

Is Doing Your Homework Associated with Becoming More Conscientious?

Accepted version for publication in

Journal of Research in Personality

Richard Göllner¹, Rodica I. Damian², Norman Rose¹, Marion Spengler¹, Ulrich Trautwein¹, Benjamin Nagengast¹, & Brent W. Roberts³

¹University of Tübingen, Hector Research Institute of Education Sciences and Psychology

²University of Houston, Department of Psychology

³University of Illinois, Urbana–Champaign, Department of Psychology

The research reported here is based upon work supported by the Postdoc Academy of the Hector Research Institute of Education Sciences and Psychology, funded by the Baden-Württemberg Ministry of Science, Research, and the Arts, and the LEAD Graduate School and Research Network, which is funded within the framework of the Excellence Initiative by the German State and Federal Governments (GSC 1028).

Involvement of Brent W. Roberts in the preparation of this paper was made possible by a grant from the Baden-Württemberg Ministry of Science, Research, and the Arts, Germany.

Richard Göllner is a Postdoctoral Fellow in the International PATHWAYS to Adulthood Programme.

Correspondence concerning this article should be addressed to Richard Göllner, University of Tübingen, Hector Research Institute of Education Sciences and Psychology, Europastraße 6, 72072 Tübingen. Email: richard.goellner@uni-tuebingen.de, Phone: (+49)

07071-29 73 913, Fax: (+49) 07071-29-5371.

Abstract

Research has shown that sustained homework effort enhances academic performance and that students' conscientiousness is a powerful predictor of students' homework effort. But does homework—as homework proponents claim—in turn also influence the development of conscientiousness over time? In the present study, we examined whether students' homework effort in two subjects (i.e., mathematics and language) was associated with inter-individual differences in students' development of conscientiousness in the early years of adolescence. Bivariate change models with a total of $N = 2,760$ students revealed that homework effort and conscientiousness were systematically related over time (Grade 5 to Grade 8). Most importantly, students who invested more effort in their homework showed more positive development in conscientiousness.

Keywords: conscientiousness; academic performance; homework effort; self-report; parent report; personality development

Is Doing Your Homework Associated with Becoming More Conscientious?

Conscientiousness refers to a family of related personality traits that include the qualities of having self-control and being responsible to others, hardworking, orderly, and rule abiding (Roberts, Lejuez, Kruger, Richards, & Hill, 2014). Conscientiousness appears to be one of the most influential trait domains, as it predicts physical health (Hampson, Goldberg, Vogt, & Dubanoski, 2007; Moffitt et al., 2011), the onset of Alzheimer's disease (Wilson, Schneider, Arnold, Bienias, & Bennett, 2007), and longevity (Kern & Friedman, 2008). Conscientiousness also predicts outcomes such as relationship quality, the duration of relationships, and occupational attainment (Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). And, in the case of school, conscientiousness is the most important factor aside from cognitive abilities when it comes to school performance (Poropat, 2009). Succinctly, conscientiousness is a personality trait that promotes better health, wealth, relationships, and school success.

Given the importance of conscientiousness, it is becoming increasingly common for institutions and the public to want to understand how to foster it (Roberts et al., 2014). Conscientiousness falls into the category of "non-cognitive" factors that are now acknowledged as complementary to but just as important as cognitive ability in determining human capital outcomes, such as educational attainment and occupational success (Almlund, Duckworth, Heckman, & Kautz, 2011). Accordingly, most parents and societies are invested in having their children become adults who are responsible, hardworking, and have appropriate self-control.

It is often assumed that childhood is the right time to develop conscientiousness (Heckman, 2012), and that school provides an ideal environment to foster conscientiousness and its constituent elements, such as industriousness or grit. Homework is one of the most widely used practices through which children are seen as learning the lesson that hard work pays off (e.g., Cooper, Robinson, & Patall, 2006; Epstein, & VanVoorhis, 2001; Trautwein, Niggli,

Schnyder, & Lüdtke, 2009). Presumably, then, homework should be one mechanism through which children learn to be more conscientious. Despite the intrinsic connection between homework and conscientiousness, to our knowledge there has never been a longitudinal study of children in which changes in the two constructs have been tracked simultaneously over time. In the current study, we report data from a four-wave longitudinal study where both students' homework effort and conscientiousness were assessed. Moreover, in addition to the typical self-report assessment of conscientiousness, our study also contains parent ratings of conscientiousness, allowing us to test not only whether self-perceptions of conscientiousness change, but also whether outside observers note the changes related to increases in homework effort.

Students' Homework Effort and Conscientiousness

In most countries around the world, students spend a substantial amount of time working on homework in subjects like mathematics or language. Typically, more homework is assigned in higher grades than in lower grades, and several literature reviews suggest that homework is associated with achievement gains. For instance, a highly influential meta-analysis by Cooper and colleagues (2006) summarized a variety of studies and provided empirical support for homework effects on students' achievement. Similar results were found in a more recent meta-analysis (Fan, Xu, Cai, He, & Fan, 2017) and a study by Falch and Rønning (2012), which found that homework effects are largely consistent across data from 16 OECD countries, even though cross-country differences do exist (see also Dettmers, Trautwein, & Lüdtke, 2009).

There are three things to be aware of when considering students' homework. First, the "active ingredient" in homework that drives achievement is homework effort as indicated by active and engaged homework behavior, as opposed to just time spent doing homework (Flunger, Trautwein, Nagengast, Lüdtke, Niggli, & Schnyder, 2015). A number of empirical studies have

shown that homework effort is consistently related to student achievement, whereas findings on the relationship between time spent on homework and academic achievement are more mixed (e.g., Cooper et al, 2006). Regarding the latter, there are some studies showing a positive relation, whereas other studies report null or even small negative effects. The negative effects likely result from the negative link between prior knowledge and time spent on homework, as the time students reportedly spent on homework is “strongly influenced by their prior knowledge” (De Jong, Westerhof, & Creemers, 2000). Second, there is a set of student characteristics that are seen as key determinants of students' homework effort. In particular, students' conscientiousness and related constructs such as self-control, persistence, and achievement goals have emerged as potential predictors of homework effort and therefore higher achievement in terms of test scores or grades (e.g., Duckworth & Seligman, 2005; Elliot, McGregor, & Gable, 1999; Galla & Duckworth, 2015; Trautwein, Lüdtke, Kastens, & Köller, 2006). Consistent with the results on student achievement, it is homework effort rather than time spent on homework that is predicted by students' conscientiousness. For instance, Trautwein and Lüdtke (2007) reported a medium-sized statistically significant relation between conscientiousness and homework effort, but non-statistically significant results for the relation between conscientiousness and time spent on homework. Moreover, conscientiousness has been shown to be particularly important for students' effort in the *homework* situation, as differences in effort between more and less conscientious students have been found to be more profound in homework as opposed to classwork. Finally, doing homework is not only relevant for students' achievement but is also considered relevant for non-academic outcomes. Epstein and VanVoorhis (2001) identified a variety of non-academic reasons for why teachers assign homework, including ensuring that everyone participates in learning, promoting parental homework involvement, and developing good personal habits among students. Personal development is achieved by creating situations

where students must utilize good time management skills in order to get their work done. Students have to control the amount of time they spend on different tasks, establish work schedules, build study skills (Muhlenbruck, Cooper, Nye, & Lindsay, 2000), and learn to deal with distractions at home (Cooper, Lindsay, & Nye, 2000; Trautwein, Niggli, Schnyder, & Lüdtke, 2009; Xu & Corno, 1998). This is particularly true in the elementary grades, as teachers are trying to prepare children for the more rigorous assignments that will come later in schooling (Muhlenbruck et al., 2000). Even though all of these educational studies have provided highly relevant findings for the trait of conscientiousness, no study exists that tests the relation between students' homework effort and changes in conscientiousness.

The Development of Conscientiousness

An increasing number of studies show that conscientiousness changes during late childhood and early adolescence, although this change does not necessarily follow a linear time trend and diverges from well-known consistent change patterns at older ages (e.g., early adulthood; Roberts, Walton, & Viechtbauer, 2006). Research has shown that children's self-control increases as they move through their preschool and elementary school years, but sometimes decreases again during the transition to adolescence (e.g., Luan, Hutteman, Denissen, Asendorpf, & van Aken, 2017; Soto & Tackett, 2015; Tackett & Durbin, 2017). Denissen, van Aken, Penke and Wood (2013) highlight the importance of regulative processes for understanding personality development at this age. They argue that regulative strategies need resources and practice, which might be a potential explanation for temporary dips in some aspects of personality maturity. At the same time, however, individual differences in personality traits become more pronounced over childhood and adolescence. Alongside age-related developmental processes, children and young adolescents experience divergent relationships with their social environment, which lead to more pronounced inter-individual differences. For example, youths

who spend less time closely supervised by parents have access to quite different learning contexts and gain greater independence in their everyday lives (Caspi, Roberts, & Shiner, 2005; Roberts, Wood, & Caspi, 2008). That is, personality changes quite a lot during childhood and adolescence (Donnellan, Hill, & Roberts, 2015), but not in a systematic way. The years from childhood to young adulthood show higher personality instability compared to other parts of the lifespan, suggesting that personality has a high level of plasticity during this period (Soto, & Tackett, 2015).

The idea that students' homework effort can lead to long-lasting changes in students' conscientiousness is guided by recent integrative models of personality traits and personality trait change (Roberts, 2009; Wrzus & Roberts, 2017). The first theoretical perspective on why changes in homework effort may lead to enduring changes in conscientiousness is the sociogenomic model of personality traits (Roberts & Jackson, 2008). According to the sociogenomic model (Roberts & Jackson, 2008), long-term shifts in states are one of the hypothesized conduits for personality trait change. With regard to the homework-conscientiousness relation, accommodating teachers' demands by studying harder would shift states related to conscientiousness. If these changes in conscientiousness-related states become extended, internalized, and automatic, they can cause changes in conscientiousness in a bottom-up fashion (Magidson, Roberts, Collado-Rodriguez, & Lejuez, 2014; Roberts, 2006). Recent support for the idea that studying might lead to change in a bottom-up fashion comes from a short-term longitudinal study of German high school students, whose conscientiousness increased proportionate to the amount of effort they put into studying for their secondary school graduation examination (Bleidorn, 2012).

