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Exposure to English Before and After Entry into Head Start1: Bilingual Children's Receptive Language Growth in Spanish and English

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Abstract

This investigation examined the Spanish and English receptive vocabulary and language comprehension abilities of bilingual preschoolers who attended Head Start over a two-year period. It was hypothesised that bilingual children's development would follow linear trajectories and that the development of children who were only exposed to Spanish in the home prior to school entry would differ from children with exposure to Spanish and English from birth. Results revealed that the two groups' language abilities in Spanish and English differed at the beginning of the study as measured by raw and standard scores and that these differences were maintained over the two years. The exceptions to this were found in the children's vocabulary abilities, with the difference between the two groups' English standard scores narrowing over time and the difference between their Spanish standard scores increasing during the two-year period. Similar to research on monolingual and bilingual children with low socioeconomic status (SES), children's development in both languages essentially followed linear trajectories. Children's raw scores on the English receptive vocabulary test accelerated, similar to research findings on monolingual children of middle SES. Also, children's standard scores on the Spanish language comprehension measure decelerated after an initial period of linear growth. Future directions for research are discussed.

Keywords

bilingualism; preschool; Latino; language development; receptive language; Head Start

Research on the growth of children's language has focused primarily on the development of monolingual children from middle income homes prior to age three. In general, studies have demonstrated that children's early language development follows a nonlinear path. Fenson *et al.* (1993), for example, conducted a cross-sectional investigation of more than 1700 English speaking children from primarily middle class homes and demonstrated that the number of words understood and produced by children increased exponentially as children increased in age from 8 to 30 months. Longitudinal studies of middle class children's

[1]Head Start is a federally-funded program in the United States that provides preschool services to children from families living in poverty.

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expressive vocabulary growth confirm that children's early language development occurs at increasing rates. Goldfield and Reznick (1990) conducted a diary study of 18 children from 14 to 22 months of age. Approximately 75% of the children demonstrated slow growth, followed by a 'vocabulary spurt' that began sometime during this age range. Similarly, Huttenlocher *et al.* (1991) and Fernald *et al.* (2006), who studied the productive abilities of children from middle and upper-middle class homes, found that growth in children's language abilities accelerated between 12 and 26 months of age.

Evidence suggests, however, that differences may exist in the developmental paths of children from varying socioeconomic groups. Hart and Risley (1995) studied the expressive vocabulary growth of 42 children of high, middle and low socioeconomic status (SES) from the ages of 10 to 36 months. Differences in the number of words in the children's vocabularies were observed among three groups. Children in the high SES group had the largest productive vocabularies as compared to children in the middle and low SES groups. Children in the low SES group had the smallest vocabularies. The gaps among the groups appeared early in development and widened over time. Additionally, the developmental paths of children in the high and middle SES groups increased at increasing rates, whereas the trajectory of the group from low SES homes was essentially linear. A key factor which was hypothesised to explain the differences between the three groups was the amount of language input provided by the children's parents. Parents from low-SES households talked markedly less to their children than parents in the other two groups.

More recently, Pan *et al.* (2005) studied the vocabulary development of 108 toddlers from low income families between the ages of 12 and 36 months. Similar to Hart and Risley's findings, Pan *et al.* (2005: 770) found that the vocabulary development of children from low income homes was essentially linear 'with a slight increase in upward curvature between 1 and 3 years of age' and that language input from mothers impacted children's outcomes. However, Pan *et al.* (2001) concluded that the diversity of vocabulary used when talking to children, the language and literacy abilities of the mothers and the mothers' emotional states, and not the amount of talk, were the best predictors of children's language outcomes.

The growth rates of the language development of bilingual children living in the USA, and in particular, Spanish-English bilingual children, have received relatively little attention. Jackson-Maldonado *et al.* (1992) conducted a cross-sectional study of 124 bilingual children, ages 8–31 months, whose mothers had at least a high school education or higher. The children's receptive and expressive vocabularies were assessed in Spanish and English using the *Communicative Development Inventories* and *Inventario del desarollo de habilidades communicativas*, a comparable parent report instrument in Spanish. The results demonstrated that the shape of the developmental paths of the children's abilities in Spanish and English were similar to those of monolingual English speaking children who took part in Fenson *et al.*'s (1993) study, with growth accelerating over time.

In a more recent study, Uchikoshi (2006) studied the English receptive and expressive vocabulary abilities of Spanish–English bilingual children from low income backgrounds during kindergarten. Children were tested three times during their kindergarten year using the Peabody Picture Vocabulary Test-III (Dunn & Dunn, 1997) and the Picture Vocabulary subtest of the *Woodcock Language Proficiency Battery-Revised* (Woodcock & Muñoz-Sandoval, 1995). Growth curve modelling revealed linear growth in children's receptive and expressive language development during the year. These results are consistent with the work on the development of monolingual children from low income homes. It is, however, too early to conclude that bilingual children of low SES exhibit linear growth in their language development, as too few studies exist. Therefore, additional studies on bilingual children are needed.

When studying bilingual children's language development, leading researchers have argued that the timing of school entry is a key variable that should be considered (Butler & Hakuta, 2004; Genesee, 2004; Oller & Eilers, 2002). This is because differences in outcomes may occur between the development of children who communicated in their home language prior to school entry and are first expected to communicate in English when they begin school, and children who are exposed to both languages before attending school. This possibility has lead Oller and Eilers (2002: 8) to argue that when studying bilingual children in the USA, 'Extent of English knowledge at entry to school could play a critical role in achievement of oral capacity and literacy and needs to be evaluated as an independent variable'. Genesee (2004) and Butler and Hakuta (2004) concurred with Oller and Eilers (2002) by arguing that findings on bilingual language development associated with non-school settings do not readily apply to school related outcomes, because classroom factors can have influences that are not present in non-school settings.

Oller and Eilers (2002) investigated this assertion through a cross-sectional study that compared the language development of children who were exposed at home to English before and after entry into school. Kindergarten, and second and fifth grade bilingual children living in the USA were divided into two groups: (1) children from families who spoke both Spanish and English at home before school entry and (2) children fromfamilies who spoke only Spanish in the home before school entry (Fernández *et al.*, 1992; Oller & Eilers, 2002; Umbel *et al.*, 1992). Comparisons revealed that both bilingual groups' English receptive vocabulary knowledge was significantly below that of monolingual English speakers early in children's development. Children from Spanish-only homes acquired English abilities that were either equal to or below that of children who were exposed to Spanish and English. By fifth grade, both groups' abilities did not differ as a function of their home language, and their abilities approached those of monolingual English speakers.

With regard to Spanish abilities, children from Spanish-only homes outperformed children from English bilingual homes at all ages; however, both groups of children scored below the test mean for monolingual Spanish speaking children. Thus, it appears that the children came to school with Spanish language abilities that were not commensurate with monolingual Spanish speaking children and did not close this gap during elementary school.

When discussing the children's Spanish language outcomes, Oller and Eilers (2002) noted that children preferred to talk in English very early in their kindergarten year. Thus, it is likely that the children were experiencing attrition of their Spanish language abilities. Unfortunately, language attrition is a common phenomenon that is observed in many bilingual children who live in primarily monolingual environments and speak non-majority languages (cf. Anderson, 2004; Portes & Rumbaut, 2001). This is particularly true when children move from their home environment into a school environment in which the majority language is spoken. Thus, children experience changes in the input that they receive as well as reduced opportunities to speak their home language. For example, Latino children in the USA may go from a home in which both Spanish and English are spoken or a home in which only Spanish is spoken to a school environment where English is the primary language used for communication. As a result, children receive fewer opportunities to hear Spanish, acquire Spanish vocabulary and speak in Spanish with adults and peers (Anderson, 2004). Although relatively few studies have been conducted on language loss of children in the USA, evidence suggests that loss of the children's first language occurs relatively quickly, particularly when parents use the second language at home (cf. Anderson, 1995, 2004).

Clearly, more investigations are needed that study language growth in bilingual children throughout childhood. This study addresses this need by investigating the receptive language development of bilingual preschoolers over a two year period. This study is unique in that it is one of the first longitudinal studies of bilingual preschoolers in the USA who attended Head Start, a group that is considered at risk for poor academic outcomes (Snow *et al.*, 1998). Specifically, the aims of the study were: to examine the developmental trajectories of bilingual children's Spanish and English receptive vocabulary and language comprehension abilities during two years in Head Start, and to determine if differences existed between the trajectories of children exposed to English and Spanish from birth and children who were not expected to communicate in English until entry into Head Start. It was predicted that differences would be found between the two groups at the beginning of Head Start in both languages and that children's development in both languages would follow linear paths. Additionally, it was hypothesised that both groups would experience gains in their English language development and that children who were not exposed to English at home before entry into Head Start would experience more positive growth in their Spanish language development in comparison to children who were exposed to both languages at home.

Method

Participants

Eighty-three children attending Head Start programmes in urban centres in Central Pennsylvania participated in the study. The children were from Puerto Rican neighbourhoods that were established in the 1950s and 60s when migrant workers from Puerto Rico moved to the area. Children who participated qualified financially for Head Start services for two years (meaning that the children were from low income homes), had a mother who spoke the Puerto Rican dialect of Spanish, had no parent or teacher concerns about their development, and passed a developmental and hearing screening administered by the Head Start staff.

