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ABSTRACT

Parental socio-economic status (SES) is often found to be associated with children's language competence in the first decade of life. To examine the effect of SES on children's vocabulary development, as well as potential compensatory effects of schooling and learning-related activities, we examined the joint and unique effects of parental education, occupational status, and learning environment at home on children's receptive vocabulary competence and growth in early childhood. We used latent growth curve models to assess pre-school receptive vocabulary and growth across primary school. Analyses were based on data from the *German National Educational Panel Study* (NEPS), a large-scale longitudinal study assessing vocabulary competence and family background from Kindergarten to the 3rd grade of elementary school. To examine the moderating effects of parental education, occupational status, and learning environment at home, we used local structural equation modeling. Results revealed a moderate to strong positive association between parental education and children's receptive vocabulary competence, which fully explained the effect of occupational status on this language skill. With the exception of the activity of reading aloud, we found no effect of learning environment at home. Initially lower performing children showed steeper growth trajectories across school, but rank-orders were relatively stable across time. In summary, the results suggest large initial differences in receptive vocabulary between children from different educational backgrounds, which are reduced, but not fully overcome across elementary school.

1. Introduction

Language competencies[1] are arguably the most important cultural competencies we acquire over the course of early childhood. Language is the foundation of all human interactions, a necessity to acquire further knowledge, and a key competence imparted in formal education. However, even before primary education, considerable differences among children in language competence and vocabulary knowledge are found. A substantial share of these differences can be explained by family background variables such as socio-economic status (SES; e.g., 14% in Haag et al., 2017). SES represents a blend of different facets capturing a person's (or family's) income, wealth, educational level, and occupational status (Conger et al., 2010). SES-associated differences in

children's language competence can already be observed in the first years of life (Fernald et al., 2013; Huttenlocher et al., 2010; Roberts et al., 1999). For example, differences in vocabulary between children from different backgrounds seem to remain constant throughout childhood (Farkas & Beron, 2004; Froiland et al., 2013). Language competence is an important and reliable predictor of school readiness and educational achievement in later years (Burchinal et al., 2002; Hoff, 2013), and can even predict the SES of the next generation (Sohr-Preston et al., 2013). Therefore, examining and understanding the impact of social and educational background on language acquisition is relevant from the perspective of students, parents, teachers, educational policy-makers, and society as a whole.

In this study, we aim to examine the associations between SES and

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[1] For similarities and possible differences between the terms ability, skill, competency, etc. please see Schroeders (2018). In the present study, we use the terms synonymously.

receptive vocabulary competence and growth from nursery school (i.e., at age five; called *Kindergarten* in the German educational system) through elementary school (i.e., at age nine) in a large representative German panel study. International large-scale studies like PISA suggest that the associations between SES and educational outcomes are particularly strong in Germany (e.g., PISA 2015: 16% of variance in science performance explained by SES, compared to an OECD average of 13%; OECD, 2016). As SES also includes both occupational and educational aspects, we used both an occupation (*International Socio-economic Index of Occupational Status*; Ganzeboom et al., 1992) and education-based (*International Standard Classification of Education*; UNESCO Institute for Statistics, 2011) indicator of SES. In addition, a large number of studies have found that the association of SES and children's language competence can be partly explained through the frequency and quality of parent-child interactions (e.g., time spent on learning-related activities; Conger & Donnellan, 2007; Lohndorf et al., 2018; Sohr-Preston et al., 2013) and child-directed language usage (Hoff, 2003, 2006; Huttenlocher et al., 2010; Rowe, 2008; Rowe & Goldin-Meadow, 2009). Therefore, we additionally examine whether the learning environment at home (i.e., the amount and type of activities parents engage in with their children) can explain potential associations between parental SES and children's receptive vocabulary competence and growth, and to what degree it uniquely explains differences in these outcomes. In the following section, we review key findings on the influence of family background variables and schooling on language acquisition in general and vocabulary in particular. Furthermore, we discuss potential transition effects that might drive inter-individual differences among children with different social and educational backgrounds.

1.1. Socio-economic status, learning environment at home and vocabulary acquisition

A large body of research has shown that vocabulary acquisition in the first decade of life is positively related to the social and educational background of the family (around 5–17% of variance explained; e.g., Burchinal et al., 2002; Coddington et al., 2014; Huston et al., 2005; Huttenlocher et al., 2010; Rowe, 2008; Volodina et al., 2020). In a large-scale educational study encompassing a representative sample of about 29,000 German elementary grade students, 14% of the variance in children's receptive vocabulary in the 4th grade was accounted for by parental SES (Haag et al., 2017). Inter-individual differences in vocabulary can be already observed at early stages of language production, that is, at two to three years of age (Arriaga et al., 1998; Dollaghan et al., 1999; Farkas & Beron, 2004 ; Huttenlocher et al., 2010). These differences seem to remain relatively stable over the first decade of life when examined longitudinally (Farkas & Beron, 2004; Huttenlocher et al., 2010). A recent study on academic vocabulary (i.e., technical, scientific, abstract words) competence in a sample of 472 German elementary school students has shown that parental education and the number of books at home explained around 23% and 25% of the variance in the initial differences and growth from Grade 2 to 4, respectively (Volodina et al., 2020). This suggests that inter-individual differences in vocabulary competence may increase across school years due to differences in the educational background of the family.

The associations between parental SES and children's educational competencies represent a blend of genetic and environmental effects, and an interaction thereof. Studies examining the heritability of reading comprehension (Hart et al., 2013) or vocabulary (Rowe et al., 1999) found average heritability estimates of $h^2 = 0.67$ and $h^2 = 0.57$, respectively. However, the genetic influence was moderated by parental SES, representing a Gene x Environment interaction. The heritability of the cognitive abilities was reported to be larger in families with higher educational or socio-economic levels, for instance ranging from $h^2 = 0.26$ to $h^2 = 0.74$ for low to high SES families (Rowe et al., 1999), suggesting a higher influence of environmental factors on inter-individual vocabulary differences in lower SES families. The estimated

heritability of educational outcomes may represent a blend of the heritability of cognitive abilities and the transmission of other relevant traits, such as personality, self-efficacy or well-being (Krapohl et al., 2014).

With respect to the processes of environmental transmission, Watermann and Baumert (2006) distinguished between (a) structural characteristics, such as the family's wealth and educational resources, and (b) process characteristics, such as communication and cultural practices within the family. The family investment model (Conger & Donnellan, 2007) suggests that families with higher financial (e.g. income), social (e.g., occupation prestige), and human (e.g., education) capital are able to invest these resources in the development of their children, whereas families under economic pressure and lower capital have to use their resources on more immediate needs (Bradley & Corwyn, 2002). According to these theoretical perspectives, the effect of SES on children's vocabulary skills may be explained through learning materials, learning activities, the standard of living, and quality and frequency of child-directed language use (see also Hoff, 2003; Huttenlocher et al., 2010; Rowe, 2008). In line with these theoretical assumptions, educational research has supported that higher investment and a more learning-supportive family environment partly mediate the effect of SES on children's receptive vocabulary (Bradley & Corwyn, 2002; Coddington et al., 2014; Conger & Donnellan, 2007; Guo & Harris, 2000; Linberg et al., 2020; Lohndorf et al., 2018; Sohr-Preston et al., 2013).

