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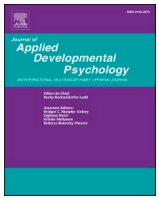

Relationships between bilingual exposure at ECEC and vocabulary growth in a linguistically diverse sample of preschoolers

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ABSTRACT

Earlier work has shown that bilingual Early Childhood Education and Care (ECEC) has positive effects on children's development of the minority language, and does not negatively impact on their development of the majority language. However, past studies leave unclear if these effects remain if home language exposure is taken into analysis. This study examines the effects of bilingual exposure at ECEC on vocabulary development in a linguistically diverse sample of 584 two- to four-year-old children attending bilingual (Dutch-English) ECEC in the Netherlands, taking into account the amount of exposure children received to Dutch and English at home. Latent Growth Modeling analyses showed that the amount of exposure to the non-majority language (English) at ECEC was positively related to children's growth of English receptive and expressive vocabulary. Amount of exposure to the majority language (Dutch) at ECEC did not bear significant relationships with growth of Dutch receptive and expressive vocabulary. The strengths of the relationships between the amount of Dutch and English exposure at ECEC and vocabulary development did not differ between two child groups depending on whether they were exposed to Dutch or English at home. Taken together, these results corroborate earlier effects of bilingual ECEC from small-scale studies for a larger sample, and indicate that these effects may remain if differences in home language exposure are taken into consideration.

The amount of exposure children receive in a given language is positively associated with their abilities in this language (Hoff et al., 2012; Paradis, 2011; Thordardottir, 2011). Earlier research has focused on effects of language exposure at home, through children's caregivers (Hoff et al., 2012; Unsworth, Brouwer, de Bree, & Verhagen, 2019) and, to a lesser degree, siblings (Bridges & Hoff, 2014). However, in many parts of the world, children also spend time at daycare or preschool from a young age onward. Such daycare or preschool programs are commonly referred to as Early Childhood Education and Care (ECEC) and attended by children aged between zero and six years. ECEC attendance has been found to be positively associated with children's development in various cognitive and socio-emotional domains, including language development (Dickinson & Porche, 2011; Leseman et al., 2017; NICHD Early Child Care Research Network, 2005).

The majority of studies examining the effects of ECEC on children's language development have focused on programs in which one language is used (Burchinal et al., 2014; Dickinson & Porche, 2011). However, ECEC programs in which more than one language is spoken by teachers are increasingly common, at least in Europe and the US (European Commission, 2012). Earlier research has demonstrated that such bilingual programs do not impede children's development of the majority language and may foster development of the other language, which can either be a minority language that children are also exposed to at home (Bialystok, 2016) or a foreign language (Thieme, Hanekamp, Andringa, Verhagen, & Kuiken, 2021).

What remains unknown, however, is how the language exposure children receive at home relates to effects of bilingual ECEC on language development. In some earlier studies, children from heterogeneous language backgrounds were examined without taking into account differences in home language exposure (Boyd & Ottesjö, 2016). In other studies, specific groups of children were excluded depending on their home language situation (Bergström, Klatte, Steinbrink, & Lachmann, 2016; Ferjan Ramírez & Kuhl, 2017, 2020). In the current study, we examined the effects of Dutch-English ECEC on language development

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in a sample of children who varied greatly in the exposure they received to Dutch and English at home. Our aim was to see whether the effects of bilingual ECEC would remain when effects of home language exposure were taken into account.

Bilingual ECEC and children's language development

Genesee (2004) defined bilingual education as "education that aims to promote bilingual (or multilingual) competence by using both (or all) languages as media of instruction for significant portions of the academic curriculum" (p. 458). Although this definition involves education rather than care, it can be applied to ECEC as well, where both languages are then used during care and educational activities. Bilingual ECEC programs come in all shapes and sizes. Some programs expose children to an additional (minority) language they are also exposed to at home, such as English-Spanish programs targeting children from Spanish-speaking homes in the US. Other programs expose children to a foreign language that children do not speak at home, such as German-English programs in Germany. These two types of programs typically differ in their aims: whereas minority language programs are aimed at fostering development of the majority language by using children's abilities in the minority language as a stepping stone (alongside maintaining and fostering the minority language), foreign language programs are aimed at fostering bilingualism in majority language children (Christian, 2016). Apart from differences in targeted populations and aims, bilingual programs also often differ in more practical aspects, such as how languages are implemented (e.g., one-teacher-one-language, set moments for each language) and whether a curriculum is used.

This enormous diversity in programs has led some to argue that effects are tied to specifics of the programs and their populations, such that studies performed in one context bear little relevance to another (Baker, 2011; Garcia, 2011). However, it appears that findings are strikingly uniform across studies, at least for the majority language. Children attending bilingual ECEC have been found to develop proficiency in the majority language at a similar rate as children attending majority language only ECEC (for reviews, see Bialystok, 2016; Thieme et al., 2021). For the non-majority language, previous studies have also found positive effects (Bergström et al., 2016; Buysse, Peisner-Feinberg, Páez, Hammer, & Knowles, 2014; Farver, Lonigan, & Eppe, 2009; Ferjan Ramírez & Kuhl, 2020; Stipek, Ryan, & Alarcón, 2001), although effects are typically small and confined to receptive proficiency if children are exposed to this language through ECEC only (Thieme et al., 2021).

A study that found positive effects of bilingual ECEC on both languages was conducted by Farver et al. (2009), who compared English and Spanish development in four-year-old children from Spanish-speaking families in the US who attended either a bilingual Spanish-English program ($N = 94$) or an English-only program ($N = 31$). The two groups did not differ in performance on standardized tests of English language and literacy, but the Spanish-English group showed greater gains in Spanish language and literacy abilities than the English-only group. For slightly younger Spanish-speaking children between 38 and 48 months ($N = 31$) who attended English-Spanish or predominantly English education, Durán, Roseth, Hoffman, and Robertshaw (2013) found that children in bilingual education developed Spanish language skills more quickly than children in English education, with no costs to English development (for an overview of other studies on Spanish-English children, see Durán & Wackerle-Hollman, 2018). Similarly, Schwartz (2013) found that four-year-old children who attended bilingual Russian-Hebrew ($N = 31$) as opposed to Hebrew-only programs ($N = 20$) in Israel developed vocabulary knowledge in Hebrew at the same rate over the course of a year as children in the Hebrew-only programs, but attained higher proficiency levels in Russian.

Studies in which the non-majority language was a foreign language – a language that children were not exposed to at home – found similar effects. Bergström et al. (2016), for example, examined two- to six-year-old children from German families who attended German-English ECEC where English was spoken half of the time ($N = 27$) or for half an hour a week ($N = 27$). Receptive and expressive vocabulary and grammar development were assessed at four time points over the course of two and a half years. The authors found that German vocabulary and grammar development did not differ between the groups and that English receptive vocabulary and grammar developed faster in the German-English ECEC group. Furthermore, the amount of time English was spoken correlated with children's English proficiency at two out of the four time points. The authors concluded that bilingual ECEC is a successful method for early foreign language learning without any costs for children's first language.

Even with low degrees of exposure to a foreign language at ECEC, positive effects on children's development of the foreign language have been attested, already in very young children. Ferjan Ramírez and Kuhl (2017) compared 7- to 33-month-old Spanish-speaking children attending an ECEC intervention group receiving one hour of English per day ($N = 126$) and a comparison group receiving two hours of English per week ($N = 124$). English and Spanish receptive vocabulary were assessed at the beginning and end of the 18-week intervention. The study showed that gains in English receptive vocabulary were higher in the intervention group than in the comparison group. There were no differences in Spanish receptive vocabulary gains (for similar results in a 36-week intervention study, see Ferjan Ramírez & Kuhl, 2020).

Thus, the picture that emerges from earlier research is that children in bilingual ECEC develop majority language proficiency at the same rate as children in monolingual ECEC (Barnett, Yarosz, Thomas, Jung, & Blanco, 2007; Schwartz & Shaul, 2013). Amount of exposure to the majority language does not seem to play a major role (Bergström et al., 2016; Javorsky & Moser, 2021). Regarding the minority language, earlier research shows positive effects (Bialystok, 2016; Thieme et al., 2021), even though foreign language ECEC may foster children's receptive abilities only (Bergström et al., 2016; Łockiewicz, Sarzała-Przybylska, & Lipowska, 2018; Rohde, 2010). Although results in studies on bilingual ECEC may have been compromised by the small samples and limited time spans examined, their results concord with those of studies on school-aged children that found that students in bilingual education developed abilities in the majority language at the same rate as children in majority language only education (Padilla, Fan, Xu, & Silva, 2013). Some of these studies used growth modeling to analyze not only students' initial and end levels, but also their growth trajectories. Using this type of analysis, Uchikoshi (2014) found, for instance, that Spanish- and Cantonese speaking children in bilingual programs started with lower levels of English receptive vocabulary but developed English receptive and expressive vocabulary from kindergarten to second grade at the same rate as children in English-only programs. This study also showed that children in the bilingual programs developed receptive vocabulary in the home language (Spanish or Cantonese) at a faster rate. Likewise, Preusler, Zitzmann, Baumert, and Möller (2022) observed that children in bilingual German-English schools showed the same reading comprehension level and developed at the same rate from fourth to sixth grade as students in German-only instruction, while having the advantage of learning an additional language.

The role of children's home language(s)

Bilingual ECEC – and in particular foreign language ECEC – often attracts parents from diverse language backgrounds whose children speak the foreign language or other languages instead of or alongside the majority language at home (Boyd & Ottesjö, 2016; Buyl & Housen, 2014; Ferjan Ramírez & Kuhl, 2017, 2020). Earlier studies on foreign language ECEC have typically collapsed children in the analyses irrespective of home language background (e.g., Boyd & Ottesjö, 2016) or limited the analyses to children from majority language only families (Bergström et al., 2016; Ferjan Ramírez & Kuhl, 2017, 2020). Ferjan Ramírez and Kuhl (2017, 2020), for example, excluded children if they

were from families that did not have at least one native speaker of the majority language (Spanish). This makes it difficult to determine to what extent previously attested effects of bilingual ECEC on dual language development are independent of home language exposure.

Very few studies have examined how the exposure children receive to the ECEC languages at home relates to effects of bilingual ECEC on language development. There are indications, however, that effects of bilingual ECEC – both minority language and foreign language ECEC – may differ for children depending on whether they are exposed to the ECEC languages at home. Barnett et al. (2007) examined language abilities in three- and four-year-old children who participated either in Spanish-English ($N = 85$) or English-only ($N = 62$) programs. About half of the children in the bilingual program spoke primarily Spanish at home, about one third spoke primarily English, and the remaining children spoke primarily another language. The authors found that children in the bilingual program showed faster development of Spanish receptive (but not expressive) vocabulary than children in the English-only program, with the largest gains for children who were mainly exposed to Spanish at home. This suggests that children who received exposure in the minority language at home and thus had well-developed abilities in this language benefited most from exposure to this language at ECEC. Exposure to the majority language at home might also matter, as suggested by Lugossy (2018) in an observational study on two Hungarian-English ECEC centers in Hungary attended by 36 children who spoke only Hungarian, Hungarian and another language, or mainly another language (e.g., Chinese). In this study, children who were not exposed to Hungarian at home developed English faster than children who were exposed to Hungarian at home. The author suggested that children's low levels in Hungarian resulted in a higher need to speak English: since children could not fall back on Hungarian, they developed English faster.

