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School Entry-Age Effect on Student's Affective–Motivational Attitudes in German Elementary Schools

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Abstract
The effect of school entry age on children's later performance is a long-debated topic without any convergence. Besides, existing studies have mostly limited themselves to examining the impact of entry age on children's cognitive achievements. In Germany, where different entry-age regulations exist across federal states and academic tracking takes place very early, it is crucial to investigate whether these differential school entry ages affect children's outcomes. This study, based on the longitudinal data available from the National Educational Panel Study, investigates the possible entry-age effect on children's willingness to make an effort and their school enjoyment in the German elementary school context. The study found a positive entry-age effect only for willingness to make an effort but not for school enjoyment, and the existing entry-age effect decreases over time. Therefore, empirical evidence confirms that, in Germany, the entry-age effect persists in the short run and some child outcomes seem more sensitive to entry age than others. These are important findings in the German context where students' academic tracking starts from lower secondary schooling and entry-age effects may significantly influence it.

Keywords Elementary schools · Entry-age effect · School enjoyment · Willingness to make an effort · Germany

Introduction

It is highly relevant for educational research and policy to find out whether heterogeneous school entry ages lead to differential child outcomes and what should be the ideal age for children to enter school. Internationally, considerable variations exist in the age at which children begin primary schooling (e.g., age four in Ireland, five in the United Kingdom, and six in Germany). Studies have already shown that the school entry age (SEA) is associated with school performance, grade progression, and diagnosis of learning disabilities, which may directly impact later outcomes conditional on educational attainment (Dater & Gottfried, 2015). Parents need to know whether holding their children back for a year (or sending them earlier than usual) pays any dividend in the short or long run. For the state, it is crucial to know whether the state-imposed entrance cutoff ages create any variation in children's later performance. For educators, it is also essential to understand whether the relative-age effect amongst the child's classmates can improve their school performance and readiness for the labour market.

However, answers to these questions are ambiguous, as the theoretical arguments and empirical evidence have not yet reached any agreement. Even though an increasing amount of empirical research has found that the entry-age variation within a grade has a causal effect on school performance (e.g., Bedard & Dhuey, 2006; Datar, 2006; Fredriksson & Öckert, 2005; McEwan & Shapiro, 2008), scholars are uncertain about the extent of such an effect. Some have claimed that delayed school entrance provides children an extra year for biological maturation. This "gift of time" gives children an additional year to become developmentally ready for the formal classroom structure and instruction, an advantage that seems to persist or even grow over time (Bedard & Dhuey, 2006; Datar, 2006; Graue & DiPema, 2000; Smith, 2009). However, others argue that the effect of entry age on achievement is strongest early on in schooling and diminishes over time, disappearing in the long run (Bedard & Dhuey, 2006; Dater & Gottfried, 2015; Elder & Lubotsky, 2009; Smith, 2009). Moreover, research on developing countries has shown that earlier school entry is beneficial for

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children from disadvantaged backgrounds (Cornelissen & Dustmann, 2019; Lee & Burkhan, 2002; Vecchiotti, 2001).

Given the importance of the early years for later development (UNICEF, 2017), the need for efficient utilization of educational resources (Magnuson et al., 2007), and the craving for research-based practice, the investigation of the relationship between SEA and children's later development is necessary. The current study, therefore, aims to investigate the entry-age effect on children's attitudes toward school in the German elementary school context. The objective is to contribute to the existing literature by providing empirical evidence from Germany, which is among the few industrialised countries where academic tracking takes place as early as from lower-middle schools.

The main research question of the study is: Does the SEA affect children's school enjoyment and willingness to make an effort in elementary school? This study uses the rich longitudinal data available from the National Educational Panel Study (NEPS) in Germany to explore the entry-age effect over time. Existing evidence in the German context is sparse on the effect of school entry age on children's attitudes towards school. Therefore, the current study differs significantly from others in that it considers children's school enjoyment and willingness to make an effort as the child's outcomes rather than confining itself to cognitive skills. This study, therefore, presents new evidence of the effects of SEA on the dimensions of affective–motivational attitudes of students.

The State of the Research

Typically, there are three potential sources of variation in SEA (Elder & Lubotsky, 2009). The first source of variation in SEA is due to the distribution of birth dates throughout the calendar year and the entrance cutoff age. The second is due to the differences across regions in entrance cutoff ages which, in turn, create variations in school entrance ages amongst children with the same birthday but living in different regions. Due to the different local regulations, the time window increases for school entrance. It should be noted here that the variations in SEA from these two possible sources are exogenous to the parents. The third source of variation in SEA arises when some children begin school earlier or later than prescribed by the entrance cutoff because their parents have requested an exception to the official cutoff age. Since the third source of variation in SEA is due to parental choice, the variation in entry age could also be endogenous in nature. This must be taken into consideration while investigating the causal effect of the entry cutoff.

A great deal of attention is devoted internationally to understanding the effect of entry age on children's later performance, and two critical viewpoints shape the relative age-effect debate. The first line of thought is a maturational view where it is believed that children need to be developmentally ready before they start formal schooling. It is argued that older children are more likely to possess the necessary skills and maturity to succeed in school and learn more in each grade. Age-related differences in educational outcomes are expected to persist or grow as children progress through school, so the decision to begin at an older age is considered worthwhile. According to these scholars, older entrants are supposed to learn more in school, complete further education, and enter the labour market with more human capital. Bedard and Duhuey (2006) found that the youngest children of a cohort showed significantly lower test scores in the fourth and eighth grades on TIMMSS test scores in math and science. Smith (2009) also came to the same conclusion by using testing scores in numeracy, reading and writing in seventh and tenth grades. Their estimates showed that older students in grade ten still had sizable skill advantages. This effect was most substantial for girls and students with low-income parents. Moreover, Dee and Sievertsen (2015) found that delaying the start of school dramatically reduces inattention and hyperactivity at age seven. In contrast, according to Datar (2006), starting kindergarten one year earlier leads to a significant increase in math and reading test scores at kindergarten entry and a steeper progression of scores in the first two years of school.