Of the different indicators of SES (e.g., income, occupational status, education), parental education seems to be most strongly related to the children's language development (e.g., Weinert & Ebert, 2013), and in particular maternal education (e.g., Harding et al., 2015; Reardon, 2011). Parental education seems relevant for providing a cognitively stimulating environment (Akukwe & Schroeders, 2016; Guo & Harris, 2000). This effect is directly and indirectly influenced by the provision of a supportive environment that encourages learning (Davis-Kean, 2005; Froiland et al., 2013), but also by the mediating role of higher educational expectations (e.g., parental career aspirations). Parents with more education have been found to provide better learning support for their children (Akukwe & Schroeders, 2016; Hill & Taylor, 2004; Hyde et al., 2006)—for example, they offer appropriate homework support (Hoover-Dempsey et al., 2001; Lee & Bowen, 2006)—and demonstrate more personal involvement and communication (Garg et al., 2002; Lee & Bowen, 2006).

In summary, SES is a very broad constructs that does not directly transfer to children's vocabulary competence, but can be mediated by the quality and frequency of learning-related parent-child interactions. Terms that are often used to characterize such interactions are parental involvement (Hoover-Dempsey & Sandler, 1995) or the learning environment at home (or home learning environment; McNeal, 1999). The learning environment at home construct encompasses various educationally relevant activities such as playing, reading aloud, providing learning support for the child (e.g., helping with homework), and visiting museums, exhibitions, or historic sites (Lindo, 2014). Some studies suggest that parents with higher SES spend more time on such learning-related activities with their children (Hartas, 2011; Hayes et al., 2016; Tarelli & Stubbe, 2010). It has been demonstrated that parent-child learning activities positively affect children's language competence and vocabulary knowledge in the first years of primary education (Burchinal et al., 2002; Coddington et al., 2014; Kluczniok & Mudiappa, 2018; Lohndorf et al., 2018; van Steensel, 2006), pre-school literacy skills (Froiland et al., 2013), and general educational achievement (Castro et al., 2015).

1.2. Informal and formal learning environments in Germany

During early childhood, children's cognitive development is primarily guided by the family. Only around one-third of German children below the age of three attended a childcare center in March 2019

(Destatis, 2019). From ages three to five, nearly all German children attend nursery school or some type of childcare center (93%; Destatis, 2019). Childcare centers in Germany focus especially on social and emotional skills, while academic precursor skills (e.g., phonological awareness, counting, letter knowledge) are rudimentarily taught in the last year prior to schooling (p. 60 ff., ECCE study group, 1999). However, a large share of the cognitive development is placed in the informal family context (Lehrl et al., 2020). In addition, childcare centers typically reflect the demographics of the surrounding area and so may reflect educational disparities attributable to socio-economic differences between neighborhoods (Leventhal & Brooks-Gunn, 2000). It is a common finding across countries that by the time children enter elementary school, those with a lower socio-economic background have a more limited language competence and vocabulary compared to children with higher SES background (Alexander et al., 2007; Farkas & Beron, 2004; Lee & Burkam, 2002; Volodina et al., 2020).

The question arises whether elementary education exerts an equalizing effect for children with different socio-economic backgrounds. Some studies examining the development of language competencies from nursery through primary school have reported compensation effects. For example, Aarnoutse and van Leeuwe (2000) examined the longitudinal development of different reading abilities (vocabulary, reading comprehension, and spelling) in primary school. The results showed that language abilities for all students were steadily increasing, whereby initial differences evened out. This might be due to two paradoxical aims of schooling, that is, to "maximize achievement outcomes for all students while minimizing achievement variations among them" (Snow, 1989, p. 871) that are applied in everyday school life by focusing on less competent students. Similar compensation effects were reported for different facets of reading skills in several other studies (e.g., Bast & Reitsma, 1998; Baumert et al., 2012; Rescorla & Rosenthal, 2004), but not in all (e.g., Cain & Oakhill, 2011; Luyten & ten Bruggencate, 2011; Pfost et al., 2012; Volodina et al., 2020). In a comprehensive meta-analysis, Pfost et al. (2014) summarized the mixed results finding slightly more studies that reported a compensation effect, but at the same time stressing the large heterogeneity. This heterogeneity has also been reported within single studies, which found decreasing differences in educational performance during the school year due to a shared schooling environment, and subsequent increases throughout the summer break due to separate family environments (e.g., Alexander et al., 2007; Downey et al., 2004).

1.3. The present study

In this study, we examine receptive vocabulary competence in the last year of nursery school (Kindergarten; i.e., at age five) and its growth across the first three years of elementary school (i.e., up to age nine) as a function of parental occupation status, parental education and learning activities at home. Due to the study's longitudinal design at this transitional stage, we investigate effects before and during elementary school. More specifically, we examine whether differences in parental education, occupation, and learning environment at home are associated with a) the initial differences in children's receptive vocabulary competence before the beginning of elementary school, and b) with growth across the first three years of school. With respect to a potential compensatory effect of schooling, we want to examine c) whether potential differences at the beginning of school decrease across the school years.

The majority of studies that investigated the effects of SES and learning environment at home on children's language acquisition examined linear associations between the variables (e.g., linear regressions, mediation analysis). In contrast, the present study complements previous findings by additionally investigating the non-linear relationship of parental education, occupation and learning environment at home with children's receptive vocabulary competence with a recently developed method within the structural equation framework. Specifically, we employ a latent growth curve model to identify individual differences in receptive vocabulary performance in nursery school and growth from nursery school to third grade. We then use *local structural equation modeling* (LSEM; Hildebrandt et al., 2009, 2016) to study the non-linear moderating effect of parental occupation, parental education, and learning environment at home on the one hand and children's receptive vocabulary competence on the other. We compare these findings to a model in which the covariates are included as linear predictors.