Children were divided into two groups, based on the mothers' report of when their children were spoken to in Spanish and English. Specifically, the mothers were asked when they, family members or others at school began talking to their children in English and in Spanish. Children who were spoken to and expected to communicate in English and Spanish in the home were considered to have Home English Communication (HEC, *n*=52). Children who were spoken to in Spanish in the home and were not expected to communicate in English until entry into Head Start at age 3 were classified as having School English Communication (SEC, *n*=31). SEC learners who were reared on the US mainland were likely to have had some exposure to English prior to their attendance in Head Start through television and interactions with individuals in their larger community (Hammer *et al.*, 2004; Kohnert *et al.*, 1999); however, these children's first exposure to the expectation of communicating in English, following directions in English and answering questions in English occurred when they entered Head Start.

In Head Start, the children were instructed primarily in English; however, the vast majority of the children who had no to minimal exposure to English prior to school entry were assigned to classrooms in which either the teacher or the classroom assistant spoke Spanish. Informal observations revealed that at the beginning of the school year, the staff typically addressed individual children in Spanish on occasion during the school day; however, communication to groups of children occurred in English with Spanish interpretation provided infrequently. Use of Spanish quickly faded when the teachers believed that the children comprehended English.

Demographic information, which was gathered by trained home visitors in the spring of the children's first year of Head Start, is presented in Table 1. The children in both groups averaged 3 years 9 months of age, with a larger percentage of children in the SEC group being born in Puerto Rico than in the HEC group. The two groups of mothers did not differ with regard to educational level or employment status. The mothers in both groups averaged less than a high school diploma, and 40% and 60% of the SEC and HEC mothers worked outside the home. Nearly all of the mothers of the SEC learners were born in Puerto Rico as opposed to close to half of the mothers of the HEC learners.

Differences in language usage occurred between the two groups and over time. Mothers in the HEC group reported speaking in English more than mothers in the SEC group during the spring of the children's first year ($p < 0.0001$) and second year ($p < 0.030$) in Head Start. Similarly, children in the HEC were reported to use more English when talking to their mothers than children in the SEC group during both years in Head Start ($p < 0.0001$, $p < 0.042$). Additionally, more mothers in both groups reported using English when speaking to their children in the second year of Head Start as compared to the first (SEC, $p < 0.031$; HEC, $p < 0.0001$). The number of children using English when speaking to their mothers also increased (SEC, $p < 0.033$; HEC, $p < 0.01$).

Procedures

The receptive language abilities of the children were tested in the fall and spring of the children's two years of Head Start. The examiners were trained by the first author, who is a certified speech-language pathologist, and were supervised by the first author and an on-site supervisor who was a fluent, native speaker of Spanish and English. Bilingual examiners who were native speakers of Spanish assessed the children's Spanish language abilities and native speakers of English tested the children in English.

The *Peabody Picture Vocabulary-III* (*PPVT-III*; Dunn & Dunn, 1997) and the *Test de vocabulario imágenes-Peabody* (*TVIP*; Dunn *et al.*, 1986) were used to assess the children's receptive vocabularies in English and Spanish. The receptive language subtest of the *Test of Early Language Development-3* (*TELD-3*; Hresko *et al.*, 1999) was administered to test their English language comprehension abilities, and the auditory comprehension subtest of the *Preschool Language Scale-3* (Spanish version) (*PLS-3*; Zimmerman *et al.*, 1992) was used to assess their Spanish language comprehension abilities.

It is recognised that these tests were standardised on monolingual populations; however, these instruments were chosen for three reasons. First, no receptive language tests standardised on bilingual children were available at the time of the study. Second, the two standardised measures of Spanish language development were selected because the *TVIP* and *PLS-3* Spanish Version included Puerto Rican children in their standardisation samples. Third, the tests demonstrate high reliability and are well accepted measures. Split half and test–rest reliability for the *PPVT-III* is reported to be 0.83–0.97 and 0.77–0.90, respectively. The median internal consistency coefficient for the *TVIP* is 0.93. It should be noted, however, that the *TVIP* is an older test. The internal consistency coefficients for the *PLS-3* Spanish version ranged from 0.86 to 0.91 and the internal consistency coefficient for the *TELD-3* is 0.91. Other established receptive vocabulary measures in Spanish were not available at the time this study was conducted.

Analysis

Growth curves were used to study change among bilingual children's language development (Cudeck, 1996; Heo *et al.*, 2004; Kshirsagar & Smith, 1995). When the focus of a study is on understanding developmental patterns, as it was for this project, the application of growth curves is particularly profitable. The utility of growth curve modelling has been demonstrated in studies where children were assessed over multiple time points (Francis *et al.*, 1991).

One important aspect of growth curve models is their flexibility. They do not require subjects be measured at the same time, nor do they require all subjects to have similar covariance structures. Growth curves parse the unexplained variance into the part that occurs within a subject and the part that occurs between subjects (Lawrence & Hancock, 1998; Raudenbush, 2001), thereby allowing the researcher to more completely understand change. By separating the variance into two components the researcher learns how much of the dispersion in scores is due to differences among subjects and what portion is attributable to measurement error.

Additionally, growth curve modelling focuses on changes in individuals as well as changes in groups. Thus, change is viewed as a continuum within individuals, who are likely to be changing at different rates between measurement occasions.

For this study, growth curves were estimated using a linear mixed model. Linear mixed models are well suited to these types of analyses (Littell *et al.*, 1996; Pinheiro & Bates, 2000; Singer, 1998). An important issue associated with using these models in this context is the estimation of the statistical significance associated with a particular parameter estimate.

The usual way of determining statistical significance is to divide the estimate by its standard error. The result of the division is compared to a reference distribution, frequently the F distribution. At issue is what degrees of freedom should be applied to evaluate the estimate. The numerator degrees of freedom are fairly well settled. They are the degrees of freedom associated with the parameter. Choice of the denominator degrees of freedom is debatable. The reason for the dispute originates with the estimation method. Linear mixed effects models are estimated using maximum likelihood. Hence, the denominator degrees of freedom are a penalised function of the residual and may vary with the parameter being estimated. Many statisticians feel differently about the magnitude of the penalty factor. Because the rationale for not computing a *p*-value is persuasive, this study utilised the Markov Chain Monte Carlo (MCMC) methods to determine the distribution of the parameter estimates and compute confidence intervals around those estimates. The MCMC method repeatedly generates a sample from the posterior distribution of the parameter estimates of a fitted model. The repeated draws produce a distribution of parameter estimates from which the middle, upper and lower points for the 95% confidence interval are calculated. Those are the values reported for the fixed effects estimates. The estimates are considered significant if the confidence interval does not contain zero.

In selecting the covariates, it is important to present estimates that are theoretically and practically sensible while preserving statistical validity. To this end, variables were centred such that a score of zero on the variable fell within the range of the data. To illustrate, the model was constructed using time centred at the first measurement occasion and child age centred at the baseline median age in months (46 months). Centring a variable means that a theoretically meaningful value is selected and then subtracted from all observations. The upshot of centring a predictor variable at a theoretically meaningful value is to make the estimate of the intercept a useful and comprehensible parameter estimate.

The time metric used to construct the growth curves was measurement occasion. Measurement occasions were recorded as ordinal data. The time metric was centred at the first measurement occasion so that the intercept represents the child’s initial score and the slope represents the child’s linear rate-of-change over the period in Head Start. All models were estimated using the R-software (R Core Development Team, 2006).

Models were constructed for the raw score and standard score forms of four outcome measures (*PPVT-III*, *TELD-3*, *TVIP*, *PLS-3*). Thus, eight growth curve models were constructed to examine each of the developmental patterns. Each model was parameterised independently of the others. Hence, some modelling efforts resulted in random slope models while others ended with random intercept models. The objective in determining which model type to report was model fit indices. The model selected had the largest likelihood of being the model, of those considered, to approximate the data generation process.

Both raw and standard scores were examined, because both sources of data are essential to understand bilingual children’s development. Raw score data provide information on changes in children’s knowledge, whereas standard score data offer information about each child’s abilities compared to children of similar ages. Because no tests have been published that are standardised on bilingual children, the comparison population for the four tests employed in this investigation was monolingual speakers of the respective languages.

Results

Descriptive statistics

Table 2 shows descriptive summaries for the language raw score outcome measures. The summaries presented are the means and standard deviations for each of the outcome measures by measurement occasion and bilingual status (i.e. HEC and SEC). Table 3 presents similar information for the standard scores. The summary statistics indicate that, in general, for the *PLS-3* Spanish language outcomes the SEC subjects had higher mean scores compared to HEC subjects at particular time points and lower standard deviations. On the other hand, for the *PPVT-III* and *TELD-3* outcomes it seems that the HEC subjects had both higher mean scores and higher levels of dispersion. On the *TVIP*, the SEC group had both higher mean scores and higher levels of dispersion compared to HEC subjects.

Figure 1 displays proportion of missing data by measurement occasion. Because subjects who provided data on one measure at a particular occasion provided data for all measures, the missing data is displayed in a generic format. The proportion of missing data was the same for the standard score variables; therefore, they are not shown. As the figure illustrates, missing data increased over the four measurement occasions, with the highest proportion missing on any measure being approximately 20%.

Our analytic goal was to use all available data to evaluate our theories. The analytic method employed permitted unbiased parameter estimation given the missing data mechanism operated in a way that made the conditional missing values unrelated to unobserved outcomes. A missing data mechanism with these characteristics is called missing at random (e.g. Schafer, 1997). Missing at random was considered plausible given the study design.