This assumption is also in line with the TESSERA framework, which explicitly addresses the theoretical integration of the short-term processes that underlie personality development

(Wrzus & Roberts, 2017). The TESSERA framework posits that long-term personality development occurs as a result of repeated short-term situational processes, which can be described as a sequence of Triggering situations, Expectancy, States/State Expressions, and Reactions (TESSERA). Repeatedly experiencing TESSERA sequences can lead to long-term personality development. In the case of homework, teachers assigning homework at the end of one lesson presumably triggers students' expectancy of how well the homework needs to be done, which in turn results in momentary thoughts (e.g., surface or deep processing of homework), feelings (curiosity or boredom), and behaviors (e.g., perseverant or non-persistent) while completing the homework at home (states/state expressions). Reactions after homework come from the students themselves (e.g., pride at one's achievement) or from the teacher the next day (e.g., feedback), and these then determine whether the way the students did their homework needs to be changed or can remain unchanged. Repeatedly experiencing the need to change one's homework effort can then lead to long-lasting changes in personality traits such as conscientiousness, of which self-control, planning, and effort are key components. Thereby, one further assumption of the TESSERA model is that individual differences exist in the sequence from behavior to personality trait change. That is, the connection between triggering situations and state expressions is not an automatic response to specific situations, it is also shaped by internal (e.g., students' attributed value) and external sources (e.g., expectations of relevant others; e.g., parents). This explains why even when confronted with high-quality learning assignments not all students will change their personality in the same direction and to the same extent.

In sum, student homework effort might be one potential source of change in conscientiousness. However, not all kinds of behaviors are associated with longstanding changes in broad personality domains. Only trans-situationally consistent and trait corresponsive

experiences/behaviors can lead to changes at the level of broad personality factors (Roberts et al., 2008). Given this strong theoretical basis for trait change in personality research, there is surprisingly little work on relating behavioral changes to personality trait changes. The present study set out to test the relation between students' homework effort and changes in students' conscientiousness. Specifically, by following a sample of German students throughout the first years of secondary education, this study provided a fine-grained investigation of the dynamic interplay between students' homework effort and changes in conscientiousness.

The Present Study

Although homework is a widely used technique to help students build upon skills that were taught in the classroom, relatively little is known about the relation between educational experiences such as homework and personality trait change over time. In the present study, we were interested whether students' homework effort after the transition from primary to secondary school is associated with changes in the trait of conscientiousness. Our study design is unique in several ways, but most notably, the study design included ratings of personality traits from both students and their parents, thus providing a more rigorous test of whether personality traits change in relation to changes in students' homework effort.

The second unique feature of this study is the four-wave longitudinal panel structure of our data. Given this data structure, we used latent change score models to answer a series of inter-related questions. Our first goal was to track changes in homework effort and conscientiousness over time. We knew from prior research on this cohort that the general trend is for self-reported conscientiousness to decrease (Göllner et al., 2017), but did not know what happens to homework effort over time. Prior research with similar student groups found a general decrease in homework effort in or after the transition from primary to secondary school, despite an increase in homework assignments (Trautwein et al., 2006). Once we established the general trends in

these two domains, we turned to analyzing how change in one domain is related to change in the other. The latent change score models afforded us the opportunity to examine several types of parameters, all of which are complementary and address slightly different questions. At the broadest and simplest level, one can estimate change in homework effort over the four waves and relate it to changes in conscientiousness. This parameter answers the question of whether changes in homework effort are associated with changes in conscientiousness. The advantage of estimating change over four waves of data is that it increases the reliability of the assessment of change, making it easier to detect a relation if one exists (Willett, 1997). However, the aggregation of information across the four waves forces us to sacrifice the ability to examine associations over shorter periods. A second set of change questions has to do with the year-to-year experiences and transitions that students go through. Students often transition from one teacher to the next, with a resulting change in homework expectations that might be period-specific. Therefore, we also examined the year-to-year lagged effects and concurrent associations between homework effort and conscientiousness. Examining these parameters allowed us to answer questions such as “Is any one period within this longitudinal time span more important than others when it comes to the relation between changes in homework effort and changes in conscientiousness?” As a side note, many people mistakenly assume that lagged effects support causal inferences, which they do not given the observational structure of the data. However, in this case, the lagged effects of homework effort on changes in conscientiousness are of particular interest. As teacher-related attitudes (e.g., homework frequency, homework quality, or homework checks) are expected to impact students' homework effort, possible teacher changes from one year to the next need to be taken into account when estimating the relations between students' homework effort and changes in students' conscientiousness.

As can be seen, to this point we have been careful about our use of causal language and inferences. Nonetheless, we assume that it is changes in homework effort that drive changes in conscientiousness. However, we are also aware that latent change and cross-lagged models do not support causal inferences in this type of data structure. Thus, in a final set of analyses, we also compared two groups of students—one that increased their homework effort over time and one that did not—and then tested whether the association remained in each of these conditions, which would strengthen the claim that changes in homework effort actually cause changes in conscientiousness. Potential group differences in background characteristics were controlled for by means of propensity score matching.

Method

Participants

Participants were drawn from the Tradition and Innovation in School Systems Study (TRAIN; Jonkmann, Rose, & Trautwein, 2013), a large-scale study which was designed to analyze the academic development of students in different school tracks in two German states (Saxony and Baden-Württemberg). Students were initially assessed right after their transition from primary to secondary school in Grade 5, when students are faced with new and demanding environments in which pre-existing behavior is less adaptive and personality trait changes are likely to occur. The study encompasses four annual measurement time points (Grade 5, Grade 6, Grade 7, and Grade 8), with assessment taking place between six and eight weeks after the start of each school year.

A total of 2,760 students provided data for measures of conscientiousness and homework effort. Among the students in the study, 46.4% were female, the mean age was 11.09 years, and 27.4% of students had an immigrant background (defined as at least one parent born outside Germany). In terms of educational level, 13.9% of the children's mothers and 16.5% of their

fathers had graduated from a college-preparatory secondary school (i.e., had qualified for university entrance). Students came from three non-college preparatory tracks in the federal states of Baden-Württemberg and Saxony: Hauptschule (i.e., the lowest and least academically demanding track), Realschule (i.e., the intermediate track and the most demanding track in the present study), and Mittelschulen (i.e., multitrack schools ranked between the lowest academic track and the intermediate track).¹²

Sample attrition was relatively low. Completion rates for self-reported conscientiousness and homework data ranged between 2,533 students in Grade 5 to 1,858 students in Grade 8. To test for attrition effects, we compared continuers, who participated throughout the study, with dropouts, who dropped out during the course of the study (i.e., did not participate in at least one measurement time point and did not participate in a following measurement time point). Attrition analysis showed that continuers exhibited higher achievement in math ($r = -.14$) and German ($r = -.13$), were a bit younger ($r = .06$), had a slightly higher socioeconomic background ($r = -.07$), and were more likely from higher achieving school tracks ($\chi^2(2) = 94.52, p < .001$) than dropouts. Other variables such as students' conscientiousness (self-report: $r = -.04$ or parent report: $r = -.02$) and students' gender exhibited statistically non-significant results ($\chi^2(1) = 0.12, p = .72$). Taken together, although dropouts and continuers differed significantly in some domains, the magnitude of these differences was rather small. We applied the full information maximum likelihood method to deal with missing data (Enders, 2010).

Measures

¹ A "tripartite" system of lower track schools (Hauptschule), intermediate track schools (Realschule), and academic track schools (Gymnasium) is the most common secondary education system in German states; some states offer multitrack schools (e.g., Mittelschule), which serve lower and intermediate track students in joint classes. Students from Hauptschule, Realschule, and Mittelschule took part in the present study.

² Data along with the Mplus code for latent change score models are available via Open Science Framework (<https://osf.io/hwzuj>).

Conscientiousness. Conscientiousness was measured using the nine Conscientiousness self-report items from the German version (Lang, Lüdtke & Asendorpf, 2001) of the Big Five Inventory (BFI; John, Donahue, & Kentle, 1991). Each item was rated on a scale ranging from 1 (strongly disagree) to 5 (strongly agree). Scale reliabilities were .51 (Grade 5), .59 (Grade 6), .68 (Grade 7), and .69 (Grade 8). As young children's personality ratings are not without problems (e.g., acquiescent responding), we paid particular attention to students' acquiescent tendency (e.g., Soto, John, Gosling, & Potter, 2008). First, we explicitly modeled acquiescent responding as an additional method factor behind item indicators (see Billiet & McClendon, 2000; Göllner et al., 2017) and replicated our results by additionally using parental reports of students' personality. The parental assessment of students' conscientiousness was conducted using a short version of the BFI with two items assessing students' conscientiousness. Scale reliabilities were .81 (Grade 5), .82 (Grade 6), .81 (Grade 7), and .85 (Grade 8).

Students' homework effort. Homework effort was measured using one item for mathematics and one item for German. The item for homework effort in mathematics was "Please think about your last 10 homework assignments in [...mathematics]. How much of it have you done as well as possible". Students indicated their response on a frequency scale ranging from zero to ten (see Dettmers, Trautwein, Lüdtke, Kunter, & Baumert, 2010). As the two variables were substantially correlated ($.72 \leq r \leq .88$) at each of the measurement time points, we decided to combine the two variables as item indicators of a latent homework variable.