The theoretical debate regarding child development was well extended by Vygotsky (1978) in his seminal works. Whereas previous literature claimed that development is always a prerequisite for learning and if a child's mental functions have not matured to the extent that he/she is capable of learning a particular subject, then no instruction will prove useful. Vygotsky altered the view and argued that development processes do not coincide with the learning process, rather they lag behind the learning process. He further postulated that the relationship between child development and learning is highly complex, and each school subject has its specific relation to child development that varies as a child grows (ibid, pp. 79–91). He also argued that the conceptual abilities of children during the preschool and school years are stretched through play and the use of their imagination. However, "imagination is a new formation which is not present in the consciousness of the very young children" (ibid, p. 129). Whitebread (2011), in this regard, demonstrated that superior learning and motivation arise from playful, as opposed to instructional, approaches to learning in children. It helps children in developing their emotional 'self-regulation' and is crucial in early learning and development. Based on the field evidence, Whitebread (2014) argued in favour of a later start to formal education in England.

However, researchers have also argued that the age-related differences in early school performance stem solely from

what children have learned before entering school. Yet there is no strong evidence that a delayed school start meaningfully improves key educational and economic outcomes (Dee & Sievertsen, 2015). Once children begin school, according to this view, older and younger children tend to learn at the same rate. The previously existing skill differences tend to fade away as they represent a smaller fraction of children's overall stock of knowledge and skills. Studies have analysed this decreasing effect of enrollment age on various outcomes. Based on a meta-analysis of numerous publications, Görlitz et al. (2019) showed the correlation between mathematics and reading/writing skills and the age at which children start school. For both competence domains, math, and text comprehension, the study detected no influence of the school entry age. Similarly, Suggate (2009) investigated relative reading achievement as a function of SEA of 15-year-old students across 55 countries using data from the PISA-2006 study. In this study, no significant association between reading achievement and SEA was found after controlling for social and economic differences (ibid). Furthermore, Magnuson et al. (2007) also found that previous differences in academic skills disappeared quickly if children were placed in a small classroom and provided with high-level reading instruction. Dater and Gottfried (2015) brought forward another possibility in addition to an absolute age effect, known as the relative age effect. The relative age effect is the varying skill levels children possess. It is a function of biological maturation (i.e., age) and preschool experiences, classroom instruction, and the child's age relative to their classroom peers. A child's age compared to their classmates may also have an independent effect on their learning if the classroom instruction level is beyond the skill set of the youngest child or below the skill set of the oldest child. Besides, children's behavioural outcomes such as self-confidence, aggressive behaviours, and motivation also vary depending on age. Therefore, variation in children's age in a classroom may also generate a relative-age effect within a classroom due to variation in these behavioural outcomes. Elder and Lubotsky (2009) found that the average age of a child's classmates positively influences test scores while simultaneously increasing the likelihood of grade repetition. They interpreted these findings as the high-performing peers influence a student's achievement positively. Nevertheless, the academic performance of the youngest pupils is comparatively worse than that of older pupils. In addition to this performance effect, school and parental decisions about remaining in the class are also partly based on the age of the pupil in comparison to his or her classmates.

Furthermore, the instructional context[1] of school in which students learn can also be more important than the additional year (Felfe & Lalive, 2018; Havnes & Mogstad, 2015; National Institute of Child Health & Human Development, 2007; Stipek, 2002). The studies by Felfe and Lalive (2018), Havnes and Mogstad (2015) showed that expansion of early childhood care was associated with better child outcomes. This was found particularly true for children from less-advantaged homes where monetary and non-monetary resources to support an additional year of childcare are relatively limited (Lee & Burkhan, 2002; Vecchiotti, 2001). Stipek (2002), on the other hand, found no evidence suggesting that younger children gained less than older children from early school experience and, therefore, suggested that 'the focus should be more on making schools ready for children than on making children ready for school' (Stipek, 2002, p. 3). Similarly, the study by the National Institute of Child Health and Human Development (2007) suggested that age at starting school should not be regarded as a major determinant of children's school achievement, and there may be other more important factors including ECE quality.

In contrast, a recent study by Cornelissen and Dustmann (2019) estimated the effects of additional schooling on cognitive and non-cognitive outcomes and found significant age effects at both levels, particularly for boys with a disadvantaged parental background. However, the age effects on cognitive outcomes measured with language and numeracy skills disappeared by age 11, while differences in non-cognitive outcomes continued to be detected. Starting school earlier improved academic interest and reduced disruptive behaviour (Cornelissen & Dustmann, 2019).

Studies of the entry-age debate predominantly emphasized cognitive skills as the outcome variable, whereas students' attitudes toward school have attracted widespread scientific interest over the past decades. However, studies argued that not only the cognitive skills but also the affective–motivational attitudes that students develop toward learning at school are crucial for child development (Hosenfeld & Helmke, 2004; Pekrun et al., 2002). Two significant components of affective–motivational attitudes are children's enjoyment of learning and their willingness to exert the effort to learn. School enjoyment is an expression of how students cope with academic expectations, their sense of belonging to the school, and their relationships with teachers and classmates (Darge, 2009; Harazd & Schürer, 2006; Lumby, 2011). Findings show that enjoyment of learning is predictive of later achievement beginning of elementary school (Martschinke & Kammermeyer, 2006), at the end of

[1] Instructional context is defined as the physical location and surroundings in which learning takes place along with the resources that are typically available in such locations (McLaren et al., 2022).

elementary school (Helmke, 1993), and during secondary school (Hagenauer & Hascher, 2011). Moreover, the effort is positively associated with achievement in first and second grades (Rauer & Schuck, 2004) and third and fourth grades (Rauer & Schuck, 2003). Also, students exerting greater learning effort get recommended for higher grades (Kaufmann, 2007).

Another crucial aspect is the gender differences in student performance and motivation which is a well-known phenomenon (Duckworth & Seligman, 2006; Ehrmann & Wolter, 2018; Stoet & Geary, 2015; Vos et al., 2023). Studies from different educational contexts indicate that often girls enjoy school significantly more and exhibit more positive attitudes toward school than boys (Eccles et al., 1993; Gentry et al., 2002; Logan & Johnston, 2009; Morris et al., 2021; Smith et al., 2016). Therefore, gender seems to be one of the important predictors of school achievements.