Raw score growth curve models

The best model for the raw *PPVT-III* was a random intercept model. Results appear in Table 4. The model contained both a linear rate-of-change (Time) (β= 4.3, $p < 0.05$) and an acceleration term (Time^2) (β=1.8, $p< 0.05$), suggesting the children learned English at an ever increasing rate. In addition, the main effect for bilingual group (Bilingual status SEC) was significant. It suggested that children with SEC had lower baseline *PPVT-III* scores (β= −9.45, $p < 0.05$) than children with HEC. Notice that the 95% confidence interval for the beta weight associated with the SEC group is very wide. It spans a difference in *PPVT-III* score of approximately −4 to −15. The wide interval reflects the uncertainty associated with bilingual effect on the response variable. That is, a group difference occurred, but because of the variation that exists within the two groups, the size of the difference score is imprecise. The difference between the two groups could be between 4 and 15 points.

The presence of a significant acceleration term in the model suggests that children's *PVTT-III* scores increase in a nonlinear fashion. That is, the model indicates that after entering Head Start, the children's *PPVT-III* scores increase at an increasing rate. This acceleration is evidenced by the positive curvature in the developmental trajectory shown in Figure 2. The acceleration component is positive and implies the scores accelerate at approximately 3.6 units per year in addition to the linear rate-of-change of 8.6 units per year. If one considers that the parameter estimates reflect the expected or average rate-of-change, then children above or below that value may be of interest. For example, a child who scores one standard deviation above the mean trajectory (approximately 34% of the subjects would be between the mean and one standard deviation above it) would accelerate at 4.4 units per year with a linear rate-of-change near 11.6 units per year.

Additionally, the model implies that children in the HEC group begin Head Start with higher scores and that this difference at baseline remains intact throughout Head Start. That is, the child's bilingual group is indicative of differences in children's English receptive vocabulary at the outset of Head Start, and those differences do not diminish during the children's two years in Head Start.

Turning to the *TELD-3* raw scores, the best fitting growth curve model contained a random intercept. Table 5 displays the estimated parameters for this model. The linear rate-of-change (Time) was positive and unaffected by bilingual group. The average child is expected to increase approximately 2.8 units per year on the *TELD-3*. The children with SEC had significantly lower baseline scores (Bilingual status SEC) ($\beta = -3.7$, $p < 0.05$). The children's age was shown to influence baseline scores, with older subjects having the higher scores, approximately 0.4 units higher per year older. Figure 3 displays the model-implied trajectories for each bilingual group.

For the Spanish measures, the best model for the raw *TVIP* was a random slope model. Table 5 displays the model estimates for the raw score growth model, which has two significant predictor variables. The first was the linear rate-of-change (Time) ($\beta = 2.01$, $p < 0.05$), suggesting that for each additional year in Head Start, the child's *TVIP* score was expected to increase by approximately four units. The second predictor was the child's bilingual status (Bilingual group SEC), which showed SEC children had, on average, higher baseline scores ($\beta \approx 3.3$, $p < 0.05$). Figure 4 displays the predicted trajectories of the two groups.

The second Spanish language instrument used was the *PLS-3*. The best model for the raw *PLS-3* was a random intercept model. The Bilingual Group term indicates that the SEC group has higher scores at baseline compared to the HEC group (see Table 7; $\beta = 4.6$, $p < 0.05$). The intercept was also affected by the child's age, with older children having higher baseline scores ($\beta = 0.07$, $p < 0.05$). To illustrate, the effect of a child being one month above the median age was to increase the intercept by 0.07 points, but the effect of a child being two months above the median age was to increase the intercept by 0.28 units, a four-fold increase. The linear rate-of-change was positive ($\beta = 2.9$, $p < 0.05$). The estimated linear rate-of-change for the *PLS-3* implied that an average child's *PLS-3* score increased almost 6 units per year in Head Start. However, the linear rate-of-change was moderated by the subject's age squared. This means that as the child's age increased above the median age, the effect of age on the linear rate-of-change became more pronounced in a similar fashion but opposite to its effect on the intercept ($\beta = -0.02$, $p < 0.05$). Thus, older children began with higher scores but exhibited shallower growth trajectories.

Figure 5 displays the estimated *PLS-3* Raw trajectories for a child of the median age. The display shows not only how close the two groups were in their expected development but also demonstrates that the growth trajectories are parallel. The predicted developmental pattern for both groups is positive, with the SEC group's trajectory always in the superior position.

Standard score growth curve models

The standard scores are raw scores transformed to age-appropriate normalised scores, as determined by the developers of each test. The standard score shows the position of the child's raw score on the instrument relative to a monolingual child's expected score of 100. For example, a bilingual child with the same performance on the *PPVT-III* as an average monolingual English speaker would have a baseline score of 100 and a flat trajectory.

For the *PPVT-III*, the best model was a random slope model, which is the first model found in this paper that contains a random slope. The implication of the random slope is that there is a significant between-child variation in the rate-of-change. In the previous four models for children's raw scores, the significant variation in children's development has been restricted to the baseline score. For the *PPVT-III* standard scores, the variation among children in their development is significantly different from zero and is unexplained by any of the variables considered in the model.

The model estimates, shown in Table 6, demonstrate that children's scores differ at baseline according to their bilingual group, with the SEC group having significantly lower vocabulary scores than the HEC group ($\beta = -15.4$, $p < 0.05$). The estimate of the intercept shows that the HEC child's expected baseline score was approximately 25 units below the average monolingual English speaker ($\beta \approx 76$, $p < 0.05$). But the linear rate-of-change reflects a significant positive linear rate-of-change that is moderated by bilingual group. Besides the lower intercept score, the SEC children have, on average, a more positive linear rate-of-change ($\beta = 2.51$, $p < 0.05$). Again, the diversity in ability on this measure among SEC children is evidenced by the wide confidence interval for the interaction of bilingual group with time.

Figure 6 exhibits the modelling results. The children with HEC have higher expected scores but the magnitude of their advantage over children with SEC diminishes over time.

Like the *PPVT-III* standard score model, the best model for the *TELD-3* standard scores was a random slope model. The model estimates are provided in Table 6. The intercept estimate shows that children with HEC performed below an average English speaking child of similar age ($\beta = 83.6$, $p < 0.05$). The significant bilingual main effect ($\beta = -10.6$, $p < 0.05$) pointed to the fact that children with SEC had a lower baseline *TELD-3* score than children with HEC. Still, the confidence interval for this estimate was wide, indicating substantial variation among these bilingual SEC children. The preferred growth model also contained a term for linear rate-of-change. The linear rate-of-change term was positive, indicating that these children were acquiring comprehension of English language at a significantly higher rate than their monolingual counterparts were ($\beta = 3.73$, $p < 0.05$). Figure 7 visually displays the estimated growth curves for each bilingual group.

Following the pattern established for standard score models, the best model for the standard *TVIP* was a random slope model. Table 7 shows the parameter estimates for the *TVIP* standard scores. The intercept estimate shows that children in the HEC group scored, on average, below their monolingual counterparts (β = 78.1, $p < 0.05$). The intercept was statistically different by bilingual group (β = 4.57, $p < 0.05$) and centred age (β = 1.2, $p < 0.05$). This implies that children with SEC had higher intercept scores. As the information in Table 7 indicates, the effect of centred age was to lower the predicted intercept score by approximately 1.2 units for each month increase in age above the median holding all other variables constant. The linear rate-of-change estimate was positive but not different from zero (β = 0.5, $p < 0.05$). This implies that the receptive vocabulary abilities of children in the HEC group developed at a rate commensurate with their monolingual Spanish counterparts. Even though the linear rate-of-change was nonexistent for the HEC group, it was present for the SEC group. Children with SEC exhibited a positive (β = 2.9, $p < 0.05$) linear rate-of-change in their *TVIP* scores, meaning that their scores were becoming closer to the average monolingual Spanish speaking child.

Figure 8 displays the predicted growth trajectories for the standard *TVIP* according to bilingual group. The trajectories diverge with the passage of time, thereby demonstrating the SEC group's advantage in Spanish language development.

Like the *PLS-3* raw score model, the best model for the Standard score *PLS-3* was a random intercept model (see Table 7). Once again, the modelling reveals that the children in the HEC group score below the Spanish speakers on whom the test was normed. And, once again, bilingual children differ with the SEC children, more closely approximating the monolingual speakers at baseline (β = 8.1, $p < 0.05$). Furthermore, older children scored lower at baseline (β = −0.9, $p < 0.05$), suggesting that for each month increase in centred age the children's *PLS-3* score declined approximately one unit at baseline. The final model contained terms for estimating a linear rate-of-change as well as acceleration. The linear rate-of-change in the standard *PLS-3* was positive (β = 11, $p < 0.05$), but the acceleration was negative (β = −4.8, $p < 0.05$). This indicates that the children were learning Spanish faster than the monolingual comparison group, but their advantage abated over time. Moreover, even though they began with lower baseline scores, older children's linear rate-of-change was more positive, indicating that their language comprehension abilities in Spanish increased at a higher rate (β = 0.56, $p < 0.05$) compared to younger children.

Figure 9 displays the predicted trajectories for each bilingual group at each measurement occasion. The negative acceleration discussed above is novel for the developmental trajectories reviewed here and is obvious in the plot. Because the children were measured at only four occasions, it is not clear what future development would look like on this measure.

Discussion

This investigation examined the receptive vocabulary and oral language comprehension development of bilingual preschoolers from low income homes who attended Head Start for two years. During this two-year period, the children experienced a significant change in their linguistic environment during their daytime hours; that is, entrance into a preschool programme that provided instruction almost exclusively in English and in which communication in English, at the exclusion of Spanish, was the expectation. Comparisons were made between the developmental trajectories of children who were communicated to in Spanish and English at home before entering Head Start (HEC) and children who did not communicate in English until age 3 when they began Head Start (SEC).