Covariates. We also included potential confounding variables into the analytical model. We used students' gender, school type, family socioeconomic status (SES), students' cognitive abilities, and students' migration status. SES was assessed using the International Socio-Economic Index (ISEI) developed by Ganzeboom, de Graaf, Treiman, and de Leeuw (1992). Students' cognitive abilities were assessed by different subscales of the Cognitive Ability Test 4

–12 R (Heller & Perleth, 2000). For school type, we created two dummy variables for three different categories (lowest academic track, the intermediate track, and multitrack schools). We used students' gender, school type, family socioeconomic status (SES), cognitive abilities, and migration status measured at Grade 5 as time-invariant model covariates.

Analysis

Latent change score models. To address whether students' homework effort was associated with changes in the trait of conscientiousness, we used a dual-bivariate change score model (McArdle & Hamagami, 2001). The model simultaneously addressed bivariate mean growth trends and cross-sequential relations of variables from one school year to the next (see Figure 1). The key variables are change scores in students' conscientiousness (C_{56} , C_{67} , and C_{78}) and homework effort (H_{56} , H_{67} , and H_{78}), which were modeled as a function of (a) an overall time trend (C_{Time} and H_{Time}), (b) the autoregressive effect of a latent factor representing the same variable at the previous time point (e.g., β_{C1} and β_{H1}), and (c) a cross-time relation of a latent factor representing the other variable at the previous time point (e.g., $\gamma_{C1 \rightarrow \Delta H1}$ and $\gamma_{H1 \rightarrow \Delta C1}$). Of particular importance for the present study were concurrent relations between changes in students' homework effort and conscientiousness at the level of overall time trends ($\sigma_{\Delta H \leftrightarrow \Delta C}$) and year-to year changes (e.g., $\sigma_{\Delta H1 \leftrightarrow \Delta C1}$) as well as cross-time relations relating changes in students' conscientiousness over time to students' previously demonstrated homework effort (e.g., $\gamma_{H1 \rightarrow \Delta C1}$).

Reliable change analysis. One relevant piece of information that is not given by latent change score models is what kind of change pattern describes the relation between the two variables. That is, cross-time or concurrent relations between students' homework effort and students' conscientiousness provide relatively little information about the nature of the relationship. For instance, it is common to interpret a positive association between changes in the

two constructs as in indication that increases in homework effort are associated with increases in conscientiousness. However, if the overall trend is for all students to decrease on both measures, this inference would be incorrect. Rather, it would be more likely that students who maintain their initial levels of homework effort also maintain their initial level of conscientiousness.

Without an explicit examination of the pattern of change at both ends of the spectrum of both change constructs, it is problematic to make strong inferences about the nature of the association. For this reason, we applied the reliable change index (RCI) statistic to examine whether students who increased their homework effort also exhibited a positive change in their conscientiousness. The reliable change index (RCI) is a statistic first proposed in psychotherapy research that is used to determine whether a change in an individual's (or group's) score is statistically significant on the basis of the measurement's test-retest reliability (Jacobson & Truax, 1991). It provides information regarding the likelihood that a change in test scores "results from 'true' or reliable change or results from chance". The RCI has been used in a number of past investigations of personality trait change (e.g., Roberts, Caspi, & Moffitt, 2001; Robins, Fraley, Roberts, & Trzesniewski, 2001).

Control of potential confounding variables. As we did not allocate students to different RCI groups, we also took special care to assure the comparability of groups in terms of relevant other variables. In order to control for potential differences, we used propensity score matching (PSM) to control for a number of potentially important covariates when estimating changes in conscientiousness among RCI groups (Stuart, 2010). That is, we created comparable groups along measured covariates and tested for group differences in self-reported and parent-reported changes in students' conscientiousness. The matching of groups was done in two steps. First, students who increased their homework (RCI+) from Grade 5 to Grade 8 were matched with students who remained unchanged (RCI+/-). We used 1:1 nearest neighbor matching without

replacement based on estimated propensity scores from a linear logistic regression model. The model was used to predict membership in the two RCI change groups compared to the RCI+/- group using the main effects of the covariates as predictors. In the matching procedure, each RCI+ student was assigned one RCI+/- student with a comparable propensity score. The same process was applied in the second step, where we matched students who decreased their homework (RCI-) from Grade 5 to Grade 8 with students who remained unchanged (RCI^{+/-}). Finally, we conducted a regression analysis predicting changes in students' conscientiousness over time to estimate group effects.

Multiple indicator models. All models were modeled as “second-order” models, where the latent construct of interest is measured by multiple indicators. Detailed analyses (Table 1) showed that strict factorial invariance held across time with respect to students' homework effort. Thus, in all presented models, the measurement part was constrained to be measurement invariant across time points (i.e., invariant factor loadings, measurement intercepts, and indicator residuals). For students' self-reported conscientiousness, we found a somewhat lower fit for the assumption of cross-time equality of indicator residuals. For that reason, we conducted the analysis of self-reported conscientiousness assuming strong invariance. Furthermore, we allowed for correlated residuals across time.

Statistical power. Because there were no previous studies allowing us to set some kind of expected effect size and due to the fact that the analytical procedures applied were not conducted using available power calculation software, we conducted a post-hoc power analysis using a Monte Carlo simulation. The simulation model was based on estimated parameters from the dual-bivariate change score model including the following parameters: (a) overall and year-to-year change scores for students' homework and conscientiousness, (b) cross-time effects at the level of year-to-year changes, and (c) concurrent relations of change scores at the level of overall time

trends and single time lags. Again, simulation models were separately applied to the self-report and parent report data. The number of sample replications was set to 1000. The results showed that a power of at least .86 was achieved for parameters describing change scores, cross-time effects, and concurrent relations between students' homework effort and conscientiousness. That is, the present study's sample size possessed sufficient statistical power for even relatively small effects (i.e., parameter estimates ranging between .10 and .20 in their standardized form).

Mplus software (Muthén & Muthén, 1998-2013) was used for analytical estimation. When evaluating models, we report the chi-square and degrees of freedom. Given the large sample size and the sensitivity of the chi-square test, we focus on the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker–Lewis index (TLI), and the standardized root mean residual (SRMR). Specifically, we use the guidelines that well-fitting models should have RMSEAs at or below .05, CFIs and TLIs at or above .95, and SRMRs at or below .06 (e.g., Hu & Bentler, 1995).

Results

Students' Conscientiousness and Homework Effort

Our first research question concerned the basic form of change found for both homework effort and conscientiousness. For this, we took the final measurement invariance models (descriptive results are shown in Table 2) and applied a change score model (Figure 1 left). We standardized all mean-level change scores based on standard deviations at Grade 5, meaning that age trends are shown on the scale of standard deviations at the first measurement time point. That is, time effects are presented in terms of variables' standard deviations at Grade 5 (i.e., the standard deviation of the intercept factor). Model fit indices for homework effort indicated a very good model fit ($\chi^2(20) = 107.02$, $p < .001$; CFI = .98, TLI = .98, RMSEA = .04, and SRMR = .02). All estimated time parameters are shown in Table 3. The overall time trend for homework

effort was slightly increasing but did not differ statistically significant from zero ($0.06, p = .25$).

However, results for single time lags indicated a curvilinear time trend, with a positive slope from Grade 5 to Grade 6 (0.27), a smaller positive slope from Grade 6 to Grade 7 (0.09), and a sharply decreasing time trend from Grade 7 to Grade 8 (-0.35). This pattern indicates that students' homework effort increased from Grade 5 to Grade 6, remained relatively stable from Grade 6 to Grade 7, and substantially declined from Grade 7 to Grade 8 (see Table 3).

The model solution for self-reported conscientiousness provided a good model fit ($\chi^2(570) = 1314.35, p < .001$; CFI = .95, TLI = .95, RMSEA = .02, and SRMR = .04) and showed an overall decrease in mean levels over time, with an accelerated decline from Grade 7 to Grade 8. The overall standardized time trend was -0.25 , with an additional negative lag time trend of -0.20 from Grade 7 to Grade 8. These findings are highly similar to those presented in prior research (e.g., Denissen et al., 2013; Göllner et al., 2017; Soto, & Tackett, 2015).

As the next questions relating changes in homework effort to changes in conscientiousness rested on the assumption that individual differences in both existed, we tested the statistical significance of the slope variance parameter for both the year-to-year data and the overall time trend (i.e., change over all four waves). In each case, we found statistically significant inter-individual differences in intra-individual change in conscientiousness and homework effort ($\sigma^2_{C_{Time}} = 0.11, p < .001$; $\sigma^2_{H_{Time}} = 2.26, p < .001$; $\sigma^2_{C_{56}} = 0.14, p < .001$; $\sigma^2_{C_{67}} = 0.18, p < .001$; $\sigma^2_{C_{78}} = 0.17, p < .001$; $\sigma^2_{H_{56}} = 4.05, p < .001$; $\sigma^2_{H_{67}} = 4.10, p < .001$; $\sigma^2_{H_{78}} = 6.93, p < .001$). In light of these statistically significant results, we then proceeded to examine bivariate relations between students' homework effort and their conscientiousness (Figure 1 right).

Model solutions for students' self-reported conscientiousness and homework effort exhibited good fit ($\chi^2(866) = 1885.60, p < .001$; CFI = .96, TLI = .95, RMSEA = .02, and SRMR = .04). When examining changes at the level of overall time trends, statistically significant

relations were found for slope correlations (see Table 4; $r = .43$ [.18, .69]) indicating that those students who increased their investment in homework also increased in conscientiousness. We also tested the intercept-slope covariations. As an overall pattern, we found substantial correlations between students' initial status at Grade 5 and overall time trends. Specifically, those students with higher initial levels of conscientiousness showed a more positive time trend in homework effort ($r = .34$ [.20, .48]). Similarly, students with higher initial levels of homework effort at Grade 5 displayed larger increases in conscientiousness ($r = .15$ [.05, .25]) over the four waves of the study. Using the aggregate information, which provides the most reliable estimate of change, we found a strong statistically significant correlation between changes in homework effort and changes in conscientiousness ($r = .43$ [.18, .69]).

