Preschoolers' self-regulation, skill differentials, and early educational outcomes

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Working Paper No. 140

December 2018

BERG Working Paper Series

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ISBN 978-3-943153-61-3

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December 20, 2018

Abstract

Are there skill differentials in young children's competence levels by their self-regulation abilities and do such early life differences mark the onset of increasing disparities in competence development? We add to previous research by investigating the relationship between preschoolers' self-regulation and their mathematical competence and its development early in primary school. We use data from the kindergarten cohort of the German National Educational Panel Study (NEPS) which provides observations of self-regulatory behavior as well as mathematical skills and allows controlling for a rich set of relevant background variables. Our results imply a positive association between children's self-regulation and their mathematical competence levels, even when holding general cognitive ability in kindergarten constant. Yet, self-regulation is not related to competence development over the first two years of primary school, meaning that the initial skill gap neither widens nor narrows substantially. Heterogeneity analyses indicate that self-regulation benefits children with low initial levels of mathematical competence at the transition from kindergarten to primary school. No growth gradient, however, is observable between grade 1 and grade 2.

Keywords: Self-regulation, Skill formation, Competence development

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1 Introduction

Individuals' capabilities of delaying or even foregoing immediate consumption in order to yield better future outcomes is a critical behavioral component in life. Underlying mechanisms and processes, however, are differently addressed across economics and psychology. In economics, the "rate of time preference" is the best known concept to reflect individuals' degree of patience and is one of the most relevant theoretical parameters for modeling future-oriented, intertemporal processes, including investment decisions, savings, health behavior, or human capital accumulation.

The psychological literature too has a long history of interest into individuals' underlying self-regulatory skills (Vohs and Baumeister, 2016), how they relate to observable heterogeneity in, for example, delaying gratifications and whether they predict different life outcomes. A particularly well established literature investigates how children differ in self-regulation and how these differentials explain e. g. adolescents' or adults' social and cognitive outcomes: Since the late 1960s, analyses based on the now famous *Marshmallow test*[1] (Mischel et al., 1989) and numerous follow-up studies suggest for higher performance and better outcomes of individuals, who in their childhood were more patient, through their mid-forties (Casey et al., 2011; Moffitt et al., 2011).[2]

Another line of research in economics addresses the elicitation of adults' time preferences (e. g. Frederick et al., 2002; Andersen et al., 2008) or individuals' health and health-related behavior (Courtemanche et al., 2015; Bradford, 2010). Little is, however, known about the time preferences and their impact for teenagers and, even sparser, for children. Spurred by the work of Heckman (e. g. Cunha and Heckman, 2007), recent research started to explore whether early differentials exist and by how much they affect (or are at least correlated to) later-life outcomes (Golsteyn et al., 2014).

We contribute to this yet scarce research by examining the relationship between preschoolers' delay of gratification, which is a manifestation of individuals' self-regulation (Neubauer et al., 2011) and their mathematical competence and its development early in primary school. Addressing children's mathematical competences is relevant because early math skills are a major determinant, if not a causal factor, for adolescents' school success (e. g. Watts et al., 2014, 2017), which then, on average, contributes to better adult life outcomes.

[1] With an interest in the underlying psychological processes, the test aimed at assessing children's ability to delay gratification for a bigger reward (Mischel and Ebbesen, 1970; Mischel et al., 1972, 1989): Children were seated at a table and they were offered a marshmallow (or a similar food item that the child liked) that was set directly in front of them. The tester instructed the child that it could either wait until the tester returned and get a second Marshmallow or eat the one available before the tester returned but would in this case not get another one. The recorded waiting time was then interpreted as measure for children's self-imposed delay of gratification.

[2] In a replication study, Watts et al. (2018), however, challenge this narrative. As will be outlined in the section on prior research, they find smaller effects of children's waiting times on behavioral outcomes at age 15 which even vanish as soon as additional background factors are accounted for.

Another contribution is the use of data from the kindergarten cohort of the German National Educational Panel Study (NEPS)[3], which is a recent and rich data source on individuals' competences and their competence development. So far, barely any research has explored NEPS for the questions addressed here. Using this data allows us both to account for a broad set of relevant background variables for a sample of children from diverse social backgrounds. We further extend the study of Lorenz et al. (2016), who look at the impatience-skills-nexus from a cross-sectional and thus more descriptive perspective, by using the longitudinal dimension of the data.

We find a significantly positive association between children's self-regulation and their mathematical competence levels, even when holding general cognitive ability in kindergarten constant. Self-regulation is however not related to competence development over the first two years of primary school, meaning that the initial skill gap neither widens nor narrows substantially. Heterogeneity analyses imply that self-regulation benefits children with low initial levels of mathematical competence at the transition from kindergarten to primary school. This advantage, however, vanishes between grade 1 and grade 2.

2 Background and Prior Research

2.1 Background

Conceptually, our study aligns with elements from the model of skill formation by Cunha and Heckman (2007). According to this model, variation in skills is the result of *self-productivity* and *dynamic complementarity*, meaning that the stock of skills at a particular stage in life is a function of all past investments: While self-productivity implies that past skills increase later skills directly, dynamic complementarity increases the productivity of investments into skills for individuals with a higher prior level of skills.

The data we use do not allow to assess the two mechanisms to full extent, mainly because they do not provide information on investment in the skills we are interested in. Beyond that, we focus on the effect of one skill on another, so that we examine what Cunha and Heckman (2007) call cross-effects: *Cross-productivity* displays the effect of the level of one type of skill in the initial period on the level of another skill in a future period while *dynamic cross-complementarity* suggests that investments into the other skill are more fruitful if the person had a higher level of the respective skill in the initial period.

In our analyses, we first assess the relationship between children's self-regulation/patience, for which we have only cross-sectional information, and the level of their mathematical com-

[3] This paper uses data from the National Educational Panel Study (NEPS): Starting Cohort 2 – Kindergarten (From Kindergarten to Elementary School), doi:10.5157/NEPS:SC2:5.1.0. From 2008 to 2013, NEPS data were collected as part of the Framework Programme for the Promotion of Empirical Educational Research funded by the German Federal Ministry of Education and Research (BMBF). As of 2014, the NEPS survey is carried out by the Leibniz Institute for Educational Trajectories (LIfBi) at the University of Bamberg in cooperation with a nationwide network.

petence as well as its short-term development. Based on the cross-productivity notion, we expect higher mathematical competence for more patient children.

We should also see that differences in initial skill levels explain different gains in mathematical competence over time, possibly driven by all four mechanisms: Self-productivity implies that higher initial math competences positively affect future math competences. Dynamic complementarity suggests that investments into mathematical skills yield higher competence increases for children who start from a higher competence level. In line with cross-productivity, children, who are more patient in kindergarten, attain higher mathematical competences, and dynamic cross-complementarity finally triggers that patient children profit more from investments into their mathematical skills. Again, as there is no information on investments and as we have only a cross-section measurement of the child's self-regulation, we cannot directly test the Cunha-Heckman model, but we rather think of it as conceptual guideline.