2. Method

2.1. Design and participants

Data were collected as part of the *National Educational Panel Study* (NEPS, Blossfeld et al., 2011), a large-scale study aiming to describe educational processes and trajectories across the entire life span in Germany. The NEPS is a longitudinal multi-cohort study that follows six starting cohorts, including newborns, secondary school students, and adults. For this study, we used the *Starting Cohort Kindergarten* (SC2; doi: https://doi.org/10.5157/NEPS:SC2:8.0.1; Blossfeld et al., 2011). Between 2008 and 2013, the data was collected as a part of the Framework Program for the Promotion of Empirical Educational Research funded by the German Federal Ministry of Education and Research (BMBF). Beginning in 2014, NEPS was carried out by the *Leibniz Institute for Educational Trajectories* (LIfBi) at the University of Bamberg in cooperation with a nationwide network. The data used in this study can be obtained upon request and free of charge at: https://www.neps-data.de /Data-Center/Data-and-Documentation/Start-Cohort-Kindergarten /105157-NEPSSC2100

Of the 9306 German children that participated in the NEPS *Starting Cohort Kindergarten*, we selected a subsample that participated in the receptive vocabulary test across all three measurement occasions (i.e., nursery school/Kindergarten, first grade, and third grade of elementary school) and provided family background variables on at least one measurement occasion. To link vocabulary scores across measurement occasion, participation in all three was required. This resulted in a final sample size of $N = 420$ (204 female) children. The children were on average 5.26 years old ($SD = 0.32$) at the first measurement occasion, 7.26 years old ($SD = 0.32$) at the second occasion, and 9.26 years old ($SD = 0.32$) at the third measurement occasion. A total of 51 children (12.0%) had at least one parent born outside Germany, and six children were born outside of Germany (1.4%). German was not the mother tongue of 25 children (6.0%). Out of these 25 children, all but one child had at least one parent who was born outside of Germany. A representative survey of elementary school students in Germany (Rjosk et al., 2017) revealed that one third of elementary school students have a migration background, with 16.8% being second-generation immigrants (i.e., at least one parent born abroad) and 1.4% first-generation immigrants. Due to the relatively and absolutely low number of children with a migration background in this NEPS starting cohort and the sample size requirements of the methods applied, we did not include migration status as an additional moderator in our analyses. To examine whether migration status can provide a partial explanation for potential effects, we separately analyzed the correlations between the different indicators of migration status (i.e., mother, father, one parent, both parents, child born outside Germany, German as second language) and the variables used in the current analysis.

2.2. Measures

The data used in this study was collected from 2011 to 2015. Receptive vocabulary was measured in 2011, 2013 and 2015. The SES measures were updated on a yearly basis. The learning environment at home questionnaire was only administered in 2011, 2012, and 2013.

2.2.1. Receptive vocabulary

Receptive vocabulary refers to the number of words a person is able to comprehend. This competence was assessed at each measurement occasion with a word-level listening comprehension test. In more detail, in an individual testing session, children were asked to select the correct picture out of four response alternatives that best depicted a spoken word. In the NEPS Starting Cohort 2, a German research adaptation (Roßbach et al., 2005) of the *Peabody Picture Vocabulary Test* (Dunn & Dunn, 2007) was administered. The items were developed for and tested in the *Bildungsprozesse, Kompetenzentwicklung und Selektionsentscheidungen im Vorschul- und Schulalter* (BiKS; Weinert, Roßbach, et al., 2013) study and European Child Care and Education Study (European Child Care and Education Study Group, 1997). Based on the BiKS sample of 504 children aged 3 years and 10 months to 5 years and 7 months, the items with highest discrimination parameters in an IRT analysis were selected for the first measurement wave of this cohort.

The measure had an anchor test design with partly overlapping items across measurement occasions. That is, non-overlapping items were used to maintain the difficulty of the scale across school years, while mutual items were used to link the item properties across measurement occasions in order to create vocabulary competence estimates on a common scale (Kolen & Brennan, 2004). There were 77 items administered in nursery school, 66 items in first grade, and 71 items in third grade. Of these, 38 linking items were included across the first two measurement occasions, and 48 across the last two, while a total of 23 common items were used in all three occasions. As indicators of vocabulary competence, we used WLEs (*weighted likelihood estimates*, Warm, 1989) derived from a two-parameter item response theory model with linked item difficulty parameters across measurement occasions for the shared items (Haberman, 2009; Kolen & Brennan, 2004). Reliability estimates for the WLEs ranged from .82 to .86 across the three measurement occasions.

2.2.2. Socio-economic status: parental occupational status

As an indicator of parental occupational status we used the *International Socio-economic Index of Occupational Status* (ISEI-88; Ganzeboom et al., 1992), which is based on the income and educational level of different occupations. The ISEI-88 is calculated based on the ISCO-88 occupational classification system by the International Labour Office (1990), which orders occupations on a scale ranging from 16 (e.g., *household help/cleaning personnel*) to 90 points (e.g., *judge*). We compared the maternal, paternal and highest ISEI of the two parents (HISEI; Pant et al., 2013; Rjosk et al., 2017) to describe a family's available socio-economic resources. We averaged the ISEI scores across the five available measurement occasions to attain an indicator of occupation based SES across the four years. In this sample, the average maternal and paternal ISEI values were 50.64 (SD = 15.05) and 50.50 (SD = 17.99), respectively. The family HISEI was 56.52 (SD = 15.22), which is higher (d = 0.29) than for representative data from Germany in 2016 (M = 50.6; SD = 20.07; Rjosk et al., 2017).

2.2.3. Socio-economic status: parental education

As an indicator of parental education, we used the *International Standard Classification of Education* (ISCED; UNESCO Institute for Statistics, 2011). The ISCED provides information about educational attainment, comprising information on both the highest school completion certificate and the highest occupational qualification. ISCED in the NEPS studies is represented by 11 categories (in contrast to the original six), capturing the following (German) levels of education: 0 = *No certificate*; 1 = *Lower general education*; 2 = *Intermediate secondary education (Realschulabschluss)*; 3 = *University entrance qualification (Abitur)*; 4 = *Basic vocational training*; 5 = *Intermediate-level civil servants*; 6 = *University entrance qualification (adult education)*; 7 = *Basic vocational training (adult education)*; 8 = *Diploma (vocational and other academics; Master's/technician's qualification)*; 9 = *Bachelor's degree, master's degree, university diploma, official professional licensure, highest-level civil servants*,

and 10 = *Doctorate or postdoctoral qualification (habilitation)*. We compared the maternal, paternal and the highest ISCED of the two parents (HISCED) as an indicator of the family's educational level. We averaged the scores across the five available measurement occasions for the subsequent analysis. The average maternal, paternal and highest family ISCED values were 5.97 (SD = 2.45), 6.25 (SD = 2.53), and 6.79 (SD = 2.37), respectively. Of the parents, 36.2% of mothers and 32.1% of fathers reported to have basic vocational training, 13.6% of mothers and 14.0% of fathers a vocational diploma or technician's qualification, and 23.3% of mothers and 25.5% of fathers a bachelor's, master's degree or university diploma.

2.2.4. Learning environment at home

The learning environment at home was assessed with a scale developed by Melhuish et al. (2008) for the use with pre-school or elementary school children. It comprised eleven items asking parents about the frequency of joint learning-related activities (e.g., "reading aloud", "painting", "drawing", "doing crafts", "sports", "playing") on an 8-point frequency scale: 1(8) = *several times a day*; 2(7) = *once a day*; 3(6) = *several times a week*; 4(5) = *once a week*; 5(4) = *several times a month*; 6(3) = *once a month*; 7(2) = *more seldom*; 8(1) = *never* (numbers in parentheses represent reverse keyed values which we used for the current analysis). The scale was administered at the household level and filled out by one parent. We reverse-coded the responses so that higher values indicate a higher frequency of learning-related activities. To form a composite learning environment at home score, we computed the mean value across all eleven items within each of the three measurement occasions. Retest correlations across one year were r = .59 and r = .52 (all p < .001), respectively, and r = .45 (p < .001) across two years. We used the mean score across all three measurement occasions as an indicator of learning environment at home for the subsequent analysis. On average, parents reported a (reverse) mean learning environment at home of 5.47 (SD = 0.70).