Given the fact that the sample transitioned from primary to secondary school and the less than linear pattern of change in students' homework effort, these overall patterns may not reflect what was happening from year to year. Therefore, we next tested the cross-lagged and concurrent associations from one year to the next (see Table 4). Higher levels of conscientiousness at the beginning of the school years predicted a greater positive change in students' homework effort ($\gamma_{C1 \rightarrow \Delta H1} = 0.10$, $\gamma_{C2 \rightarrow \Delta H2} = 0.16$, and $\gamma_{C3 \rightarrow \Delta H3} = 0.15$), and conversely, students who put more effort into their homework at the beginning of the school year increased more in conscientiousness ($\gamma_{H1 \rightarrow \Delta C1} = 0.10$, and $\gamma_{H2 \rightarrow \Delta C2} = 0.13$). Only from Grade 7 to Grade 8 was there a statistically non-significant lagged result ($\gamma_{H3 \rightarrow \Delta C3} = 0.03$). In addition, we found statistically significant relations between the change scores of the two constructs, showing that changes in students' homework effort and their conscientiousness are connected with one another year over year ($\sigma_{\Delta H1 \leftrightarrow \Delta C1} = .34$, $\sigma_{\Delta H2 \leftrightarrow \Delta C2} = .26$, and $\sigma_{\Delta H3 \leftrightarrow \Delta C3} = .26$). The composite findings reveal a consistent year-to-year association between antecedent standing on one variable and changes in

the other, as well as consistent associations between changes in both constructs. Thus, it does not seem to be the case that any one period had a decisive impact on the overall pattern.

Can the Results be Replicated Using Parental Reports of Conscientiousness?

While the links between changes in self-reported conscientiousness and changes in homework effort revealed statistically significant results, we sought to find out whether these relations could be replicated using parent ratings of conscientiousness. We started by examining the overall time trend using a difference score model. Again, model fit was very good ($\chi^2(20) = 41.58, p < .01$; CFI = 1.00, TLI = .99, RMSEA = .02, and SRMR = .02). Similar to self-reports, parent reports of conscientiousness declined (see Table 3), but less dramatically than self-reports, and the change was not statistically significant (-0.04 [-0.10, 0.01]). This overall downward trend was compensated for by small increasing time trends from Grade 6 to Grade 7 (0.05 [-0.00, 0.10]) and from Grade 7 to Grade 8 (0.05 [-0.00, 0.10]).

As in the analyses of self-reports, we first tested the patterns of associations between the intercepts and slopes of homework effort and conscientiousness across all four waves of the study. The bivariate change score model using parental-rated conscientiousness was also a good fit to the longitudinal data ($\chi^2(99) = 243.18, p < .001$; CFI = .99, TLI = .99, RMSEA = .02, and SRMR = .03) and delivered highly similar findings for overall time trend relations between homework effort and conscientiousness (see Table 4). That is, we found a substantial correlation of slope factors ($r = .63$ [.39, .88]), meaning that changes in homework effort were associated with changes in parent-rated conscientiousness. Students' initial conscientiousness status at Grade 5 was positively related to changes in students' homework effort ($r = .48$ [.34, .62]); and students' initial status in terms of homework effort was positively related to changes in parent-reported conscientiousness ($r = .20$ [.13, .28]). Students exhibiting higher initial levels of homework effort at Grade 5 displayed larger increases in conscientiousness over time.

However, when we turned to examining the year-to-year cross-lags and concurrent change relations, we found no additional relations. Students' conscientiousness did not predict changes in students' homework effort, nor did homework effort at the beginning of a school year predict changes in students' conscientiousness. We also found no statistically significant relation between change scores year-to-year (see Table 4). This would appear to indicate that parents were not sensitive to year-to-year fluctuations in either personality or homework effort beyond the overall trends seen across the four years as a whole.

The Nature of the Relationship Between Homework Effort and Conscientiousness

The statistically significant relation between changes in homework effort and changes in conscientiousness can only be understood in the context of developmental trends in the overall sample. It would be natural to assume that the associations indicated that increasing homework effort led to increasing conscientiousness. However, given the overall negative trend for conscientiousness and homework effort beginning at Grade 6, it is possible that the association was driven largely by people decreasing in both. If this were the case, it would be inappropriate to conclude that putting more effort into doing homework is associated with increases in conscientiousness. To determine what the overall pattern of changes looked like, we computed reliable change scores for homework effort. The reliable change index (RCI) allowed us to determine whether a significant portion of the sample actually increased their level of homework effort and then whether that increase was associated with a commensurate increase in conscientiousness. We found that a substantial portion of students increased their homework effort over time ($N = 705$, 25.54 %). We also found a second group that decreased their homework effort over time ($N = 473$; 17.14%). The percentage of students in the change categories exceeded what would be expected due to chance ($\chi^2(1) = 45.69$, $p < .001$), thus we can

infer that there was substantial change in homework patterns over time and that many students did actually increase their homework effort.

We next examined the change patterns for conscientiousness exhibited by each RCI group. Consistent with the inference that increasing homework effort is related to an increase in conscientiousness, the RCI increasing group (RCI⁺) showed more increasing conscientiousness over the three years of the study (see Table 5). The same patterns held for parent-reported conscientiousness and after controlling for possible confounding covariates (students' gender, school type, SES, IQ, and migration status; see Table 5). In the eyes of their parents, students who increased their homework effort also showed a more increasing time trend in conscientiousness, and conversely, those who decreased their homework (RCI⁻) effort decreased in conscientiousness. The overall mean changes in self-reported and parent-reported conscientiousness after controlling for covariates are depicted in Figure 2.

Finally, we used a propensity score matching procedure that equates groups on observed covariates to facilitate comparison of the RCI groups. The matching of groups was done in two steps. First, students who increased their homework (RCI⁺) from Grade 5 to Grade 8 were matched with students who remained unchanged (RCI^{+/-}). We used 1:1 nearest neighbor matching without replacement on the basis of estimated propensity scores from a linear logistic regression model. The model was used to predict membership in the two changing RCI groups compared to the RCI^{+/-} group using the main effects of the covariates as predictors. In the matching procedure, each RCI⁺ student was assigned one RCI^{+/-} student with a comparable propensity score. With regard to covariates, only relatively small differences existed between groups, and these became even smaller after matching (all $ds' \leq |0.04|$; see Table 6). We then applied the same procedure to the second step of matching students who decreased their

homework (RCI⁻) from Grade 5 to Grade 8 with students who remained unchanged (RCI^{+/-}; see Table 6).

We then re-ran the longitudinal analysis of changes in students' conscientiousness from Grade 5 to Grade 8 separately for the two matched samples. A comparison of the differences in students' overall changes is reported in Table 7. The analyses based on the matched samples revealed effect estimates similar to the effects without covariates. Students whose homework effort decreased also decreased in conscientiousness, and students who increased their homework effort also showed a more increasing time trend in conscientiousness. However, and due to the substantially lower sample sizes of the matched samples, the effects for RCI⁺ students did not reach statistical significance.

Discussion

The main goal of the present study was to test whether doing homework was associated with a positive development in young people's conscientiousness over time. We addressed this question by examining changes in students' homework effort and conscientiousness over a three-year period during the early years of adolescence and after the transition from primary to secondary school. Using a large-scale longitudinal data set from Germany, we obtained empirical support that students' homework effort in two different subjects (i.e., math and German) was associated with inter-individual differences in the development of students' conscientiousness.

The present study is one of the first to test the interplay between changes in homework effort and changes in conscientiousness across multiple waves of a longitudinal cohort of students. Unlike almost all prior research, we examined this interplay for both self-reported and parent-reported changes in personality. The preponderance of research linking life experiences to personality trait change has used self-reported personality measures only (e.g., Hudson &

Roberts, 2014). This is one of the first studies to show that the pattern found in self-reports is replicated across modalities.

The most robust pattern was found across the full three years of the study. For both self-reported and parent-rated personality, the largest association was found when using all of the information across all four waves of the data. This is most likely an indication that change can be more reliably estimated by moving away from somewhat impoverished, two-wave longitudinal designs to more thorough longitudinal studies that provide more assessments over time and therefore a more reliable estimate of change (Willett, 1997). We also examined the changes that occurred from year-to-year. Whereas the results for self-reported personality ratings supported the notion that students' homework effort is prospectively related to changes in students' conscientiousness, parent-report data did not provide any additional confirmation at the year-to-year level of analysis. But what is the reason for this? Does it mean that there is no change or could it be that parents might not detect the change that has taken place? Prior theorizing and empirical studies indicate that the latter might indeed be the case. For instance, both socioanalytic theory (e.g., Hogan and Shelton, 1998) and neo-socioanalytic theory (e.g., Roberts & Wood, 2006) point out that there is a fundamental difference between one's own and others' perspectives of one's personality characteristics. From the observer's perspective, personality refers to an individual's public self or social reputation (e.g., the way a child is perceived by his or her parents), whereas from the individual's perspective, personality refers to the structures, dynamics, and processes inside a person that explain why he or she behaves in a particular way. From this perspective, it is impressive to see that the present study's findings at the level of overall time trends were highly similar for self-reports and parent reports of students' conscientiousness. However, further research is needed to examine whether the somewhat less consistent results for year-to-year relations might be due to the lower sensitivity of parents' conscientiousness reports

(i.e., even a small degree of change in parent reports requires a much greater behavioral change than an equivalent change in students' self-reports).