2.2 Prior Research

Research on individuals' self-regulatory skills, or patience, in both psychology and economics can be grouped by its respective interest, i. e. whether the studies examine determinants of self-regulation/patience, its use as predictor of life outcomes, or whether children's intertemporal choice behavior can be influenced.[4]

As for determinants, both nature and nurture play a role for how children differ in self-regulation in their first years of life.[5] Children's age, reflecting their brain development and its effects on decision processes, is a critical factor, (Sutter et al., 2015; Bartling et al., 2010), as are children's birth weight, their cognitive skills (Bartling et al., 2010), or breastfeeding duration (Falk and Kosse, 2016). Family background matters as well: Bartling et al. (2010), for example, use data from the German Socio-economic Panel (SOEP) and refer to the importance of maternal patience, which may hint towards a genetic component in children's initial skill endowment, but they also refer to the importance of parental assets, including house-ownership or number of books at home. Exploring data from NEPS, Lorenz et al. (2016) also find that patience increases with age, and that girls are more patient than boys. With respect to socio-economic background they find that children with educated parents tend to be more patient and children with both parents born abroad are slightly more patient.

As for outcomes, there is by now abundant evidence that individuals' patience is related to a large set of socio-economic indicators. To start with, results from the initial marshmallow tests show that more patient children, i. e. preschool children who were able to delay gratification for more time, performed better on a variety of outcomes throughout adolescence

[4] This experimental literature is yet in its infancy. It for example adresses whether changes in the default choice setting can moderate self-regulation behavior (Carroll et al., 2009; Sutter et al., 2015).

[5] Sethi et al. (2000) show that the onset of differentials seems to be already observable in children as young as 18 months: children who are better at coping with a brief absence of their mother also perform better on the Marshmallow test at the age of 5 years.

and adulthood: More patient children had a lower body mass index (BMI) (Schlam et al., 2013; Seeyave et al., 2009), and performed better on a test of cognitive control during adolescence (Eigsti et al., 2006) and even in their mid-forties (Casey et al., 2011).

Recently, (Watts et al., 2018) challenge this pattern. They argue that the original longitudinal associations found by Mischel and his team were based on small and highly selective samples of children whose parents were highly qualified academics. Their conceptual replication instead uses a larger and more diverse sample of children, i.e. a sample that also includes children from less thriving backgrounds. As noted before, their results suggest for smaller effects of children's waiting times on behavioral outcomes at age 15 and that these effects vanish as soon as additional background factors are accounted for.

Yet, other replications and adaptations of the initial study reconfirm the relevance of self-regulation. For example, individuals who were more patient as child, commit less crimes until and in adulthood (Akerlund et al., 2016; Moffitt et al., 2011). They also have a lower BMI (Sutter et al., 2015; Bub et al., 2016; Golsteyn et al., 2014), perform better financially (Moffitt et al., 2011; Golsteyn et al., 2014), depend on substances less frequently (Moffitt et al., 2011), are somewhat less likely to smoke (Fuchs, 1982; Bickel et al., 1999), and are healthier in general (Bub et al., 2016; Moffitt et al., 2011).

A potential pathway of the relationship between time preferences and lifetime outcomes may be through educational attainment. Studies from the original Marshmallow tests found patient children to be rated more favorable by their parents in terms of competence, attentiveness, and their ability do deal with frustration and stress (Mischel et al., 1988), and to perform better in school (Mischel et al., 1989).

More recent studies indicate that impatience relates to more disruptive behavior in school (Castillo et al., 2011), decreases the probability of graduating from high school (Castillo et al., forthcoming), or increases drop-out from college (Cadena and Keys, 2015). Benjamin et al. (2013) further report that patient children achieve higher Scholastic Aptitude Test (SAT) scores. Bettinger and Slonim (2007), on the other hand, do not find a correlation of time preferences with school performance. Complementing the link between (im)patience and education, Golsteyn et al. (2014) find that the effect of time preferences on lifetime outcomes falls substantially if they account for educational attainment. Controlling for ability reduces the estimates as well, though to a lesser extent.

Further research demonstrates a clear, positive relationship between patience and cognitive skills. There is, however, only little research yet that examines whether this relationship is causal indeed, and in which direction causality works. For Chilean high-schools students, Benjamin et al. (2013) not only report on a link between cognitive skills and time preferences, but they suggest a possible causal impact of cognitive resources on expressed preferences. Correlations between time preferences and cognitive abilities are also found in adult populations (Shamosh and Gray, 2008; Dohmen et al., 2010), but it is unclear for these studies, which trait begets which.

Finally, and as mentioned before, we enhance the study of Lorenz et al. (2016), who conduct a cross-sectional analysis using the kindergarten cohort of the NEPS data. Their results imply a positive relation between children's patience and mathematical, language, and cognitive skills as well as working memory, even when controlling for social background. We extend their approach by exploring the longitudinal dimension of the data in order to examine whether early self-regulation differentials add to mathematical competence development.

3 Data and Empirical Strategy

3.1 Data

For our analyses we use data from the kindergarten children cohort of the German National Educational Panel Study (NEPS, Starting Cohort 2) (Blossfeld et al., 2011). A sample of four year old preschoolers attending kindergarten in Germany was first surveyed in 2011 and has since been followed into primary school and beyond. In the first wave, roughly 3,000 children took part in the study, but only 576 children could be followed into school which leads to a substantial decline of suitable observations for our analyses. Because we restrict our data to a balanced panel, and because of missing values in key variables our analysis sample further decreases to 370 observations.[6]

In each wave every child was tested in various competence domains over two consecutive days. The assessments were conducted individually in kindergarten and in groups in primary school. In 2012, i.e. the second wave, when the preschoolers were around their sixth birthday, their self-regulatory abilities were measured with the following test: Each child was shown a small bag with unknown content at the end of the first day of testing. The child was told that there were presents inside and it was then offered the choice to either draw one present from the bag immediately or two presents on the next day. After making sure that the child understood the implications of the decision, it was asked to choose between the two options.

Although Mischel's Marshmallow test inspired the NEPS-test of self-regulatory abilities, the two procedures differ: Most importantly, the children in Mischel's experiments knew what kind of gratification they would get and were in most cases exposed to it while waiting.[7] This is an implementation of what Neubauer et al. (2011) call the waiting paradigm (e. g. Mischel and Metzner, 1962; Langenfeld et al., 1997; Mischel et al., 1988; Shoda et al., 1990). Mischel and Ebbesen (1970) and Mischel et al. (1972) show that waiting times for the preferred but delayed reward reduce dramatically if children direct their attention towards the rewards (e. g. if the reward is placed directly in front of them instead of being out of their sight). In the NEPS-test,

[6] Table A.1 in the appendix shows that the majority of variables does not differ significantly between the analysis sample and the full cohort sample in terms of normalized differences (Imbens and Wooldridge, 2009). Initial math competence, however, is higher for children who participated in the survey in all three waves which are of interest to us. We are therefore quite reserved about generalizing our findings.

[7] Mischel and his co-authors experimented with a variety of different experimental settings. The one sketched here is probably the most widely known implementation.

the children did not know what kind of present they could expect and were not exposed to it during the waiting period. Therefore, the NEPS-test is an implementation of what Neubauer et al. (2011) call the choice paradigm (e. g. Mischel and Gilligan, 1964; Bochner and David, 1968). According to Lemmon and Moore (2007), such tests are valid measures for children's delay of gratification from the age of four years on.

The NEPS also provides a set of competence measures to assess children's mathematical, language, and cognitive skills as well as their working memory. Mathematical competence, however, is the only competence measure that was assessed in 2012 and in the following years. We therefore focus on the mathematical competence domain as dependent variable because we are especially interested in competence development and because it is a major predictor of educational attainment (Watts et al., 2014, 2017).