Differences based on timing of exposure to English

The findings of this investigation confirm our hypothesis and the assertion made by Butler and Hakuta (2004), Genesee (2004) and Oller and Eilers (2002) that the timing of exposure to English in relation to school entry is a key factor that needs to be considered when studying bilingual children's language development. Children with dual language exposure in the home prior to Head Start (HEC) had English receptive vocabulary and language comprehension abilities that were significantly higher than children who were not expected to communicate in English until attendance in Head Start (SEC) at age 3, as measured by raw and standard scores. The opposite was true for children's Spanish abilities. Children who were only exposed to Spanish in the home had significantly higher Spanish receptive vocabulary and language comprehension abilities at the beginning of Head Start. These differences are consistent with the findings of Oller, Eilers and colleagues (Fernández *et al.*, 1992; Oller & Eilers, 2002; Umbel *et al.*, 1992), although the children in this study were a minimum of two years younger.

The differences that were observed between the two groups at the beginning of Head Start were maintained throughout the two years, as demonstrated by raw scores on all four language measures and standard scores on the two language comprehension measures. Thus, the two groups started and ended Head Start with differences in their scores. The exceptions to this were the standard scores on the receptive vocabulary tests in each language. Instead of maintaining the differences in standard scores on the *TVIP*, the Spanish vocabulary test, the gap between the two groups increased over time. Specifically, children exposed to only Spanish before school demonstrated a positive rate of growth over the two years; however, children with bilingual exposure at home prior to school entry did not exhibit changes in their standard scores during the preschool years. Children who were not expected to communicate in English prior to preschool experienced more communication in Spanish at home than children from dual language homes. This difference in the amount of input in Spanish at home, the primary source of Spanish input, may have been necessary for children to make gains in their Spanish vocabulary in comparison to monolingual Spanish speaking children upon which the test was normed.

Contrary to the Spanish vocabulary results, the gap between the two groups narrowed over time on the English vocabulary measure, with the children with only Spanish exposure prior to school entry learning at a faster rate than the children who were exposed to both languages prior to entrance into Head Start. The change in the language environment may have resulted in this outcome. That is, when children entered Head Start, they experienced a dramatic change in their language learning environment during the time that they spent in school. They went from a home that emphasised Spanish primarily to a school environment in which English was the predominant and expected language of communication. Therefore, children with only Spanish exposure at home prior to school entry needed to adapt faster to this change in the environment than children who had received input in Spanish and English in the home. Additionally, children from Spanish speaking homes prior to school also experienced changes in the language environment in the home over the two-year period. Our preliminary analysis of the data shows that more English is used in the home over time between the mothers and children. Because children with only Spanish in the home had limited knowledge of English at the beginning of the study, they had to quickly adapt to an English speaking environment at school. They also experienced more English in the home over time. These factors resulted in greater gains in their receptive language vocabulary development than children with bilingual exposure at home. It should be noted, however, that the gap between the two groups did not close by the end of the second year. Continued study of these children will reveal whether this gap closes completely.

Growth trajectories

Consistent with the findings of Pan *et al.* (2005), who studied low income monolingual children, and Uchikoshi (2006), who followed low income bilingual children, the results of this investigation confirmed that many aspects of the receptive language growth of bilingual children from low income homes followed a linear trajectory. Children's English language trajectories were linear, as measured by their standard scores on the receptive vocabulary test and raw and standard scores on the language comprehension test. Additionally, the children's Spanish language development was linear, as evidenced by raw and standard vocabulary scores and raw scores on the language comprehension test. At this point, however, it is unclear if linear development was the result of learning two languages or the result of being from low-SES homes.

There were two exceptions to the hypothesis that low income, bilingual children's receptive development would follow a linear path. These exceptions were shown in the growth curves of the children's raw scores on the *Peabody Picture Vocabulary Test-III* and the Spanish version of the auditory comprehension subtest of the *Preschool Language Scale-3*. Specifically, during their two years in Head Start, the children's English receptive vocabulary grew at increasing rates, as demonstrated by raw scores. This is consistent with research on the vocabulary development of monolingual children (cf. Fernald *et al.*, 2006; Huttenlocher *et al.*, 1991). It may be that the increased use of English at home and the input the children received in Head Start accelerated their development in English. However, this increasing rate of change in raw scores was not sufficient to accelerate children's development as measured by standard scores. It may be that monolingual children in the norming sample of the *PPVT-III* also experienced nonlinear growth in their raw scores. Therefore, the bilingual children in our sample were not able to gain on their monolingual counterparts as measured by standard scores.

In addition, children's Spanish language comprehension, as demonstrated by their standard scores, did not show linear growth over the two-year period. Although children showed linear growth during the first year of Head Start, this was followed by a deceleration during the remainder of Head Start. Thus, the children demonstrated linear growth in their raw score performance during their preschool years, but demonstrated a rapid decrease in their

Spanish receptive language abilities in comparison to monolingual children. It appears that children's exposure to Spanish at home is insufficient to support children's development of Spanish that is commensurate with monolingual children. Further studies will be conducted to address the role of home language usage on children's outcomes.

Development of English language abilities

Our results also confirm our hypothesis that children in both groups would experience positive growth in their English language abilities during their preschool years. Children in both groups exhibited positive rates of growth in their English receptive vocabulary and language comprehension, as measured by raw and standard scores. This was expected, because children in both groups experienced a significant change in their linguistic environment at age three. Children went from a home environment in which only Spanish or a mixture of Spanish and English was used, to a school environment that used English as the primary language of communication. Additionally, changes in the children's language environment at home were occurring at this time.

Our findings also showed that children who were older at the first measurement occasion had higher baseline scores than younger children. Given that raw scores are not adjusted for children's ages as are standard scores, it seems probable that older children would pass more items than younger children. However, this result was only demonstrated for the measure of English language comprehension and not vocabulary. It may be that the vocabulary items targeted by the *PPVT-III* are more school based than the items on the *TELD-3* and, therefore, older children did not have an advantage over younger children as the children attended an educational programme for the same amount of time.

Our results also showed that wide variations existed among the children's receptive language development and, in particular, their English vocabularies. Wide variations were observed in their raw scores at baseline and in their rates of growth as determined by their standard scores. As noted by Bialystok (2001), bilingual children constitute a heterogeneous group due to differences in the timing of and amount of exposure to their two languages.

Development of Spanish language abilities

The results, however, only partially supported our hypothesis that children with only Spanish exposure in the home prior to Head Start would experience more positive growth in their Spanish language development than children from bilingual homes. In particular, only the findings on children's standard scores on the receptive vocabulary supported our hypothesis. Children with only Spanish exposure prior to school entry demonstrated higher rates of growth on their standard scores on the receptive vocabulary measure than children with bilingual exposure. Children with only Spanish exposure prior to Head Start gained on their monolingual counterparts during Head Start whereas children with bilingual exposure prior to Head Start did not.

The growth curves of the children's raw scores on the Spanish receptive vocabulary and language comprehension measures did not support our prediction, as children in both groups made positive gains over time. Recall, however, that the children with only Spanish exposure began with higher scores and maintained those higher scores over the two years.

Additionally, the growth curves on children's standard scores on language comprehension did not support our hypothesis. Recall that the growth curves for the standard scores of the Spanish language comprehension measure demonstrated a positive rate of development during the children's first year in Head Start and then a deceleration during the remaining one and a half years of the study. Thus, children in both groups appeared to be losing their language comprehension abilities in Spanish after a significant change in the language environment occurred. It appears that children's Spanish exposure in the home was insufficient to support children's maintenance of their ability to comprehend Spanish. It is unclear, however, why children's vocabulary abilities were not lost but their overall comprehension abilities were.

As noted with children's English abilities, age also impacted children's Spanish vocabulary abilities and language comprehension, which was not predicted. Older children began the investigation with lower standard scores on the receptive vocabulary measure than their younger counterparts. Because the children in this study were at the lower age limit of the test, it is possible that younger children were not able to receive standard scores below a particular level. In fact, the lowest standard score the youngest child in our study could receive was 87, whereas the oldest child could receive a score as low as 68. Therefore, the *TVIP* does not appear to be able to make fine discriminations among the abilities of children at the younger end of its age range.

Similar to children's performance on the English language comprehension measures, older children began the study with higher receptive language abilities than their younger peers; however, older children had shallower growth trajectories as measured by raw scores, but more positive rates of growth as measured by standard scores. The test publishers' procedures for converting raw scores into standard scores may explain the unexpected results. Our attempts to contact the test publisher for this information, however, were unsuccessful.

Conclusions and Future Directions

The findings of this investigation demonstrated that the timing of exposure to English in relation to school entry impacts children's development in English as well as Spanish. Thus, the timing of children's exposure to English is a key factor to be considered in subsequent investigations of the language abilities of bilingual children. Additionally, it is important to learn if the gaps that were observed during the preschool years remain after continued exposure to English in school. We will be able to address this question, as we have continued to follow all of the children through first grade and a subset of the children through second and third grades.