The mere association between changes in homework effort and changes in conscientiousness is a significant finding, but it could be misinterpreted without a more detailed examination of the overall patterns of change for both variables. For example, if most students saw declines in both homework effort and conscientiousness, the positive association between the two variables would have been driven by the students who decreased the most on both variables. This type of pattern would have undermined the inference that increasing homework effort is associated with increasing conscientiousness.

The fact that there was a large subgroup of students who actually increased their homework effort and showed a more positive trend in conscientiousness further supports the notion that changes in students' homework effort and conscientiousness are two interrelated but not equivalent processes (e.g., Bleidorn, 2012; Roberts et al., 2014). Related to this, it should be noted that the stand-alone slope for students increasing their homework effort was not statistically significant, showing that homework effort is necessary for conscientiousness to not drop off and might further indicate the stronger normativity of students' conscientiousness compared to their homework effort. Nevertheless, drawing causal inferences from observational data is problematic. The best thing to do to bolster support for the interpretation that homework effort caused changes in conscientiousness would be to compare the students whose homework effort increased with a group whose homework effort did not increase using a propensity score strategy. Propensity score matching was used to optimally control for potential group differences in background characteristics. When we conducted this analysis, we found that the association held. Thus, we are willing to tentatively propose that changing one's homework effort may lead to changes in conscientiousness, but obviously, this inference and our results await more rigorous

testing, preferably with some form of randomized control trial involving an intervention in homework effort in which changes in conscientiousness are tracked.

All of these findings have implications for theoretical approaches to identifying the basic parts and processes of daily experience and behavior that lead to patterns of continuity and change in personality over time. As hypothesized by personality theories (e.g., TESSERA, Wrzus & Roberts, 2017), behavioral changes are accompanied by long-lasting changes in students' personality, with student behavior in terms of homework effort emerging as the starting point for personality trait change in this study. Triggered by external factors (e.g., teachers' homework quality), consistent behavioral changes have the potential to lead to persistent changes in students' personality. Thereby, our study's focus on students' homework provides a framework for testing further components of the assumed mechanism, including the relevant triggers on the teacher side and important moderators on the side of the developing students. The latter point about potential moderators is particularly important for understanding why the personality development of students in the same classroom is likely to differ even if their teacher's homework assignments are of exceptionally high quality. For instance, it can be assumed that teachers' high expectations about responsible homework completion will not result in the same amount of homework effort from all students, as students differ in the extent to which they ascribe value to the activity of doing homework (e.g., Trautwein et al., 2006). This perspective is also in line with existing theories in the field of motivational research and can easily serve as a guide for future research on personality development (Magidson et al., 2014).

Limitations

In addition to the many advantages of this long-term study of homework effort and conscientiousness, there are also some limitations. First, the present study was based on observational data. We took special care to better understand the relationship, such as when it

was most strong, rule out potential confounding variables, and further explore the patterns of change in conscientiousness exhibited by different homework groups, but the reader should still keep the non-experimental character of our study in mind. An experimental design is particularly important to even more sufficiently control for potentially confounding variables.

Second, it has to be emphasized that the indicators used to assess students' homework behavior clearly tap into individuals' state expressions of their homework effort. Future research including measures of teachers' homework practice and students' homework behavior, including time spent on homework, will help researchers better understand the daily experiences and behavior that lead to patterns of continuity and change in personality over time. The inclusion of such additional variables will also provide a stronger empirical basis for testing students' homework as an important driver of conscientiousness. For instance, testing the mediating role of students' homework effort on the effect of teachers' homework practice on changes in students' conscientiousness would be a highly interesting next step. The inclusion of moderating variables, such as the value that students attribute to homework, will also be necessary in future research to explain existing differences in students' homework behavior and thus also in students' personality development.

Third, it is important to point out that we only focused on students' conscientiousness, and thus, readers should be careful not to conclude that "more homework is always better" because it may not have the same benefits for other outcomes (e.g., relationships, happiness, etc.), particularly in the early adolescent years.

Fourth, generalizability is also an issue with regard to several features of the study sample. Even though homework effort affects students around the world and we see no reason why the processes uncovered in the present study should substantially differ across countries, future research needs to empirically test whether cultural differences might affect the findings

described in the present study. For instance, a study by Falch and Rønning (2012) on the homework-achievement relation suggested that the homework effect on students' achievement is a bit larger in countries where homework is seen as a complement to classroom learning and is typically completed in school. Thus, it would be interesting to see whether country-specific differences can also be found for the prospective link between students' homework and their conscientiousness. For instance, it may be that the link is more profound when homework takes place at home (as typically practiced in Germany; Falch & Rønning, 2012), where a higher level of self-regulated learning is needed.

Finally, we should note that students in the highest school track in Germany (i.e., Gymnasium) did not participate in our study. Thus, future research is needed to test the generalizability of our findings to more demanding school tracks. We would predict that the effects presented here would be larger for students exposed to more demanding academic tracks, as their identification with and internalization of academic behavior might be more profound than among students from less academically demanding school tracks.

Conclusion

This research provides evidence that students' homework effort can lead to increases in the trait of conscientiousness. Although prior research has confirmed that conscientiousness is an important predictor of students' homework effort, the idea that doing homework can also be an important vehicle through which children become more conscientious has received less attention. Coupled with the fact that homework is one of the most widely used educational practices, the present study suggests that homework effort has the potential to significantly alter longstanding individual differences in personality traits. Knowledge about the long-term effects of education on personality may help identify an important mechanism through which education not only contributes to students' cognitive development but also to changes in their personality.

References

- Almlund, M., Duckworth, A. L., Heckman, J. J., & Kautz, T. D. (2011). *Personality Psychology and Economics*, NBER Working Paper 16822 (Cambridge, MA: National Bureau of Economic). <http://www.nber.org/papers/w16822.pdf>. Accessed 6 July 2017.
- Billiet, J. B., & McClendon, M. J. (2000). Modeling acquiescence in measurement models for two balanced sets of items. *Structural Equation Modeling*, 7, 608-628.
doi:10.1207/S15328007SEM0704_5
- Bleidorn, W. (2012). Hitting the road to adulthood: Short-term personality development during a major life transition. *Personality and Social Psychology Bulletin*, 38, 1594-1608.
doi:10.1177/0146167212456707
- Caspi, A., Roberts, B. W., & Shiner, R. L. (2005). Personality development: Stability and change. *Annual Review of Psychology*, 56, 453-484.
doi:10.1146/annurev.psych.55.090902.141913
- Cooper, H., Lindsay, J.J., & Nye, B. (2000). Homework in the home. How student, family and parenting-style differences relate to the homework process. *Contemporary Educational Psychology*, 25(4), 464-487. doi:10.1006/ceps.1999.1036
- Cooper, H., Robinson, J. C., & Patall, E. A. (2006). Does homework improve academic achievement? A synthesis of research, 1987-2003. *Review of Educational Research*, 76, 1-62. doi:10.3102/00346543076001001
- De Jong, R., Westerhof, K. J., & Creemers, B. P. M. (2000). Homework and student math achievement in junior high schools. *Educational Research and Evaluation*, 6, 130-157.
doi: [http://dx.doi.org/10.1076/1380-3611\(200006\)6:2;1-E;F130](http://dx.doi.org/10.1076/1380-3611(200006)6:2;1-E;F130)

- Denissen, J. A., van Aken, M. G., Penke, L., & Wood, D. (2013). Self-regulation underlies temperament and personality: An integrative developmental framework. *Child Development Perspectives, 7*, 255-260. doi:10.1111/cdep.12050
- Dettmers, S., Trautwein, U., and Lüdtke, O. (2009). The relationship between homework time and achievement is not universal: evidence from multilevel analyses in 40 countries. *School Effectiveness and School Improvement, 20*, 375-405. doi: 10.1080/09243450902904601
- Dettmers, S., Trautwein, U., Lüdtke, O., Kunter, M., & Baumert, J. (2010). Homework works if homework quality is high: Using multilevel modeling to predict the development of achievement in mathematics. *Journal of Educational Psychology, 102*, 467-482. doi:10.1037/a0018453
- Donnellan, M.B., Hill, P.L., & Roberts, B.W. (2015). Personality development across the life span: Current findings and future directions. In Cooper, L. & Mikulincer, M. (Eds.), *Handbook of personality and social psychology*, (pp. 107-126). American Psychological Association.
- Duckworth, A. L., & Seligman, M. P. (2005). Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychological Science, 16*(12), 939-944. doi: <https://doi.org/10.1111/j.1467-9280.2005.01641.x>
- Elliot, A. J., McGregor, H. A., & Gable, S. (1999). Achievement goals, study strategies, and exam performance: A mediational analysis. *Journal of Educational Psychology, 91*(3), 549-563. doi:10.1037/0022-0663.91.3.549
- Enders, C. K. (2010). *Applied missing data analysis*. New York: Guilford Press.

Epstein, J. L., & Van Voorhis, F. L. (2001). More than minutes: Teachers' roles in designing homework. *Educational Psychologist, 36*(3), 181-193.

doi:http://dx.doi.org/10.1207/S15326985EP3603_4

Falch, T., & Rønning, M. (2012). *Homework assignment and student achievement in OECD countries*. Trondheim, Norway: Statistics Norway.

Fan, H., Xu, J., Cai, Z. c., He, J., & Fan, X. (2017). Homework and students' achievement in math and science: A 30-year meta-analysis, 1986-2015. *Educational Research Review, 20*, 35-54. doi:10.1016/j.edurev.2016.11.003

Flunger, B., Trautwein, U., Nagengast, B., Lüdtke, O., Niggli, A., & Schnyder, I. (2015). The Janus-faced nature of time spent on homework: Using latent profile analyses to predict academic achievement over a school year. *Learning and Instruction, 39*, 97-106.

doi:10.1016/j.learninstruc.2015.05.008

Galla, B. M., & Duckworth, A. L. (2015). More than resisting temptation: Beneficial habits mediate the relationship between self-control and positive life outcomes. *Journal of Personality and Social Psychology, 109*(3), 508-525. doi:10.1037/pspp0000026

Ganzeboom, H.B.G., De Graaf, P.M., Treiman, D.J., and de Leeuw, J. (1992). A standard international socio-economic index of occupational status. *Social Science Research, 21*, 1-56. doi:10.1016/0049-089X(92)90017-B

Göllner, R., Roberts, B. W., Damian, R. I., Lüdtke, O., Jonkmann, K., & Trautwein, U. (2017). Whose “storm and stress” is it? Parent and child reports of personality development in the transition to early adolescence. *Journal of Personality, 85*(3), 376–387.