Not all studies found that effects of bilingual ECEC were modulated by home language exposure, however. Javorsky and Moser (2021) investigated French language development in twelve three-year-old children from diverse language backgrounds attending an English-French ECEC center in the US. Half of the children were exposed to another language than English at home, either alongside English or as the sole language. The authors found that all children acquired some French and that whether or not children were from English-only homes did not correlate with their scores in French. However, no firm conclusions can be drawn from this study, since exposure to French was relatively short, with a weekly 30- to 60-minute French class during 10 weeks and the sample contained twelve children only. Rohde (2010) analyzed receptive vocabulary data from 200 three- to six-year-olds attending ECEC centers in Germany, Sweden and Belgium in which English was spoken as an additional language alongside German, Swedish or French. The results showed no differences in English receptive vocabulary gains between a subgroup of 36 children who were not exposed to the majority language (i.e., German, Swedish or French) at home and the remaining children. Finally, Steinlen, Håkansson, Housen, and Schelletter (2010) – who analyzed grammar data from 22 children in a subsample from Rohde ($N = 148$) – found no indications that children who spoke another language than the majority language at home differed in grammatical development from other children. Since in all these studies, small groups of children with a non-majority small groups of children with a non-majority language background were studied (*Ns* between 12 and 36), firm conclusions do not seem warranted. In sum, few studies have examined how children's home language exposure relates to effects of bilingual ECEC. There is some initial evidence that home language exposure may modulate effects of bilingual ECEC, such that children might benefit more from exposure to a minority language at ECEC if they are exposed to this language at home (Barnett et al., 2007) or if they are not exposed to the majority language at home (Lugossy, 2018). Other studies found no differences between groups of children depending on home language background, but their samples were typically small (Javorsky & Moser, 2021; Rohde, 2010; Steinlen et al., 2010). Moreover, earlier work used rather global estimates of home language exposure, typically whether a language was spoken or not (Buyl & Housen, 2014; Lugossy, 2018; Rohde, 2010; Steinlen et al., 2010). Hence, it is currently unknown whether effects of bilingual ECEC play out differently depending on *the extent to which* children are exposed to the ECEC languages at home.

This study

We investigated receptive and expressive vocabulary development in children aged two to four years who attended monolingual Dutch or bilingual Dutch-English ECEC in the Netherlands. Children constituted a linguistically diverse group, spanning the whole monolingual-bilingual continuum with, at one end, children who were solely exposed to Dutch at home and at ECEC, and at the other end, children who were exposed to two or more languages other than Dutch and English at home and to Dutch and English at ECEC. By including both monolingual and bilingual ECEC as well as children from diverse home language environments, we aimed at obtaining a wide range of exposure to Dutch and English at home and at ECEC. Our study addressed the following question: How does bilingual Dutch-English language exposure at ECEC relate to children's development of receptive and expressive vocabulary in Dutch and English, taking into account the amount of exposure children receive to these languages at home?

Unlike many other studies on the effects of bilingual ECEC on language development, we did not compare subgroups of children in our primary analysis, but included all children. The reason for this that, by treating the exposure variables in our study as continuous, we could take all naturally occurring variation in our sample into account, with no need for arbitrary cutoff points.

Method

Participants

Participants were 30- to 53-month-old children ($N = 584$) who participated in a longitudinal study on the effects of bilingual ECEC on children's language development called Project MIND (Multilingualism in Daycare) - see also Keydeniers, Aalberse, Andringa, and Kuiken (2021). Children attended ECEC centers in the Netherlands that had volunteered to participate and had been selected by the Dutch Ministry of Social Affairs and Employment to take part in the project. They were assessed in four assessment waves that were approximately nine months apart. The current participants were selected from a larger sample ($N = 751$) if they had obtained a test score in at least one of the assessment waves on at least one of the tasks and if they were at least 30 months, the earliest age at which children were administered to all four tasks.

At each wave, all children were assessed, including children that had not been assessed in previous waves, because they were too young to be tested or had not yet enrolled at ECEC. Of all children, 294 children (50%) were assessed once, 214 children (37%) were assessed twice, 72 children (12%) participated in three assessments, and 4 children were assessed four times. This decrease in numbers was due to the short period in which children attend ECEC in the Netherlands, where they enter primary school around their fourth birthday. In addition, the COVID-19 pandemic started right before our third assessment wave, as a result of which many ECEC centers closed, and we had to abort this assessment wave.

The sample contained 300 girls (52%) out of all 581 children for whom gender was available ($N = 3$ missing). Mean age was 37.46 months at first assessment ($SD = 5.09$ months, min-max = 30–49 months). The majority of children ($N = 445$, 76%) attended bilingual ECEC where they were exposed to both Dutch and English; the remaining 144 children attended monolingual ECEC where they were exposed to Dutch only. Ten ECEC organizations participated, five of which provided both monolingual and bilingual ECEC. English was

spoken at the bilingual ECEC centers between 11% and 50% of the time, and children were exposed to English 43.41% of the time on average (*SD* = 13.94, min-max = 11–50). Average ECEC attendance was 5.90 time units per week (*SD* = 3.13), as based on a questionnaire filled out by 404 (83%) parents. These time units referred to mornings, afternoons and evenings. For example, if a child spent two mornings and one afternoon at daycare, they were considered to spend three time units at daycare. Parental education was high: 300 (74%) of the children whose parents had completed the questionnaire had parents with a university degree.

Children were from heterogeneous language backgrounds. Parent reports indicated that 171 children (42.33%) were from households in which Dutch was spoken, either as the sole language or alongside other languages; 70 children (17.33%) were from households in which English was spoken, either as the sole language or alongside other languages; 77 children (19.06%) were from families in which both Dutch and English were spoken; and 86 children (21.28%) were from families in which one or more other language(s) than Dutch or English were spoken. These other languages formed a diverse set of which German, Spanish, French, Italian, Greek and Portuguese were most frequent. Many other languages were spoken, too, including – but not limited to – Arabic, Catalan, Mandarin, Danish, Hindi, and Papiamentu.

Materials

Dutch Language Proficiency Tests

Dutch receptive vocabulary. The Dutch Peabody Picture Vocabulary Test (PPVT) was used to assess receptive vocabulary (PPVT-III-NL, Dunn & Dunn, 2005). In this test, children choose one out of four pictures after an orally presented word. The test is adaptive such that testing is stopped after a certain number of errors. For the current study, raw scores instead of standard scores were used, because standard scores are available for monolingual children only (e.g., Goriot et al., 2021).

Dutch expressive vocabulary. The Expressive Vocabulary subtest of the Dutch Clinical Evaluation of Language Fundamentals (CELF) (Preschool-2-NL, CELF-Preschool-NL, Wigg, Secord, Semel, & de Jong, 2012) was used to assess expressive vocabulary. In this test, children are asked to label a picture through a prompt (i.e., "What is this?" "What is the girl doing?"). The test is adaptive such that testing is stopped after a fixed number of consecutive errors. Raw scores of the CELF were used, since norm scores are available for monolingual children only. Although the original starting age for the test is 36 months, children were administered the task if they were 30 months or older, following earlier work (e.g., Unsworth et al., 2019).

English language proficiency tests

English receptive vocabulary

The English Peabody Picture Vocabulary Test was used to assess receptive vocabulary (PPVT-4, Dunn & Dunn, 2007). As in the Dutch version of the task, children choose one out of four pictures after an orally presented word, through an adaptive protocol. Raw scores were used, since norm scores are available for monolingual children only.

English expressive vocabulary

The Expressive Vocabulary subtest of the English Clinical Evaluation of Language Fundamentals (CELF) (CELF Preschool-2, Wigg, Secord, & Semel, 2004) was used to assess expressive vocabulary. Like in the Dutch version of the test, children are asked to label a picture through a prompt (i.e., "What is this?"). The test is adaptive such that test administration is stopped when the child makes a fixed number of consecutive errors. As for the other tests, raw scores were used, because norm scores are based on monolingual children only.

Parental questionnaire

Parents were sent an online parental questionnaire to obtain information on the language exposure children received at home. This questionnaire was programmed in the software *Easion* (Parantion, 2017), and assessed, amongst others, which language(s) children were exposed to by their main caregivers and how often these caregivers spoke these languages. It also assessed more qualitative aspects such as how often caregivers code-switched, but these variables were not analyzed for the current study. The questionnaire was constructed for the purposes of the current study but based on existing questionnaires (i.e., Bilingualism Language Exposure Calculator, Unsworth, 2013; Language Exposure Questionnaire, Cattani et al., 2014).

Dutch and English exposure at home

The amount of exposure in Dutch and English was calculated on the basis of three questions. In a first question, parents were asked which language(s) they spoke to their child, for all main caregivers separately. Then, in a second question, they were asked to indicate for each caregiver how often they used these languages with their child, in percentages. Finally, they were asked for a typical week how often each caregiver looked after their child in a detailed breakdown of week and weekend days into mornings, afternoons, and evenings. We referred to mornings, afternoons and evenings as time units. For example, if a caretaker spent the morning and the evening with a child, that caretaker spent two time units on that particular day with the child. The amount of exposure per language was then calculated by multiplying the amount of a language being reported by a caregiver and the time spent with the child by this caregiver, summed over all caregivers. The exposure estimates for situations in which two caregivers were present at the same time, were divided in half.

To illustrate this, consider the following example where caregiver 1 (e.g., father) speaks Dutch 60% and French 40% of the time, and caregiver 2 (e.g., mother) speaks Dutch 30% and English 70% of the time. A third caregiver (nanny) speaks 100% French. Caregiver 1 spends 14 mornings/afternoons/evenings with the child; caregiver 2 spends 10 mornings/afternoons/evenings with the child, with 6 time units overlapping between both caregivers. Caregiver 3 spends 7 time units per week with the child. For Dutch, then, the amount of exposure at home was calculated as follows: (% Dutch caregiver 1 * number of unique time units caregiver 1) + (% Dutch caregiver 2 * number of unique time units caregiver 2) + (% Dutch caregiver 3 * number of time units caregiver 3) + ((% Dutch caregiver 1 * number of time units overlapping with caregiver 2) + (% Dutch caregiver 2 * number of time units overlapping with caregiver 1) / 2). The amount of exposure in Dutch was the following: (60*8) + (30*4) + (0*7) + ((60*6 + 30*4) / 2) = 840. The resultant value was divided by 100, to be able to relate values to the maximum number of time units per week (7 days *3 time units = 21 time units), yielding a value of 8.40 time units in this example. Amount of exposure in English for these parents was calculated in the same way, as follows: (0*8) + (70*4) + (0*0) + ((0*6) + (70*6) / 2) = 490 /100 = 4.90 time units. Exposure to other languages was not computed for the purposes of this study.

Dutch and English exposure at ECEC

Amount of exposure at ECEC was calculated on the basis of parents' answers to the question how many time units their child spent at ECEC. Weighted estimates were then calculated for the amount of exposure in Dutch and English by multiplying the percentage of Dutch and English spoken at ECEC and the number of time units (mornings, afternoons) parents reported their child to attend ECEC. Percentages of Dutch and English at ECEC were derived as follows: 100% Dutch and 0% English for monolingual Dutch centers; 89% Dutch and 11% English for centers using English about 2 hours a day; 75% Dutch and 25% English for centers in which one teacher always spoke Dutch while the other spoke English and Dutch equally, and 50% and 50% for centers reporting a

one-teacher-one-language approach. Thus, if a child attended an ECEC center with a 75% Dutch and 25% English distribution, and was reported to spend 6 time units at ECEC, the resultant weighted estimates for Dutch and English were 75*6 = 450/100 = 4.5 units and 25*6 = 150/100 = 1.5 units, respectively.

Procedure

Children were assessed individually in a quiet room at their ECEC centers. Each child performed two sessions per assessment wave, one with the Dutch tasks and one with the English tasks. These sessions were administered by trained research assistants who were (near-)native speakers. Sessions took place one to two weeks apart, and the ordering of the sessions differed across children. Within sessions, tasks were intermixed with other tasks not reported in this study, and administered in a fixed order, in which the receptive vocabulary task (PPVT) preceded the expressive vocabulary task (CELF). Children received a sticker after each task and a small gift at the end of each session. The questionnaire was completed online. Parents were sent the same questionnaire at each assessment wave. If they had filled it out in a previous wave, their answers were already filled in at the next wave and they were instructed to only make adjustments if changes had occurred, to minimize completion time.