Therefore, in sum, the theoretical discussions and empirical evidence suggest a puzzling contrast. On the one hand, parents in developed countries often delay children's school entry, and there is sizable evidence that these delays confer developmental gains on the children. On the other hand, there is also evidence that suggests delaying school entry does not provide any long-term benefit.

School Entry Age in Germany

In Germany, each federal state has specific guidelines and regulations regarding when children are eligible to enter elementary school. Usually, there is an entry cutoff month specified by each federal state in Germany. Children who are 6 years or older during that entry cutoff month are by default eligible to enter school in that year. For example, in federal states like Baden-Württemberg, Bavaria, and Lower Saxony, the cutoff month is set as September (exact date varies). Therefore, children who turn six in or before September of the current year qualify to enter school in that year in these federal states. Based on this framework, there is an entry-age variation of about 12 months (born between October last year and September of the current year) among the children in grade one. The youngest entrants would be children who turned exactly 6-years-old in September of current year, and the oldest would be children who turned six in October last year. In this study, we refer to this situation as *regular entry*, where the school entry of a child was following the entry regulation in that federal state.

However, there are exceptions to this guideline, and often parents and schools have discretionary powers regarding young children's school entry, which causes a variation in the entry age. For example, children who were already 6 years-old during the entry cutoff and were age-wise qualified (i.e. turned six on or before the entry cut-off in September current year) to enter school in a given year might be considered too young to enter school by their parents. Therefore, school entry of these children might be held back by their parents. These children then entered school the following year and represented the older age group (84 months or older) in grade one.

Alternatively, relatively younger children who turned six after September and were not age-wise eligible to start schooling in a given year could also be allowed to enter school if their parents desire to send their children to school earlier, and these children fulfil federal state-specific criteria or entry-related evaluations. This kind of event will cause the inclusion of younger children aged 71 months or younger to join grade one in the year, and it is referred to as *early entry* in this study. Therefore, an elementary school cohort in a particular year is a combination of early, regular, and late entrants and is demonstrated in the following tables for the year 2012 for the German federal states, using the NEPS Starting Cohort Kindergarten (SC2) data (NEPS, 2020). Table 1 shows the variation in entry age across federal states, and one can see the differences in mean entry age from region to region.

According to the available data for the 2012–2013 school year, 7% of the children were deferred and not enrolled in school until the following year due to parent consent, recommendation from a doctor or kindergarten teacher referral. Bavaria, Baden-Württemberg, Brandenburg, and Hesse have the highest accrual rates at over 10%. On average, 3.1% of children were enrolled early in the under-review school year. The highest percentages of children enrolled earlier were from Bremen (15%), Hamburg (10%), Hesse (7%), and Saarland (7%), which are the federal states that have not changed the enrollment date (Autorengruppe Bildungsberichterstattung, 2014).

In addition, it is worth to mention here about the early academic tracking of the German education system. In most of the federal states in Germany, the academic tracking starts from the fifth grade (i.e., students are assigned to distinct educational tracks). This phase of student life is crucial as the transition to lower secondary school is associated with various changes in the learning and social environment, and it may affect students' attitudes, emotions, and educational outcomes (Meyer & Schlesier, 2021; Smith et al., 2016; Wang & Eccles, 2013). A recent study found that in a setting with early ability tracking, SEA had only small effects on long-term outcomes, although, there was a substantial effect on students' achievement at the end of primary school (Oosterbeek et al., 2021).

Therefore, considering the German context and existing literature, this study examines any causal relation between differential entry age and child outcomes, including school enjoyment and willingness to make an effort to learn.

Table 1 SEA in German federal states 2012–2013

Sl. No.	Name of state	Observation	SEA (in months)		
			Mean	Min	Max
1.	Schleswig–Holstein	308	79.17	70	99
2.	Hamburg	98	77.39	65	85
3.	Lower Saxony	803	78.63	67	99
4.	Bremen	77	77.49	65	86
5.	North Rhine–Westphalia	1656	76.49	58	97
6.	Hesse	472	78.95	67	96
7.	Rhineland–Palatinate	382	77.45	67	94
8.	Baden–Württemberg	820	78.38	58	97
9.	Bavaria	1190	78.06	59	95
10.	Saarland	77	78.55	69	95
11.	Berlin	272	74.50	67	95
12.	Brandenburg	83	77.33	70	89
13.	Mecklenburg–Western Pomerania	160	81.20	64	98
14.	Saxony	257	81.00	70	100
15.	Saxony–Anhalt	131	80.51	73	97
16.	Thuringia	130	78.79	72	86

Source: Authors' calculation from NEPS-SC2 SUF 9.0.0

Data and Methodology

Data

This paper uses data from the National Educational Panel Study (NEPS; see Blossfeld & Roßbach, 2019), Starting Cohort Kindergarten (NEPS, 2020). The NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi, Germany) in cooperation with a nationwide network. The longitudinal data we use for our analyses followed children from 2011/12 when they had attended day-care facilities (Kindergartens) up to 2019/20 when they attended secondary schools. As our focus in this study predominantly is on elementary education, we included about 8500 children in the final sample, whom we followed from grade 1 to grade 4 in elementary school (i.e. from 2012/13 up to 2015/16).

Measures

School Entry Age

The variable of interest in this study was the age of entry into elementary school, which we measured in months. We measured entry age only at the beginning of elementary school, that is, in grade 1. The overall mean SEA was 77.95 months and varied between 58 and 100 months depending on the individual federal states.

Willingness to Make an Effort

Parents reported at each grade in elementary school the willingness of the child to put an effort into completing their schoolwork. We adopted three items from the German questionnaire on emotional and social school experiences of children (Rauer & Schuck, 2003), namely (i) Child handles work material with care, (ii) Child completes all tasks with great care, (iii) Child makes an effort when assignments are difficult. Each of these students' effort items was estimated on a four-point Likert scale ranging from *does not apply at all (=1), does rather not apply (=2), does rather apply (=3), and applies completely (=4)*. We then ran an exploratory factor analysis using Principal Component Analysis (PCA) (see Appendix Tables 5 and 6) to create a latent variable named *willingness*, a linear composite of the three original variables.