2.3. Statistical analysis

The starting point for our analyses was a latent growth curve model (McArdle, 2009) quantifying individual differences in initial vocabulary performance (i.e., level) and growth (i.e., slope) from nursery school to third grade. As the indicators for the factors, we used the linked vocabulary WLEs. We included standardized age as control variables in the model. In the latent growth curve model (see Fig. 1), indicator intercepts were constrained to 0 to estimate the latent means of the intercept and slope factors. Loadings on the initial performance (intercept) factor were all constrained to 1, thus capturing stable individual differences in vocabulary competence across the measurement occasions. A model in which the factor loadings of the growth (slope) factor were constrained to 0, 1 and 2, respectively (i.e., linear growth) did not fit the data well (χ^2 (2, N = 420)= 141.2; p < .001; CFI = .799; RMSEA = .407; SRMR = .088). We thus freed the third growth factor loading to account for non-linear growth across the three measurement occasions. The model provided good fit to the data (χ^2 (1, N = 420) = 1.4; p = .235; CFI =.999; RMSEA = .031; SRMR = .008).

We then used local structural equation modeling (LSEM; Hildebrandt et al., 2009, 2016) to examine moderation effects of parental occupation, education and learning environment at home on the latent growth curve model described above. LSEM is a newly developed method within the structural equation modeling framework that allows for estimating a model at every potential value of the moderator (e.g., every level of parental education). As such, all model parameters (including factor means, correlations, and variances) can be compared across different levels of the moderators. LSEM allows for the analysis of continuous moderators by estimating the models at each level of the moderator and weighting observations within a specific range around each focal point of the moderator. More specifically, each observation is weighted according to its distance to a given focal point on the moderator (i.e., the
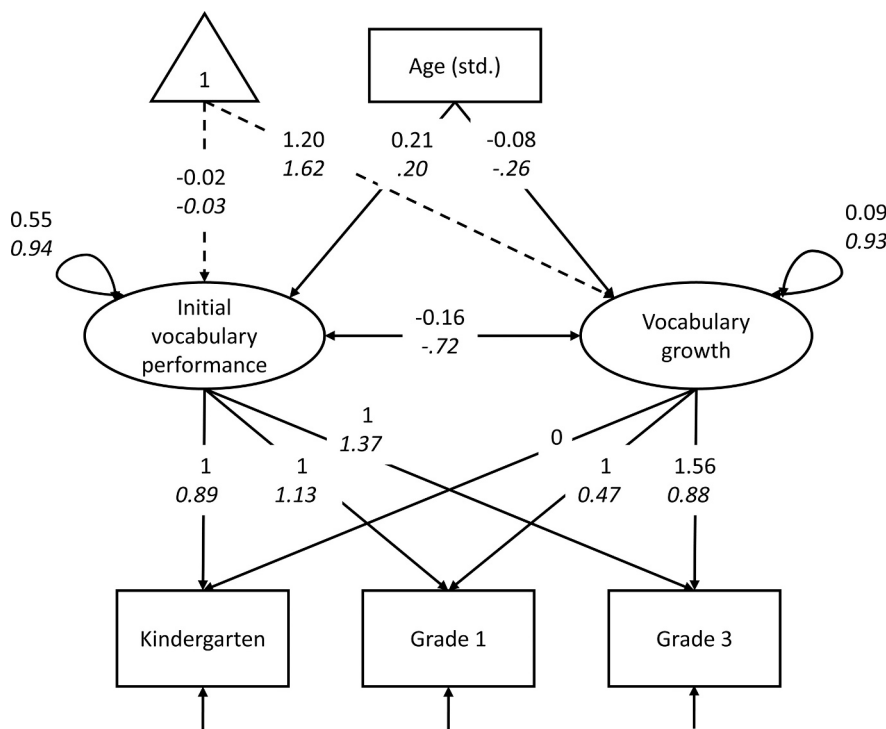
target moderator level for each model) at which the model is estimated. Sampling weights are 1 for participants with the target moderator value, and decrease symmetrically to the left and right as the distance between an observation and the focal point at which the model is being estimated increases. With this procedure, nonlinear effects of the moderator on model parameters can be examined without imposing any restrictions on the shape of the moderation effect (for more details, see Hildebrandt et al., 2016; Olaru et al., 2019). The LSEM approach goes beyond mean-level differences across the moderators (as are typically addressed in the literature) by permitting the examination of moderation effects on the variance and covariance of the vocabulary performance and growth factor. As such, investigations utilizing LSEM provide far more insight into the moderators' effects on different types of longitudinal change, such as absolute, structural, and differential change or stability (for a discussion of different types of change, see Allemand et al., 2007; Caspi & Roberts, 2001). We apply a permutation-based procedure to test the statistical significance of the nonlinear moderation effects (Hildebrandt et al., 2016; Hülür et al., 2011; Jorgensen et al., 2018). Unless otherwise stated, all moderation effects reported in the results section were significant ($p < .001$).

Analyses were conducted in the R Software for Statistical Computing (version 3.4.2; R Core Team, 2018). We used the psych package (Revelle, 2020) for descriptive statistics and correlations, the TAM package (Robitzsch et al., 2019) to obtain and link item response theory parameters across measurement occasions and calculate WLEs for each participant, and the lavaan package (Rosseel, 2012) to estimate structural equation models. To test for nonlinear associations between the latent parameters of the growth curve model and parental occupation, education, and learning environment at home, we used the functions *lsem.estimate* and *lsem.permutationTest* as implemented in the sirt package (Robitzsch, 2019). All analysis scripts and supplementary tables are available in an Open Science Foundation (OSF) repository: https://osf.io/x84fw/.