Analyses

To investigate how language exposure at ECEC related to children's development of Dutch and English over time, Latent Growth Modeling (LGM) was used (Duncan, Duncan, & Strycker, 2006). This technique falls within the Structural Equation Modeling framework and is used for the analysis of longitudinal trajectories. LGM allows for the inclusion of covariates that can be time-invariant (i.e., variables that do not change over time, such as gender), to predict differences between individuals, both regarding their starting level (intercept) and growth rate (slope). Two bivariate LGMs were fitted in which Dutch and English vocabulary were each modeled as latent factors. In the first, the latent factors represented Dutch and English receptive vocabulary; in the second, these factors represented Dutch and English expressive vocabulary. For each latent ability (Dutch or English), two latent factors corresponding to children's initial level (intercept) and rate of growth (slope) were estimated. The amount of Dutch and English exposure at ECEC and the amount of Dutch and English exposure at home were added as time-invariant covariates. We considered these covariates as time-invariant, given the very high correlations across waves. The conceptual model is presented in Fig. 1.

As shown in Fig. 1, four time points underlay the latent intercept and slope factors. Importantly, these time points did not correspond to the four assessment waves. Specifically, since new children were tested at each wave, these waves could not be used, since any effects of growth would be masked by the inclusion of new (and typically) younger children entering the study at each wave. Instead, four age intervals were created, each spanning six months (i.e., 30–35, 36–41, 42–47, 48–53 months), representing the four time points in the model. Six-month intervals were used to accommodate the high number of missing data in our data, because initial analyses demonstrated that models did not converge if smaller intervals were used. The use of age rather than wave in our study resembles the approach taken in a so-called cohort sequential design, in which participants of varying ages are sampled at a single time point and then followed over time. In such designs, the age of the participants defines a cohort, and the overlapping measurements of these cohorts are linked together to determine a common growth curve or developmental trend for the entire sample (Prinzie & Onghena, 2005). To make this more concrete, in our study, a child who was tested at 30 months and at 39 months contributed two data points: one for the 30–36 month interval and one for the 36–41 month interval (regardless of the waves this child was tested in).

As can be seen from Fig. 1, the intercept and slope factors were regressed on the exposure variables to investigate the relationships between these exposure variables and children's starting levels and growth rates in Dutch and English. All covariances between these covariates were estimated as well, because of selection effects in our data (e.g., children from English-speaking families were more likely to attend ECEC centers where high amounts of English were spoken than other children). Slopes were regressed on intercepts across languages (i.e., Dutch slope on English intercept, English slope on Dutch intercept) and within languages (i.e., Dutch slope on Dutch intercept, English slope on English intercept), but the covariances between these factors were only retained if significant.

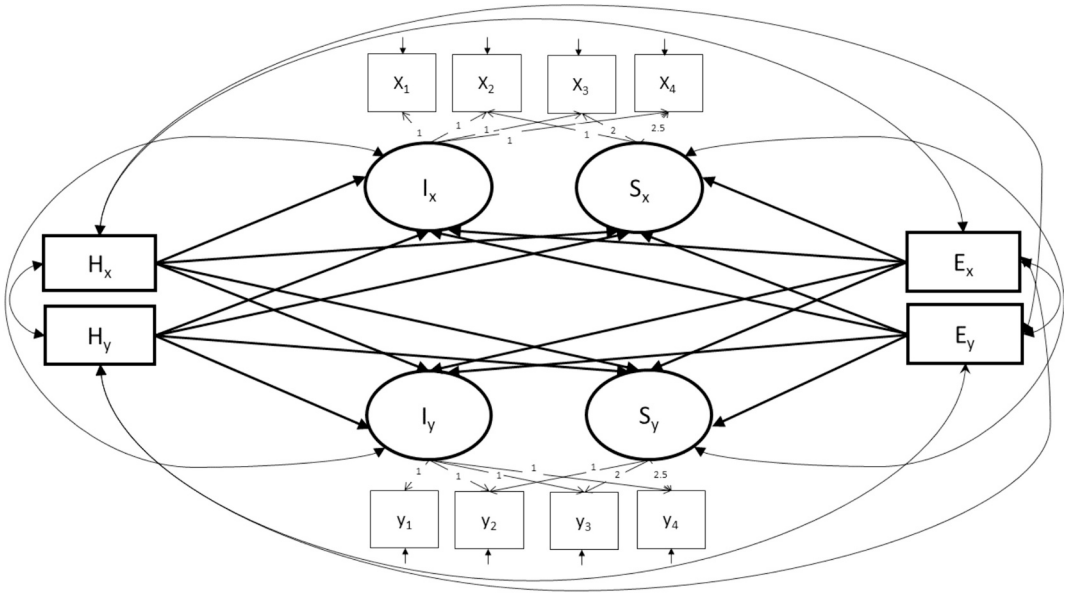

Fig. 1. Conceptual model of our bivariate Latent Growth Model.
Note. This LGM contains two variables (x, y, assessed at four age intervals) representing Dutch and English vocabulary, intercepts (I_x, I_y), slopes (S_x, S_y), and four time-invariant covariates representing home exposure (H_x, H_y) and ECEC exposure (E_x, E_y). Slope on intercept regressions across languages (i.e., S_y on I_x, S_x on I_y) and within languages (S_x on I_x, S_y on I_y), were explored, and retained if significant.

Models were fitted in Mplus version 8 (Muthén & Muthén, 1998-2017) with the default ML estimator. Regression weights for the slopes were fixed at 0, 1, 2, and 2.5, representing the time intervals between each of the assessment waves. The regression weight for the last age interval was set at 2.5 instead of 3 to accommodate the fact that most data points in this age interval were collected in the third assessment wave when ECEC centers had multiple closures due to COVID. Because many children could not be tested during this wave, less time was needed to test all the children in this wave, reducing at least on average – the time interval with the previous wave. Each factor was allowed to contain time-specific measurement error and the covariates (i.e., exposure variables) were mean-centered. Multi-level analyses were not performed because a total of ten ECEC organizations was not considered enough to warrant such analyses, for which a minimum number of 50 has been proposed (Maas & Hox, 2005).

To evaluate model fit, we took a non-significant chi-square, a Root Mean Square Error of Approximation (RMSEA) below 0.05 and a Comparative Fit Index (CFI)/Tucker-Lewis Index (TLI) above 0.90 to indicate good fit (Little, 2013). Furthermore, as chi-square is often significant with large samples, we followed Aspahourov and Muthén (2018) and considered chi-square first, and – if significant – evaluated the Standardized Root Mean Square Residual (SRMR). SRMR below 0.08 was considered as indicating good fit (Hu & Bentler, 1999). All code and output can be accessed at https://osf.io/r7w65/?view_only=2f68c4c94d1e47f38b3e6984abf8205a.

Results

Descriptive statistics

Descriptive statistics for language exposure are presented in Table 1. Recall that the exposure variables were based on caregiver reports of which languages children were exposed to as well as how much time children spent with a caregiver/at ECEC. If parents reported this information at more than one wave, estimates were averaged, which seemed warranted given the high correlations across waves for both home (*r*s: .83–.98) and ECEC exposure (*r*s: .83–.89). Table 1 shows that, on average, children were exposed to Dutch more often than to English both at home and at ECEC. There was, however, substantial variation for each estimate, as indicated by large standard deviations, especially for language exposure at home.

Descriptive statistics for receptive and expressive vocabulary at each age interval are given in Tables 2 and 3. For ease of visual inspection, these same data are also presented in Fig. 2. These results show that scores increased with age for both vocabulary tasks and both languages. English vocabulary seemed to grow less steeply than Dutch vocabulary, but note that scores cannot be compared across languages because the items in the tests were largely not equivalent. We do not present the scores by wave, because children's vocabulary growth was modeled in terms of age in the present study. However, descriptive statistics for both receptive and expressive vocabulary presented by wave can be found in Table A1 in the Appendix.

Table 1
Descriptive Statistics for Dutch and English Exposure at Home and at ECEC.

	M	*SD*	*Min-Max*	*N*
Home exposure				
Dutch	6.49	7.24	0–23.00	463
English	2.14	3.91	0–22.55	465
ECEC exposure				
Dutch	3.72	1.65	1–12.00	402
English	2.02	1.84	0–10.50	451

Note. As indicated in the text, averages were calculated if parents completed the questionnaire at multiple waves.

Relationships between ECEC exposure and Children's vocabulary development

Before we present the results of our LGM analyses for receptive and expressive vocabulary separately, we provide correlations between all variables of interest, that is, between the vocabulary scores per age interval and the exposure variables. These correlations are presented in Tables 4 and 5 for receptive vocabulary and expressive vocabulary, respectively.

Tables 4 and 5 show that, overall, the correlations between home exposure and vocabulary are positive within languages, but negative between languages: amount of Dutch exposure at home thus correlates positively and significantly with Dutch vocabulary, but negatively with English vocabulary (and the opposite pattern is found for English exposure at home). For English exposure at ECEC, a similar pattern is found, as it correlates positively with English vocabulary, but negatively with Dutch vocabulary. For Dutch exposure at ECEC, in contrast, the pattern is different: for this variable, correlations with vocabulary in both languages are negative, weak, and largely non-significant.

As we discussed before, there were interrelationships in our data, such that children from English-speaking families were more likely to visit ECEC centers where higher portions of English were spoken than children from other families. Table 6 shows the correlations across the four exposure variables. As can be seen from this table, amount of English at home indeed correlated moderately and significantly with amount of English exposure at ECEC. Also, there were weak to moderate, significant correlations between the amount of exposure to Dutch at home and the other variables, such that children with higher portions of Dutch at home were less likely to hear also much English at home and less likely to hear relatively high amounts of Dutch and English at ECEC than children with lower degrees of exposure to Dutch at home. While some of these correlations might seem counterintuitive, it is important to realize that our exposure variables were not mere percentages, but weighted estimates (i.e., percentages weighted for the time spent at home or ECEC). Hence, the negative correlation between Dutch at home and Dutch at ECEC was likely due to the fact that children who spent more time at home spent less time at ECEC, and vice versa. Also, one might think that the amount of Dutch and the amount of English at ECEC should be mutually exclusive, making a correlation close to zero as seen in Table 6 seem counterintuitive at first sight. However, thinking of the exposure variables as weighted estimates, it becomes clear that the fact that children spent varying amount of time (e.g., between 1 or 10 time units (mornings, afternoons)) at ECEC where they heard varying amounts of Dutch (50% to 100%) and English (0% to 50%), the amount of English a child was exposed to ECEC was not necessarily the mirror image of the amount of Dutch they were exposed to.

Results for receptive vocabulary

The LGM for receptive vocabulary was fitted on the data of children who had obtained at least one score on the Dutch or English receptive vocabulary tasks ($N = 581$). As shown in Fig. 3, the intercepts and slopes of the latent factors in this model were regressed on four time-invariant covariates representing Dutch and English exposure at home and at ECEC, and all covariances between the exposure variables were estimated. The model fitted the data well: $\chi^2(42, N = 581) = 88.994$, $p < .001$, RMSEA = 0.044, CFI/TLI = 0.946/0.923, SRMR = 0.070. Note that, in Fig. 3, standardized estimates are provided, and only estimates for significant paths ($p < .05$) and trend effects ($p < .075$) are included. For the full results, see Appendix A.

The estimated slope means of Dutch and English receptive vocabulary were positive, indicating that both abilities improved over time. The positive and significant covariance between the slopes of both languages ($\beta = .50$, $p = .002$) indicates, furthermore, that children who had a higher growth rate in Dutch receptive vocabulary were likely to also have a higher growth rate in English receptive vocabulary. For exposure

Table 2
Descriptive Statistics for Receptive Vocabulary Scores in Dutch and English per Age Interval.

