350)	-0.122 (0.180)
Reform*Quarter 4	-0.065 (0.419)	-0.391 (1.627)	-0.847 (1.073)	0.644 (1.219)	0.401 (1.114)	0.587 (0.330)
Observations	693	698	697	699	697	684
<b>Including dummy for having graduated as further control<sup>1</sup></b>						
Reform	-0.140 (0.149)	-0.111 (0.188)	0.213** (0.094)	0.212 (0.148)	0.284* (0.133)	-0.011 (0.119)
High school diploma	-0.231 (0.427)	-0.087 (0.317)	-0.284 (0.328)	0.089 (0.323)	-0.117 (0.401)	-0.158 (0.324)
Observations	1047	1054	1055	1056	1052	1015
<b>Subsample: Youth Questionnaire<sup>1</sup></b>						
Reform	-0.186 (0.178)	0.048 (0.203)	0.224 (0.130)	0.292* (0.143)	0.197 (0.179)	-0.089 (0.194)
Observations	577	582	582	583	582	572
<b>Ordered Probit Estimation<sup>2</sup></b>						
Reform	-0.158 (0.144)	-0.126 (0.190)	0.228** (0.101)	0.207 (0.133)	0.298** (0.132)	-0.003 (0.125)
Observations	1047	1054	1055	1056	1052	1015

Notes: SOEPv29 waves 2005 to 2012. <sup>1</sup>OLS regressions. <sup>2</sup>Ordered Probit estimation with the standardized personality measures as categorical outcomes. In addition to the displayed coefficients, age, age squared, female, rural area, non-intact family, working-class father, high parental education, working mother, Christian parents, migration background, low-performing student and a maximum set of state dummies, year of school entry dummies, dummies for the different SOEP samples, and a constant are included (as well as quarter dummies for the time of the interview in the first estimation). Standard errors, reported in parentheses, are clustered at the state level. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

Table 15: Sensitivity Analyses 6.5 - 6.7: Selectivity, Double Cohort, and Implementation Effects

	Outcome Variables: Personality Traits					
	Open.	Consc.	Extrav.	Agree.	Neurot.	LoC
<b>Subsample: Lateadopter states<sup>1</sup></b>						
Reform	-0.266*	0.098	0.072	0.153	0.182	0.520**
	(0.113)	(0.143)	(0.161)	(0.288)	(0.179)	(0.160)
Observations	661	666	667	668	665	644
<b>Subsample: States without comprehensive schools<sup>2</sup></b>						
Reform	0.537	0.158	0.287*	0.342*	0.134	0.190
	(0.414)	(0.138)	(0.109)	(0.136)	(0.099)	(0.338)
Observations	410	412	412	412	411	398
<b>Subsample: Exclusion of double graduating cohort</b>						
Reform	-0.139	-0.148	0.399*	-0.070	0.256*	0.032
	(0.121)	(0.126)	(0.191)	(0.170)	(0.135)	(0.310)
Observations	863	869	870	871	867	835
<b>Heterogeneous Effects by Time since Implementation of Reform<sup>3</sup></b>						
Reform	-0.120	-0.099	0.106	0.193	0.302**	-0.009
	(0.190)	(0.177)	(0.134)	(0.122)	(0.137)	(0.103)
Cohort=2	-0.098	-0.038	0.356	0.112	-0.056	-0.078
	(0.201)	(0.160)	(0.226)	(0.090)	(0.089)	(0.149)
Cohort $\geq$ 3	-0.004	-0.105	0.360	-0.169	-0.152	0.310
	(0.192)	(0.119)	(0.242)	(0.153)	(0.126)	(0.191)
Observations	1047	1054	1055	1056	1052	1015

Notes: SOEPv29 waves 2005 to 2012. OLS regressions. Only the coefficients of *REFORM* and the respective number of observations are presented. Age, age squared, female, rural area, non-intact family, working-class father, high parental education, working mother, Christian parents, migration background, low-performing student and a maximum set of state dummies, year of school entry dummies, dummies for the different SOEP samples, and a constant are included. Standard errors, reported in parentheses, are clustered at the state level.\* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

<sup>1</sup>These are states where the first students affected by the reform graduate in 2012 or later, that is, Baden-Wuerttemberg, Bremen, Hesse, North Rhine-Westphalia, Berlin, Schleswig-Holstein, and Brandenburg.