Joy of Learning

Parents also reported school enjoyment of their children at each grade in elementary school, and it consists of three items: (i) The child enjoys going to school (pb00020), (ii) The child has fun at school (pb00060), and (iii) The child enjoys learning in school a lot (pb00100). Each of these parameters was measured on a 4-point scale ranging in a similar fashion explained earlier [i.e. from *does not apply at all* (=1) to *applies completely* (=4)]. We adopted the same

Table 2 Descriptive statistics

Grade		Entry age (in months)	Willingness score	School enjoyment score
1st grade	Mean (S.D)	77.95 (4.70)	0.184 (1.235)	0.404 (1.348)
	N	6916	6790	6817
2nd grade	Mean (S.D)	–	0.065 (1.250)	0.178 (1.468)
	N		6169	6177
3rd grade	Mean (S.D)	–	− 0.028 (1.262)	− 0.097 (1.551)
	N		5281	5283
4th grade	Mean (S.D)	–	− 0.055 (1.283)	− 0.170 (1.576)
	N		4859	4860

Source: Authors' calculation from NEPS-SC2 SUF 9.0.0 (https://doi.org/10.5157/NEPS:SC2:9.0.0)

PCA approach (see Appendix Tables 5 and 6) to form a linear composite of the three school enjoyment variables and create a latent variable named s*chool enjoyment*.

Controls

Based on the literature and after careful preliminary analyses of the context, we considered the following set of covariates, potentially influencing children's competencies. Among child characteristics, gender was measured as 'female' or 'male', and another child-related dummy was included to control if the child needed any special education. We also included a variable called 'relative age', which measured the difference between the actual age of a child and the mean classroom age. The purpose of including this variable was to control for any relative-age effect, as mentioned in Dater and Gottfried (2015). To control for other competencies, we accounted for children's social, German, and math skills, which were measured in grade 1 (wave 3) up to grade 4 (wave 7).

For the household and institutional context, migration was defined as having no migration or having a migration background (i.e., one or both parents of the child born abroad). Parents' highest education was measured by 'up to the primary,' 'middle school,' 'higher education,' and 'university'. Furthermore, as the class teachers had to assess children's competencies compared with other children in the classroom, there was the possibility of school-related differences in child assessments. Therefore, we controlled for the school-fixed effect. Finally, we also controlled for federal states for any region-specific-fixed effects.

Table 2 shows the descriptive statistics of our variables of interest over different time points. There is a downward trend in the mean score of willingness and school enjoyment over time. Table 3 shows the sample distribution according to essential child and household characteristics which are controlled for in this study. Importantly, there was equal gender distribution of the sample, and most of the children belonged to families with no migration background. In addition, about 90% of children's elementary school entries were based on the school entry regulation of the respective federal states, while about 10% were either delayed or advanced.

Empirical Strategy

The impact of the heterogeneous entry age on children's school enjoyment and willingness was examined using confirmatory regression analysis. In the German context, there is the possibility for parents or, in the case of developmental delays, for the receiving school to enroll the child earlier or later than what is otherwise specified by the entry cut-off. Thus, there is a possibility of unobserved heterogeneity where one or more of the model's observed and unobserved control variables may influence both the dependent and the independent variables. Consequently, we deployed a two-stage least squares (2SLS) estimation using an *instrumental variable* (IV) (Greene, 2000) as our main empirical strategy. This method has already been used to predict the causal relationship between entry age and child outcomes (Bedard & Dhuey, 2006; Elder & Lubotsky, 2009). For example, the identification strategy was deployed by Bedard and Dhuey (2006) in their study of 20 countries where a student's predicted school-starting age was used as an instrumental variable for their actual school-starting age. Therefore, the identification strategy adopted in this study has already been validated to interpret the causal effect of SEA in the context of industrialized countries like Germany.

In the first stage, we estimated the entry age using the instrument variable named 'assigned age'. In the second stage, the estimated value of the entry age from the first stage was used to estimate the entry-age effect on child outcomes. The two-stage model can be written as follows:

$$Entryage_i = \gamma_1 + \gamma_2 assignedage_i + \gamma_3 H_i + \varepsilon_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (Firststage)$$

$$Child\_outcome_i = \beta_0 + \beta_1 \widehat{entry\_age}_i + \beta_2 H_i + \varepsilon_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (Secondstage)$$

Table 3 Sampling distribution according to control variables

Variables	Categories		Observation (%)
Sex of the child	Male		3387 (49)
	Female		3529 (51)
Parents' education	Up to primary		729 (9)
	Secondary		2418 (31)
	Higher secondary		1939 (25)
	University		2733 (35)
Migration	No migration		4156 (77)
	Having a migration background		1210 (23)
Special education	Not needed		6148 (95.5)
	Needed		284 (4.5)
Previous skill differences	Social skills	Much worse	230 (3.88)
		Slightly worse	875 (14.75)
		Just as well	2420 (40.80)
		Slightly better	1431 (24.13)
		Much better	975 (16.44)
	German skills	Much worse	275 (4.65)
		Slightly worse	903 (15.26)
		Just as well	2338 (39.51)
		Slightly better	1499 (25.33)
		Much better	902 (15.24)
	Math skills	Much worse	248 (4.28)
		Slightly worse	842 (14.53)
		Just as well	2343 (40.43)
		Slightly better	1573 (27.14)
		Much better	789 (13.62)
School entry types	Early entry		218(3.40)
	Regular entry		5760 (89.50)
	Late entry		453 (7.10)

Source: Authors' calculation from NEPS-SC2 SUF 9.0.0

In the second stage, we used $assignedage_i$ as an instrument for determining the estimated value of entryage for the ith child. Here assignedage[2] is the difference in months between a child's sixth birthday and the state entry cutoff. As the date of birth and state entry cutoff are two exogenous sources of variation in school entryage, assigned age is also arguably exogenous (Bedard & Dhuey, 2006; Black et al., 2011; Datar, 2006; Dobkin & Ferreira, 2010; Elder & Lubotsky, 2009; Smith, 2009). After obtaining the estimated value of entry age for the ith child, it was used at the second stage to estimate the entry-age effects on different child outcomes of the ith child. Since the study consider two outcome variables i.e. willingness and school enjoyment, the entry-age effect was estimated separately for each of these outcomes. In both stages, Hi is the vector for household and child-level controls for the ith child, and ε_1 and ε_2 are the usual individual-level error terms. The parameter of our interest was β_1 which showed the causal impact of entry age on child outcomes.