	Dutch				English			
	M	*SD*	*Min-Max*	*N*	*M*	*SD*	*Min-Max*	*N*
30–35 months	23.96	11.98	2–53	159	16.99	11.82	1–66	164
36–41 months	33.09	13.15	8–73	239	23.31	17.65	1–89	230
42–47 months	41.30	14.76	0–48	247	26.40	19.98	2–102	263
48–53 months	44.61	15.91	3–85	127	34.37	21.57	2–95	131

Table 3
Descriptive Statistics for Expressive Vocabulary Scores in Dutch and English per Age Interval.

	Dutch				English			
	M	*SD*	*Min-Max*	*N*	*M*	*SD*	*Min-Max*	*N*
30–35 months	6.40	4.87	2–22	50	4.62	3.92	1–19	39
36–41 months	9.93	6.68	1–27	160	6.20	5.09	1–23	109
42–47 months	13.90	8.00	1–30	203	7.36	5.39	1–26	140
48–53 months	15.01	9.72	1–34	102	9.54	6.96	1–30	83

at ECEC, the results showed that the amount of English at ECEC was positively associated with children's growth rate of English receptive vocabulary ($\beta = .38$, $p < .001$), as well as with their starting level ($\beta = .31$, $p = .001$). The amount of Dutch at ECEC was not significantly associated with the growth rate of Dutch receptive vocabulary. Moreover, no cross-language associations were found, showing that Dutch ECEC exposure was not significantly associated with English receptive vocabulary or the other way around. For language exposure at home, the results showed that the amount of Dutch at home was positively related to children's starting level in Dutch ($\beta = .64$, $p < .001$) and negatively to their starting level in English ($\beta = -.19$, $p < .040$). The amount of English at home was positively related to children's starting level ($\beta = .40$, $p < .001$) and growth rate ($\beta = .27$, $p = .001$) of English receptive vocabulary.

Regarding the relationships between the exposure variables, we found that there was a negative relationship between the amount of Dutch exposure and English exposure at home ($\beta = -.29$, $p < .001$). Furthermore, there were several significant relationships between home exposure and ECEC exposure: a negative covariance between Dutch exposure at home and Dutch exposure at ECEC ($\beta = -.27$, $p < .001$), a positive covariance between English exposure at home and English exposure at ECEC ($\beta = .30$, $p < .001$), and a negative covariance between Dutch exposure at home and English exposure at ECEC ($\beta = -.49$, $p < .001$). These findings suggest selection effects that we touched upon above and will come back to in our Discussion. All the results held true when we winsorized the home exposure variables (i.e., set the scores above the 95th percentile to the 95th percentile), to deal with high outlier values in these variables.

Results for expressive vocabulary

For expressive vocabulary, the same model was fitted, except that the latent growth factors were based on children's expressive vocabulary scores. The model was based on all children who had obtained at least one score on the Dutch or English expressive vocabulary tasks ($N = 544$). This model, presented in Fig. 4, fitted the data well: $\chi^2(41, N = 544) = 59.987$, $p = .028$, RMSEA = 0.029, CFI/TLI = 0.975/0.963, SRMR = 0.064. For the full results, see Appendix B.

As in the model for receptive vocabulary, the estimated slope means of Dutch and English receptive vocabulary were positive, indicating that both abilities improved over time. As for ECEC exposure, there was a positive relationship between the amount of English at ECEC and the growth of English expressive vocabulary ($\beta = .29$, $p = .021$), but not with the starting level. As in the model for receptive vocabulary, there were no effects of Dutch exposure at ECEC on children's vocabulary development, neither in Dutch nor in English. As for home exposure, the amount of Dutch exposure at home was positively related to children's starting level ($\beta = .61$, $p < .001$) and growth rate ($\beta = .37$, $p = .001$) of Dutch expressive vocabulary. It was negatively related to the growth rate of English expressive vocabulary ($\beta = -.51$, $p = .002$). The amount of English exposure at home positively predicted children's starting level ($\beta = .38$, $p < .001$) and growth rate ($\beta = .34$, $p = .001$) of English expressive vocabulary. Unlike in the model for receptive vocabulary, the cross-language covariance between the slopes was not significant, and there was no trend towards a significant cross-language covariance between the intercepts. What was observed, however, was a positive relationship between children's starting level in Dutch and their growth rate in English ($\beta = .46$, $p = .009$). Thus, children with a relatively high

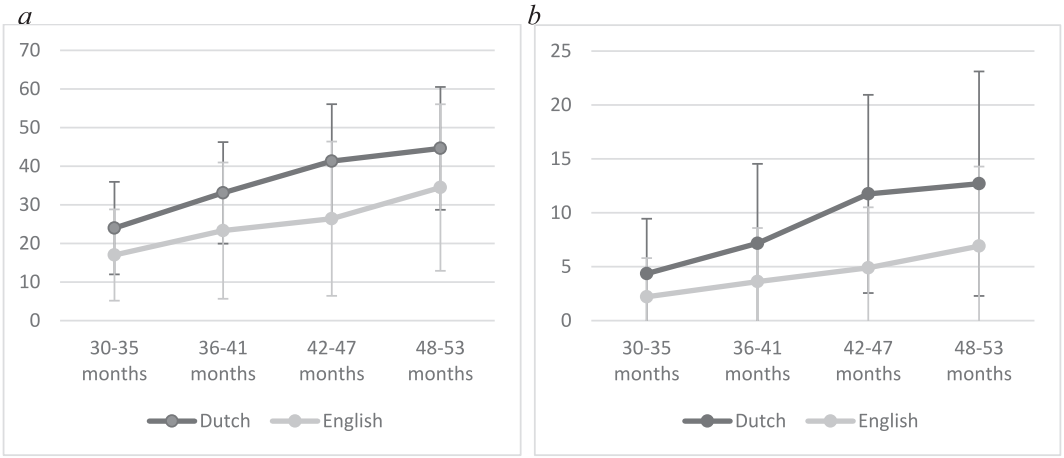

Fig. 2. Growth of Receptive Vocabulary (2a) and Expressive Vocabulary (2b) in Dutch and English (Mean Scores and Standard Deviations).

Table 4
(Pearson) Correlations Between the Exposure Variables and DDutch and English Receptive Vocabulary Scores per Age Interval

	Dutch at home	English at home	Dutch at ECEC	English at ECEC
Dutch				
30–35 months	.51***	−.30***	−.09	−.35***
36–41 months	.53***	−.17*	−.12	−.32***
42–47 months	.58***	−.35***	−.17*	−.35***
48–53 months	.48***	−.18	.13	−.35***
English				
30–35 months	−.43***	.48***	−.03	.47***
36–41 months	−.43***	.56***	−.10	.45***
42–47 months	−.38***	.53***	−.08	.59***
48–53 months	−.51***	.57***	.01	.66***

Note. *N* ranged between 93 and 211. For *p*-values and *N*s, see: https://osf.io/r7w65/?view_only=2f68c4c94d1e47f38b3e6984abf8205a

Table 5
(Pearson) Correlations between the Exposure Variables and Dutch and English Expressive Vocabulary Scores per Age Interval.

	Dutch at home	English at home	Dutch at ECEC	English at ECEC
Dutch				
30–35 months	.44**	−.31*	−.17	−.26*
36–41 months	.46***	−.19*	−.13	−.18*
42–47 months	.55***	−.29***	-.28**	-.32***
48–53 months	.56***	−.22*	−.05	−.36**
English				
30–35 months	−-.09	.33*	.18	.28
36–41 months	−.20	.37***	−.02	.16
42–47 months	−21*	.48***	−.06	.26**
48–53 months	−.36**	.56***	.20	.44**

Note. *N* ranged between 32 and 160. For *p*-values and *N*s see: https://osf.io/r7w65/?view_only=2f68c4c94d1e47f38b3e6984abf8205a

Table 6
(Pearson) Correlations Between the Exposure Variables.

	Dutch at home	English at home	Dutch at ECEC	English at ECEC
Dutch at home	–	−.30***	−.25***	−.50***
English at home		–	−.01	.32***
Dutch at ECEC			–	.05
English at ECEC				–

starting level in Dutch expressive vocabulary generally developed English expressive vocabulary at a higher rate than children with a relatively low starting level in Dutch. Regarding the relationships between the covariates, effects were very similar to those in the previous model. Again, all results held true when the home exposure variables were winsorized at the 95th percentile.

Post-hoc analysis 1: Checking the results for children attending bilingual ECEC only

The above models were based on data from children who attended bilingual ECEC as well as children who attended Dutch monolingual ECEC. Although this latter group constituted a minority (24%) and our analytical approach was based on detailed estimates of each child's language exposure, the question arises whether the inclusion of children who attended monolingual ECEC affected our results. Specifically, the inclusion of children who did not receive English exposure at ECEC at all (and conversely, high amounts of exposure to Dutch) might have attenuated any effects of Dutch ECEC exposure on vocabulary development.

To explore this, post-hoc analyses were performed in which the above models were run on the data of children attending bilingual ECEC only. These models fitted the data less well, presumably due to lower sample size ($N = 444$ for receptive vocabulary; $N = 420$ for expressive vocabulary), but showed a similar pattern of results as the models fitted on the whole sample. One exception to this was a high covariance between Dutch and English exposure at ECEC in the post-hoc models. Also, while the relationships between English exposure at ECEC and English vocabulary were in the same range as in the earlier models (βs ranging between .24 and .39), they did not reach significance, presumably due to reduced power. Overall, however, results were largely similar to the results based on the entire sample – see Appendix C.

Post-hoc analysis 2: Children without exposure to Dutch or English at home

The results presented thus far showed significant associations between English exposure at ECEC and English vocabulary growth, but no significant associations between Dutch exposure at ECEC and Dutch vocabulary growth. Recall from above that a considerable number of children in our sample (39%) did not hear Dutch at home, and a considerable number (63%) did not hear English at home. Thus, for these children, one of the languages spoken at ECEC was completely new. It is possible that the effects for these children are different, because these children were dependent on ECEC exposure as the only source of input for their development, and exposure to another, second language at ECEC led to reduced exposure in this language. Thus, for children who were not exposed to Dutch at home, receiving exposure to English at ECEC might have had adverse effects on their development in Dutch, because these children were fully dependent on ECEC exposure for their development in Dutch, and exposure at home could not compensate for any negative effects. This would mean that effects of language exposure on vocabulary development are not linear, but stronger for some groups of children than others, depending on whether they receive exposure to the ECEC languages at home.

To examine this, two multiple-group models were fitted in which two groups were compared. In the first multiple-group model, children exposed to Dutch at home were compared to children not exposed to Dutch at home. In the second model, children exposed to English at home were compared to children not exposed to English at home. Only receptive vocabulary was examined, since the models for expressive vocabulary did not converge.