3. Results

3.1. Descriptive statistics and correlations

Table 1 summarizes descriptive statistics and correlations for vocabulary scores (i.e., WLEs linked across measurement occasions) and all background variables used in this study. In general, there was a strong increase in receptive vocabulary, with Cohen's $d = 1.22$ and $d = 0.96$ between the first and second and second and third measurement occasion, respectively. Receptive vocabulary scores were strongly correlated across measurement occasions ($r = .64$ to $.76$), indicating a stable rank order in receptive vocabulary over time. However, the variance of the receptive vocabulary scores decreased over time from $\sigma^2 = 0.74$ to 0.45 and 0.31 at the first, second and third measurement occasion, respectively (1 vs. 2: $F(1,419) = 1.63$; 2 vs. 3: $F(1,419) = 1.44$; all $p < .001$). Even though the rank order remained stable, the differences between low and high performing children decreased over time. Maternal and paternal indicators of education (ISCED) and occupation (ISEI) both correlated highly with the corresponding highest index for the family (i.e., HISEI; HISCED), with an average $r = .80$. The average correlation between vocabulary scores and highest parental, maternal and paternal occupational status (i.e., ISEI) amounted to $r = .27, .22$ and $.21$, respectively. For the parental, maternal and paternal education, the average correlations were $r = .32, .33$ and $.28$, respectively. Because of the small differences, we used the highest family indicator for the subsequent analyses. The correlation between parental occupational status and education amounted to $r = .63$ ($p < .001$), showing considerable overlap between the two indicators. The learning environment at home composite was unrelated to parental education and occupational status, as well as children's receptive vocabulary competence.

3.2. Initial receptive vocabulary and growth

The latent growth curve model indicated nonlinear growth across the three measurement occasions (see Fig. 1), with a standardized factor loading of $\lambda = 1.56$ at the third measurement occasion (i.e., third grade). The standardized mean of the growth factor was 1.58 (i.e., standardized

Table 1
Descriptive statistics and correlations of variables used in this study.

Variable	M	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11
1. WLE 1	−0.02	0.86	−3.69	2.22											
2. WLE 2	1.17	0.67	−1.11	3.09	.70***										
3. WLE 3	1.85	0.56	0.16	3.42	.64***	.76***									
4. Highest occupation	56.52	15.22	16.00	90.00	.24***	.31***	.25***								
5. Mother occupation	50.64	15.05	16.00	90.00	.17***	.28***	.21***	.76***							
6. Father occupation	50.50	17.99	19.00	88.00	.20***	.25***	.18***	.81***	.41***						
7. Highest education	6.79	2.37	1.00	10.00	.32***	.36***	.27***	.63***	.50***	.55***					
8. Mother education	5.97	2.45	0.00	10.00	.33***	.37***	.29***	.55***	.55***	.41***	.80***				
9. Father education	6.25	2.53	1.00	10.00	.30***	.33***	.21***	.60***	.42***	.63***	.84***	.55***			
10. LEH	5.47	0.70	3.50	7.18	.01	.04	.02	−.04	−.02	−.05	.01	−.05	−.01		
11. Age	5.32	0.34	4.46	7.29	.24***	.14**	.13**	−.10*	−.10*	−.09	−.07	−.04	−.07	−.03	
12. Gender (f)	m = 213	f = 204			−.06	.03	−.02	.03	.06	.06	.00	.02	.01	.09	−.10*

Note. WLE = Linked weighted likelihood estimates of receptive vocabulary from a two-parameter item response theory model; occupation = parental *International Socioeconomic Index of Occupational Status* (ISEI); education = parental *International Standard Classification of Education*; highest = highest of both parents; LEH = Learning environment at home.

* *p* < .05.
** *p* < .01.
*** *p* < .01.

by the standard deviation of the initial performance factor), indicating that receptive vocabulary competence increased by over one and a half standard deviations between nursery school and first grade and close to one standard deviation between first and third grade. The growth in receptive vocabulary was negatively correlated with baseline performance ($r = -.67$; $p < .001$), suggesting that initially lower-performing children experience stronger gains in vocabulary compared to initially better-performing children. Despite this steeper growth among lower-performing children, the variance in the growth factor was small compared to the variance of the initial performance factor ($\sigma^2_{Growth} = 0.09$; $\sigma^2_{Performance} = 0.55$). This illustrates that inter-individual differences in receptive vocabulary competence decrease across the course of the assessment, but the rank order remains relatively stable (see also Table 1).

3.3. Linear relationships between receptive vocabulary and background variables

We included parental occupational status, education, learning environment at home, and children's age (control variable) as linear predictors of initial vocabulary performance and growth. We also modeled the indirect effects of parental education through occupational status and learning environment at home as well as the indirect effects of

occupational status and education through learning environment at home. The regression parameter estimates can be found in Table 2 (for models based on maternal and paternal education, please see OSF Table 1). Apart from children's age, parental education was the only significant predictor of vocabulary performance (standardized $\beta = .35$; $p = .001$) and growth (standardized $\beta = -.35$; $p = .009$). Most notably, occupational status had no substantial association with initial receptive vocabulary performance and growth when education was included as an additional covariate (compare to the zero-order correlations in Table 1). Instead, the relation between occupational status and children's language competence can be mostly explained by the educational aspects related to occupational status (occupational status predicted by education: standardized $\beta = .62$; $p < .001$). Parental education had a moderate positive relationship with children's initial receptive vocabulary, but it was also associated with lower rates of growth. This can be explained by the large negative correlation between performance and growth (i.e. initially better performing children increasing less on the receptive vocabulary scores). Nevertheless, the unstandardized regression weight of parental education on children's vocabulary growth (unstandardized B = −0.04) was relatively small compared to the positive weight on initial vocabulary performance (unstandardized B = 0.11). As both factors are represented on the same metric, this suggests that the initial differences are partly maintained across the four years, which is also supported by

Table 2
Linear associations between family background and receptive vocabulary performance and growth.

Outcome	Predictor	Estimate	CI 95%	*p*-Value	Std. estimate
Parental occupational status	Parental education	4.025	[3.545; 4.505]	<.001	.626
Learning Environment Home	Parental education	0.017	[−0.018; 0.052]	.344	.059
	Parental occupational status	−0.004	[−0.010; 0.002]	.213	−.078
RV performance	Parental education	0.109	[0.070; 0.148]	<.001	.346
	Parental occupational status	0.006	[0.000; 0.012]	.075	.114
	Learning Environment Home	0.028	[−0.076; 0.132]	.601	.026
	Standardized age	0.647	[0.431; 0.863]	<.001	.294
RV growth	Parental education	−0.041	[−0.063; −0.019]	<.001	−.353
	Parental occupational status	0.000	[−0.004; 0.004]	.790	.024
	Learning Environment Home	−0.001	[−0.056; 0.054]	.971	−.003
	Standardized age	−0.257	[−0.371; −0.143]	<.001	−.315

Note. CI 95% = 95% confidence intervals; *p*-value = significance value; RV = children's receptive vocabulary; Parental occupation (HISEI) = highest parental *International Socioeconomic Index of Occupational Status*; Parental education (HISCED) = highest parental *International Standard Classification of Education*.

the high rank-order stability (r = .64 to .76) of receptive vocabulary scores across measurement occasions (see Table 1).