This investigation also showed that bilingual children's English language abilities grew positively during two years in Head Start and that the children were making gains on monolingual children, as demonstrated by changes in their standard scores. Although positive growth occurred in children's Spanish language abilities as shown by their raw scores, the growth that was observed in children's Spanish language standard scores was not as positive as their English growth. In fact, a negative pattern was observed in their auditory comprehension of Spanish. Future investigations are needed to replicate this finding and to determine whether children's Spanish and English receptive language abilities continue to develop in the current directions. Inspection of the data also revealed that wide variations in the children's language abilities occurred. It is likely that differences in the children's home environment, such as language usage in the home, the presence of older siblings, generational status (that is, the number of generations the family has lived on the US mainland), exposure to literacy events in the home, etc., impact children's language outcomes. In subsequent studies, we will investigate the relationships between environmental variables and the children's language development to determine factors that influence children's language trajectories.

Additionally, the evidence from this investigation suggests that bilingual children's language development, as measured through raw scores, follows a linear trajectory. Children's English receptive vocabulary development, which accelerated over time, was the exception to this. Studies are needed that replicate these findings. In addition, it is important to determine whether the linear growth that was observed is due to the influences of bilingualism or the influences of being from homes with limited resources. Studies that compare the growth trajectories of bilingual children of middle SES and low SES will address this question. Such investigations will greatly add to the field's understanding of the language development of bilingual children living in communities in which bilingualism is not the norm and one of the languages spoken by the families is a minority language.

Acknowledgements

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References

Anderson, R. Spanish morphological and syntactic development. In: Kaiser, H., editor. Bilingual Speech-language Pathology: An Hispanic Focus. San Diego, CA: Singular Publishing Group, Inc; 1995.

Anderson, R. First language loss in Spanish-speaking children: Patterns of loss and implications for clinical practice. In: Goldstein, B., editor. Bilingual Language Development and Disorders in Spanish–English Speakers. Baltimore, MD: Paul H. Brookes; 2004. p. 187-212.

Bialystok, E. Bilingualism in Development: Language, Literacy and Cognition. Cambridge: Cambridge University Press; 2001.

Bryk, AS.; Raudenbush, SW. Hierarchical Linear Models: Applications and Data Analysis Methods. Newbury Park, CA: Sage; 1992.

Butler, Y.; Hakuta, K. Bilingual and Second Language Acquisition. The Handbook of Bilingualism. Malden, MA: Blackwell; 2004. p. 114-144.

Cudeck R. Mixed-effects models in the study of individual differences with repeated measures data. Multivariate Behavioral Research. 1996; 31:371–403.

Duncan TE, Duncan SC. Modeling the processes of development via latent variable growth curve methodology. Structural Equation Modeling Journal. 1995; 2:187–213.

Duncan, TE.; Duncan, SC.; Strycker, LA.; Li, F.; Alpert, A. An Introduction to Latent Variable Growth Curve Modeling: Concepts, Issues, and Applications. Mahwah, NJ: Lawrence Erlbaum; 1999.

Dunn, LW.; Dunn, LM. Peabody Picture Vocabulary Test-III. Circle Pines, MN: American Guidance Service; 1997.

Dunn, LW.; Padilla, L.; Dunn, LM. Test de vocabulario en imágenes Peabody. Circle Pines, MN: American Guidance Service; 1986.

Fenson, L.; Dale, P.; Reznick, J.; Thal, D.; Bates, E.; Hartung, J.; Pethick, S.; Reilly, J. Technical Manual for the MacArthur Communicative Development Inventories. San Diego, CA: Singular Press; 1993.

Fernald A, Perfors A, Marchman V. Picking up speed in understanding. Speech processing efficiency and vocabulary growth across the second year. Developmental Psychology. 2006; 42(1):98–116. [PubMed: 16420121]

Fernández M, Pearson B, Umbel V, Oller D, Molinet-Molina M. Bilingual receptive vocabulary in Hispanic preschool children. Hispanic Journal of Behavioral Sciences. 1992; 14:268–276.

Fitzmaurice, GM.; Laird, NM.; Ware, JH. Applied Longitudinal Analysis. Hoboken, NJ: John Wiley & Sons; 2004.

Francis D, Fletcher J, Stuebing K, Davidson K, Thompson N. Analysis of change: Modeling individual growth. Journal of Consulting and Clinical Psychology. 1991; 59:27–37. [PubMed: 2002140]

Genesee, F. What do we Know about Bilingual Education for Majority-language Students? The Handbook of Bilingualism. Malden, MA: Blackwell; 2004. p. 547-576.

Genesee, F.; Paradis, J.; Crago, M. Dual Language Development and Disorders. Baltimore: Paul H. Brookes; 2004.

Goldfield B, Reznick JS. Early lexical acquisition: Rate, content and the vocabulary spurt. Journal of Child Language. 1990; 17(1):171–183. [PubMed: 2312640]

Hammer, CS.; Miccio, AW.; Rodríguez, B. Bilingual language development and the child socialization process. In: Goldstein, B., editor. Bilingual Language Development: A Focus on Spanish-English Speakers. Baltimore, MD: Paul H. Brookes; 2004. p. 21-50.

Hart, B.; Risley, T. Meaningful Differences in the Everyday Experience of Young American Children. Baltimore, MD: Paul H. Brookes; 1995.

Hedeker, D.; Gibbons, RD. Longitudinal Data Analysis. Hoboken, NJ: Wiley; 2006.

Heo, M.; Faith, MS.; Mott, JW.; Gorman, BS.; Redden, DT.; Allison, DB. Hierarchical linear models for the development of growth curves: An example with body mass index in overweight/obese adults. In: D'Augostino, RB., editor. Tutorials in Biostatistics. Vol. Vol. 2. Chichester, England: John Wiley & Sons; 2004. p. 95-126.

Hresko, W.; Reid, DK.; Hammill, D. Test of Early Language Development – 3. Austin, TX: ProEd Publishers; 1999.

Huttenlocher J, Haight W, Bryk A, Seltzer M, Lyons T. Early vocabulary growth: Relation to language input and gender. Developmental Psychology. 1991; 27:2, 236–248.

Jackson-Maldonado D, Bates E, Gutiérrez-Clellen V. Early lexical development in Spanish-speaking infants and toddlers. Journal of Child Language. 1991; 20:523–549. [PubMed: 8300774]

Kohnert KJ, Bates E, Hernandez AE. Balancing bilinguals: Lexical-Semantic production and cognitive processing in children learning Spanish and English. Journal of Speech, Language, and Hearing Research. 1999; 42:1400–1413.

Kshirsagar, AM.; Smith, WB. Growth Curves. New York: Marcel Dekker; 1995.

Lawrence FR, Hancock GR. Assessing change over time using latent growth modeling. Measurement and Evaluation in Counseling and Development. 1998; 30(4):211–224.

McArdle JJ, Epstein D. Latent growth curves within developmental structural equation models. Child Development. 1987; 58:110–133. [PubMed: 3816341]

Meredith W, Tisak J. Latent curve analysis. Psychometrika. 1990; 55:107–122.

Merino, B. Acquisition of syntactic and phonological features in Spanish. In: Butler, KG., editor. Hispanic Children and Adults with Communication Disorders. Gaithersburg, MD: Aspen Publishers, Inc.; 1992.

Muthen, BO. Analysis of longitudinal data using latent variable models with varying parameters. In: Collins, LM.; Horn, JL., editors. Best Methods for the Analysis of Change: Recent Advances, Unanswered Questions, Future Directions. Washington, DC: American Psychological Association; 1991.

Muthen BO, Curran PJ. General longitudinal modeling of individual differences in experimental designs: A latent variable framework for analysis and power estimation. Psychological Methods. 1997; 2(4):371–402.

Oller, DK.; Eilers, RE. Language and Literacy in Bilingual Children. Tonawanda, NY: Multilingual Matters; 2002.

Pan B, Rowe M, Singer J, Snow C. Maternal correlates of growth in toddler vocabulary production in low-income families. Child Development. 2005; 76:763–782. [PubMed: 16026495]

Pearson B, Fernández S, Lewedeg V, Oller K. The relation of input factors to lexical learning by bilingual infants. Applied Psycholinguistics. 1997; 18:41–58.

Pinheiro, JC.; Bates, DM. Mixed-effects Models in S and S-plus. New York: Springer; 2000.

Portes, A.; Rumbaut, R. Legacies: The Story of the Immigrant Second Generation. Berkeley, CA: University of California Press; 2001.

R Core Development Team. R: A Language and Environment for Statistical Computing (Version 2.1.1). Vienna, Austria: R Foundation for Statistical Computing; 2005.

Raudenbush, SW. Alternative covariance structures for polynomial models of individual growth and change. In: Moskowitz, DS.; Hershberger, SL., editors. Modeling Intraindividual Variability with Repeated Measures Data: Methods and Applications. Mahwah, NJ: Lawrence Erlbaum; 2002a. p. 25-58.

Raudenbush, SW. Toward a coherent framework for comparing trajectories of individual change. In: Collins, LM.; Sayer, AG., editors. New Methods for the Analysis of Change. Washington, DC: American Psychological Association; 2002b. p. 33-64.

Restrepo MA, Silverman S. Validity of the Spanish Preschool Language Scale-3 for use with bilingual children. American Journal of Speech-Language Pathology. 2001; 10:382–393.

Rovine, MJ.; Molenaar, PC. A structural equations modeling approach to the general linear mixed model. In: Collins, LM.; Sayer, AG., editors. New Methods for the Analysis of Change. Washington, DC: American Psychological Association; 2002. p. 65-96.

Schafer, JL. Analysis of Incomplete Multivariate Data. London: Chapman & Hall; 1997.

Singer JD. Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. Journal of Educational and Behavioral Statistics. 1998; 24:323–355.

Snow, CE.; Burns, MS.; Griffin, P. Preventing Reading Difficulties in Young Children. Washington, DC: National Academy Press; 1998.