Children with vs. without exposure to Dutch at home

To obtain two groups of children that differed in whether or not they heard Dutch at home, children with a value of five time units (i.e., mornings, afternoons, evenings) or higher for the variable Dutch exposure at home were classified as the "Dutch at home" group ($N = 209$), while children with a value lower than five time units were classified as the "No Dutch at home" group ($N = 191$). The value of five as a cutoff was chosen, since analyses with lower cutoffs resulted in problems

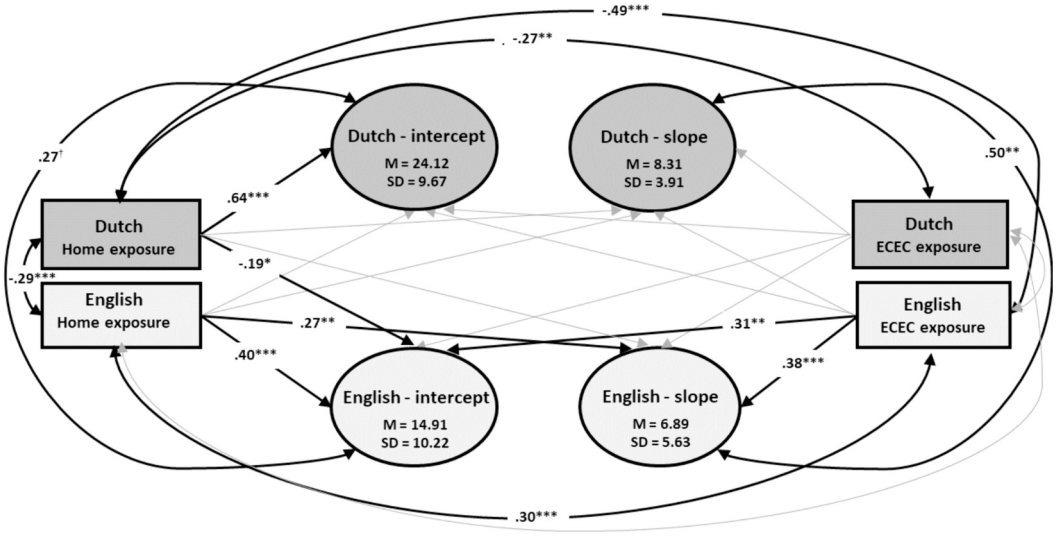

Fig. 3. Bivariate Latent Growth Model for Dutch and English Receptive Vocabulary with Dutch and English Exposure at Home and at ECEC as Time-Invariant Covariates.

Note. For latent variables (ovals), unstandardized means and variances are presented. For regressions (single-sided arrows) and covariances (double-sided arrows), standardized estimates are presented. † $p < .075$, * $p < .050$, ** $p < .010$, *** $p < .001$.

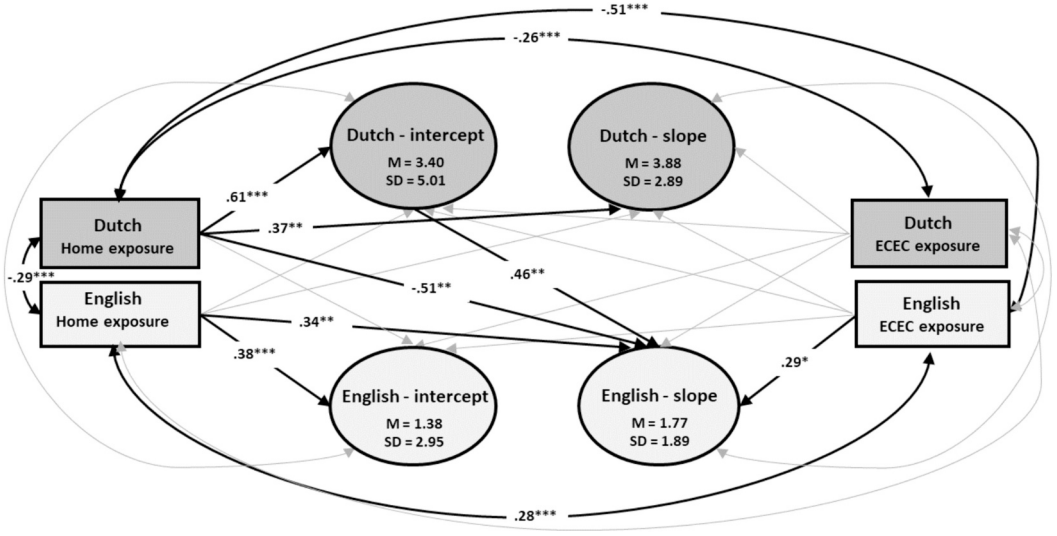

Fig. 4. Bivariate Latent Growth Model on Dutch and English Expressive Vocabulary with Dutch and English Exposure at Home and at ECEC as Time-Invariant Covariates.

Note. For latent variables (ovals), unstandardized means and variances are presented. For regressions (single-sided arrows) and covariances (double-sided arrows), standardized estimates are presented. * $p < .050$, ** $p < .010$, *** $p < .001$.

estimating the intercept in the "No Dutch at home" group. Mean exposure to Dutch was 13.51 ($SD = 4.46$, min-max = 5.07–23) in the "Dutch at home" group and 0.55 ($SD = 1.20$, min-max = 0–4.88) in the "No Dutch at home" group. Here, we only present the main results of the multiple group LGM model. For descriptive statistics and more detailed model results, see Appendix D. The same model was fitted as above, except that Dutch home exposure was not included (since values were (close to) zero in the "No Dutch at home" group). All intercepts, slopes, regressions and covariances were allowed to vary between the groups, except the paths from Dutch and English ECEC exposure to the latent slopes, which were constrained to be equal. The model fitted the data poorly $\chi^2(80, N = 406) = 154.316$, $p < .001$, RMSEA = 0.068, CFI/TLI = 0.865/0.824, SRMR = 0.125. Leaving out the last age interval for English vocabulary yielded a model with good fit: $\chi^2(58, N = 400) = 64.229$, $p = .268$, RMSEA = 0.023, CFI/TLI = 0.984/0.977. To test whether the effects of ECEC exposure on vocabulary growth differed between the two groups, we then compared, in successive steps, this "baseline" model to three nested models in which paths were freely estimated in the two groups: (i) the paths from Dutch ECEC exposure to the slope factors, (ii) the paths from English ECEC exposure to the slope factors and (iii) the paths from Dutch and English ECEC exposure to the slope factors. The first model in which the paths from Dutch ECEC exposure to the slope factors were freely estimated fitted the data well, albeit slightly less well than the previous model ($\chi^2(56, N = 400) = 63.609$, $p = .226$, RMSEA = 0.026, CFI/TLI = 0.981/0.971). A chi-square difference test showed that the baseline, more constrained model was preferred ($\chi^2 = 0.681$, $p = .711$). The second model in which the paths from English ECEC exposure to the slope factors were allowed to vary also fitted the data well: $\chi^2(56, N = 400) = 63.786$, $p = .222$, RMSEA = 0.026, CFI/TLI = 0.980/0.971), but not better than the

baseline model ($\chi^2 = 0.504$, $p = .777$). Finally, a model in which the paths from Dutch and English ECEC exposure to the slope factors were freely estimated ($\chi^2(54, N = 400) = 63.266$, $p = .182$, RMSEA = 0.029, CFI/TLI = 0.977/0.964) did not fit the data better than the baseline model ($\chi^2 = 1.024$, $p = .906$). This indicates that the relationships between amount of Dutch and English ECEC exposure and receptive vocabulary growth did not differ between children depending on whether they were exposed to Dutch at home. For the results of the final model, see Appendix D.

Children with vs. without exposure to English at home

To assess whether the effects of ECEC exposure differed depending on whether children were exposed to English at home, two groups were compared: children exposed to English at home ($N = 179$) and children not exposed to English at home ($N = 276$). Specifically, children with a value higher than zero for the variable English exposure at home were classified as the "English at home" group, while children with a value of zero were classified as the "No English at home" group. Mean exposure to English was 5.47 ($SD = 4.59$, min-max = 0.15–22.55) in the "English at home" group (and zero in the "No English at home" group). A lower cutoff value was used than in the previous analysis, because the "English at home" group would otherwise become too small ($N = 100$). However, since the vast majority of the children in the "No Dutch at home" were exposed to one time unit of Dutch exposure or less (i.e., 178 out of 191 children (93%)), the "No Dutch at home" group was rather similar to the "No English at home" group in that, in both groups, children were not or only minimally exposed to Dutch or English. Also, while there was overlap between the current subgroups based on English exposure at home and the previous subgroups based on Dutch exposure at home, most of the children ($N = 265$, 66%) fell in different subgroups across the two analyses.

A multiple-group LGM was fitted that was the same as the previous models, except that English exposure at home was not included. In a first, baseline model, all intercepts, slopes, regressions and covariances were freely estimated, but the paths from Dutch and English ECEC exposure to the latent slope factors were constrained to be equal across the groups. This model fitted the data well, except that chi-square was significant and SRMR was too high: $\chi^2(59, N = 455) = 81.370$, $p = .028$, RMSEA = 0.041, CFI/TLI = 0.958/0.940, SRMR = 0.106. To improve model fit, covariances were added between Dutch vocabulary scores in the second and third age interval and between English vocabulary scores in the first and second interval. The resultant model fitted the data well: $\chi^2(55, N = 455) = 70.124$, $p = .082$, RMSEA = 0.035, CFI/TLI = 0.971/0.956.

A series of alternative models were then run in which the equality constraints on the paths from ECEC exposure to the slope factors were successively released, and compared through chi-square difference tests, as above. None of these models fitted the data better than the baseline model in which the paths from ECEC exposure to the slope factors were constrained across the groups. Specifically, model fit and chi-square difference test outcomes were: $\chi^2(53, N = 455) = 69.476$, $p = .064$, RMSEA = 0.037, CFI/TLI = 0.969/0.950 / $\chi^2 = 0.364$, $p = .834$ for the model in which the paths from English ECEC exposure to the slope factors were freely estimated; $\chi^2(53, N = 455) = 68.929$, $p = .070$, RMSEA = 0.036, CFI/TLI = 0.970/0.952 - $\chi^2 = 1.195$, $p = .550$ for the model in which the paths from Dutch ECEC exposure the slope factors were allowed to freely estimated; and $\chi^2(51, N = 455) = 68.406$, $p = .052$, RMSEA = 0.039, CFI/TLI = 0.967/0.946 - $\chi^2 = 1.718$, $p = .787$ for the model in which all paths from ECEC exposure to the slope factors were freely estimated. Thus, as in our previous model, the relationships between amount of Dutch and English ECEC exposure and receptive vocabulary growth did not differ between children depending on whether they were exposed to English at home. For the final model, see Appendix E.

Discussion

We investigated how bilingual exposure at ECEC relates to children's dual language development when the exposure children receive to the ECEC languages at home was taken into account. To this aim, we examined longitudinal data from 584 preschool children in the Netherlands who learned Dutch and English at ECEC, in varying amounts. Children were from diverse home language backgrounds, being from families in which Dutch or English was spoken – either in isolation or alongside other languages, families in which both Dutch and English were spoken, or families in which one or more other languages were spoken. The amount of Dutch and English exposure at ECEC was examined in relation to receptive and expressive vocabulary scores between 30 and 53 months, through Latent Growth Modeling, while controlling effects of Dutch and English exposure at home.

Our results showed significant, positive relationships between the amount of English exposure children received at ECEC and the rate at which they developed English receptive and expressive vocabulary knowledge. The amount of Dutch exposure at ECEC was not related to children's growth of Dutch receptive and expressive vocabulary, and there was no significant (positive or negative) relationship between the amount of Dutch exposure at ECEC and children's growth rate in English, or vice versa. This pattern of results remained largely unchanged when, in a post-hoc analysis, about one quarter of the children who visited Dutch monolingual daycare were left out. Specifically, the relationship between English ECEC exposure and English receptive vocabulary growth remained positive and moderate in the smaller sample, albeit no longer significant, presumably due to reduced power. Post-hoc comparisons between groups of children with and without exposure to Dutch or English at home showed, furthermore, that the relationships between ECEC exposure and vocabulary growth did not differ as a function of whether children learned the ECEC languages at home. These results show that, in our sample of children and the bilingual ECEC programs investigated, effects of ECEC exposure on vocabulary growth were specific to the non-majority language: English. The effects of English ECEC exposure were independent of English home exposure, held for both receptive and expressive vocabulary, and did not differ between children depending on whether they learned Dutch or English at home.