<http://dx.doi.org/10.1111/jopy.12246>.

- Hampson, S. E., Goldberg, L. R., Vogt, T. M., & Dubanoski, J. P. (2007). Mechanisms by which childhood personality traits influence adult health status: Educational attainment and healthy behaviors. *Health Psychology, 26*, 121-125. doi:10.1037/0278-6133.26.1.121
- Hogan, R., & Shelton, D. (1998). A socioanalytic perspective on job performance. *Human Performance, 11*(2/3), 129-144.
- Heckman, J. J. (2012). The case for investing in young children. In B. Falk (Ed.), *Defending childhood: Keeping the promise of early education* (pp. 235-242). New York: Teachers College Press.
- Heller, K. A., & Perleth, C. (2000). *KFT 4-12+R Kognitiver Fähigkeitstest für 4. bis 12. Klassen, Revision – Manual [KFT 4-12+R Cognitive Abilities Test for Grades 4 to 12]*. Weinheim: Beltz.
- Hu, L., & Bentler, P. (1995). Evaluating model fit. In R. H. Hoyle (Ed.), *Structural equation modeling. Concepts, issues, and applications* (pp. 76-99). London: Sage.
- Hudson, N. W., & Roberts, B. W. (2014). Goals to change personality traits: Concurrent links between personality traits, daily behavior, and goals to change oneself. *Journal of Research in Personality, 53*, 68-83. doi:10.1016/j.jrp.2014.08.008
- Jacobson, N. S., & Truax, P. (1991). Clinical significance: A statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology, 59*, 12-19. doi:10.1037/0022-006X.59.1.12
- John, O. P., Donahue, E. M., & Kentle, R. L. (1991). *The Big Five Inventory—Versions 4a and 54*. Berkeley, CA: University of California, Berkeley, Institute of Personality and Social Research.
- Jonkmann, K., Rose, N., & Trautwein, U. (Eds.). (2013). *Tradition und Innovation: Entwicklungsverläufe an Haupt- und Realschulen in Baden-Württemberg und*

Mittelschulen in Sachsen - Abschlussbericht für die Länder Baden-Württemberg und Sachsen [Tradition and innovation: Student development in two German states].

Tübingen, Germany: Projektbericht an die Kultusministerien der Länder.

Kern, M. L., & Friedman, H. S. (2008). Do conscientious individuals live longer? A quantitative review. *Health Psychology, 27*, 505-512. doi:10.1037/0278-6133.27.5.505

Lang, F. R., Lüdtke, O., & Asendorpf, J. B. (2001). Testgüte und psychometrische Äquivalenz der deutschen Version des Big Five Inventory (BFI) bei jungen, mittelalten und alten Erwachsenen [Test quality and psychometric equivalence of the German version of the Big Five Inventory (BFI) in young, middle-aged and elderly adults]. *Diagnostica, 47*, 111-121. doi:10.1026/0012-1924.47.3.111

Luan, Z., Hutteman, R., Denissen, J. J., Asendorpf, J. B., & van Aken, M. A. (2017). Do you see my growth? Two longitudinal studies on personality development from childhood to young adulthood from multiple perspectives. *Journal of Research in Personality, 67*, 44-60. doi:10.1016/j.jrp.2016.03.004

Magidson, J. F., Roberts, B. W., Collado-Rodriguez, A., & Lejuez, C. W. (2014). Theory-driven intervention for changing personality: Expectancy value theory, behavioral activation, and conscientiousness. *Developmental Psychology, 50*, 1442-1450. doi:10.1037/a0030583

McArdle, J. J., & Hamagami, F. (2001). Latent difference score structural models for linear dynamic analyses with incomplete longitudinal data. In L. M. Collins, A. G. Sayer, L. M. Collins, A. G. Sayer (Eds.), *New methods for the analysis of change* (pp. 139-175). Washington, DC, US: American Psychological Association.

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., & ... Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety.

- PNAS Proceedings of the National Academy of Sciences of the United States of America*, 108, 2693-2698. doi:10.1073/pnas.1010076108
- Muhlenbruck, L., Cooper, H., Nye, B., & Lindsay, J. J. (2000). Homework and achievement: Explaining the different strengths of relation at the elementary and secondary school levels. *Social Psychology of Education*, 3(4), 295-317. doi:10.1023/A:1009680513901
- Muthén, L. K., & Muthén, B. O. (1998-2013). *Mplus user's guide (7th ed.)*. Los Angeles: Muthén & Muthén.
- Poropat, A. E. (2009). A Meta-analysis of the Five-Factor model of personality and academic performance. *Psychological Bulletin*, 135, 322-338. doi: 10.1037/a0014996
- Roberts, B. W., & Jackson, J. J. (2008). Sociogenomic personality psychology. *Journal of Personality*, 76, 1523–1544. <http://dx.doi.org/10.1111/j.1467-6494.2008.00530.x>.
- Roberts, B. W., Kuncel, N. R., Shiner, R., Caspi, A., & Goldberg, L. R. (2007). The power of personality: The comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes. *Perspectives on Psychological Science*, 2, 313–345. <http://dx.doi.org/10.1111/j.1745-6916.2007.00047.x>.
- Roberts, B. W., Lejuez, C., Krueger, R. F., Richards, J. M., & Hill, P. L. (2014). What is conscientiousness and how can it be assessed? *Developmental Psychology*, 50, 1315–1330. <http://dx.doi.org/10.1037/a0031109>.
- Roberts, B. W. (2006). Personality development and organizational behavior. In B. M. Staw (Ed.), *Research on organizational behavior* (pp. 1–41). New York, NY: Elsevier Science/JAI Press.
- Roberts, B. W., Walton, K., & Viechtbauer, W. (2006). Patterns of mean-level change in personality traits across the life course: A meta-analysis of longitudinal studies. *Psychological Bulletin*, 132, 1–25. <http://dx.doi.org/10.1037/0033-2909.132.1.1>.

- Roberts, B. W., & Wood, D. (2006). Personality development in the context of the neo-socioanalytic model of personality. In D. K. Mroczek & T. D. Little (Eds.), *Handbook of personality development* (pp. 11–39). Mahwah: Erlbaum.
- Roberts, B. W., Wood, D., & Caspi, A. (2008). The development of personality traits in adulthood. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and Research* (3rd ed.), pp. 375–398). New York, NY: Guilford Press.
- Robins, R. W., Fraley, R. C., Roberts, B. W., & Trzesniewski, K. H. (2001). A longitudinal study of personality change in young adulthood. *Journal of Personality*, *69*, 617–640.
<http://dx.doi.org/10.1111/1467-6494.694157>.
- Soto, C. J., John, O. P., Gosling, S. D., & Potter, J. (2008). The developmental psychometrics of Big Five self-reports: Acquiescence, factor structure, coherence, and differentiation from ages 10 to 20. *Journal of Personality and Social Psychology*, *94*, 718–737.
<http://dx.doi.org/10.1037/0022-3514.94.4.718>.
- Soto, C. J., & Tackett, J. L. (2015). Personality traits in childhood and adolescence: Structure, development, and outcomes. *Current Directions in Psychological Science*, *24*, 358–362.
<http://dx.doi.org/10.1177/0963721415589345>.
- Stuart, E. (2010). Matching methods for causal inference: A review and a look forward. *Statistical Science*, *25*, 1–21. <http://dx.doi.org/10.1214/09-STS313>.
- Tackett, J. L., & Durbin, C. E. (2017). Advances in research on youth personality: Introduction to the special issue. *Journal of Research in Personality*, *67*, 1–2.
<http://dx.doi.org/10.1016/j.jrp.2017.03.004>.
- Trautwein, U., & Lüdtke, O. (2007). Students' self-reported effort and time on homework in six school subjects: Between-students differences and within-student variation. *Journal of Educational Psychology*, *99*(2), 432–444. <http://dx.doi.org/10.1037/0022-0663.99.2.432>.

- Trautwein, U., Lüdtke, O., Kastens, C., & Köller, O. (2006). Effort on homework in grades 5–9: Development, motivational antecedents, and the association with effort on classwork. *Child Development, 77*, 1094–1111. <http://dx.doi.org/10.1111/j.1467-8624.2006.00921.x>.
- Trautwein, U., Niggli, A., Schnyder, I., & Lüdtke, O. (2009). Between-teacher differences in homework assignments and the development of students' homework effort, homework emotions, and achievement. *Journal of Educational Psychology, 101*, 176–189. <http://dx.doi.org/10.1037/0022-0663.101.1.176>.
- Trautwein, U., Schnyder, I., Niggli, A., Neumann, M., & Lüdtke, O. (2009). Chameleon effects in homework research: The homework-achievement association depends on the measures used and the level of analysis chosen. *Contemporary Educational Psychology, 34*(1), 77–88. <http://dx.doi.org/10.1016/j.cedpsych.2008.09.001>.
- Willett, J. B. (1997). Measuring change: What individual growth modeling buys you. In E. Amsel, K. A. Renninger, E. Amsel, & K. A. Renninger (Eds.), *Change and development: Issues of theory, method, and application* (pp. 213–243). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.
- Wilson, R. S., Schneider, J. A., Arnold, S. E., Bienias, J. L., & Bennett, D. A. (2007). Conscientiousness and the incidence of Alzheimer disease and mild cognitive impairment. *Archives of General Psychiatry, 64*(10), 1204–1212. <http://dx.doi.org/10.1001/archpsyc.64.10.1204>.
- Wrzus, C., & Roberts, B. W. (2017). Processes of personality development in adulthood: The TESSERA framework. *Personality and Social Psychology Review, 21*(3), 253–277. <http://dx.doi.org/10.1177/1088868316652279>.
- Xu, J., & Corno, L. (1998). Case studies of families doing third-grade homework. *Teachers college Record, 100*, 402–436.