Stoolmiller, M. Using latent growth curve models to study developmental processes. In: Gottman, JM., editor. The Analysis of Change. Mahwah, NJ: Lawrence Erlbaum; 1995. p. 103-138.

Uchikoshi Y. English vocabulary development in bilingual kindergarteners: What are the best predictors? Bilingualism, Language and Cognition. 2006; 9(1):33–49.

Umbel VM, Pearson BZ, Fernández MC, Oller DK. Measuring bilingual children's receptive vocabularies. Child Development. 1992; 63(4):1012–1020. [PubMed: 1505238]

Willett JB, Sayer AG. Using covariance structure analysis to detect correlates and predictors of individual change over time. Psychological Bulletin. 1994; 116:363–381.

Woodcock, RW.; Muñoz-Sandoval, AF. Woodcock Language Proficiency Battery-Revised Spanish form. Itasca, IL: Riverside Publishing; 1995.

Zimmerman, I.; Steiner, V.; Pond, R. Preschool Language Scale-3. Spanish Edition. San Antonio, TX: Psychological Corporation; 1992.

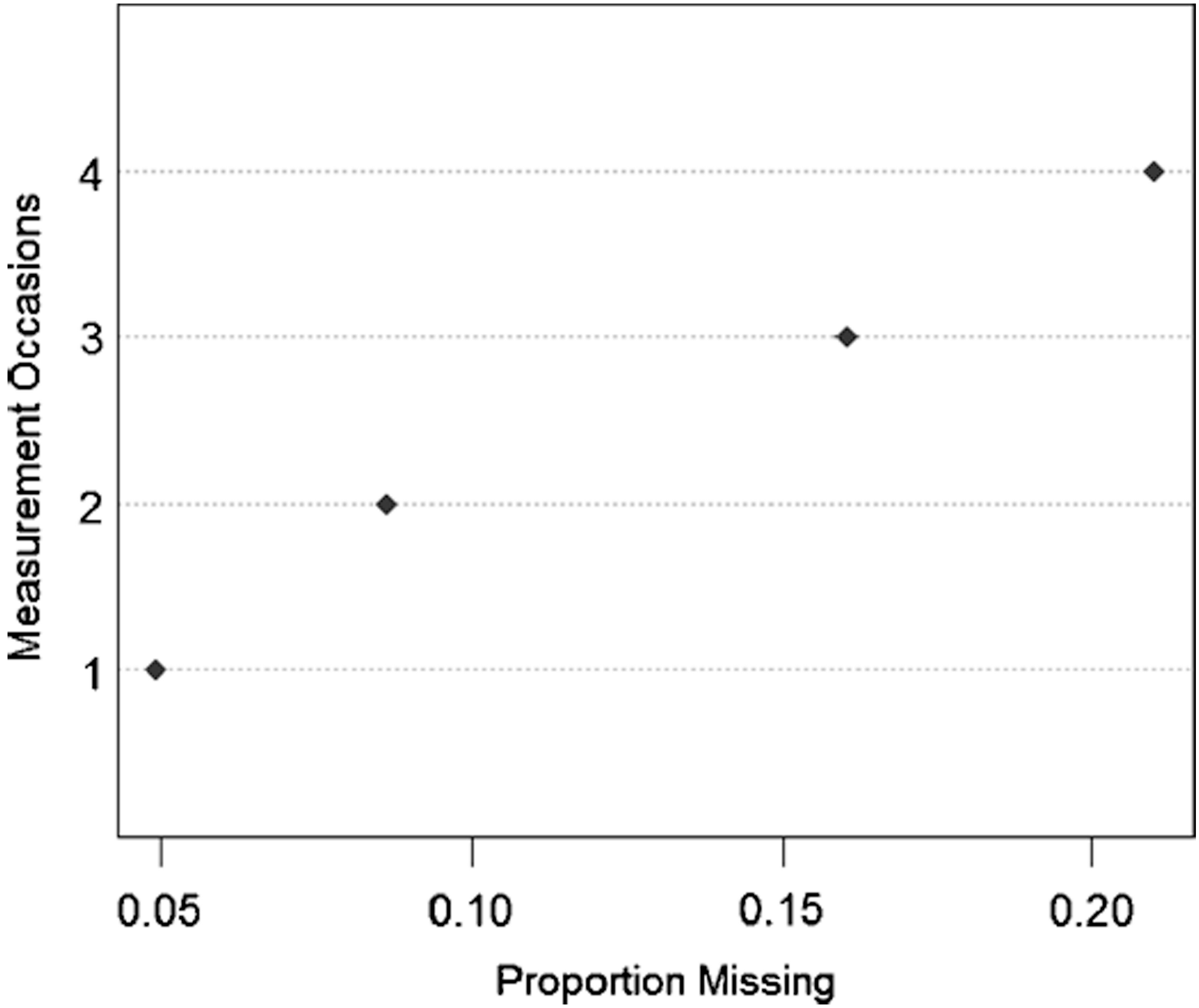

Figure 1.
Proportion missing data by measurement occasion

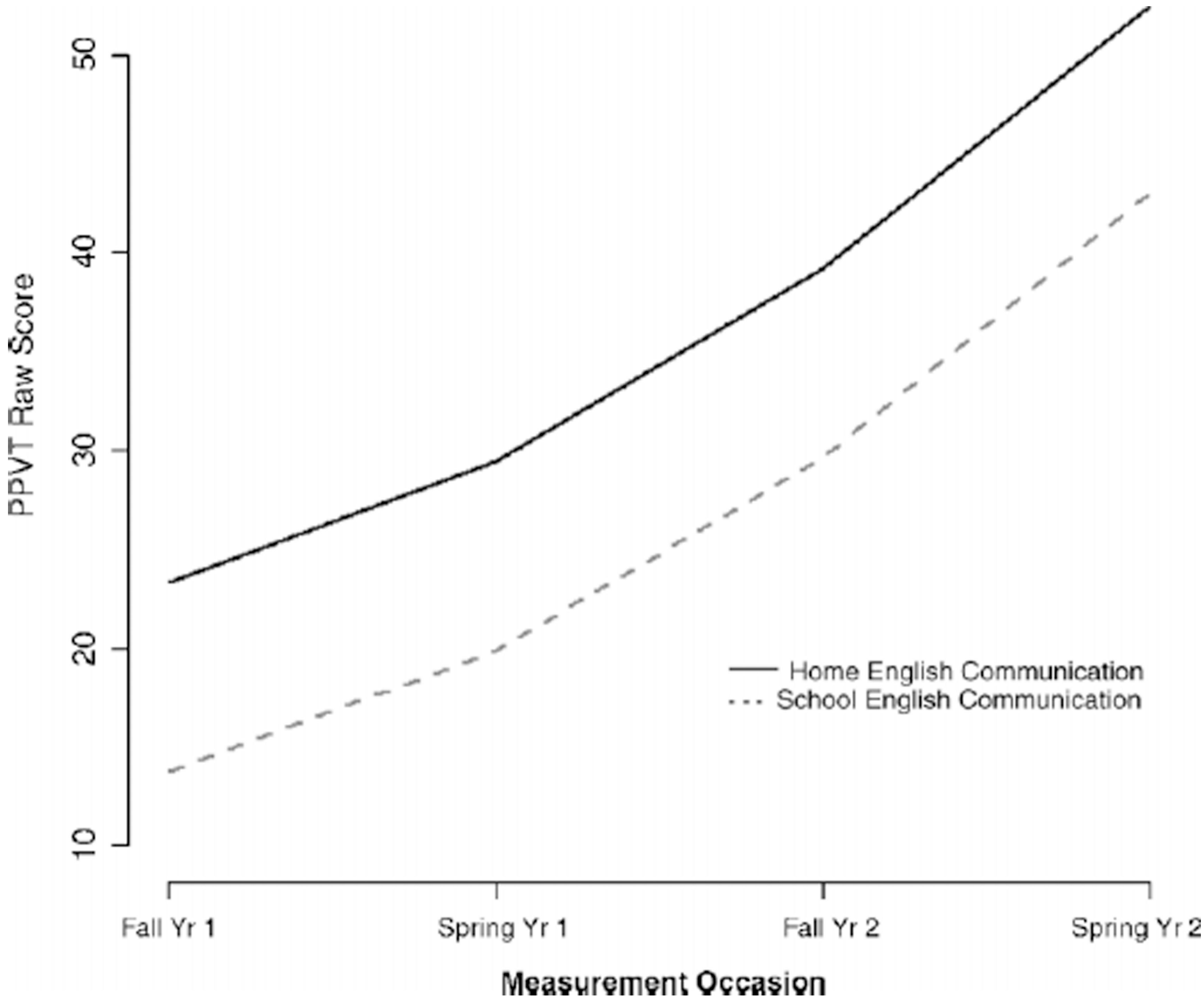

Figure 2.
Trajectory for PPVT-III raw score by bilingual status