Given the longitudinal nature of the data, we estimated the model using random-effects panel IV regressions (Rabe-Hesketh & Skrondal, 2012; Wooldridge, 2020). Random-effect panel regression allows the modelling of both the time-varying and time-invariant predictors of the outcome. The random-effect approach assumes between-subject differences in the outcome reflected by the case-specific intercepts estimated. In these models, the variance of the intercepts is estimated as a model parameter, along with the predictors' fixed effects and the residuals' variance. As random effect models consider differences between subjects in the outcome, it can incorporate characteristics that vary between subjects as additional predictors of variation in the outcome variables. Also, random-effect models assist in controlling

[2] For example, considering a federal state where the entry cutoff was September 2012, a zero value for the assigned age for a child means that the child turned exactly six in September 2012 (therefore, born in September 2006). Alternatively, an assigned age of five denotes that the child was 6 years and 5 months old in September 2012 (which means the child was born in April 2006).

Table 4 Multivariate analysis of entry-age effects

	Willingness	School enjoyment
Entry age	0.147**	0.009
	(0.006)	(0.007)
Grades (Ref. 1st grade)		
2nd grade	0.0519	− 0.0323
	(0.127)	(0.158)
3rd grade	0.177	0.093
	(0.263)	(0.488)
4th grade	0.309	− 0.003
	(0.393)	(0.488)
Entry age* grade	− 0.002	− 0.001
	(0.001)	(0.001)
Sex of the child (Ref. male)		
Female	0.429***	0.406***
	(0.030)	(0.036)
Relative age	0.004	− 0.006
	(0.003)	(0.004)
Parents' education (Ref. up to primary)		
Secondary	0.039	− 0.095
	(0.058)	(0.068)
Higher secondary	− 0.001	− 0.095
	(0.059)	(0.068)
University	− 0.021	− 0.065
	(0.059)	(0.069)
Migration (Ref. no migration)		
Having migration background	0.211***	0.171***
	(0.036)	(0.041)
Special education needed (Ref. No)		
Yes	-0.113***	− 0.078
	(0.044)	(0.054)
Controls for other skills: social, German, mathematics skills	Yes	Yes
Control for federal state-wise fixed effects	Yes	Yes
Control for school-fixed effects	Yes	Yes
Constant	− 1.980***	− 2.060***
	(0.776)	(0.916)
N	5256	5259

Standard errors in parenthesis. ***p < 0.001, **p < 0.01, *p < 0.05

for unobserved heterogeneity when the heterogeneity is constant over time and not correlated with independent variables.

Results

Our main objective was to investigate the entry-age effect and the extent of such effect over time. Table 4 provides the findings from the 2SLS estimation of the entry-age effects where the first column shows the coefficients for children's willingness to make an effort, and the second column indicates school enjoyment.

The result yielded a statistically significant positive entry-age effect for children's willingness to make an effort. After controlling for child and household characteristics, and school-fixed effects, an increase in entry age was associated with a 0.14 point ($p < 0.01$) higher willingness to make an effort. But no such effect was observed for children's school enjoyment. Besides, the interaction between entry age and grade captures the change in child outcomes for a given entry age over time, which is negative for both the child outcomes. This implies that for any given school entry age, both willingness and school enjoyment decreases over time. Additionally, we did not see any relative-age effect for either of the child outcomes. Therefore, whether a child is older or younger than the average age in the classroom does not make any significant difference.

Among other covariates, the sex of the child had a consistent impact on child outcomes. Being a girl significantly increases the willingness to make an effort by 0.42 points ($p < 0.001$) and school enjoyment by 0.40 points ($p < 0.001$) school compared to boys. Some of the institutional contexts such as migration background also seem crucial for child outcomes. Children with migration backgrounds were found to be 0.21 points ($p < 0.001$) more willing to make an effort and also had 0.17 points ($p < 0.001$) higher school enjoyment compared to children without any migration background. Furthermore, if children needed special education during kindergarten, then it significantly negatively affected their willingness but not their school enjoyment. Children with special needs had, in general, 0.11 points lower ($p < 0.001$) willingness compared to children without need of any special education.

Therefore, assimilating the results, we found that a positive entry-age effect in the German elementary school context did exist, but not all child outcomes are equally sensitive to it. Besides, the initial differences in child outcomes seem to fade away as children progress to higher grades.

Discussion

The main goal of this study was to use the German longitudinal data to discuss one of the important questions of educational research: Whether SEA has heterogeneous effects on child outcomes and how long such effects persist. The answers to these questions are not straightforward as studies conducted in various countries differ considerably in their findings. This study found a positive entry-age effect, however, the effect decreased over time. Moreover, some child outcomes were more sensitive to entry-age variation than others. Therefore, the findings of this study enrich the

existing literature and appear to be relevant to education policies.

Implications for Research

From the considerations presented in this paper, further areas of research emerge. The findings raise the obvious question of whether the entry-age effect persists also in the long run. This question is even more relevant for the German education system where academic tracking is introduced as early as in lower-middle schools. As different school tracks offer diverse school environments and curricula (such as education or training) focused on children, school enjoyment is likely to vary considerably, which in turn, might affect children's emotions and attitudes toward school. Recent studies have confirmed the tendency of increased school enjoyment directly after the transition to secondary school (Geis-Thöne, 2020; Ömeroğulları & Gläser-Zikuda, 2021). It is argued in the context of early academic tracking that the sparse evidence on the long-term effects of the month of birth indicates that these effects are 'quite small' (Oosterbeek et al., 2021, p. 8). Therefore, investigating the possible persistence of the entry-age effect during secondary schooling and beyond, and its impact on labour market outcomes is crucial for future research.

Another important finding of the study was concerning gender differences in motivational attitudes. We found that girls reported higher school enjoyment and willingness to make efforts which adhere to previous findings from different educational contexts. For example, Gentry et al. (2002) found that girls indicated that their class activities were more frequently interesting and enjoyable than did boys, Logan and Johnston (2009) found that girls had a more positive attitude towards reading and school. In contrast, another study (Eccles et al., 1993) found subject-specific variations in gender roles. Boys had more positive competence beliefs and values than did girls for sports activities and mathematics, whereas girls had more positive competence beliefs and values than did boys for reading and music activities (ibid).