Table 1

Fit Indexes for Measurement Invariance Models

Model	χ^2	<i>df</i>	RMSEA	CFI	TLI	SRMR
<i>Self-reported Conscientiousness</i>						
Configural invariance	1129.13	524	0.02	0.96	0.95	0.03
Over-time metric invariance	1215.87	548	0.02	0.96	0.95	0.04
Over-time strong invariance	1328.82	572	0.02	0.95	0.94	0.04
Over-time strict invariance	1626.79	599	0.03	0.93	0.93	0.04
<i>Parent-reported Conscientiousness</i>						
Configural invariance	-	-	-	-	-	-
Over-time metric invariance	19.87	11	0.02	1.00	0.99	0.02
Over-time strong invariance	21.24	14	0.02	1.00	1.00	0.02
Over-time strict invariance	41.42	20	0.02	1.00	0.99	0.02
<i>Homework Effort</i>						
Configural invariance	-	-	-	-	-	-
Over-time metric invariance	25.59	11	0.02	1.00	0.99	0.01
Over-time strong invariance	55.98	14	0.03	0.99	0.98	0.02
Over-time strict invariance	106.07	20	0.04	0.98	0.98	0.02

Note. Because only two items were used for parent-reported conscientiousness, over-time metric invariance was assumed for reasons of model identification.

Table 2

Means, Standard Deviations, and Bivariate Correlations of Conscientiousness and Homework Effort

	Self-reported Conscientiousness								Parent-reported Conscientiousness							
	C ₅	C ₆	C ₇	C ₈	H ₅	H ₆	H ₇	H ₈	C ₅	C ₆	C ₇	C ₈	H ₅	H ₆	H ₇	H ₈
C ₆	.66								.76							
C ₇	.52	.68							.68	.74						
C ₈	.44	.60	.69						.68	.70	.72					
H ₅	.27	.25	.17	.14					.11	.16	.17	.14				
H ₆	.33	.45	.38	.26	.24				.21	.23	.21	.22	.24			
H ₇	.29	.39	.46	.36	.24	.40			.19	.18	.17	.20	.24	.40		
H ₈	.25	.31	.33	.41	.18	.32	.37		.23	.26	.20	.25	.18	.32	.36	
<i>M</i>	3.78	3.72	3.70	3.59	7.25	7.75	7.49	6.83	3.47	3.39	3.46	3.47	7.24	7.76	7.51	6.84
<i>SD</i>	0.59	0.63	0.66	0.66	3.11	2.49	2.65	3.08	0.78	0.79	0.77	0.78	3.12	2.50	2.67	3.10

Note. Analyses of self-reported ($N = 2,688$) and parent-reported data ($N = 2,736$) on students' conscientiousness were conducted separately. All estimates reached statistical significance ($p < .001$).

Table 3

Standardized Parameter Estimates for Time Trends

	Self-reported Conscientiousness			Parent-reported Conscientiousness			Students Homework Effort		
	Est.	SE	95% CI	Est.	SE	95% CI	Est.	SE	95% CI
Ind. differences at Grade 5	0.34	0.02	[0.25, 0.42]	0.52	0.07	[0.38, 0.66]	1.50	0.14	[1.22, 1.78]
Overall linear time trend	-0.25	0.05	[-0.34, -0.16]	-0.04	0.03	[-0.10, 0.01]	0.06	0.05	[-0.04, 0.16]
Time trends within lags									
Grade 5 → Grade 6	0.12	0.03	[0.05, 0.18]	-0.10	0.02	[-0.15, -0.05]	0.27	0.05	[0.18, 0.35]
Grade 6 → Grade 7	0.09	0.04	[0.01, 0.17]	0.05	0.03	[-0.00, 0.10]	0.09	0.03	[0.03, 0.15]
Grade 7 → Grade 8	-0.20	0.04	[-0.28, -0.12]	0.05	0.03	[-0.00, 0.10]	-0.35	0.05	[-0.45, -0.26]

Note. For reasons of model identification, latent means at Grade 5 (C_{5th} , H_{5th}) were constrained to be zero. To get mean effects for overall trends and time trends for each of the lags, the mean of the latent difference scores was constrained to be zero. All parameter estimates were standardized using the standard deviation at Grade 5.

Table 4

Standardized Estimates for Bivariate Relations Between Students' Conscientiousness and Homework Effort

	Self-reported			Parent-reported		
	Conscientiousness			Conscientiousness		
	Est.	SE	95% CI	Est.	SE	95% CI
<i>Overall time relations</i>						
$\sigma_{H \leftrightarrow C}$	0.27	0.03	[0.22, 0.33]	0.11	0.03	[0.06, 0.16]
$\sigma_{\Delta H \leftrightarrow \Delta C}$	0.43	0.13	[0.18, 0.69]	0.63	0.13	[0.39, 0.88]
$\sigma_{H \leftrightarrow \Delta C}$	0.15	0.05	[0.05, 0.25]	0.20	0.04	[0.13, 0.28]
$\sigma_{C \leftrightarrow \Delta H}$	0.34	0.07	[0.20, 0.48]	0.48	0.07	[0.34, 0.62]
<i>Concurrent time relations</i>						
$\sigma_{\Delta H1 \leftrightarrow \Delta C1}$	0.34	0.06	[0.22, 0.46]	-0.07	0.08	[-0.22, 0.08]
$\sigma_{\Delta H2 \leftrightarrow \Delta C2}$	0.26	0.06	[0.15, 0.37]	-0.09	0.08	[-0.25, 0.07]
$\sigma_{\Delta H3 \leftrightarrow \Delta C3}$	0.26	0.05	[0.18, 0.35]	0.05	0.06	[-0.06, 0.16]
<i>Time lagged effects</i>						
$\gamma_{C1 \rightarrow \Delta H1}$	0.10	0.04	[0.02, 0.17]	-0.07	0.05	[-0.16, 0.02]
$\gamma_{C2 \rightarrow \Delta H2}$	0.16	0.06	[0.04, 0.29]	-0.21	0.10	[-0.41, -0.01]
$\gamma_{C3 \rightarrow \Delta H3}$	0.15	0.06	[0.03, 0.27]	-0.08	0.08	[-0.23, 0.07]
$\gamma_{H1 \rightarrow \Delta C1}$	0.10	0.05	[0.01, 0.19]	0.00	0.05	[-0.10, 0.10]
$\gamma_{H2 \rightarrow \Delta C2}$	0.13	0.05	[0.03, 0.23]	-0.04	0.06	[-0.16, 0.07]
$\gamma_{H3 \rightarrow \Delta C3}$	0.03	0.05	[-0.06, 0.13]	-0.03	0.06	[-0.15, 0.09]

Table 5

Effects of Reliable Change on Students' Conscientiousness (5 → 8) with and Without Covariates

	Self-reported Conscientiousness						Parent-reported Conscientiousness					
	Est.	SE	95% CI	Est.	SE	95% CI	Est.	SE	95% CI	Est.	SE	95% CI
RCI ⁺	0.24	0.09	[0.07, 0.41]	0.22	0.08	[0.06, 0.37]	0.11	0.05	[0.02, 0.21]	0.09	0.04	[0.01, 0.13]
RCI ⁻	-0.39	0.06	[-0.50, -0.27]	-0.38	0.06	[-0.50, -0.26]	-0.10	0.05	[-0.19, -0.01]	-0.08	0.04	[-0.11, -0.00]
Female				0.03	0.03	[-0.04, 0.09]				0.01	0.03	[-0.04, 0.05]
LoTrack ^a				0.16	0.05	[0.08, 0.25]				0.03	0.04	[-0.05, 0.09]
IntTrack ^a				0.11	0.05	[0.02, 0.20]				0.05	0.04	[-0.02, 0.09]
SES				-0.02	0.04	[-0.09, 0.05]				0.00	0.00	[-0.00, 0.00]
IQ				-0.00	0.01	[-0.02, 0.02]				0.01	0.01	[-0.01, 0.02]
Migrant				-0.04	0.05	[-0.13, 0.05]				0.04	0.05	[-0.04, 0.10]

Note. RCI group differences were coded as two dummy variables with unchanging students (RCI^{+/-}) as the reference category.

RCI⁺ = students with increasing homework effort; RCI⁻ = students with decreasing homework effort; RCI^{+/-} = students with unchanging homework effort. All parameter estimates were standardized using the standard deviation of conscientiousness at Grade 5. ^a Students from multitrack schools served as the reference category and were compared to students from the lowest (LoTrack) and intermediate tracks (IntTrack).