The mathematical competence test procedure requires that children at the initial age of our target population (5-6 years) have already developed an understanding of the concept of numbers and are able to answer simple questions about comparisons of sets, counting tasks or ordinal aspects with the aid of illustrative materials[8] (Neumann et al., 2013). To ensure that mathematical competence is measured independently from reading competence, the items were read to the children and the children answered using pictures or arabic numbers smaller than 20 (Leibniz Institute for Educational Trajectories, 2015, p. 5). Based on such tests, the scientific use file of the NEPS provides weighted maximum likelihood estimates (WLE) of the observed responses as measure of children's mathematical competence. In order to enable comparisons over time, the competence scores were linked in a scaling study between kindergarten and grade 1 (Schnittjer, 2018) and, using anchor items, between grade 1 and 2 (Schnittjer and Gerken, 2018).

Cognitive basic skills were also tested in the second wave by assessing perceptual speed and reasoning abilities. These skills do not depend on domain-specific cognitive processes, such as language skills, but are general abilities, and core elements of the so-called fluid intelligence, which represents an important determinant of learning processes (Primi et al., 2010). To measure perceptual speed the participants have to match figures with graphical symbols as quickly as possible. For reasoning, a geometrical element has to be selected which fits the logical rules of a shown pattern of such elements (Haberkorn and Pohl, 2013). In the scientific use file of NEPS, the results of these tests are available as sum scores of correct answers.

In addition to competence measures and child characteristics, the NEPS provides information on family background. In our case, we can use context data for a rich set of cross-sectional as well as longitudinal information on background characteristics of the children and their families.[9]

[8] For example: "In this bowl are four stones. Now I add three stones. [The bowl is covered, so the child cannot see what is inside.] Can you tell me, how many stones are in the bowl now?" (Schnittjer and Duchhardt, 2015, p. 3 ; our translation).

[9] Table A.2 in the appendix provides information on all the variables we use in our analyses.

3.2 Empirical strategy

To assess the impact of the decision to wait on the child's math competence levels, we estimate the following model:

$$M_{i,t} = \alpha \cdot delay_{i,t=k} + \boldsymbol{X_i}\beta + \epsilon_i, \tag{1}$$

where $M_{i,t}$ is the mathematical competence of child i in time period $t \in k, 1, 2$ (kindergarten, grade 1 or grade 2), $delay$ is a dummy variable indicating whether the child decided to wait in the delay of gratification task, so that α is the coefficient of interest. $\boldsymbol{X_i}$ is a set of individual background characteristics as outlined in detail later on, which first excludes and later includes measures for basic cognitive skills in $t = k$; ϵ_i is the individual error term clustered at kindergarten group level.

We next examine whether the child's decision to wait also relates to the gains in skills over time in a second set of estimations:

$$M_{i,t} - M_{i,t-s} = \alpha \cdot delay_{i,t=k} + \boldsymbol{X_i}\beta + \epsilon_i, \tag{2}$$

i. e. we measure the effect of being able to wait on the development of mathematical competence. $M_{i,t}$ displays math competence in $t = 1$ or $t = 2$ and $M_{i,t-s}$ is math competence one or two periods earlier ($t = k$ or $t = 1$).

In a final step, to assess potential effect heterogeneity within the initial mathematical competence distribution, we add a dummy for whether the child's mathematical competence was below average in kindergarten ($D_{i,M_{i,k}<\bar{M}_k}$) and interact it with delay of gratification:

$$M_{i,t} - M_{i,t-s} = \alpha \cdot delay_{i,t=k} + \delta \cdot (D_{i,M_{i,k}<\bar{M}_k} \cdot delay_{i,t=k}) + \gamma \cdot D_{i,M_{i,k}<\bar{M}_k} + \boldsymbol{X_i}\beta + \epsilon_i. \tag{3}$$

Based on prior research, the vector $\boldsymbol{X_i}$ contains a range of covariates to account for likely influences on both the child's competence development and his or her self-regulation. In particular, we control for the following child's characteristics: age, gender, and whether it lives in East or West Germany.

To account for a potential confounding impact of the child's personality on self-regulation, we include parental ratings of the child's Big Five personality traits, i. e. openness, conscientiousness, extraversion, agreeableness, and neuroticism (McCrae and John, 1992).[10]

Parental background is controlled for by including covariates on migration background, whether the interviewed parent lives with a partner, parental education, and household in-

[10] Parental ratings of children's personality were measured in a specifically designed questionnaire by Müller et al. (2016).

come. We further account for the learning environment at home by controlling for the number of books at home, as well as the number of siblings.[11]

Table 1: Descriptive Statistics

	Pooled		**Patient**		**Impatient**		**Difference**	
	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)	Diff	(p-value)
Delayed gratification (DG)	0.39	(0.49)						
Competence measures								
Math competence: kindergarten	0.49	(0.99)	0.74	(0.95)	0.33	(0.99)	0.41^{***}	(0.00)
Math competence: grade 1	1.80	(1.13)	2.04	(1.02)	1.64	(1.17)	0.40^{***}	(0.00)
Math competence: grade 2	2.51	(1.14)	2.77	(1.02)	2.35	(1.18)	0.42^{***}	(0.00)
Perceptual speed	18.88	(5.56)	19.57	(6.11)	18.44	(5.14)	1.13^{*}	(0.07)
Reasoning	5.82	(2.46)	6.19	(2.41)	5.58	(2.47)	0.60^{**}	(0.02)
Child characteristics								
East German	0.21	(0.41)	0.15	(0.36)	0.24	(0.43)	-0.09^{**}	(0.03)
Male child	0.49	(0.50)	0.47	(0.50)	0.50	(0.50)	−0.03	(0.60)
Age in months	71.15	(3.76)	71.35	(3.77)	71.03	(3.75)	0.32	(0.42)
Child's personality								
Big Five: Extraversion	8.07	(1.67)	7.95	(1.70)	8.15	(1.65)	−0.19	(0.28)
Big Five: Conscientiousness	6.31	(1.58)	6.39	(1.64)	6.25	(1.54)	0.14	(0.42)
Big Five: Agreeableness	5.90	(1.66)	6.13	(1.57)	5.75	(1.70)	0.39^{**}	(0.03)
Big Five: Openness/Intellect	8.26	(1.24)	8.43	(1.30)	8.15	(1.20)	0.28^{**}	(0.04)
Big Five: Neuroticism	3.60	(1.86)	3.53	(1.95)	3.64	(1.80)	−0.12	(0.57)
Parental background								
Migration background	0.07	(0.26)	0.10	(0.31)	0.05	(0.22)	0.05^{*}	(0.09)
Highest CASMIN:								
Basic sec. educ. or less	0.04	(0.20)	0.03	(0.16)	0.05	(0.22)	−0.02	(0.29)
Intermediate sec. educ.	0.34	(0.47)	0.29	(0.46)	0.36	(0.48)	−0.07	(0.15)
Univ. entrance qualif. or more	0.62	(0.48)	0.68	(0.47)	0.59	(0.49)	0.09^{*}	(0.07)
Household income	0.09	(0.66)	0.09	(0.63)	0.10	(0.68)	−0.01	(0.86)
Living together with a partner	0.93	(0.25)	0.94	(0.23)	0.92	(0.26)	0.02	(0.45)
Home environment								
Number of siblings	1.04	(0.88)	1.06	(0.78)	1.02	(0.93)	0.03	(0.71)
More than 100 books at home	0.62	(0.49)	0.65	(0.48)	0.60	(0.49)	0.04	(0.39)
Observations	370		144		226		370	

Notes: Data: NEPS SC2 5.1.0, own calculations. Difference displays the difference between patient and impatient individuals.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4 Results

We start by presenting descriptive differences between children who decide to wait and who do not. In a next step we discuss our baseline specification OLS models with mathematical

[11] In additional specifications, we included further context information on kindergarten characteristics. The additional estimations included children-to-kindergarten-staff ratio as a rough global indicator for childcare quality, group size, or gender composition. Because of large unit non-response at the kindergarten management level, sample size is substantially lower. This yields trivial results which are not reported here.

competence levels as dependent variable. Note that we always cluster our standard errors at the kindergarten group level to control for within-group error correlation (Angrist and Pischke, 2009).[12] We first estimate level differences in math competence by self-regulation in kindergarten, grade 1 and grade 2 separately. We then analyze how delayed gratification is related to the competence development of children by using gains in mathematical competence as dependent variable. Finally, we interact initial mathematical competence with the decision to delay gratification to detect whether children, who were initially weaker in the math test, show different competence gains over time.