3.4. Nonlinear relationships between vocabulary acquisition and background variables

The regression model only examined linear relationships between the background variables and initial performance and growth in receptive vocabulary. To overcome this limitation, we used LSEM to study nonlinear moderating effects on all model parameters. Fig. 2 illustrates the effect of parental occupation, education, and learning environment at home on initial receptive vocabulary performance and growth. Overall, initial vocabulary competence increased across parental education and occupational status, but not the learning environment at home composite used in this study. The increase was not perfectly linear, but only occurred for below-average parental education (i.e., up to a HISCED = 7) and occupational status (i.e., up to a HISEI = 50). This suggests that differences in educational and occupational background are more strongly related to differences in receptive vocabulary competence in the lower spectrum of parental education and occupation. Children from parents with lower educational qualifications or less prestigious occupations had lower scores compared to their peers from average to highly educated families, with a strong absolute standardized effect size of about d = 0.80 and 0.85 across the examined range of educational and occupational levels, respectively. In contrast, the linear approximation only suggested a moderate effect size due to the actual underlying curvilinear pattern (see Fig. 2). Children from less educated families also showed higher growth in the receptive vocabulary over the course of elementary school. However, compared to the initial differences, differences in growth were small (e.g., an absolute effect size of d = 0.24 and 0.25 across the examined educational and occupational levels, respectively). This may also represent a ceiling effect in the initial measurement of receptive vocabulary competence, as the test administered on the first measurement occasion was comparatively easy (i.e., a median of 71% and maximum of 94% correctly solved

items at the first measurement occasion).

3.5. The unique effect of parental occupational status

Because the association between occupational status and receptive vocabulary was attenuated when accounting for shared variance with education in the regression approach, we also wanted to examine whether occupational status would be a significant moderator in LSEM after controlling for education. To do so, we removed the education-related variance in occupational status by partialing out the HISCED from the HISEI (according to the rationale that education is an antecedent of occupation). Education explained about 39% of the variance in occupational status. Conversely, 61% of inter-individual differences in occupational status could not explained by education. Nonetheless, the LSEM analyses with residualized occupational status as a moderator demonstrated that the association with vocabulary competence disappeared when correcting for educational aspects (Fig. 3), supporting our previous findings with the regression based approach.

3.6. Exploratory analyses

3.6.1. Learning environment at home

Contrary to expectations, we did not find a significant association between the learning environment at home and children's receptive vocabulary skills. One potential reason is that the measure was too broad and heterogeneous, masking potential associations of single activities relevant to vocabulary development. We thus added all eleven learning environment at home activities as covariates of the vocabulary performance and growth factors (Fig. 1), controlling for age, parental education and occupational status. The associations are presented in Table 3. Of all activities measured in the questionnaire, only *reading aloud* had a significant positive association with the receptive vocabulary performance factor (standardized β = .22; p = .001). Playing had a weak negative association with receptive vocabulary (standardized β = −.13; p = .040). Given the high p-value and large number of tests conducted,

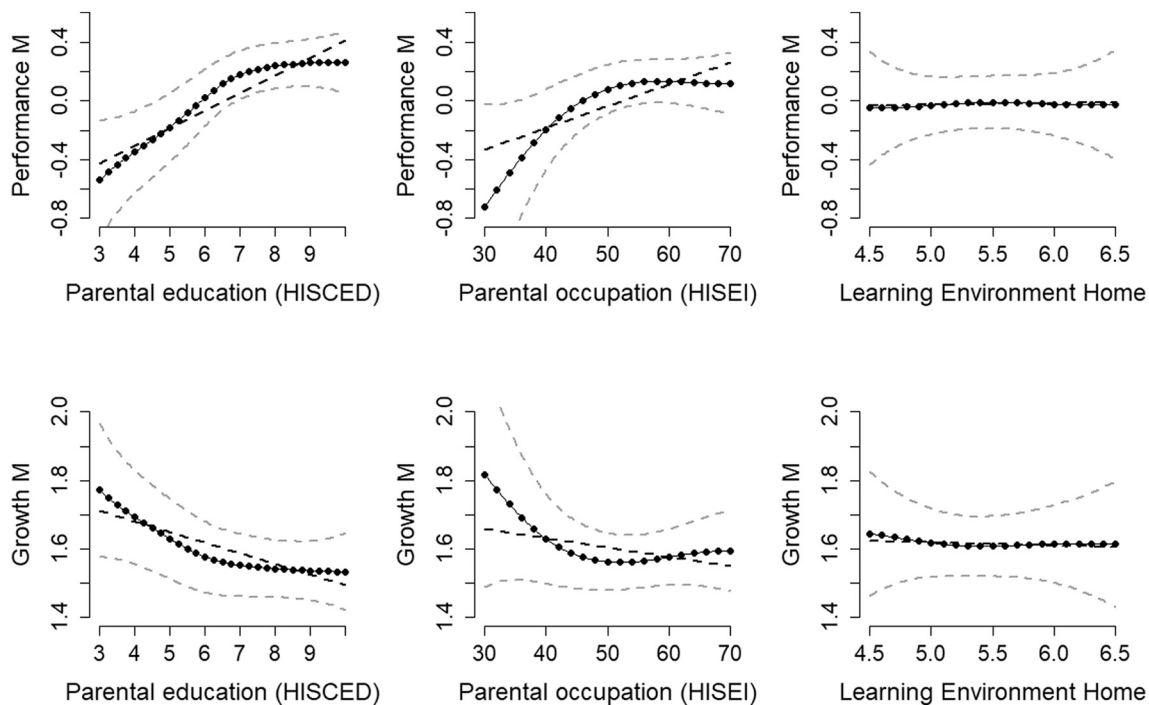**Fig. 2.** Standardized factor means of performance and growth factor in receptive vocabulary competence across parental education, occupational status and learning environment at home.

Note. The dark dots represent point estimates at focal moderator values. The dashed black line depicts the linear approximation. Dashed grey lines represent the 95% confidence interval for each point estimate.
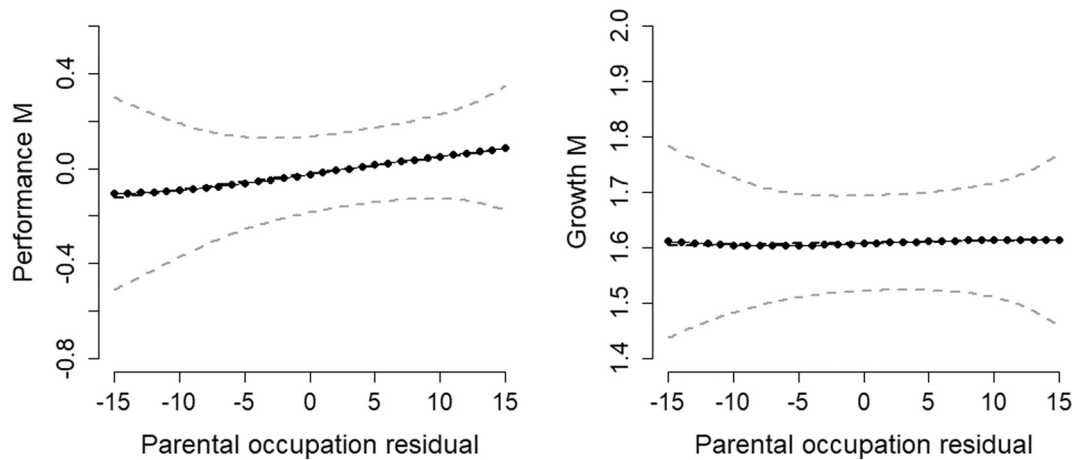
Fig. 3. Standardized means of the performance and growth factors across parental occupational status controlled for parental education.
Note. Dots represent point estimates at each moderator level. The dashed black line shows the linear approximation. Dashed grey lines represent the 95% confidence interval for each point estimate. Parental occupation residual = Residual of the regression explaining parental occupational status by parental education.