Although, the gender-related findings of the current study is consistent with previous evidence, however, questions remain concerning the extent of these gender differences across subject areas and school types, and the identification of possible moderator variables. Therefore, further scope of research emerges from the empirical findings concerning gender differences in motivational attitudes.

Implications for Practice

The findings of the study also have implications for educational policies and practices in Germany. In general, older children in German elementary school benefit from the positive entry-age effect, but not from the relative-age effect. The benefits of starting elementary schooling at an older age reflect two broad mechanisms. The first mechanism is relative maturity: students may benefit when they start school at an older age simply because they have, on average, a variety of developmental advantages relative to their classroom peers. The second mechanism, absolute maturity, reflects that formal schooling is more developmentally appropriate for older children (Vygotsky, 1978; Whitebread, 2011).

We also witnessed that the effect tends to fade away as children progress to higher grades which indicates a *catching up*. Even though younger children in a cohort begin with lower willingness and school enjoyment levels, they seem eventually to catch up with their older peers towards the end of elementary school. Although studies have argued that the entry-age effect exists mostly in the short run, we cannot say with any certainty how long such an effect persists in this German context. We have noticed a positive entry-age effect at least until the end of elementary school. Similarly in the Swiss context, Balestra et al. (2020) found that the effect persisted throughout compulsory schooling; however, it did not affect employment or earnings in the long run. Therefore, the simultaneous existence of the entry-age effect and the catching-up effect suggests that institutional contexts such as classroom environment and teacher-student relations could be more effective in child development. The current practices in schools, in general, help to label the field to some extent for students from different age groups. Therefore, educational policies and practices need to be focused on the institutional contexts and a more inclusive approach.

Limitations and Further Directions

One restriction of the study is that it cannot portray the extent of the entry-age effect beyond elementary school. As the study estimated the entry age effect only until grade 4, it cannot answer whether the effect persists during secondary school and beyond. Besides, previously existing differences in skills and competencies were not controlled due to the unavailability of information. Furthermore, aspects of the home learning environment, other than the socioeconomic status of parents, were also not included.

Despite the limitations, this study shows the differential entry age effect in the German elementary school. Essentially, the study focuses on student's affective–motivational attitudes which have been less researched so far. The empirical findings of the study justify the necessity of explicitly considering the type of variation in entry age and different child outcomes while estimating the entry age effect.

Conclusion

The formation of school classes based on birth dates implies that within a class children may differ up to 1 year in age. Much research has shown that children who start school at an older age do better than their younger peers. This evidence is, however, limited to settings where the so-called academic tracking occurs relatively late. We found that in German schools, where academic tracking occurs relatively early, there is a small but positive entry-age effect on students' attitudes toward school. This new evidence, therefore, advances the literature in several ways. First, we have based our study on a unique source of data, a recent and large-scale survey of the National Educational Panel Study (NEPS). Second, by taking into consideration the possibility of an endogenous source of variation in entry age, we credibly identified the effects of delayed school entry through a two-stage least squares estimation technique. Third, instead of restricting itself to cognitive skills, this study focused on children's school enjoyment and their willingness to make an effort in school which are considered important factors for school success. Finally, we unscrambled the entry-age and relative-age effect mechanisms. The findings of the study, therefore, have substantial policy relevance and provide further direction for research.

Appendix

See Tables 5 and 6.

Table 6 Principal components

Components	Willingness		School enjoyment	
	Eigenvalue	Cumulative	Eigenvalue	Cumulative
Comp1	1.906	0.635	2.282	0.760
Comp2	0.706	0.871	0.477	0.919
Comp3	0.387	1.000	0.240	1.000

Source: Primary Data

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Declarations

Conflict of interest The authors declare no conflict of interest.

Ethical Approval As the current study uses the NEPS data, the following ethical considerations apply. The NEPS study is conducted under the supervision of the German Federal Commissioner for Data Protection and Freedom of Information (BfDI) and in coordination with the German Standing Conference of the Ministers of Education and Cultural Affairs (KMK) and—in the case of surveys at schools—the Educational Ministries of the respective Federal States. All data collection procedures, instruments, and documents were checked by the data protection unit of the Leibniz Institute for Educational Trajectories (LIfBi). The necessary steps are taken to protect participants' confidentiality according to national and international regulations of data security. Participation in the NEPS study is voluntary and based on the informed consent of participants. This consent to participate in the NEPS study can be revoked at any time.

Table 5 Eigenvectors from the principal component analysis

Variables	Willingness				School enjoyment			
	Comp1	Comp2	Comp3	Unexplained	Comp1	Comp2	Comp3	Unexplained
Child handles work material with care	0.589	− 0.519	0.619	0	–	–	–	–
Child completes all tasks with great care	0.629	− 0.186	− 0.754	0	–	–	–	–
Child makes an effort when assignments are difficult	0.507	0.833	0.217	0	–	–	–	–
Child enjoys going to school	–	–	–	–	0.586	− 0.492	0.643	0
Child has fun at school	–	–	–	–	0.603	− 0.264	− 0.752	0
Child enjoys learning in school a lot	–	–	–	–	0.540	0.829	0.142	0

Source: Primary data

References

Balestra, S., Eugster, B., & Liebert, H. (2020). Summer-born struggle: The effect of school starting age on health, education, and work. *Health Economics, 29*(5), 535–651. https://doi.org/10.1002/hec.4005

Bedard, K., & Dhuey, E. (2006). The persistence of early childhood maturity: International evidence of long-run age effects. *The Quarterly Journal of Economics, 121*(4), 1437–1472. https://doi.org/10.1093/qje/121.4.1437

Autorengruppe Bildungsberichterstattung (2014). Bildung in Deutschland 2014. Ein indikatorengestützter Bericht mit einer Analyse zur Bildung von Menschen mit Behinderungen. https://www.bildungsbericht.de/de/bildungsberichte-seit-2006/bildungsbericht-2014/bildung-in-deutschland-2014

Black, S., Devereux, P., & Salvanes, K. G. (2011). Too young to leave the nest? The effects of school starting age. *Review of Economics and Statistics, 93*, 455–467. https://doi.org/10.1162/REST_a_00081

Blossfeld, H.-P., & Roßbach, H.-G. (2019). *Education as a lifelong process: The German national educational panel study (NEPS)* (2nd ed.). Springer.