These findings support earlier results by Bergström et al. (2016) who found positive associations between the amount of time English was spoken at ECEC and English receptive vocabulary scores in a group of 27 children attending German-English ECEC in Germany. They are also in line with the earlier result that children attending bilingual ECEC show faster growth in the non-majority ECEC language than children attending monolingual ECEC (Bergström et al., 2016; Farver et al., 2009; Ferjan Ramírez & Kuhl, 2020; Stipek et al., 2001). Crucially, our study suggests that this positive effect remains when precise estimates of amount of home language exposure are taken into account. In our study, higher amounts of exposure to English were not associated with slower growth of Dutch (or vice versa). This is an important finding, as it suggests that earlier expressed concerns that bilingual education comes at the cost of children's majority language development (Rossell & Baker, 1996; Wong Fillmore, 1991, see also Bialystok, 2016 for an overview) is unwarranted. While most recent studies see bilingual education as positive, the evidence is scattered and based on small-scale studies (see Nikolov and Djigunović (2023) for a similar conclusion). The results of the current study are a first step into the direction of large-scale, longitudinal research into the effects of bilingual education on very young children's language development. Also, our results showed weak and non-significant relationships between the amount of Dutch exposure at ECEC and children's receptive and expressive vocabulary growth in Dutch. This could not be explained by a lack of variation in the Dutch ECEC exposure estimate or in children's Dutch vocabulary scores, since there was substantial interindividual variation in both. The lack of effects of Dutch ECEC exposure sits well with previous research on

bilingual ECEC of various types and in different countries, which found that children in bilingual ECEC develop abilities in the majority language at the same rate as children in monolingual ECEC, despite receiving less exposure in this language (Barnett et al., 2007; Bialystok, 2016; Schwartz & Shaul, 2013; Thieme et al., 2021).

However, the question arises how the lack of significant relationships for Dutch ECEC exposure can be explained. Why did we find significant relationships for English ECEC exposure only? A possible explanation relates to the fact that, in the current study, children generally received higher levels of exposure at ECEC to Dutch (50% to 100%) than English (0% to 50%), because of regulations set for the participating ECEC centers. A tentative idea is that exposure beyond the minimum level of 50% does not contribute further to children's vocabulary development because of so-called threshold effects, along the same lines as proposed for home exposure (Cattani et al., 2014; Thordardottir, 2011). Specifically, earlier work indicated that children who receive 40% to 60% of their (parental) exposure in a given language develop that language no differently from monolingual children (Thordardottir, 2011). Another possible explanation for the lack of effects of Dutch ECEC exposure on Dutch vocabulary growth is that the exposure estimates did not capture children's language exposure well. In particular for Dutch, children were likely to receive exposure outside of the ECEC and home contexts, for example, through books, television or other media, contacts outside of the home, as this language was omnipresent in their environments. For English, in contrast, such additional exposure outside the home and ECEC was less likely. Consequently, a possible explanation of why no effects of ECEC exposure for Dutch were found is that the Dutch exposure variables – unlike the English exposure variables – did not cover the full amount of Dutch that children were exposed to. This might also explain why effects of English exposure at home were found for both receptive and expressive vocabulary growth in English, whereas effects of Dutch exposure at home were found for expressive vocabulary growth in Dutch only.

Our finding that the relationships between ECEC exposure and vocabulary growth did not differ between children with and without exposure to the ECEC languages at home is in keeping with results from Javorsky and Moser (2021), Rohde (2010) and Steinlen et al. (2010). In these studies, children who spoke a non-majority language at home did not differ from children from majority language backgrounds in vocabulary or grammar development. The current results support these findings for a much larger group of children and show that the same patterns hold if relatively precise amounts of home language exposure are taken into account. However, this lack of effects for home language background does not align with two earlier studies where differences between children with different home language situations were found. First, and as outlined earlier, Barnett et al. (2007) found the largest vocabulary gains in children in Spanish-English ECEC who were from families in which predominantly Spanish was spoken. Lugossy (2018) observed that children in Hungarian-English ECEC with poor proficiency in Hungarian developed English proficiency most quickly. In Barnett et al. (2007), however, three groups were compared: two groups that were not (predominantly) exposed to Spanish and a group that was predominantly exposed to Spanish. This comparison is different from our study where we compared a group with no exposure to English and a group with exposure to English, including very low amounts of exposure. The results of Lugossy (2018) might have differed from our findings for a variety of factors, such as the older age of the participants in that study (1 to 7 years) and the different ways in which proficiency was operationalized (observations of communicative competence instead of direct tests). It is of note, moreover, that sample size was very small in Lugossy's study: only six out of 36 children were from non-majority language families. Additionally, language distance might have played a role. Since Hungarian is a non-Indo-European language it might have been less accessible than Dutch, yielding a stronger reliance on English. Finally, it is possible that the extent to which children spoke their other language played a role, such that the higher their level in this language, the easier it might have been to learn an additional language, in line with Cummins' Interdependence hypothesis (Cummins, 1979, 2000). Future work could address how children's ability to learn a new language at ECEC relates to their proficiency in the home language(s), ideally taking the degree of similarity between the home and ECEC languages into account.

The current results largely support the conclusions in earlier work, despite the fact that our analytical approach was different in at least three ways. First, we investigated the effects of *amount* of exposure to each of the ECEC languages (based on how often a language was spoken and children's ECEC attendance), whereas earlier studies compared groups of children who visited bilingual or monolingual ECEC (Barnett et al., 2007; Bergström et al., 2016; Farver et al., 2009). Second, we considered the effects of English and Dutch home and ECEC exposure simultaneously in one analysis, as well as all covariances between these variables, to control for any selection effects in our data. This is important, because we were confronted with a number of selection biases, such that, for example, children from families in which high portions of English were spoken were more likely to visit ECEC centers where relatively high amounts of English were spoken. A final difference with earlier work is that we used Latent Growth Modeling to investigate the relationships between language exposure and vocabulary growth. This enabled us to look at effects on growth *rate* over the entire trajectory between 30 and 53 months, rather than differences in children's level of proficiency at specific time points. An advantage of including all relevant variables into one analysis, not only at the level of exposure (English, Dutch, home, ECEC) but also vocabulary (Dutch, English), as well as all possible confounding relationships between the exposure variables, was that we could investigate the net effects of ECEC exposure, uncontaminated by effects of other variables. By looking at the rate of development (i.e., slope), we were able to investigate relationships with growth of vocabulary as well as relationships between both growth factors. Our results showed a positive and significant relationship between the two growth factors, which indicates that children who showed relatively steep growth in Dutch were more likely to also show steep growth in English, at least for receptive vocabulary. This is in line with the idea that bilingual children's languages are not in competition, but support each other (Cummins, 1979; Scheele, Leseman, & Mayo, 2010).

The study has a number of limitations. First, we did not have a baseline measurement: at the youngest age interval (i.e., 30 to 35 months), most children had been attending ECEC for some time where they had been exposed to Dutch and/or English. Hence, it is an open question how the exposure variables would relate to vocabulary development at a younger age and, more importantly, in children without previous exposure to bilingual ECEC. Future work could examine how effects of bilingual exposure at ECEC pan out if children are being followed from their first encounter with bilingual ECEC onwards. Such work could also investigate whether any effects of bilingual ECEC persist beyond preschool age, and how they relate to whether children receive continued exposure to the additional ECEC language at primary school. A second limitation relates to the nature of our data. Specifically, our data were incomplete, as many children were assessed only once or twice. Although this was certainly not ideal, it seems unlikely that the large number of missings impacted on our LGM results: the outcomes of the LGM models were not only very similar to the pattern shown in a correlation matrix, but also proved robust in post-hoc analysis with different subgroups. Perhaps, a larger drawback of our dataset was that children from ten ECEC centers participated – a too small number to allow for multi-level modeling taking into account the clustering of the data (i.e., children being nested within daycares). Ideally, future research includes more centers such that the dependency of the observations can be taken into consideration. Also, our sample was heavily skewed towards children from families with highly educated parents. This high selectivity in our sample was due to the types of participating ECEC centers in our study: since bilingual ECEC is not (yet) a legal option in the Netherlands except when the additional language is an

official language (Frisian) or a regional language (Limburgish), many of the ECEC centers in our study were mainly attended by children from expat families. Given well-attested effects of SES on children's language development, future research should explore if the results can be generalized to children from lower SES families who experience less advantageous learning environments (Hoff, 2006). Such research could also explore the effects of bilingual ECEC where a language other than English is provided – ideally languages spoken by migrant communities with lower prestige than English. A third limitation is that our exposure estimates were based on parent reports. Parents indicated how often they spoke a given language to their child, as well as how often their child spent time with them and at ECEC in a typical week. Although this yielded rather precise estimates that allowed us to investigate effects of amount of exposure, a clear limitation is that the quality of our findings is a function of the extent to which parents could reliably estimate their language use and weekly schedule. Likewise, for the amount of exposure at ECEC, percentages were based on the language policies that the ECEC centers reported (e.g., one-teacher-one-language), although the actual exposure likely fluctuated depending on which teachers were present on a given day, and how strictly they adhered to the policy. Future work could consider more detailed assessments such as diaries, phone interviews or observational procedures to assess the amount of exposure children receive in each of their languages, both at home and at ECEC. Finally, in future work, it would be interesting to investigate which qualitative properties of exposure at ECEC benefits children's language development. Earlier work on monolingual ECEC indicates that high-quality teacher-child interactions foster children's development (Dickinson & Porche, 2011), and there is some preliminary evidence that stories and routines foster children's earliest steps in development of a foreign language (Thieme et al., 2021). In our study, we found that relationships between exposure and vocabulary development were more prominent for the home than ECEC context. Specifically, for expressive vocabulary, effects of home exposure were found for both languages, whereas effects of ECEC exposure emerged for English vocabulary only. This may suggest that the type of exposure children received played a role, and that parental exposure in particular drives language development, perhaps because it is better tailored to children's communicative needs and children's proficiency level, at least in the current sample. Future studies could investigate more qualitative properties of exposure that children receive at bilingual ECEC and how these relate to dual language development in more diverse groups of children. Finally, in our study, we did not consider child characteristics other than children's home language background. It is not unlikely that children benefit from bilingual exposure at ECEC to different degrees, depending on individual characteristics, such as verbal working memory, analytical abilities, or socialness, as well as group characteristics, including how many children within a group speak the majority and minority languages and the type of interactions they have. It would be worth exploring whether, and if so, in what ways, such characteristics may modulate effects of bilingual exposure at ECEC on language development. Such work could target not only vocabulary but also abilities at the sentence or discourse level.

In conclusion, our results showed that exposure to an additional, non-majority language in bilingual ECEC is associated with vocabulary development in that language and does not negatively impact majority language development. Our results also showed that exposure to the majority language does not relate to children's vocabulary development, at least not in our sample in which children were exposed to this language half of the time or more. For the majority language, home exposure turned out to be more important than exposure at ECEC. The current study adds to earlier work by investigating a relatively large sample of over 500 children from linguistically diverse backgrounds and examining the effects of ECEC exposure independently of effects of home exposure. Its findings support the earlier claim that bilingual ECEC benefits children's development in the non-majority language and does not harm their development in the majority language. These findings are important for research and practice, as they indicated that, at least with the current sample and in the current context, bilingual ECEC can support dual language development from a young age onward.

CRediT authorship contribution statement

Josje Verhagen: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation. **Jan Boom:** Writing – review & editing, Visualization, Formal analysis. **Anne-Mieke Thieme:** Writing – review & editing, Investigation. **Folkert Kuiken:** Writing – review & editing, Project administration, Funding acquisition. **Darlene Keydeniers:** Writing – review & editing, Project administration, Investigation. **Suzanne Aalberse:** Writing – review & editing. **Sible Andringa:** Writing – review & editing, Project administration, Conceptualization.