Table 3
Learning environment at home activities as predictors of receptive vocabulary performance and growth factors.

Vocabulary performance	Estimate	CI 95%	p-Value	Std. estimate
Parental education	0.099	[0.056; 0.142]	<.001	.325
Parental occupation	0.003	[−0.003; 0.009]	.394	.062
Standardized age	0.521	[0.300; 0.742]	<.001	.253
Activity with letters	0.014	[−0.055; 0.083]	.686	.027
Activity with numbers	−0.027	[−0.111; 0.057]	.533	−.042
Learning poems, rhymes, songs	−0.023	[−0.082; 0.036]	.439	−.051
Visit a library	−0.006	[−0.071; 0.059]	.847	−.011
Reading aloud	0.222	[0.095; 0.349]	.001	.222
Telling stories	−0.003	[−0.050; 0.044]	.893	−.008
Musical activities	0.021	[−0.030; 0.072]	.414	.050
Painting, drawing, doing crafts	0.021	[−0.055; 0.097]	.597	.035
Sport activities	0.006	[−0.061; 0.073]	.858	.011
Playing	−0.093	[−0.181; −0.005]	.040	−.134
Playground/park	0.032	[−0.041; 0.105]	.380	.051

Vocabulary growth	Estimate	CI 95%	p-Value	Std. estimate
Parental education	−0.041	[−0.065; −0.017]	<.001	−.396
Parental occupation	0.001	[−0.003; 0.005]	.775	.032
Standardized age	−0.232	[−0.348; −0.116]	<.001	−.334
Activity with letters	−0.015	[−0.050; 0.020]	.424	−.082
Activity with numbers	−0.007	[−0.050; 0.036]	.746	−.034
Learning poems, rhymes, songs	0.021	[−0.010; 0.052]	.178	.138
Visit a library	−0.007	[−0.040; 0.026]	.684	−.036
Reading aloud	−0.031	[−0.098; 0.036]	.363	−.091
Telling stories	−0.010	[−0.035; 0.015]	.453	−.072
Musical activities	−0.015	[−0.040; 0.010]	.280	−.103
Painting, drawing, doing crafts	−0.003	[−0.042; 0.036]	.875	−.016
Sport activities	−0.006	[−0.041; 0.029]	.754	−.030
Playing	0.038	[−0.009; 0.085]	.110	.161
Playground/park	0.009	[−0.028; 0.046]	.640	.042

Note. Cl 95% = 95% confidence intervals; *p*-value = significance value; RV = children's receptive vocabulary; Parental occupation (HISEI) = highest parental *International Socioeconomic Index of Occupational Status*; Parental education (HISCED) = highest parental *International Standard Classification of Education*.

we assume that this may only represent a spurious correlation that may not generalize across samples. All activity items correlated positively among each other (average $r = .20$; Cronbach's $\alpha = .72$; for correlations

see OSF Table 2).

3.6.2. Immigration status

We next examined how immigration status was correlated with the receptive vocabulary scores, parental education and occupation, as well as learning environment at home (see Table 4). With exception of whether the child was born outside Germany, which only applied to six children, all migration variables showed small to moderate negative associations with vocabulary scores, parental occupational status and education. The magnitude of the correlations did not depend on whether at least one or both parents were born outside Germany. The mother tongue of the child (non-German: $N = 25$) yielded the strongest associations, with an average $r = -.38$ with the receptive vocabulary scores, $r = -.22$ with parental occupational status, and $r = -.33$ with parental education.

4. Discussion

In this study, we examined differences in children's receptive vocabulary from Kindergarten throughout elementary school and their association with parental education, occupational status and learning environment at home. We applied latent growth curve modeling to differentiate between initial levels of receptive vocabulary competence at school entrance as well as growth across the examined time range. Furthermore, we compared maternal, paternal and family-level indicators of education and occupational status and studied linear and non-linear associations in a structural equation modeling context.

Our first research question was whether initial differences in receptive vocabulary competence were associated with parental education, occupation, and learning environment at home. We found that the highest parental educational index explained around 12.0% of the variance in children's receptive vocabulary skills, which is similar to previous findings on the association between vocabulary and SES (Burchinal et al., 2002; Coddington et al., 2014; Huston et al., 2005; Huttenlocher et al., 2010; Rowe, 2008; Volodina et al., 2020). The explained variance was slightly larger for maternal (11.0%; see OSF Table 1) than paternal education (8.6%), supporting the notion that maternal education is particularly relevant (Harding et al., 2015; Reardon, 2011). However, the slightly larger explained variance (12.0%) of the highest parental index suggests that it may provide a more adequate representation of the family's educational capital. One of the key findings of this study is that parental education fully explained the relationship between occupational status and children's receptive vocabulary competence from nursery school to third grade. This

Table 4
Frequencies and correlations between immigration status and variables used in this study.

Born outside Germany	No	Yes	WLE 1	WLE 2	WLE 3	Highest occu.	Mother occu.	Father occu.	Highest education	Mother education	Father education	LEH
Mother	379	38	−.33***	−.27***	−.22***	−.19**	−.17*	−.10	−.33***	−.36***	−.27***	0.06
Father	360	39	−.39***	−.30***	−.28***	−.17*	−.09	−.15	−.32***	−.28***	−.34***	0.12
One parent	345	51	−.38***	−.28***	−.24***	−.17*	−.12	−.13	−.32***	−.33***	−.32***	0.09
Both parents	373	23	−.34***	−.28***	−.26***	−.17*	−.12	−.13	−.33***	−.31***	−.30***	0.10
Child	414	6	−.12	−.05	−.05	.01	.05	.00	−.18**	−.16*	−.15	0.07
German second language	389	25	−.44***	−.37***	−.34***	−.22***	−.14	−.19**	−.33***	−.31***	−.35***	0.02

Note. WLE = Linked weighted likelihood estimates of receptive vocabulary from a two-parameter item response theory model; occu. = occupation (*International Socioeconomic Index of Occupational Status*); education = *International Standard Classification of Education*; highest = highest of both parents; LEH = Learning environment at home.