Cornelissen, T., & Dustmann, C. (2019). Early school exposure, test scores, and non-cognitive outcomes. *American Economic Journal: Economic Policy, 11*(2), 35–63. https://doi.org/10.1257/pol.20170641

Darge, K. (2009). Wie gern gehst du zur Schule?—Eine empirische Studie zum Ausmaß und zur Entwicklung der Schulfreude bei Berliner Schülerinnen und Schülern. In R. Peek, W. Plöger, B. Peperhove, & J. Stratmann (Eds.), *Tagungsband des Symposiums 2008—Heterogenität von Lerngruppen—Eine Herausforderung an die Schulpädagogik* (pp. 91–114). Köln.

Datar, A. (2006). Does delaying kindergarten entrance give children a head start? *Economics of Education Review, 25*, 43–62. https://doi.org/10.1016/j.econedurev.2004.10.004

Dater, A., & Gottfried, M. A. (2015). School entry age and children's social-behavioural skills: Evidence from a national longitudinal study of U.S. kindergartens. *Educational Evaluations and Policy Analysis, 37*(3), 333–353. https://doi.org/10.3102/0162373714547268

Dee, T. S., & Sievertsen, H. H. (2015). The gift of time? School starting age and mental health. *Health Economics*. https://doi.org/10.1002/hec.3638

Dobkin, C., & Ferreira, F. V. (2010). Do school entry laws affect educational attainment and labor market outcomes? *Economics of Education Review, 29*(1), 40–54. https://doi.org/10.1016/j.econedurev.2009.04.003

Duckworth, A., & Seligman, M. E. (2006). Self-discipline gives girls the edge: Gender in self-discipline, grades, and achievement test scores. *Journal of Educational Psychology, 98*(1), 198–208. https://doi.org/10.1037/0022-0663.98.1.198

Eccles, J., Wigfield, A., Harrold, R. D., & Blumenfeld, P. (1993). Age and gender differences in children's self-and task perceptions during elementary school. *Child Development, 64*(3), 830–847. https://doi.org/10.1111/j.1467-8624.1993.tb02946.x

Ehrtmann, L., & Wolter, I. (2018). The impact of students' gender role orientation on competence development in mathematics and reading in secondary school. *Learning and Individual Differences, 61*, 256–264. https://doi.org/10.1016/j.lindif.2018.01.004

Elder, T. E., & Lubotsky, D. H. (2009). Kindergarten entrance age and children's achievement-impacts of state policies, family background and peers. *The Journal of Human Resources, 44*(3), 641–683. https://doi.org/10.3368/jhr.44.3.641

Felfe, C., & Lalive, R. (2018). Does early child care affect children's development? *Journal of Public Economics, 159*, 33–53. https://doi.org/10.1016/j.jpubeco.2018.01.014

Fredriksson, P., & Ockert, B. (2005). Is early learning really more productive? The effect of school starting age on school and labour market performance. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.760728

Geis-Thöne, W. (2020). *Lernmotivation und Freude an der Schule: Eine Auswertung des Nationalen Bildungspanels (NEPS)* (IW-Report No. 30). Institut der deutschen Wirtschaft (IW). http://hdl.handle.net/10419/221914

Gentry, M., Gable, R. K., & Rizza, M. G. (2002). Students' perceptions of classroom activities: Are there grade-level and gender differences? *Journal of Educational Psychology, 94*(3), 539–544. https://doi.org/10.1037/0022-0663.94.3.539

Görlitz, K., Penny, M., & Tamm, M. (2019). *The long-term effect of age at school entry on competencies in adulthood*. IZA Discussion Paper No. 12157. https://ssrn.com/abstract=3390144

Graue, E., & DiPerna, J. (2000). Redshirting and early retention: Who gets the gift of time and what are its outcomes? *American Educational Research Journal, 37*(2), 509–534. https://doi.org/10.3102/00028312037002509

Greene, W. H. (2000). *Econometric analysis* (4th ed.). Macmillan.

Hagenauer, G., & Hascher, T. (2011). Lernfreude, engagierte Mitarbeit im Unterricht und erfolgreiches Leisten bei instrumentellen Formen der Lernmotivation—ein Widerspruch in sich? *Zeitschrift Für Bildungsforschung, 1*, 97–113. https://doi.org/10.1007/s35834-011-0011-3

Harazd, B., & Schürer, S. (2006). Veränderung der Schulfreude von der Grundschule zur weiterführenden Schule. In A. Schründer-Lenzen (Ed.), *Risikofaktoren kindlicher Entwicklung* (pp. 208–222). Verlag für Sozialwissenschaften.

Havnes, T., & Mogstad, M. (2015). Is universal child care leveling the playing field? *Journal of Public Economics, 127*, 100–114. https://doi.org/10.1016/j.jpubeco.2014.04.007

Helmke, A. (1993). Die Entwicklung der Lernfreude vom Kindergarten bis zur 5. Klassenstufe. *Zeitschrift für Pädagogische Psychologie, 7*, 77–86.

Hosenfeld, I., & Helmke, A. (2004). Wohlbefinden und Leistung—unvereinbare Ziele? In T. Hascher (Ed.), *Schule positiv erleben* (pp. 113–132). Haupt.

Kaufmann, A. (2007). Merkmale und Einstellungen von Schülern. In H. Ditton (Ed.), *Kompetenzaufbau und Laufbahnen im Schulsystem* (pp. 117–143). Waxmann.

Lee, V. E., & Burkham, D. (2002). *Inequality at the starting gate: Social sociodemographic differences in achievement as children begin school*. Economic Policy Institute.