4.1 Descriptive differences between patient and impatient children

Differences in test scores and characteristics between patient and impatient children are reported in table 1. In our sample, 39% of the children decided to wait for the next day in order to receive two presents instead of one present they could have got immediately. We further see a strong assocation between children's ability to wait and their mathematical competence: Patient children outperform impatient children in all domains.

There, however, are not many statistical differences in child characteristics. On average, patient children score higher on the Big Five measure of Openness to Experience and Agreeableness, come from a household where parents have higher educational attainment, live less often in Eastern Germany, and more often have a migration background than impatient children. They however do not statistically differ in terms of age, gender, the Big Five traits other than Openness and Agreeableness, and the learning environment at home.

4.2 Self-regulation and competence levels

The purely descriptive patterns suggest a strong positive association between patience and mathematical competence. To net out a confounding impact of the child's characteristics, we next analyze the association between the ability to wait in kindergarten and mathematical competence in all observed years in a regression framework. That is, we condition on the covariates as described before and run multiple regressions for the kindergarten wave, where both mathematical competences and self-regulation were measured, as well as for grade 1 and grade 2 for which we examine levels of and gains in mathematical competences. For each wave, we regress two specifications, one accounting for self-regulation only and another that additionally includes general cognitive abilities in order to capture potentially confounding effects. The main results of these regressions are summarized in table 2, full results are given in the appendix, table A.3.

The results in columns 1 and 2 of table 2 show the cross-sectional relationship between patience in kindergarten and mathematical competence. Both constructs were measured on the same day, so that the results cannot be interpreted as causal. The coefficients show a

[12] Our results are, however, not sensitive to this as we show in section 5.

Table 2: Effects on Math competence level

	Kindergarten		Grade 1		Grade 2	
	(1)	(2)	(3)	(4)	(5)	(6)
Delayed gratification (DG)	0.317***	0.233***	0.299***	0.217**	0.313***	0.222**
	(0.089)	(0.085)	(0.104)	(0.103)	(0.103)	(0.096)
Perceptual speed std		0.243***		0.293***		0.218***
		(0.048)		(0.056)		(0.063)
Reasoning std		0.254***		0.205***		0.310***
		(0.044)		(0.051)		(0.060)
N	370	370	370	370	370	370
adj. R^2	0.199	0.331	0.131	0.229	0.153	0.271

Notes: Data: NEPS SC2 5.1.0, own calculations. All estimations contain a constant and all other explanatory variables named in table 1. For results on controls see appendix, table A.3. Standard errors, reported in parentheses, are clustered at kindergarten group level.
* p < 0.1, ** p < 0.05, *** p < 0.01.

strong positive relationship between the decision to wait and mathematical competence in kindergarten. With a competence score differential of 0.31 points (roughly 31% of a standard deviation), the size of the level difference is substantial (column 1). When additionally controlling for general cognitive ability in kindergarten (column 2), the differential decreases only slightly, implying that general cognitive skills are a confounding factor, yet that self-regulation is not fully determined by or simply representing these skills.[13]

In columns 3 to 6, we present the results of the decision to delay gratification in kindergarten on mathematical competence in grade 1 and 2, again based on specifications ex- or including general cognitive skills. The magnitude of the level differences as given in the kindergarten wave remains almost unchanged.[14]

Our results indicate a substantial positive relationship between children's ability to delay gratification and current as well as future mathematical competence. In terms of inequalities we see a competence gap between more and less patient children already in our first wave, i.e. when patience is measured, and that it persists over the following two years, even if initial general cognitive ability is controlled for.

4.3 Effects on competence development

We next examine whether the competence gap between patient and impatient children persists and estimate a value-added-type specification. The dependent variable in this setting is

[13] Note however that explained variation increases substantially if general cognitive skills are accounted for. For the other covariates, we observe that being male, age, being open for experiences, and higher parental education are positively related to math competence, while being neurotic, extraverted and having a migration background are negatively related to kindergarten math competence (cf. A.3, column 2).

[14] Similar to the estimates in column 2, the explanatory power of the model increases substantially if general cognitive abilities are accounted for.

Table 3: Math competence development

	Kindergarten - Grade 1		Kindergarten - Grade 2		Grade 1 - Grade 2	
	(1)	(2)	(3)	(4)	(5)	(6)
Delayed gratification (DG)	−0.003	−0.003	0.039	0.028	0.037	0.025
	(0.100)	(0.100)	(0.095)	(0.094)	(0.099)	(0.098)
Perceptual speed std		0.053		0.013		−0.037
		(0.065)		(0.069)		(0.058)
Reasoning std		−0.043		0.052		0.089*
		(0.047)		(0.058)		(0.048)
N	370	370	370	370	370	370
adj. R^2	0.002	0.000	0.037	0.035	0.056	0.060

Notes: Data: NEPS SC2 5.1.0, own calculations. All estimations contain a constant, control for months between tests and all other explanatory variables named in table 1. For results on controls see appendix, table A.4. Standard errors, reported in parentheses, are clustered at kindergarten group level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

the difference in mathematical competence between two waves. We consider three different time frames and examine changes in mathematical competences: from kindergarten to grade 1 (table 3, columns 1 and 2), from kindergarten to grade 2 (columns 3 and 4) and, finally, changes between grade 1 and grade 2 (columns 5 and 6).[15] We again estimate two sets of specifications, first accounting only for socio-demographic characteristics and adding general cognitive ability in the second set of models.

The results imply that self-regulation has no impact on the change in mathematical competence in the first two years of primary school. Adding general cognitive ability, the coefficients are again slightly attenuated and in general do not suggest that general cognitive abilities impact competence gains, except for the development between grade 1 and 2, where the coefficient for reasoning is statistically different from zero.

The findings shown in table 2 and 3 together suggest that despite the relation between self-regulation measured in kindergarten and children's math competence level, self-regulation does on average not affect competence development in the first two years of primary school. Put differently, we observe a gap in math competence between patient and impatient children which already exists in kindergarten and persists until grade 2, but it neither widens nor narrows because of children's ability to wait.[16]

[15] Full results are displayed in table A.4 in the appendix.

[16] This conflicts with expectations from the model of skill formation. As outlined before, the NEPS data do, however, not provide details on children's investments, e.g. in terms of time spent on homework or learning, so that more in-depth analyses are not feasible.

4.4 Heterogeneity analyses

We have seen for the full sample, that children's patience does not affect their mathematical competence development. The ability to delay gratification might however—via dynamic cross-complementarity—be differently useful for children of different initial competence endowment. Children with lower initial mathematical competence may particularly benefit from higher self-regulation.