* $p < .05$.
** $p < .01$.
*** $p < .01$.

suggests that the human capital (Conger & Donnellan, 2007) of a family is particularly relevant for children's receptive vocabulary development. We do not know which environmental or hereditary factors within the family are responsible for these effects. Both differences in the environment and genes contribute to the observed differences in receptive vocabulary, but the strength of the associations seems to vary across levels of socio-economic status (e.g., higher heritability of intelligence in families with higher socio-economic status; Harden et al., 2007; Rowe et al., 1999; Turkheimer et al., 2003). Apart from the heritability of cognitive abilities or other traits relevant to learning (Krapohl et al., 2014), potential transmission processes of parental education on children's vocabulary development may be, among others, the complexity of language used when communicating with the child (Huttenlocher et al., 2010) and the quality of cognitively stimulating activities (Harding et al., 2015). The non-linear moderation analysis has shown a strong difference in children's receptive vocabulary competence at the beginning of school in the lower spectrum of educational background, whereas we found no differences between families with an advanced educational degree (e.g., vocational diploma, master's/technician's qualification, university degree, high-level civil servants, doctorate). Interventions aimed at increasing parental education (e.g., Gennetian et al., 2008) may thus provide the strongest benefit for families with particularly low educational levels.

Contrary to previous studies, we did not find an association between the learning environment at home and parental education or children's receptive vocabulary (Coddington et al., 2014; Kluczniok & Mudiappa, 2018; Linberg et al., 2020; Lohndorf et al., 2018; Melhuish et al., 2008; Weinert & Ebert, 2013). We found that only the activity of reading aloud was related to initial differences, explaining around 4.9% of the differences after controling for parental education. The number of books in the household has been shown to explain the variance in academic vocabulary competence in elementary school children beyond the parental education alone (books: 20%; parental education: 17%; Volodina et al., 2020), and reading books together has been reported to facilitate vocabulary acquisition and early literacy skills (Ewers & Brownson, 1999; Scarborough & Dobrich, 1994; Sénéchal, 2006). Reading together thus seems to provide a compensatory mechanism to reduce disparities at the beginning of elementary school. Potential reasons for the smaller effect size in our study might be that the self-report frequency scales did not differentiate well across the actual underlying differences in the amount and in particular the quality of these activities. The positive correlations among all indicators may suggest a general engagement level in parent-child activities, but also inter-individual differences in the usage of the response scale (e.g., acquiescent responding). A more objective measurement of learning environment at home is needed in future replications to potentially identify more pronounced effects.

Our second and third research question were whether the growth in children's receptive vocabulary is associated with the family background, and whether initial differences in receptive vocabulary decreased during elementary school. The negative correlation between initial levels and growth, as well as the decreasing variance in the vocabulary scores across time, support the notion that school provides an equalizing effect on children's receptive vocabulary (see also, Pfost et al., 2014). The negative association between parental education and growth also shows that the initial differences due to educational background also decreased across elementary school. Arguably, children with initially lower receptive vocabulary competence profit most from the schooling environment.

In contrast to elementary school, attending nursery school (Kindergarten) is not compulsory in Germany, and inter-individual differences due to family background were particularly large at the beginning of elementary school. The German tracked school system has a relative early separation of ability groups into different school paths (i.e., starting in Grade 5), which may further increase the initial differences in educational outcomes. Elementary school is thus particularly relevant for the educational trajectory of students in Germany. However, even though we found that the differences in vocabulary competence decreased during the first years of school, the rank-order stability remained high, and differences in growth were smaller than initial differences. The unstandardized effect of parental education on initial differences was also more than twice as high as the negative effect on growth, suggesting that schooling may reduce initial differences in receptive vocabulary among children of different educational backgrounds, but not fully overcome them. The genetic influence on cognitive abilities or traits relevant to learning (Krapohl et al., 2014), as well as informal learning after school or during the summer break (Alexander et al., 2007; Downey et al., 2004), may be some of the reasons why these initial differences are maintained.

4.1. Limitations and future research

The first limitation of this study was the exclusive reliance on receptive vocabulary as the sole indicator of vocabulary competence. Moreover, the vocabulary measure for the first measurement occasion was relatively easy. This skewed measurement of receptive vocabulary competence may have reduced estimates of the true effect size, or actual differences in receptive vocabulary skills within the higher spectrum of parental education might not have been captured by the administered test. Additional measures of vocabulary or language competence, such as expressive vocabulary, would also have been desirable, but were not available in the analyzed panel data.

Our second limitation refers to the covariates used in this study. The measure of the learning environment at home was both highly subjective due to the self-reported nature of the assessment and limited with respect to language-related activities. Similarly, the other moderators used in this study (i.e., ISEI and ISCED) only provide approximation of

the true underlying differences in human (i.e., education), social (i.e., occupational prestige) and financial (i.e., income, wealth) capital between families. These measures are no causal entities in themselves, but are related to the processes that drive the found associations between SES and receptive vocabulary instead. We thus examined the associations with children's receptive vocabulary at a descriptive level, but further research is needed to uncover the processes through which parental education affects this outcome (e.g. Conger et al., 2010; Harding et al., 2015). The occupational status index (ISEI-88) available in the dataset at the time of the analysis was also based on the occupational status of the professions in 1988 (Ganzeboom & Treiman, 1996), and might have provided an outdated evaluation of occupational status. Furthermore, we did not include household income as an indicator of financial capital because it was only assessed at the first measurement occasion and only available for 335 participants. A sensitivity analysis in which income was additionally added as a covariate of the receptive vocabulary performance and growth factor yielded no significant associations (see OSF Table 3).

Third, due to a lack of three measures of vocabulary skills for the majority of the panel study sample, the overall sample size used in this study was comparatively small, in particular with respect to a low number of children with migration background. In our sample, only 25 of children did not speak German as their first language, six children were born outside of Germany, and 51 children had at least one parent who was born outside of Germany. Accordingly, we were not able to incorporate migration background as an additional moderator into our analysis. Our additional analyses have shown that migration status was related to both receptive vocabulary competence and parental education and occupational status, providing a partial explanation for the found association between receptive vocabulary and educational background at the overall sample level. A replication examining whether the association between parental education and vocabulary competence is similar within the group of children with and the group without migration background is required to further understand the role of parental education in children's language development. Within the group of children with migration status, several additional moderators are relevant for the vocabulary development of the children, such as the language spoken at home, the time when parents or children moved to Germany, or the time children learned German as a secondary language.

4.2. Conclusion

In this study, we investigated the linear and nonlinear relationships between parental education, occupational status and learning environment at home with children's receptive vocabulary over the first years of education in Germany. Differences in parental education were moderately (linear effect) to strongly (non-linear effect) associated with children's receptive vocabulary at the start of school. Similar effects were found for parental occupational status, but the associations vanished after controlling for parental education. Initial differences in children's receptive vocabulary decreased over the course of elementary school, but rank-orders remained relatively stable across time. With the exceptions of the small effect size of reading aloud, we found no effect of learning environment at home on children's receptive vocabulary, which might be attributed to issues in the measurement of this construct.

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Declaration of competing interest

We have no conflicts of interest to disclose.

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