<sup>2</sup>States where comprehensive schools typically do not exist are Baden-Wuerttemberg, Bavaria, Mecklenburg-West Pomerania, Saarland, and Saxony-Anhalt.

<sup>3</sup>Next to *REFORM*, dummies for the second cohort affected by the reform and for cohorts three and higher are included in the estimation and presented.

Table 16: Sensitivity Analyses 6.8: Other Institutional Changes

	Outcome Variables: Personality Traits					
	Open.	Consc.	Extrav.	Agree.	Neurot.	LoC
<b>Subsample: States with standardized exit examinations established<sup>1</sup></b>						
Reform	0.107 (0.355)	-0.158 (0.191)	0.295* (0.113)	0.349 (0.198)	0.323 (0.206)	-0.191** (0.042)
Observations	401	403	402	403	403	386

Notes: SOEPv29 waves 2005 to 2012. OLS regressions. Only the coefficients of *REFORM* and the respective number of observations are presented. Age, age squared, female, rural area, non-intact family, working-class father, high parental education, working mother, Christian parents, migration background, low-performing student and a maximum set of state dummies, year of school entry dummies, dummies for the different SOEP samples, and a constant are included. Standard errors, reported in parentheses, are clustered at the state level. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

<sup>1</sup>These states with central exit examinations long in place are Baden-Wuerttemberg, Bavaria, Mecklenburg-West Pomerania, Saarland, and Saxony-Anhalt.

Table 17: Sensitivity Analyses 6.9: Placebo Estimation

	Outcome Variables: Personality Traits					
	Open.	Consc.	Extrav.	Agree.	Neurot.	LoC
<b>Sample: Students from other school tracks</b>						
Reform	0.091 (0.102)	-0.089 (0.141)	-0.004 (0.065)	0.013 (0.085)	0.079 (0.089)	0.019 (0.127)
Female	-0.012 (0.030)	-0.030 (0.072)	0.003 (0.061)	-0.002 (0.050)	-0.001 (0.056)	0.018 (0.091)
Rural area	-0.039 (0.062)	0.104 (0.091)	0.054 (0.070)	-0.022 (0.058)	0.052 (0.077)	0.131 (0.085)
Non-intact family	-0.019 (0.078)	-0.093* (0.044)	0.005 (0.037)	-0.106 (0.076)	0.151** (0.060)	-0.085 (0.065)
Work.-class father	-0.077 (0.061)	0.042 (0.036)	0.013 (0.076)	-0.071 (0.050)	-0.033 (0.070)	-0.099 (0.068)
High parental educ.	0.166** (0.061)	-0.091 (0.064)	0.201** (0.067)	-0.041 (0.053)	-0.039 (0.082)	0.243*** (0.045)
Working mother	0.090 (0.061)	-0.013 (0.046)	0.006 (0.044)	0.058 (0.086)	0.012 (0.077)	0.144** (0.057)
Christian parents	0.156** (0.062)	0.016 (0.055)	0.038 (0.054)	-0.048 (0.066)	0.005 (0.066)	-0.048 (0.065)
Migration backgr.	0.079 (0.058)	0.097 (0.085)	0.198* (0.103)	-0.060 (0.061)	-0.186** (0.069)	-0.077 (0.095)
Low-perf. student	-0.145* (0.074)	-0.075 (0.067)	-0.212*** (0.042)	0.006 (0.041)	-0.046 (0.066)	-0.086 (0.051)
R <sup>2</sup>	0.035	0.082	0.040	0.026	0.033	0.064
Observations	1590	1591	1598	1599	1602	1518

Notes: SOEPv29 waves 2005 to 2012. OLS regressions. Age, age squared and a maximum set of state dummies, year of school entry dummies, dummies for the different SOEP samples, and a constant are included. Standard errors, reported in parentheses, are clustered at the state level. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .



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