To examine potential effect heterogeneities with respect to the initial level of math competence, we run estimations according to the model outlined in equation 3, i.e. we add a dummy indicating whether the child's math competence was below average in kindergarten and, in a second step, by interacting this dummy with the decision to wait. The results in table 4 show that, compared to the findings in table 3, the coefficients for delayed gratification slightly increase in the first step (columns 1, 3, and 5), but remain statistically insignificant.

Table 4: Effect heterogeneity by initial math competence

	Kindergarten - Grade 1		**Kindergarten - Grade 2**		**Grade 1 - Grade 2**	
	(1)	(2)	(3)	(4)	(5)	(6)
Delayed gratification (DG)	0.071	−0.017	0.081	0.030	0.083	0.077
	(0.097)	(0.110)	(0.093)	(0.105)	(0.094)	(0.144)
Math comp. below avg.	0.521***	0.412***	0.383***	0.319**	0.606***	0.601***
	(0.111)	(0.119)	(0.122)	(0.143)	(0.095)	(0.116)
DG × Math comp. below avg.		0.416*		0.244		0.013
		(0.217)		(0.211)		(0.208)
N	370	370	370	370	370	370
adj. R^2	0.049	0.054	0.059	0.059	0.147	0.144
Wald test: p-value[a]		0.036		0.143		0.501

Notes: Data: NEPS SC2 5.1.0, own calculations. All estimations contain a constant, control for months between tests and all other explanatory variables named in table 1. For results on controls see appendix, table A.5. Standard errors, reported in parentheses, are clustered at kindergarten group level.
[a] Test of hypothesis H_0: Delayed gratification (DG) + DG × Math comp. below avg. = 0.
* p < 0.1, ** p < 0.05, *** p < 0.01.

We do, however, see that children with low initial skills exhibit larger competence gains: The coefficients for the dummy variables on low initial math competence are rather large and statistically different from zero.

The results of the interaction term further show that for the development between kindergarten and grade 1 patient children with low initial math competence gain more than patient children with high initial math competence. They also gain more math competence than impatient children, as the p-values from the Wald-test implies. There is, however, no advantage for patient children between kindergarten and grade 2 or between grades 1 and 2.

5 Robustness checks

This section details the robustness checks we conducted. We first examined whether clustering at different levels than at the kindergarten level, i.e. not at all, or at grade 1 level, plays a role. We then run additional models using grade 1 or grade 2 covariates, and finally checked whether not accounting for children's personality traits matters.

Different standard error calculations: We estimated our models in section 4 with standard errors clustered at the kindergarten group level in all of our specifications to account for unobservable group composition or environment. As this most likely changes when the child leaves kindergarten and becomes a student in primary school, we run additional estimates with clustered standard errors at the classroom level. The standard errors, however, change only marginally in these analyses or, as additional exercise, if we do not cluster at all (see table A.6 in the appendix).

Using grade 1 controls: When examining the effects of delayed gratification on math competence development from grade 1 to grade 2, we used the information on the child's sociodemographics from the kindergarten wave as control variables. It is however possible that children's circumstances changed between kindergarten and grade 1. We therefore also estimated the math competence development from grade 1 to grade 2, accounting for all covariates as outlined before, from the grade 1 wave. Because of missing data in some of the background information the sample decreases to 221 observations.[17] The results, however, change only marginally (see table A.7 in the appendix).

Personality measures as controls: As noted before, we control for the child's Big Five personality traits to account for potential confounding relationships to self-regulation. The measures in our main models are based on parental ratings, surveyed in the first wave, i.e. when the child was attending kindergarten. Personality, however, still evolves in this age group (Herzhoff et al., 2017) and may as well be related to changes in self-regulation. The latter is not available in the NEPS and the child's Big Five personality traits are re-measured only in grade 2.[18]

Becker et al. (2012) furthermore suggest that facets of individuals' personality are related to patience or time-discounting[19] but that they are complements in explaining lifetime outcomes. The self-regulation test in the NEPS data, however, differs from the typical time preference measurements in economics. Therefore, as an additional robustness check, we estimated our models without controlling for the Big Five personality traits. The exclusion of the Big Five personality traits only marginally changes the coefficients for competence levels, competence

[17] We also considered running random effects models, but the feasible longitudinal sample was way too small to turn this into a meaningful endeavor.

[18] Although pairwise correlations between a child's self-regulation and the Big Five personality traits do not indicate substantial changes in the relation between kindergarten and grade 2, using grade 2 data induces yet another decrease in sample size, so that interpretation gets problematic.

[19] Interestingly, there is yet only some small corpus of research addressing the relation between the Big Five personality traits and measures of self-control (Hoyle and Davisson, 2016; Becker et al., 2012).

development, and effect heterogeneity (cf. table A.8, table A.9, and table A.10, respectively in the appendix).

6 Conclusion

We contribute to the literature on early life skills differentials and the role of self-regulation in this. To do so, we examined how children's ability to delay gratification relates to their mathematical competence and its development. We use NEPS data and find that, even when controlling for general cognitive skills, there is a positive relationship between the ability to wait in kindergarten and mathematical competence from kindergarten through grade two of primary school. The relationship is quite strong with patience explaining 20 to 30% of a standard deviation in mathematical competence. Furthermore, the estimates for the level differences do not decrease substantially over the first years of primary school.

In a second step we examined the effect of kindergarten patience on math competence gains. Complementing the level differentials, we do not find that patience affects the speed of competence gains, but heterogeneity analyses suggest that being patient in kindergarten positively affects mathematical competence gains at the transition from kindergarten to the first year of primary school for children with lower initial mathematical competence. Self-regulation, however, seems to play no further role for competence development between grade 1 and grade 2.

In the NEPS data, information on children's self-regulation is given by observable behavior, and their mathematical competences are derived from specifically developed assessments tests. Both sets of indicators are therefore more reliable than e. g. self-reported data or grades, which strengthens our results. We, however, are not able to draw straightforward causal claims from our analyses, because we have no exogenous variation in the NEPS data. Future research could therefore attempt to establish more evidence on causality by, for example, using interventions designed to foster children's self-regulation skills. This would help to derive policy implications on how to decrease the competence gap that relates to differences in children's patience or self-regulation.

Acknowledgements

We are grateful for helpful comments and suggestions by Stefanie Herber, Thorsten Schneider and Reinhard Weisser as well as by participants of the BAGSS Weekly Seminar, the 3rd Bamberg-Halle-Leipzig-Meeting on Empirical Microeonomics, the 2nd International NEPS Conference, the Scottish Economic Society Annual Conference 2018, 32nd Annual ESPE Conference, the Conference of the Society for Longitudinal and Life Course Studies 2018, and the 5th Annual Meeting of the BIEN Network who provided valuable feedback. This work was supported by the Bamberg Graduate School of Social Sciences (BAGSS) which is funded by the German Research Foundation (DFG) under the German Excellence Initiative (GSC1024).