Data availability

The data and scripts are available on OSF.

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Appendix A. Descriptive statistics

Table A1
Descriptive statistics for children's receptive and expressive vocabulary scores in Dutch and English per assessment.

	Receptive vocabulary						Expressive vocabulary					
	Dutch			English			Dutch			English		
	M	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*
Assessment 1	31.77	16.69	470	19.38	16.38	482	8.28	8.35	357	3.02	4.83	344
Assessment 2	39.29	14.16	253	26.62	19.17	250	10.76	8.98	243	4.01	5.03	216
Assessment 3	44.31	12.78	51	35.66	22.36	68	12.26	10.22	50	7.81	8.10	67
Assessment 4	50.00	24.04	4	32.25	12.01	4	18.67	3.79	3	14.00	–	1

Appendix B. Latent growth models for the full sample

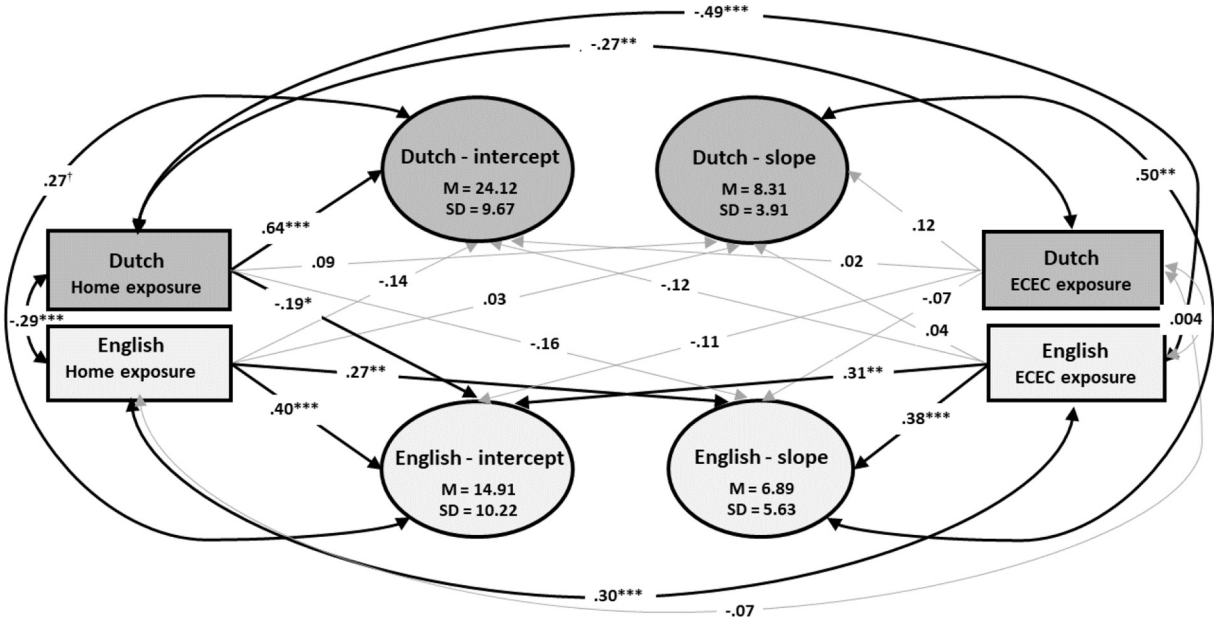


Fig. B1. Bivariate latent growth model for Dutch and English receptive vocabulary with Dutch and English exposure at home and at ECEC as time-invariant covariates. † $p < .075$, * $p < .050$, ** $p < .010$, *** $p < .001$. † $p < .075$, * $p < .050$, ** $p < .010$, *** $p < .001$.

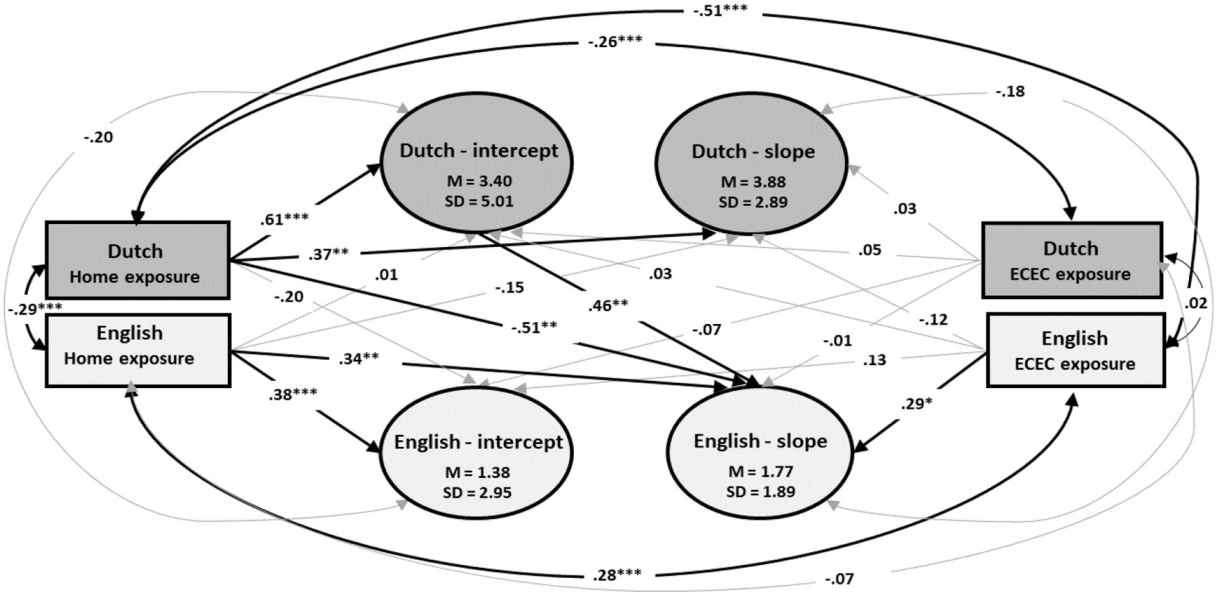


Fig. B2. Bivariate latent growth model for Dutch and English expressive vocabulary with Dutch and English exposure at home and at ECEC as time-invariant covariates. * $p < .050$, ** $p < .010$, *** $p < .001$. * $p < .050$, ** $p < .010$, *** $p < .001$.

Appendix C. Results for post-hoc analysis 1: Children attending bilingual ECEC only

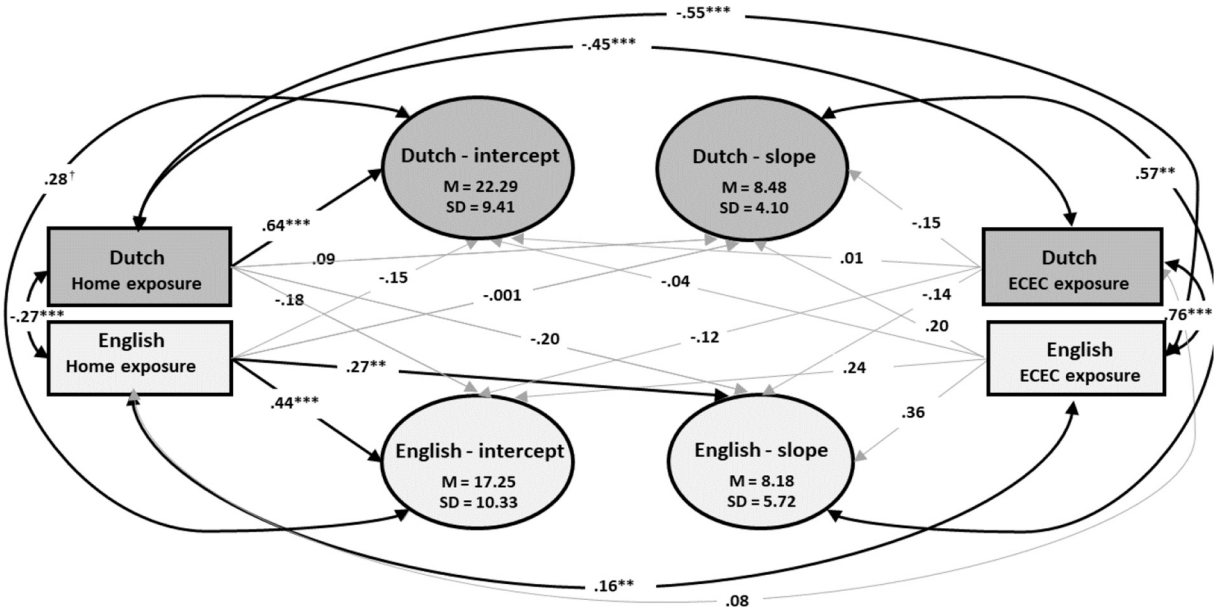


Fig. C1. Bivariate Latent Growth Model for Dutch and English Receptive Vocabulary for Children at Bilingual ECEC ($\chi^2(42, N = 444) = 88.071$, $p < .001$, RMSEA = 0.050, CFI/TLI = 0.919/0.885, SRMR = 0.087). † $p < .075$, * $p < .050$, ** $p < .010$, *** $p < .001$. † $p < .075$, * $p < .050$, ** $p < .010$, *** $p < .001$.

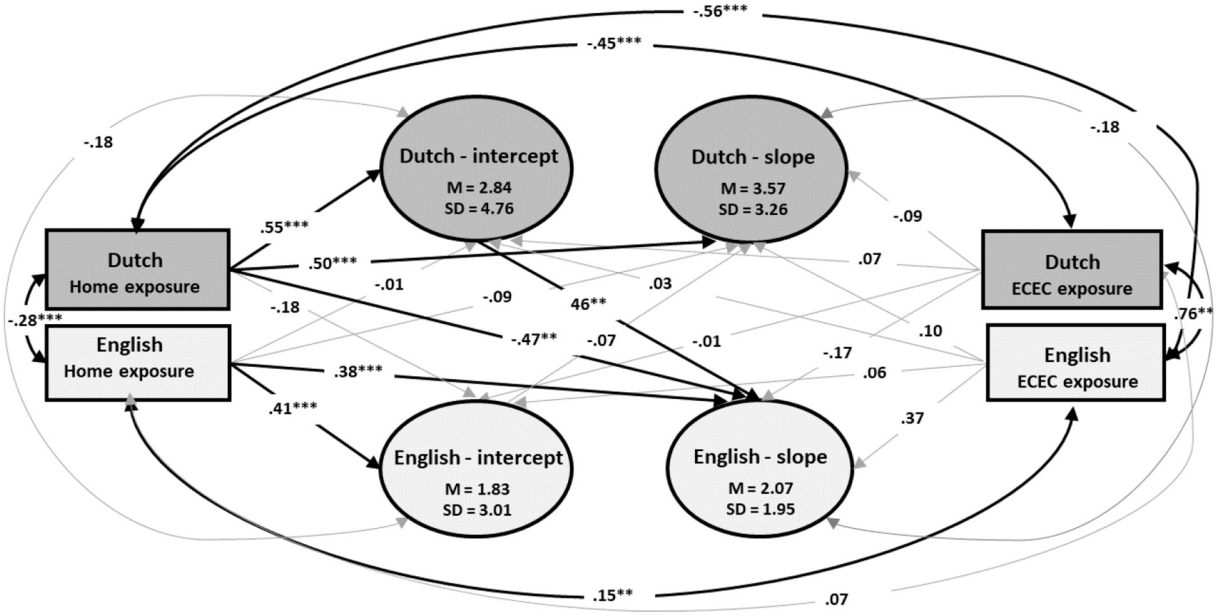


Fig. C2. Bivariate Latent Growth Model for Dutch and English Expressive Vocabulary for Children at Bilingual ECEC ($\chi^2(40, N = 420) = 94.142$, $p < .001$, RMSEA = 0.057, CFI/TLI = 0.914/0.871, SRMR = 0.097). * $p < .050$, ** $p < .010$, *** $p < .001$. ** $p < .010$, *** $p < .001$.