Logan, S., & Johnston, R. (2009). Gender differences in reading ability and attitudes: Examining where these differences lie. *Journal of Research in Reading, 32*(2), 199–214. https://doi.org/10.1111/j.1467-9817.2008.01389.x

Lumby, J. (2011). Enjoyment and learning: Policy and secondary school learners' experience in England. *British Educational*

Research Journal, 37(2), 247–264. https://doi.org/10.1080/01411920903540680

Magnuson, K. A., Ruhm, C., & Waldfogel, J. (2007). The persistence of preschool effects: Do subsequent classroom experiences matter? *Early Childhood Research Quarterly, 22*(1), 18–38. https://doi.org/10.1016/j.ecresq.2006.10.002

Martschinke, S., & Kammermeyer, G. (2006). Selbstkonzept, Lernfreude und Leistungsangst und ihr Zusammenspiel im Anfangsunterricht. In A. Schründer-Lenzen (Ed.), *Risikofaktoren kindlicher Entwicklung. Migration, Leistungsangst und Schulübergang* (pp. 125–139). Verlag für Sozialwissenschaften.

McEwan, P. J., & Shapiro, J. S. (2008). The benefits of delayed primary school enrolment. Discontinuity estimates using exact birth dates. *Journal of Human Resources, 43*(1), 1–29. https://doi.org/10.3368/jhr.43

McLaren, B. M., Richey, J. E., Nguyen, H., & Hou, X. (2022). How instructional context can impact learning with educational technology: Lessons from a study with a digital learning game. *Computers & Education, 178*, 104366. https://doi.org/10.1016/j.compedu.2021.104366

Meyer, S., & Schlesier, J. (2021). The development of students' achievement emotions after transition to secondary school: A multilevel growth curve modelling approach. *European Journal of Psychology of Education*. https://doi.org/10.1007/s10212-021-00533-5

Morris, T. T., Dorling, D., Davies, N. M., & Smith, G. D. (2021). Associations between school enjoyment at age 6 and later educational achievement: Evidence from a UK cohort study. *Science of Learning, 6*(18), 1–9. https://doi.org/10.1038/s41539-021-00092-w

National Institute of Child Health and Human Development. (2007). Age of entry to kindergarten and children's academic achievement and socioemotional development. *Early Educational Development, 18*, 337–368. https://doi.org/10.1080/10409280701283460

NEPS Network. (2020). *National educational panel study, scientific use file of starting cohort Kindergarten*. Leibniz Institute for Educational Trajectories (LIfBi).

Ömeroğulları, M., & Gläser-Zikuda, M. (2021). Entwicklung affektiv-motivationaler Merkmale am Übergang in die Sekundarstufe—Wie ergeht es bildungsbenachteiligten Kindern? *Zeitschrift Für Bildungsforschung, 11*(2), 363–383. https://doi.org/10.1007/s35834-021-00314-6

Oosterbeek, H., ter Meulen, S., & Van der Klaauw, B. (2021). Long-term effects of school-starting-age rules. *Economics of Education Review, 84*, 102144. https://doi.org/10.1016/j.econedurev.2021.102144

Pekrun, R., Götz, T., Titz, W., & Perry, R. (2002). Positive emotions in education. In E. Frydenberg (Ed.), *Beyond coping: Meeting goals, visions and challenges* (pp. 149–174). Elsevier.

Rabe-Hesketh, S., & Skrondal, A. (2012). *Multilevel and longitudinal modelling using Stata*. Stata Press.

Rauer, W., & Schuck, K. D. (2003). *Fragebogen zur Erfassung emotionaler und sozialer Schulerfahrungen von Grundschulkindern dritter und vierter Klassen (FEESS 3–4)*. Beltz Test GmbH.

Rauer, W., & Schuck, K. D. (2004). *Fragebogen zur Erfassung emotionaler und sozialer Schulerfahrungen von Grundschulkindern erster und zweiter Klassen (FEESS 1–2)*. Beltz Test GmbH.

Smith, J. (2009). Can regression discontinuity help answer an age-old question in education? The effect of age on elementary and secondary school achievement. *The B.E. Journal of Economic Analysis & Policy, 9*(1), 1–30. https://doi.org/10.2202/1935-1682.2221

Smith, M. L., Mann, M. J., Georgieva, Z., Curtis, R., & Schimmel, C. J. (2016). What counts when it comes to school enjoyment and aspiration in the middle grades. *RMLE Online, 39*(8), 1–13. https://doi.org/10.1080/19404476.2016.1226100

Stipek, D. (2002). At what age should children enter kindergarten? A question for policymakers and parents. *SRCD Social Policy Report, 16*(2), 3–16.

Stoet, G., & Geary, D. C. (2015). Sex differences in academic achievement are not related to political, economic, or social inequality. *Intelligence, 48*, 137–151. https://doi.org/10.1016/j.intell.2014.11.006

Suggate, S. P. (2009). School entry age and reading achievement in the 2006 Programme for International Student Assessment (PISA). *International Journal of Educational Research, 48*(3), 151–161. https://doi.org/10.1016/j.ijer.2009.05.001

UNICEF. (2017). *Early moments matter for every child*. United Nation's Children Fund.

Vecchiotti, S. (2001). Kindergarten: The overlooked school years. *The Foundation for Child Development Working Paper Series.* https://eric.ed.gov/?id=ED458948

Vos, H., Marinova, M., De Léon, S. C., Sasanguie, D., & Reynvoet, B. (2023). Gender differences in young adults' mathematical performance. Examining the contribution of working memory, math anxiety and gender-related stereotypes. *Learning an Individual Differences, 102*, 102255. https://doi.org/10.1016/j.lindif.2022.102255

Vygotsky, L. S. (1978). *Mind in society*. Harvard University Press.

Wang, M.-T., & Eccles, J. S. (2013). School context, achievement, motivation, and academic engagement: A longitudinal study of school engagement using a multidimensional perspective. *Learning and Instruction, 28*, 12–23. https://doi.org/10.1016/j.learninstruc.2013.04.002

Whitebread, D. (2014). Hard evidence: At what age are children ready for school? *The Conversation*. https://theconversation.com/hard-evidence-at-what-age-are-children-ready-for-school-29005

Whitebread, D. (2011). *Development psychology and early childhood education*. Sage.

Wooldridge, J. M. (2020). *Introductory econometrics: A modern approach* (7th ed.). Cengage.