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Appendix

Table A.1: Comparison of full and analysis sample

	Full sample		Dropout sample		Analysis sample		Difference		
	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)	Diff	(p-value)	Norm Diff
Delayed gratification (DG)	0.35	(0.48)	0.35	(0.48)	0.39	(0.49)	−0.04	(0.11)	0.06
Competence measures									
Math competence: kindergarten	0.01	(1.17)	−0.07	(1.18)	0.49	(0.99)	−0.56***	(0.00)	0.36
Math competence: grade 1	1.75	(1.17)	1.61	(1.28)	1.80	(1.13)	−0.18	(0.13)	0.11
Math competence: grade 2	2.44	(1.18)	2.24	(1.27)	2.51	(1.14)	−0.27**	(0.03)	0.16
Perceptual speed	17.84	(6.09)	17.67	(6.16)	18.88	(5.56)	−1.21***	(0.00)	0.15
Reasoning	5.32	(2.38)	5.24	(2.36)	5.82	(2.46)	−0.58***	(0.00)	0.17
Child characteristics									
East German	0.22	(0.41)	0.22	(0.41)	0.21	(0.41)	0.01	(0.58)	−0.02
Male child	0.50	(0.50)	0.50	(0.50)	0.49	(0.50)	0.01	(0.71)	−0.02
Age in months	70.69	(3.94)	70.62	(3.96)	71.15	(3.76)	−0.53**	(0.01)	0.10
Child's personality									
Big Five: Extraversion	8.09	(1.70)	8.09	(1.71)	8.07	(1.67)	0.02	(0.83)	−0.01
Big Five: Conscientiousness	6.20	(1.70)	6.17	(1.73)	6.31	(1.58)	−0.14	(0.14)	0.06
Big Five: Agreeableness	5.80	(1.71)	5.78	(1.72)	5.90	(1.66)	−0.12	(0.24)	0.05
Big Five: Openness/Intellect	8.18	(1.38)	8.16	(1.42)	8.26	(1.24)	−0.10	(0.18)	0.05
Big Five: Neuroticism	3.60	(1.82)	3.59	(1.82)	3.60	(1.86)	0.00	(0.97)	0.00
Parental background									
Migration background	0.15	(0.36)	0.17	(0.37)	0.07	(0.26)	0.10***	(0.00)	−0.21
Highest CASMIN:									
Basic sec. educ. or less	0.09	(0.29)	0.11	(0.31)	0.04	(0.20)	0.07***	(0.00)	−0.18
Intermediate sec. educ.	0.33	(0.47)	0.33	(0.47)	0.34	(0.47)	0.00	(0.88)	0.01
Univ. entrance qualif. or more	0.58	(0.49)	0.56	(0.50)	0.62	(0.48)	−0.06**	(0.03)	0.09
Household income	0.02	(1.02)	−0.01	(1.10)	0.09	(0.66)	−0.10**	(0.03)	0.08
Living together with a partner	0.90	(0.30)	0.89	(0.31)	0.93	(0.25)	−0.04**	(0.01)	0.10
Home environment									
Number of siblings	1.08	(0.92)	1.09	(0.93)	1.04	(0.88)	0.05	(0.31)	−0.04
More than 100 books at home	0.55	(0.50)	0.53	(0.50)	0.62	(0.49)	−0.09***	(0.00)	0.12
Observations	2644		2274		370		2644		2644

Notes: Data: NEPS SUF, SC2 5.1.0, own calculations. The full sample contains all individuals for whom we observe data on delayed gratification and kindergarten math competence; all other variables have fewer observations than stated in the full and dropout sample. Difference displays the difference between analysis and dropout sample. Norm Diff displays normalized differences as suggested by Imbens and Wooldridge (2009) where the critical value typically is 0.25 or -0.25.
* p < 0.1, ** p < 0.05, *** p < 0.01.

Table A.2: Variable definitions

Variable	Definition
Delayed gratification	Dummy equal to one if the child decided to wait for the second gift
Competence measures	
Math competence	WLE score of child's math competence
Perceptual speed	Sum score of child's perceptual speed
Reasoning	Sum score of child's reasoning abilities
Months between tests	Number of months between the two survey dates
Child demographics	
Male child	Dummy equal to one if the child is male
Age (months)	Child's age in months
East German	Dummy equal to one if interviewed parent lives in East Germany
Child personality	
Big Five: Extraversion std	Parental report z-standardized over full NEPS kindergarten sample
Big Five: Conscientiousness std	Parental report z-standardized over full NEPS kindergarten sample
Big Five: Agreeableness std	Parental report z-standardized over full NEPS kindergarten sample
Big Five: Openness/Intellect std	Parental report z-standardized over full NEPS kindergarten sample
Big Five: Neuroticism std	Parental report z-standardized over full NEPS kindergarten sample
Parental background	
Migration background	Dummy equal to one if at least one parent and both parents of the other parent are born abroad
Living together with a partner	Dummy equal to one if the interviewed parent lives with a partner
CASMIN	Highest educational level of the parents living in the same household with the child coded using the CASMIN classification
Home environment	
Books at home: more than 100	Dummy equal to one if more than 100 books are available in parental home
Number of siblings	Number of siblings living in the same household with the child

Table A.3: Effects on Math competence level

	Kindergarten		Grade 1		Grade 2	
	(1)	(2)	(3)	(4)	(5)	(6)
Delayed gratification (DG)	0.317***	0.233***	0.299***	0.217**	0.313***	0.222**
	(0.089)	(0.085)	(0.104)	(0.103)	(0.103)	(0.096)
Perceptual speed std		0.243***		0.293***		0.218***
		(0.048)		(0.056)		(0.063)
Reasoning std		0.254***		0.205***		0.310***
		(0.044)		(0.051)		(0.060)
East German	−0.088	−0.014	−0.190	−0.100	−0.269*	−0.202
	(0.154)	(0.141)	(0.140)	(0.132)	(0.153)	(0.150)
Male child	0.143	0.222**	0.203*	0.276**	0.183	0.270**
	(0.096)	(0.086)	(0.109)	(0.107)	(0.115)	(0.119)
Age in months std	0.777***	0.527***	0.499**	0.236	0.324	0.070
	(0.206)	(0.197)	(0.228)	(0.214)	(0.230)	(0.221)
Extraversion std	−0.139***	−0.128**	−0.120	−0.114	−0.068	−0.051
	(0.053)	(0.052)	(0.075)	(0.072)	(0.069)	(0.070)
Conscientiousness std	−0.001	−0.070	−0.030	−0.100	0.054	−0.019
	(0.055)	(0.053)	(0.064)	(0.063)	(0.061)	(0.060)
Agreeableness std	0.010	0.003	0.034	0.034	0.001	−0.011
	(0.045)	(0.045)	(0.062)	(0.062)	(0.056)	(0.051)
Openness/Intellect std	0.207***	0.192***	0.093	0.082	0.215***	0.196***
	(0.061)	(0.056)	(0.088)	(0.080)	(0.071)	(0.066)
Neuroticism std	−0.093*	−0.086*	−0.119*	−0.111*	0.036	0.044
	(0.055)	(0.048)	(0.070)	(0.067)	(0.064)	(0.060)
Migration background	−0.569***	−0.554***	−0.388**	−0.384**	−0.480**	−0.455***
	(0.200)	(0.191)	(0.191)	(0.181)	(0.188)	(0.149)
CASMIN (ref. *Basic sec. educ. or less*)						
− Intermediate sec. educ.	0.444	0.535**	0.875***	0.981***	0.445	0.531*
	(0.290)	(0.258)	(0.327)	(0.284)	(0.334)	(0.270)
− Univ. entrance qualif. or more	0.711**	0.780***	1.191***	1.286***	0.794**	0.848***
	(0.299)	(0.272)	(0.341)	(0.298)	(0.342)	(0.282)
More than 100 books at home	0.157	0.098	0.208*	0.140	0.261**	0.208*
	(0.110)	(0.103)	(0.121)	(0.120)	(0.119)	(0.121)
Household income	0.047	0.014	0.021	−0.014	0.059	0.025
	(0.082)	(0.067)	(0.109)	(0.095)	(0.104)	(0.090)
Living together with a partner	0.086	0.081	−0.037	−0.041	0.067	0.060
	(0.228)	(0.204)	(0.261)	(0.234)	(0.252)	(0.244)
Number of siblings	−0.097*	−0.035	−0.098	−0.031	−0.063	−0.002
	(0.053)	(0.045)	(0.062)	(0.059)	(0.069)	(0.068)
Constant	0.478	0.011	1.134**	0.633	1.903***	1.434***
	(0.426)	(0.353)	(0.465)	(0.398)	(0.456)	(0.395)
N	370	370	370	370	370	370
adj. R^2	0.199	0.331	0.131	0.229	0.153	0.271