Appendix D. Results for post-hoc analysis 2: Children with vs. without exposure to Dutch at home

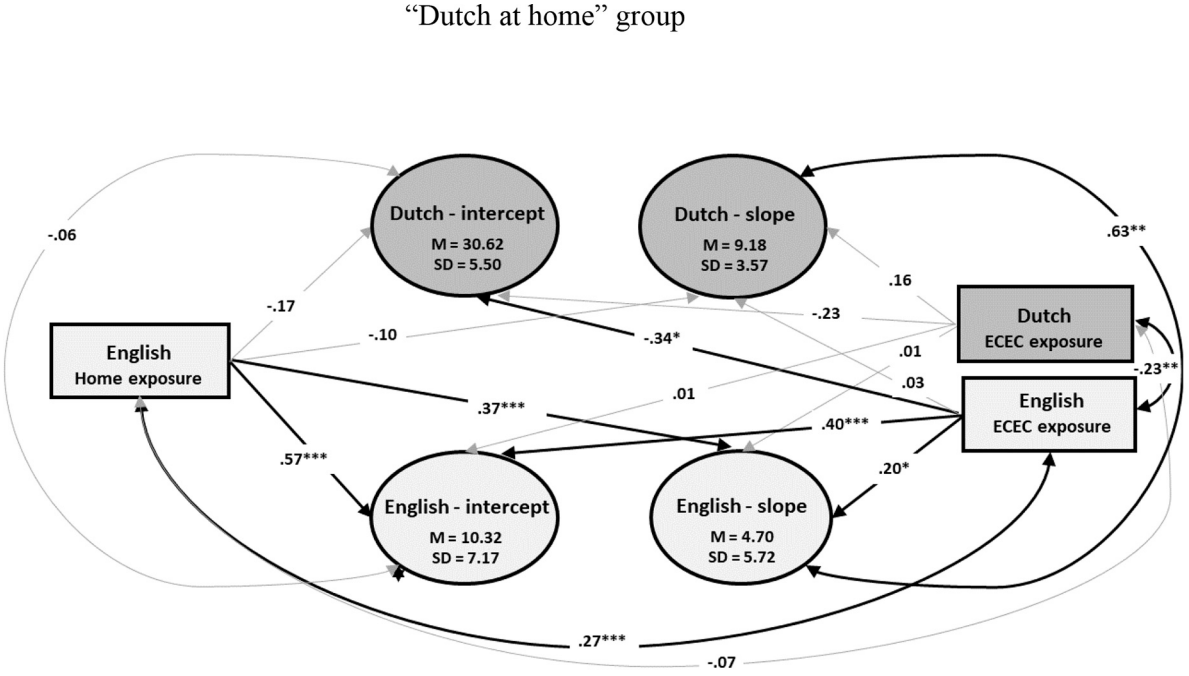
Table D1
Descriptive statistics for Dutch and English exposure for children with and without Dutch at home.

	Dutch at home			No Dutch at home		
	M	SD	N	M	SD	N
Home exposure						
Dutch	13.50	4.45	209	0.56	1.21	191
English	1.09	2.44	209	3.89	4.95	191
ECEC exposure						
Dutch	3.42	1.64	206	4.05	1.55	187
English	1.35	1.42	208	3.18	1.61	189

Note. Averages were calculated if parents completed the questionnaire at multiple waves.

Table D2
Descriptive statistics for receptive vocabulary for children with and without Dutch at home.

	Dutch at home						No Dutch at home					
	Dutch			English			Dutch			English		
	M	SD	N	M	SD	N	M	SD	N	M	SD	N
30–35 months	29.78	10.08	64	12.45	8.65	73	16.55	9.75	60	21.37	12.67	64
36–41 months	39.66	10.69	106	16.13	13.24	101	26.63	10.92	88	30.77	18.10	92
42–47 months	49.63	10.46	98	18.99	16.39	100	31.61	13.59	76	35.87	21.17	83
48–53 months	53.93	12.47	44	21.83	13.26	41	38.18	13.80	51	47.85	20.70	52



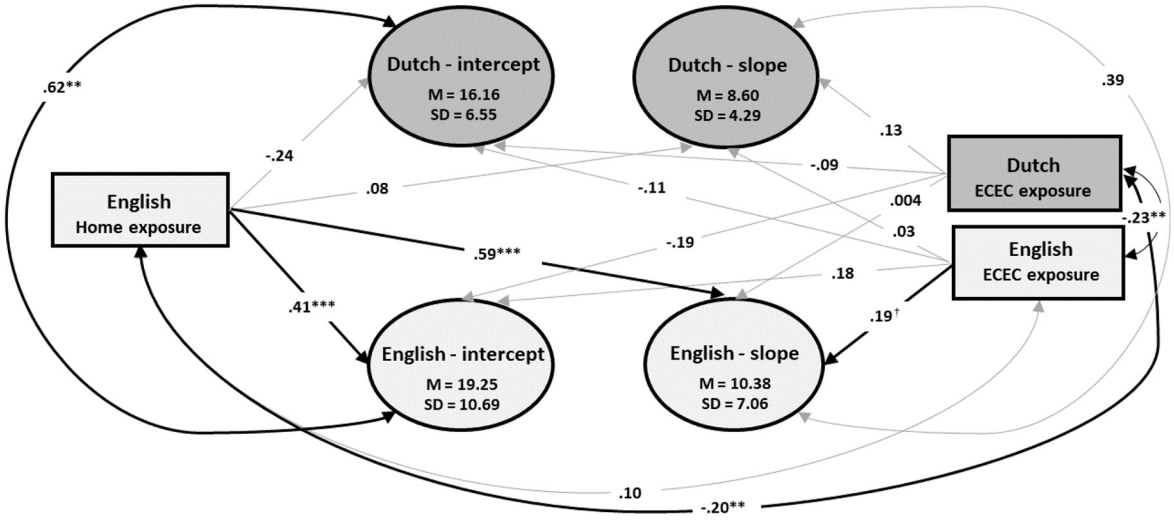


Fig. D1. Bivariate multiple-group latent growth model for Dutch and EEnglish receptive vocabulary for children with and without Dutch at home. * $p < .050$, ** $p < .010$, *** $p < .001$. † $p < .075$, * $p < .050$, ** $p < .010$, *** $p < .001$.

Appendix E. Results for post-hoc analysis 2: Children with vs. without exposure to English at home

Table E1
Descriptive statistics for Dutch and English exposure for children with and without English at home.

	English at home			No English at home		
	M	SD	N	M	SD	N
Home exposure						
Dutch	4.34	5.67	178	7.85	7.78	275
English	5.47	4.59	179	0	–	276
ECEC exposure						
Dutch	3.69	1.34	167	3.74	1.82	218
English	2.81	1.61	177	1.62	1.74	239

Note. As indicated in the text, averages were calculated if parents completed the questionnaire at multiple waves.

Table E2
Descriptive statistics for receptive vocabulary for children with and without English at home.

	English at home						No English at home					
	Dutch			English			Dutch			English		
	M	SD	N	M	SD	N	M	SD	N	M	SD	N
30–35 months	20.40	10.95	60	22.28	12.56	66	26.58	12.35	76	12.12	8.39	81
36–41 months	30.87	12.26	87	31.66	18.79	89	34.95	13.05	128	17.17	13.55	120
42–47 months	35.14	15.61	71	37.95	20.93	102	44.90	13.61	127	19.75	16.18	130
48–53 months	42.53	15.19	43	48.40	21.51	95	47.98	15.53	63	26.21	16.68	56

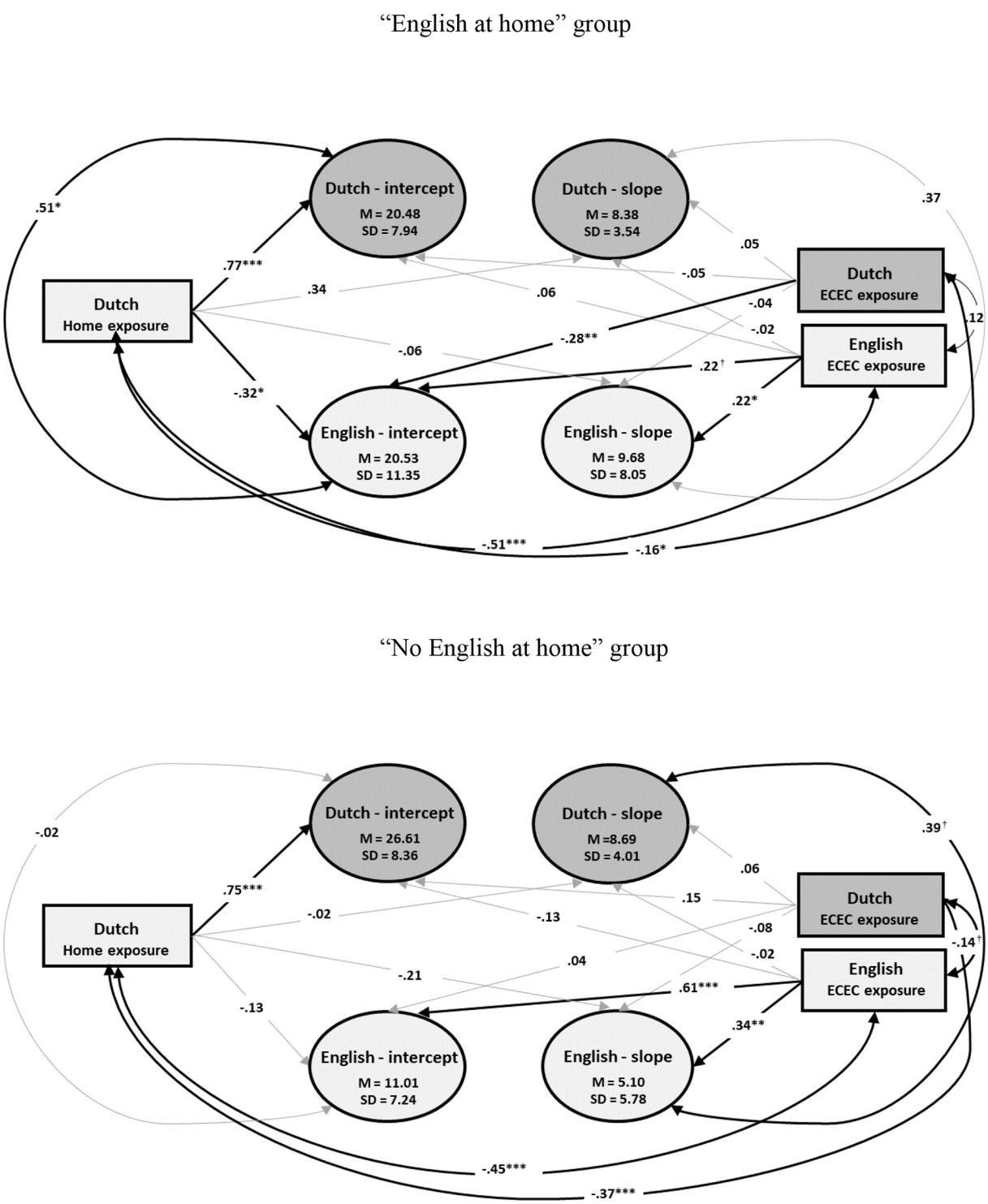


Fig. E1. Bivariate multiple-group latent growth model for Dutch and English receptive vocabulary for children with and without English at home. † $p < .075$, * $p < .050$, ** $p < .010$, *** $p < .001$. † $p < .075$, * $p < .050$, ** $p < .010$, *** $p < .001$.

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