Table 6

Differences Between RCI Groups Prior to and After Matching

	RCI ^{+/-}		RCI ⁺		RCI ⁻		RCI ^{+/-} vs. RCI ⁺			RCI ^{+/-} vs. RCI ⁻		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>d</i>	<i>t</i>	<i>p</i>	<i>d</i>	<i>t</i>	<i>p</i>
<i>Prior Matching</i>												
Female	0.47	0.50	0.43	0.50	0.47	0.50	0.08	1.54	.13	0.01	0.28	.78
LoTrack ^a	0.40	0.49	0.45	0.50	0.40	0.49	-0.11	-2.18	.03	-0.02	-0.36	.72
IntTrack ^a	0.23	0.42	0.18	0.38	0.26	0.44	0.14	2.37	.02	-0.06	-1.33	.18
SES	44.28	13.92	43.13	13.60	44.93	13.95	0.09	1.49	.14	-0.05	-0.96	.34
IQ	-0.06	1.51	-0.31	1.47	0.01	1.52	0.17	3.22	<.001	-0.04	-0.96	.34
Migrant	0.27	0.44	0.31	0.46	0.25	0.43	-0.09	-1.68	.09	0.04	0.79	.43
<i>After Matching (RCI^{+/-} vs. RCI⁺; N = 946)</i>												
Female	0.43	0.49	0.43	0.50			-0.01	-0.09	.93			
LoTrack ^a	0.45	0.50	0.45	0.50			-0.00	-0.04	.97			
IntTrack ^a	0.17	0.38	0.18	0.38			-0.03	-0.38	.70			
SES	43.26	13.36	43.13	13.60			0.01	0.13	.90			

IQ	-0.26	1.53	-0.31	1.47		0.04	0.37	.71
Migrant	0.31	0.46	0.31	0.46		0.01	0.10	.93
<i>After Matching (RCI^{+/-} vs. RCI⁻; N = 1,410)</i>								
Female	0.46	0.50		0.47	0.50		-0.01	-0.08 .94
LoTrack ^a	0.41	0.49		0.40	0.49		0.02	0.32 .75
IntTrack ^a	0.26	0.44		0.26	0.44		0.00	0.05 .96
SES	44.61	14.00		44.92	13.95		-0.02	-0.34 .73
IQ	0.00	1.52		0.01	1.52		-0.01	-0.08 .94
Migrant	0.27	0.44		0.25	0.43		0.04	0.56 .58

Note. All covariates were assessed at the beginning of Grade 5. Matching a RCI⁺ and RCI⁻ sample with RCI^{+/-} students was conducted separately. ^a Students from multitrack schools served as the reference category and were compared to students from the lowest (LoTrack) and intermediate tracks (IntTrack).

Table 7

Comparison of Changes in Students' Conscientiousness from Grade 5 to Grade 8 for the Matched RCI Samples

	Self-reported Conscientiousness			Parent-reported Conscientiousness		
	Est.	SE	95% CI	Est.	SE	95% CI
RCI ⁺ vs. RCI ^{+/-}	0.18	0.17	[-0.16, 0.51]	0.18	0.12	[-0.04, 0.40]
RCI ⁻ vs. RCI ^{+/-}	-0.43	0.10	[-0.62, -0.24]	-0.13	0.06	[-0.25, -0.01]

Note. Shown are mean differences in change values between RCI groups. Estimated differences were standardized using the standard deviation of conscientiousness at Grade 5.

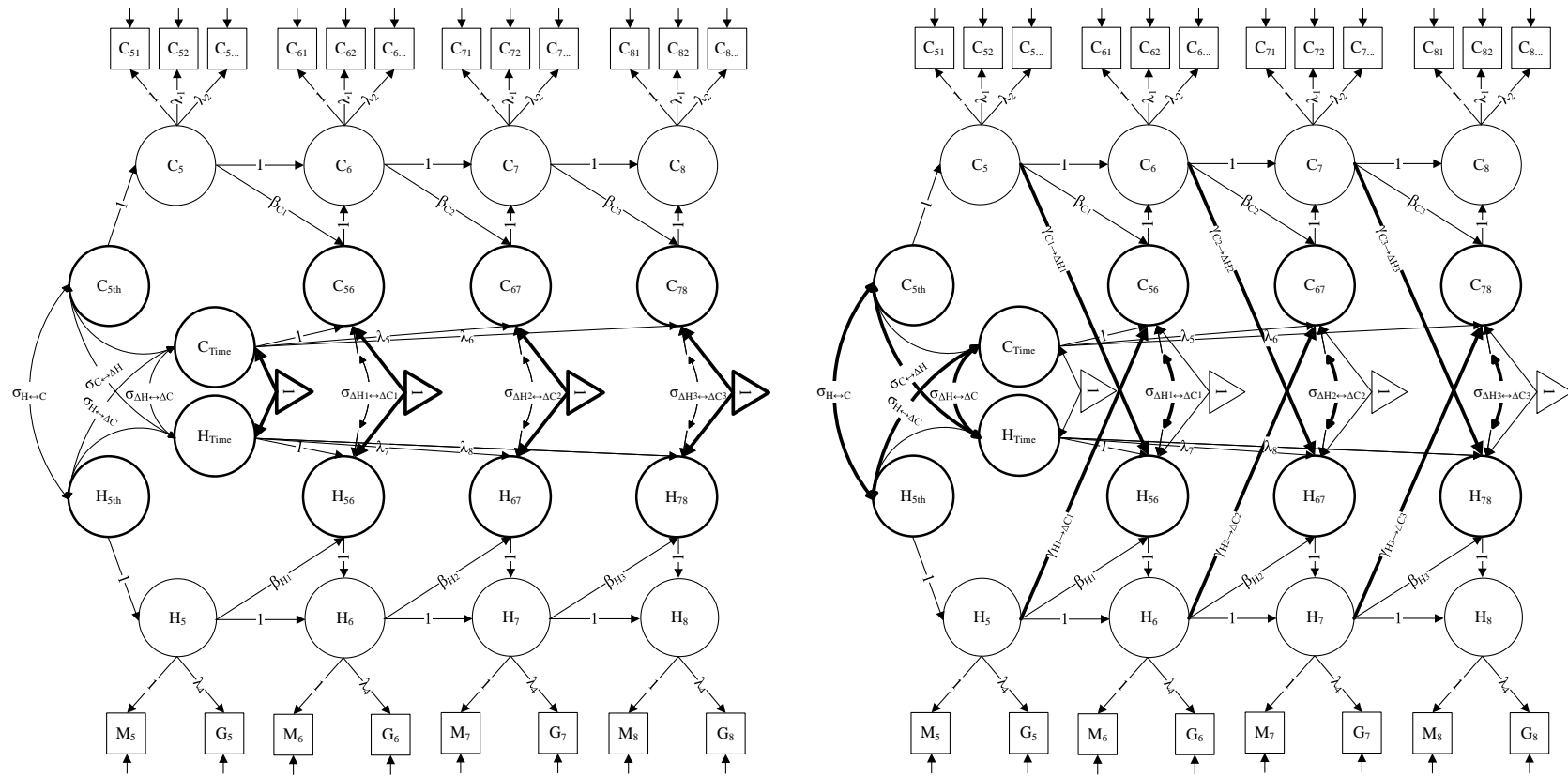


Figure 1. Overall time trend (left) and bivariate relation model (right). Squares represent observed variables; circles represent latent variables. Covariance of indicator-specific residuals and covariance between initial status at Grade 5 and difference scores as well as differences scores between time lags were modeled but not shown.

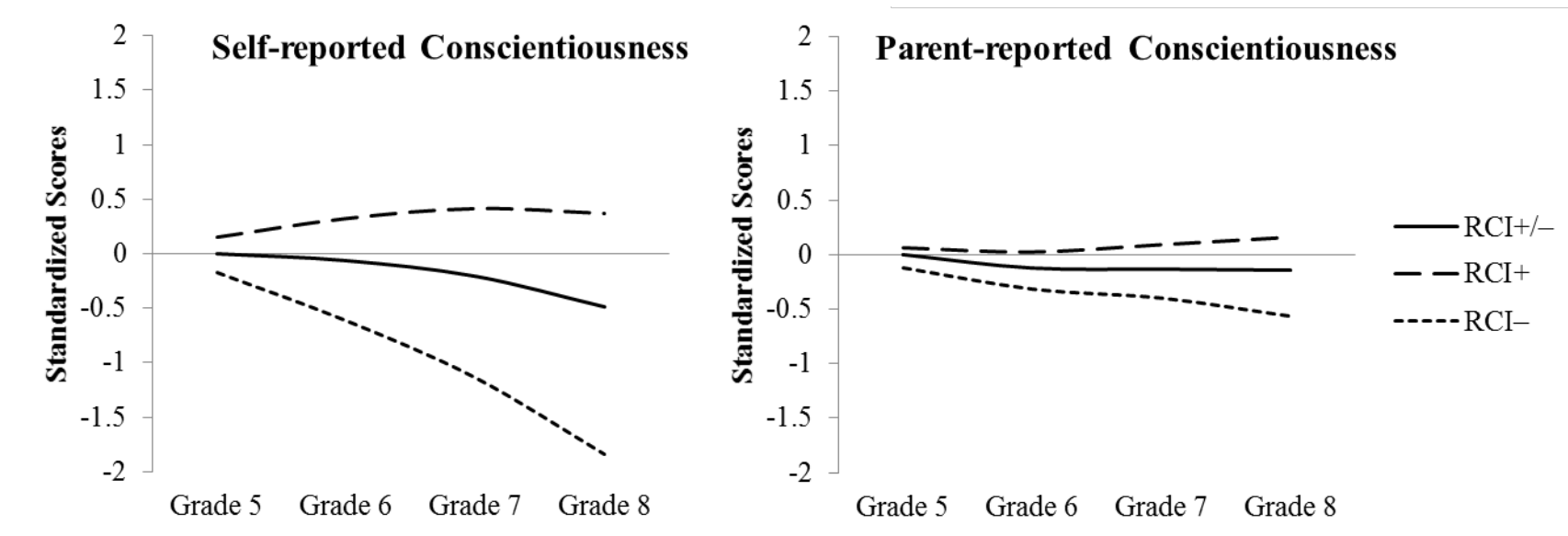


Figure 2. Overall time trend separated by RCI groups and self-reported and parent-reported conscientiousness and controlled for covariates. RCI⁺ = students with increasing homework effort; RCI⁻ = students with decreasing homework effort; RCI^{+/-} = students with unchanging homework effort.