Notes: Data: NEPS SC2 5.1.0, own calculations. Standard errors, reported in parentheses, are clustered at kindergarten group level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: Math competence development

	Kindergarten - Grade 1		Kindergarten - Grade 2		Grade 1 - Grade 2	
	(1)	(2)	(3)	(4)	(5)	(6)
Delayed gratification (DG)	−0.003	−0.003	0.039	0.028	0.037	0.025
	(0.100)	(0.100)	(0.095)	(0.094)	(0.099)	(0.098)
Perceptual speed std		0.053		0.013		−0.037
		(0.065)		(0.069)		(0.058)
Reasoning std		−0.043		0.052		0.089*
		(0.047)		(0.058)		(0.048)
Months between tests	0.118*	0.116*	0.191***	0.194***	0.234***	0.221***
	(0.063)	(0.063)	(0.055)	(0.054)	(0.061)	(0.060)
East German	−0.114	−0.098	−0.210	−0.206	−0.089	−0.100
	(0.151)	(0.150)	(0.133)	(0.135)	(0.121)	(0.122)
Male child	0.045	0.041	0.044	0.056	0.014	0.028
	(0.093)	(0.095)	(0.104)	(0.108)	(0.104)	(0.108)
Age in months std	−0.186	−0.204	−0.344*	−0.370*	−0.225	−0.232
	(0.195)	(0.193)	(0.199)	(0.204)	(0.186)	(0.188)
Extraversion std	0.018	0.012	0.062	0.066	0.044	0.053
	(0.065)	(0.064)	(0.062)	(0.063)	(0.060)	(0.062)
Conscientiousness std	−0.034	−0.036	0.043	0.034	0.080	0.074
	(0.060)	(0.061)	(0.062)	(0.061)	(0.055)	(0.055)
Agreeableness std	0.019	0.025	−0.029	−0.032	−0.048	−0.055
	(0.058)	(0.059)	(0.052)	(0.050)	(0.054)	(0.054)
Openness/Intellect std	−0.117	−0.113	0.007	0.003	0.126*	0.120
	(0.087)	(0.086)	(0.062)	(0.062)	(0.075)	(0.075)
Neuroticism std	−0.025	−0.024	0.124**	0.124**	0.147***	0.147***
	(0.052)	(0.051)	(0.051)	(0.052)	(0.053)	(0.053)
Migration background	0.168	0.157	0.094	0.101	−0.059	−0.045
	(0.235)	(0.238)	(0.222)	(0.220)	(0.178)	(0.174)
CASMIN (ref. *Basic sec. educ. or less*)						
Intermediate sec. educ.	0.376	0.392	−0.086	−0.080	−0.426	−0.435
	(0.286)	(0.287)	(0.303)	(0.301)	(0.266)	(0.265)
Univ. entrance qualif. or more	0.426	0.451	0.028	0.027	−0.355	−0.381
	(0.300)	(0.302)	(0.295)	(0.294)	(0.266)	(0.267)
More than 100 books at home	0.055	0.044	0.075	0.071	0.009	0.018
	(0.113)	(0.116)	(0.113)	(0.119)	(0.107)	(0.105)
Household income	−0.029	−0.031	0.015	0.011	0.047	0.046
	(0.082)	(0.082)	(0.078)	(0.078)	(0.058)	(0.060)
Living together with a partner	−0.106	−0.104	−0.009	−0.010	0.081	0.080
	(0.230)	(0.228)	(0.178)	(0.181)	(0.204)	(0.205)
Number of siblings	−0.009	−0.003	0.017	0.023	0.031	0.031
	(0.056)	(0.054)	(0.058)	(0.057)	(0.063)	(0.063)
Constant	−0.662	−0.689	−2.450**	−2.559**	−1.343**	−1.238*
	(0.895)	(0.885)	(1.163)	(1.155)	(0.632)	(0.635)
N	370	370	370	370	370	370
adj. R^2	0.002	0.000	0.037	0.035	0.056	0.060

Notes: Data: NEPS SC2 5.1.0, own calculations. Standard errors, reported in parentheses, are clustered at kindergarten group level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Effect heterogeneity by initial math competence

	Kindergarten - Grade 1		**Kindergarten - Grade 2**		**Grade 1 - Grade 2**	
	(1)	(2)	(3)	(4)	(5)	(6)
Delayed gratification (DG)	0.071	−0.017	0.081	0.030	0.083	0.077
	(0.097)	(0.110)	(0.093)	(0.105)	(0.094)	(0.144)
Math comp. below avg.	0.521***	0.412***	0.383***	0.319**	0.606***	0.601***
	(0.111)	(0.119)	(0.122)	(0.143)	(0.095)	(0.116)
DG × Math comp. below avg.		0.416*		0.244		0.013
		(0.217)		(0.211)		(0.208)
Perceptual speed std	0.102	0.095	0.048	0.043	0.021	0.021
	(0.064)	(0.064)	(0.067)	(0.066)	(0.058)	(0.060)
Reasoning std	−0.022	−0.020	0.068	0.068	0.128***	0.128***
	(0.047)	(0.047)	(0.058)	(0.058)	(0.046)	(0.047)
Months between tests	0.120**	0.116*	0.189***	0.185***	0.190***	0.190***
	(0.060)	(0.060)	(0.053)	(0.053)	(0.056)	(0.057)
East German	−0.091	−0.099	−0.201	−0.205	−0.131	−0.131
	(0.135)	(0.132)	(0.127)	(0.127)	(0.117)	(0.118)
Male child	0.075	0.099	0.081	0.095	0.083	0.084
	(0.095)	(0.093)	(0.110)	(0.111)	(0.105)	(0.107)
Age in months std	−0.074	−0.048	−0.279	−0.264	−0.122	−0.122
	(0.188)	(0.187)	(0.210)	(0.208)	(0.187)	(0.188)
Extraversion std	−0.012	−0.004	0.048	0.053	0.044	0.044
	(0.062)	(0.061)	(0.062)	(0.063)	(0.057)	(0.057)
Conscientiousness std	−0.049	−0.051	0.026	0.024	0.054	0.054
	(0.059)	(0.060)	(0.059)	(0.059)	(0.052)	(0.052)
Agreeableness std	0.033	0.033	−0.026	−0.026	−0.039	−0.039
	(0.056)	(0.057)	(0.049)	(0.049)	(0.050)	(0.050)
Openness/Intellect std	−0.091	−0.091	0.020	0.020	0.133*	0.133*
	(0.082)	(0.082)	(0.062)	(0.061)	(0.068)	(0.068)
Neuroticism std	−0.045	−0.047	0.109**	0.108**	0.127**	0.127**
	(0.053)	(0.053)	(0.053)	(0.053)	(0.050)	(0.050)
Migration background	0.074	0.032	0.040	0.015	−0.153	−0.153
	(0.218)	(0.208)	(0.206)	(0.200)	(0.146)	(0.147)
Intermediate sec. educ.	0.595**	0.601**	0.072	0.077	−0.248	−0.248
	(0.283)	(0.276)	(0.303)	(0.302)	(0.257)	(0.257)
Univ. entrance qualif. or more	0.711**	0.713**	0.221	0.222	−0.076	−0.076
	(0.300)	(0.295)	(0.297)	(0.297)	(0.257)	(0.259)
More than 100 books at home	0.081	0.076	0.099	0.097	0.032	0.032
	(0.112)	(0.112)	(0.116)	(0.116)	(0.101)	(0.101)
Household income	−0.040	−0.028	0.005	0.012	0.029	0.029
	(0.080)	(0.079)	(0.074)	(0.075)	(0.055)	(0.055)
Living together with a partner	−0.120	−0.109	−0.023	−0.016	0.116	0.116
	(0.220)	(0.222)	(0.180)	(0.180)	(0.209)	(0.207)
Number of siblings	−0.024	−0.028	0.008	0.006	0.016	0.016
	(0.053)	(0.053)	(0.059)	(0.059)	(0.061)	(0.061)
Constant	−1.018	−0.922	−2.654**	−2.541**	−1.472**	−1.467**
	(0.813)	(0.815)	(1.120)	(1.122)	(0.602)	(0.609)
N	370	370	370	370	370	370
adj. R^2	0.049	0.054	0.059	0.059	0.147	0.144
Wald test: p-value[a]		0.036		0.143		0.501

Notes: Data: NEPS SC2 5.1.0, own calculations. Standard errors, reported in parentheses, are clustered at kindergarten group level.
[a] Test of hypothesis H_0: Delayed gratification (DG) + DG × Math comp. below avg. = 0.
* p < 0.1, ** p < 0.05, *** p < 0.01.

Table A.6: Different standard error calculations

	Coefficient	Level of standard error clustering		
		none	kindergarten group	grade 1 classroom
	Panel A: Effects on competence level			
Kindergarten	0.233	0.090**	0.085***	
Grade 1	0.217	0.110**	0.103**	0.107**
Grade 2	0.222	0.108**	0.096**	0.097**
	Panel B: Effects on competence development			
Kindergarten - Grade 1	−0.003	0.103	0.100	0.100
Kindergarten - Grade 2	0.028	0.104	0.094	
Grade1 - Grade 2	0.025	0.100	0.098	0.093

Notes: Data: NEPS SC2 5.1.0, own calculations. The left column displays the respective coefficient for the decision to delay in the main estimations including general cognitive skill measures (tables 2 & 3, columns (2),(4) and (6)). The three columns on the right display the respective standard errors produced by different levels of standard error clustering.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.7: Competence development from Grade 1 to Grade 2 (Control variables from Grade 1. Standard errors, reported in parantheses, are clustered at classroom level.)

	(1)	(2)	(3)	(4)	(5)	(6)
Delayed gratification (DG)	−0.026	0.052	0.120	−0.038	0.049	0.119
	(0.132)	(0.125)	(0.201)	(0.130)	(0.122)	(0.197)
Math comp. below avg.		0.550***	0.611***		0.646***	0.712***
		(0.118)	(0.140)		(0.126)	(0.156)
DG × Math comp. below avg.			−0.167			−0.173
			(0.280)			(0.282)
Perceptual speed std				−0.062	0.036	0.042
				(0.075)	(0.074)	(0.077)
Reasoning std				0.127*	0.168***	0.166***
				(0.065)	(0.063)	(0.063)
N	221	221	221	221	221	221
adj. R^2	0.034	0.102	0.100	0.043	0.129	0.126
Wald test: p-value[a]			0.769			0.746

Notes: Data: NEPS SC2 5.1.0, own calculations. All estimations contain a constant, control for months between tests and all other explanatory variables named in table 1.
[a] Test of hypothesis H_0: Delayed gratification (DG) + DG × Math comp. below avg. = 0.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.8: Effects on Math competence level (Extended version of table 2)

	Kindergarten			Grade 1			Grade 2		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Delayed gratification (DG)	0.317***	0.233***	0.276***	0.299***	0.217**	0.252**	0.313***	0.222**	0.249**
	(0.089)	(0.085)	(0.087)	(0.104)	(0.103)	(0.103)	(0.103)	(0.096)	(0.097)
Perceptual speed std		0.243***	0.237***		0.293***	0.281***		0.218***	0.217***
		(0.048)	(0.050)		(0.056)	(0.053)		(0.063)	(0.067)
Reasoning std		0.254***	0.266***		0.205***	0.207***		0.310***	0.325***
		(0.044)	(0.045)		(0.051)	(0.050)		(0.060)	(0.061)
Personality measures	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
N	370	370	370	370	370	370	370	370	370
adj. R^2	0.199	0.331	0.312	0.131	0.229	0.226	0.153	0.271	0.262

Notes: Data: NEPS SC2 5.1.0, own calculations. All estimations contain a constant and control for all other explanatory variables named in table 1. A full table with all controls is also displayed in the appendix table A.3. Standard errors, reported in parentheses, are clustered on kindergarten group level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.9: Math competence development (Extended version of table 3)

	Kindergarten - Grade 1			Kindergarten - Grade 2			Grade 1 - Grade 2		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Delayed gratification (DG)	−0.003	−0.003	−0.013	0.039	0.028	0.010	0.037	0.025	0.017
	(0.100)	(0.100)	(0.103)	(0.095)	(0.094)	(0.091)	(0.099)	(0.098)	(0.104)
Perceptual speed std		0.053	0.045		0.013	0.017		−0.037	−0.025
		(0.065)	(0.065)		(0.069)	(0.071)		(0.058)	(0.059)
Reasoning std		−0.043	−0.054		0.052	0.053		0.089*	0.101**
		(0.047)	(0.048)		(0.058)	(0.060)		(0.048)	(0.049)
Personality measures	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
N	370	370	370	370	370	370	370	370	370
adj. R^2	0.002	0.000	0.000	0.037	0.035	0.034	0.056	0.060	0.032

Notes: Data: NEPS SC2 5.1.0, own calculations. All estimations contain a constant, control for months between tests and all other explanatory variables named in table 1. Standard errors, reported in parentheses, are clustered at kindergarten group level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.10: Effect heterogeneity by initial math competence (Extended version of table 4)

	Kindergarten - Grade 1			Kindergarten - Grade 2			Grade 1 - Grade 2		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Delayed gratification (DG)	0.071	−0.017	−0.015	0.081	0.030	0.017	0.083	0.077	0.074
	(0.097)	(0.110)	(0.112)	(0.093)	(0.105)	(0.104)	(0.094)	(0.144)	(0.150)
Math comp. below avg.	0.521***	0.412***	0.417***	0.383***	0.319**	0.334**	0.606***	0.601***	0.615***
	(0.111)	(0.119)	(0.121)	(0.122)	(0.143)	(0.140)	(0.095)	(0.116)	(0.117)
DG × Math comp. below avg.		0.416*	0.399*		0.244	0.259		0.013	0.024
		(0.217)	(0.226)		(0.211)	(0.204)		(0.208)	(0.203)
Personality measures	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
N	370	370	370	370	370	370	370	370	370
adj. R^2	0.049	0.054	0.054	0.059	0.059	0.061	0.147	0.144	0.122
Wald test: p-value[a]		0.036	0.057		0.143	0.119		0.501	0.449

Notes: Data: NEPS SC2 5.1.0, own calculations. All estimations contain a constant, control for months between tests and all other explanatory variables named in table 1. Standard errors, reported in parentheses, are clustered at kindergarten group level.
[a] Test of hypothesis H_0: Delayed gratification (DG) + DG × Math comp. below avg. = 0.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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