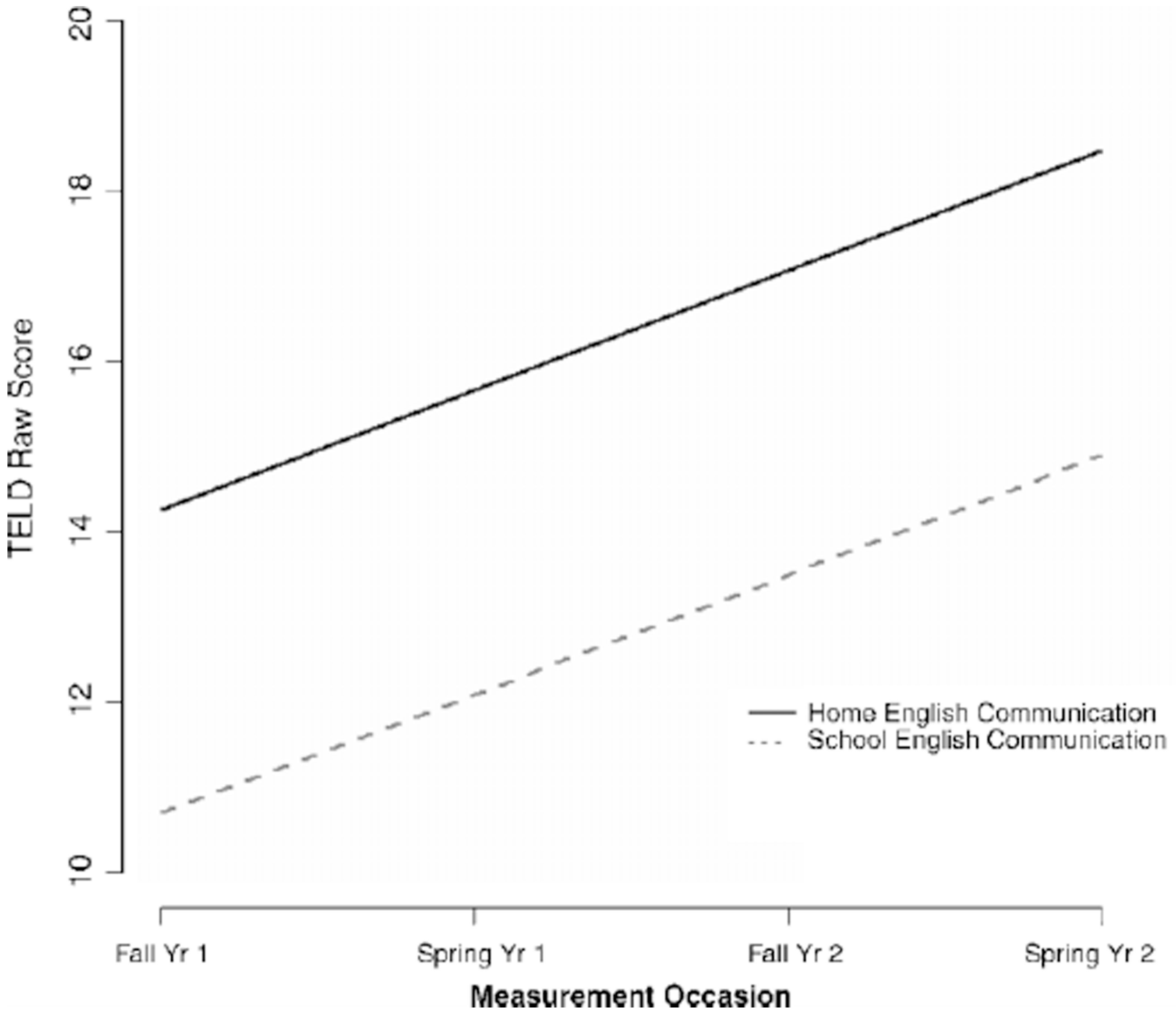

Figure 3.
Trajectory for TELD-3 raw score by bilingual status

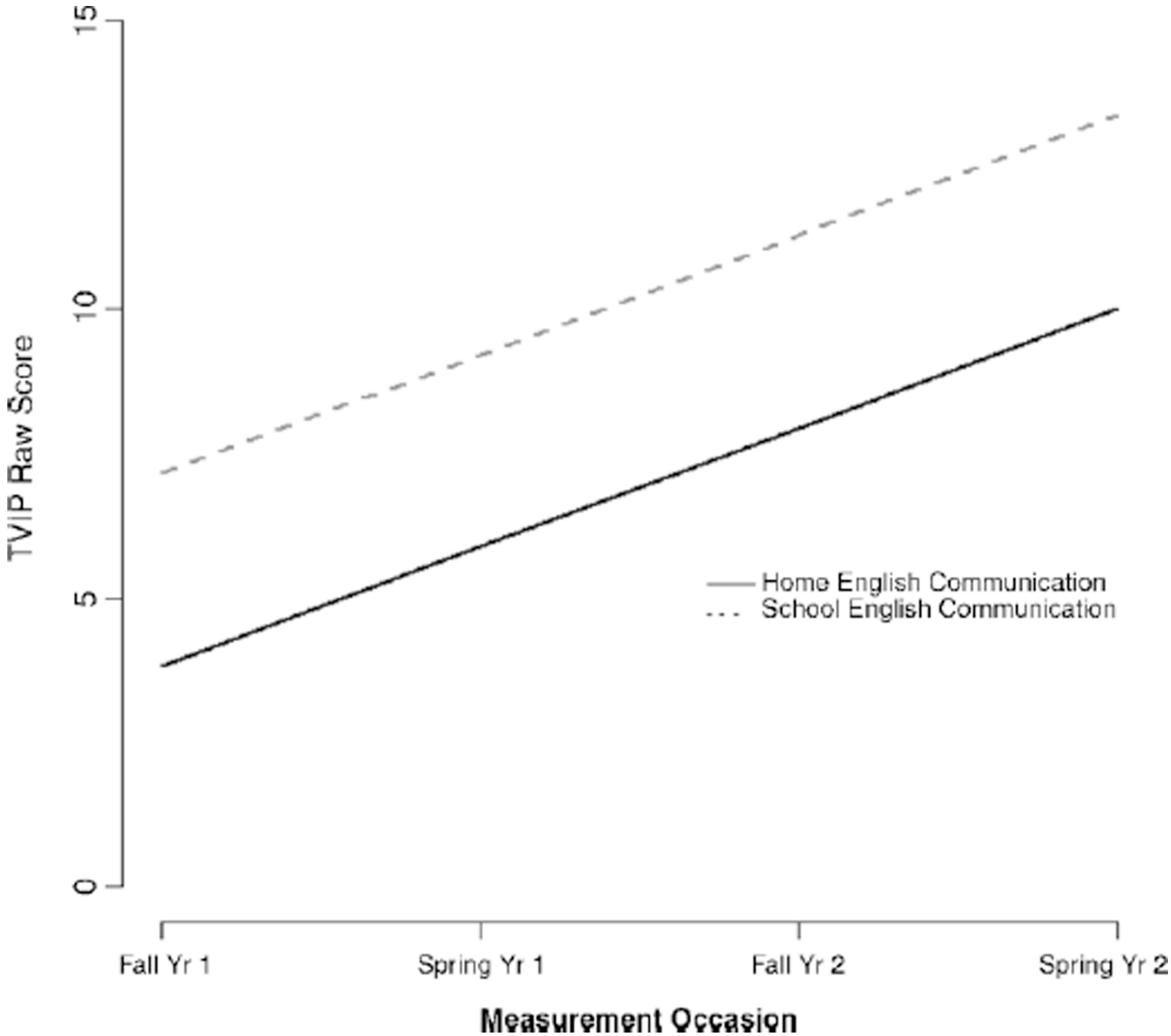

Figure 4.
Trajectory for TVIP raw score by bilingual status

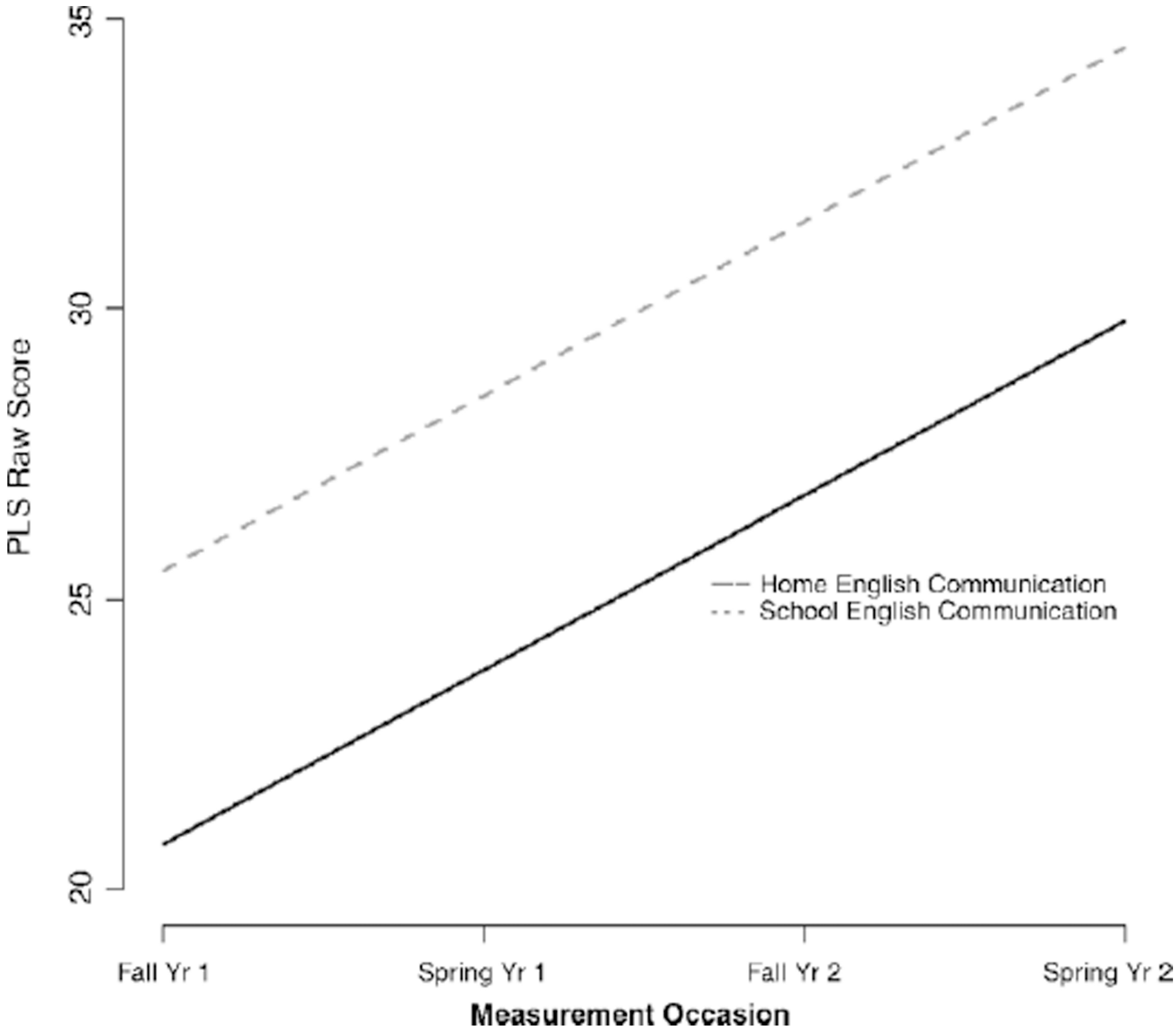

Figure 5.
Trajectory for PLS-3 standard score by bilingual status

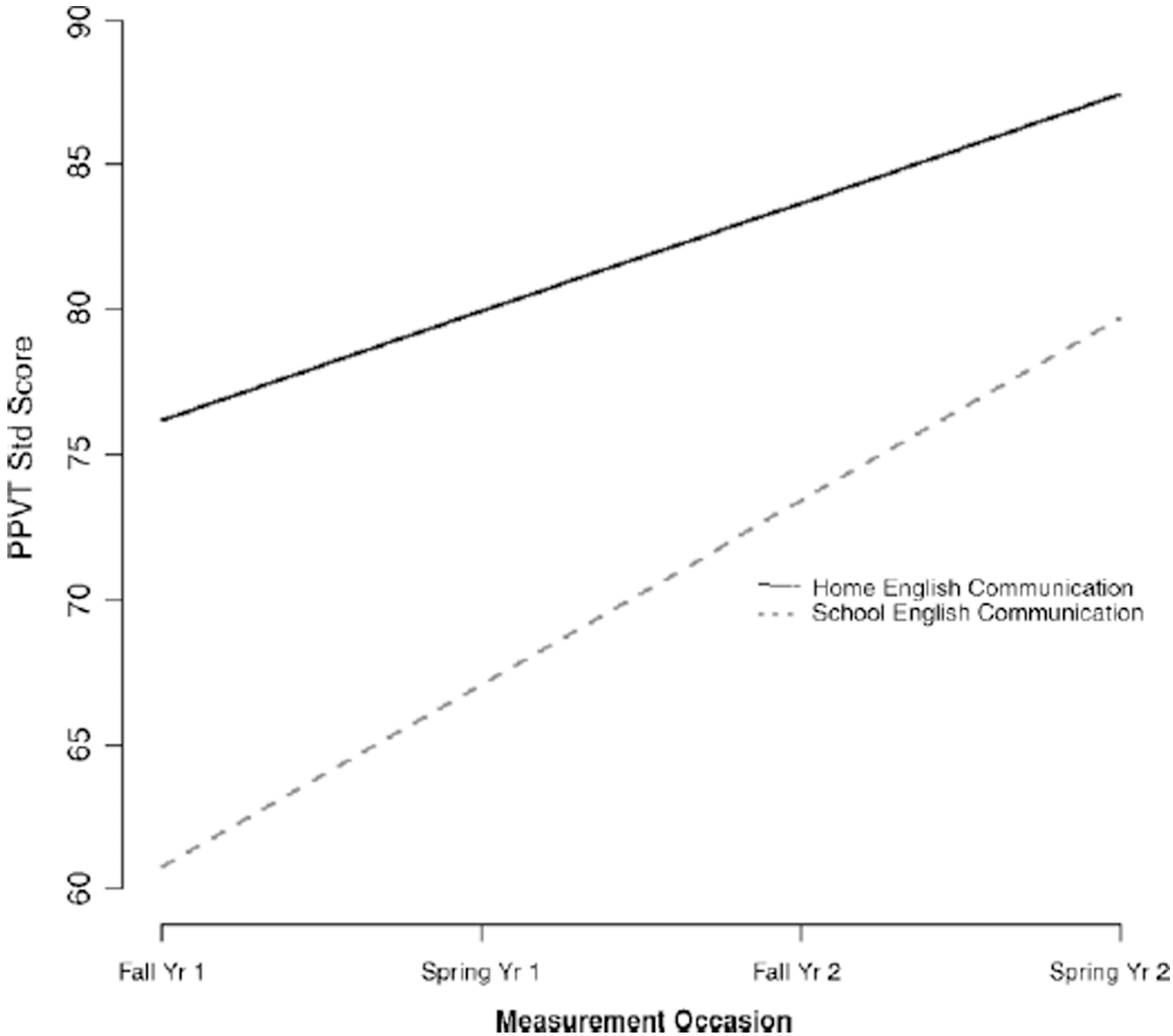

Figure 6.
Trajectory for PPVT-III standard score by bilingual status

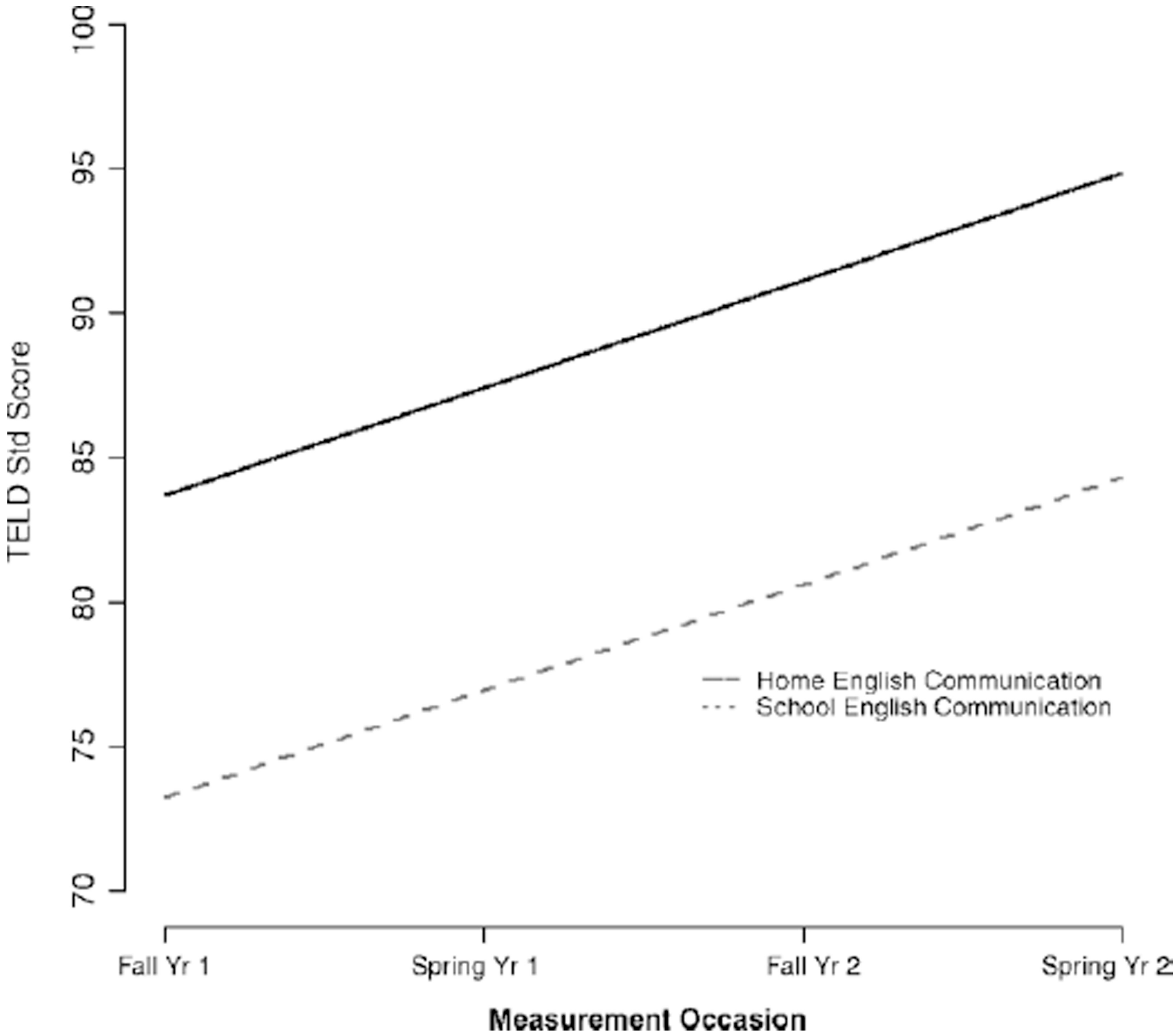

Figure 7.
Trajectory for TELD-3 standard score by bilingual status

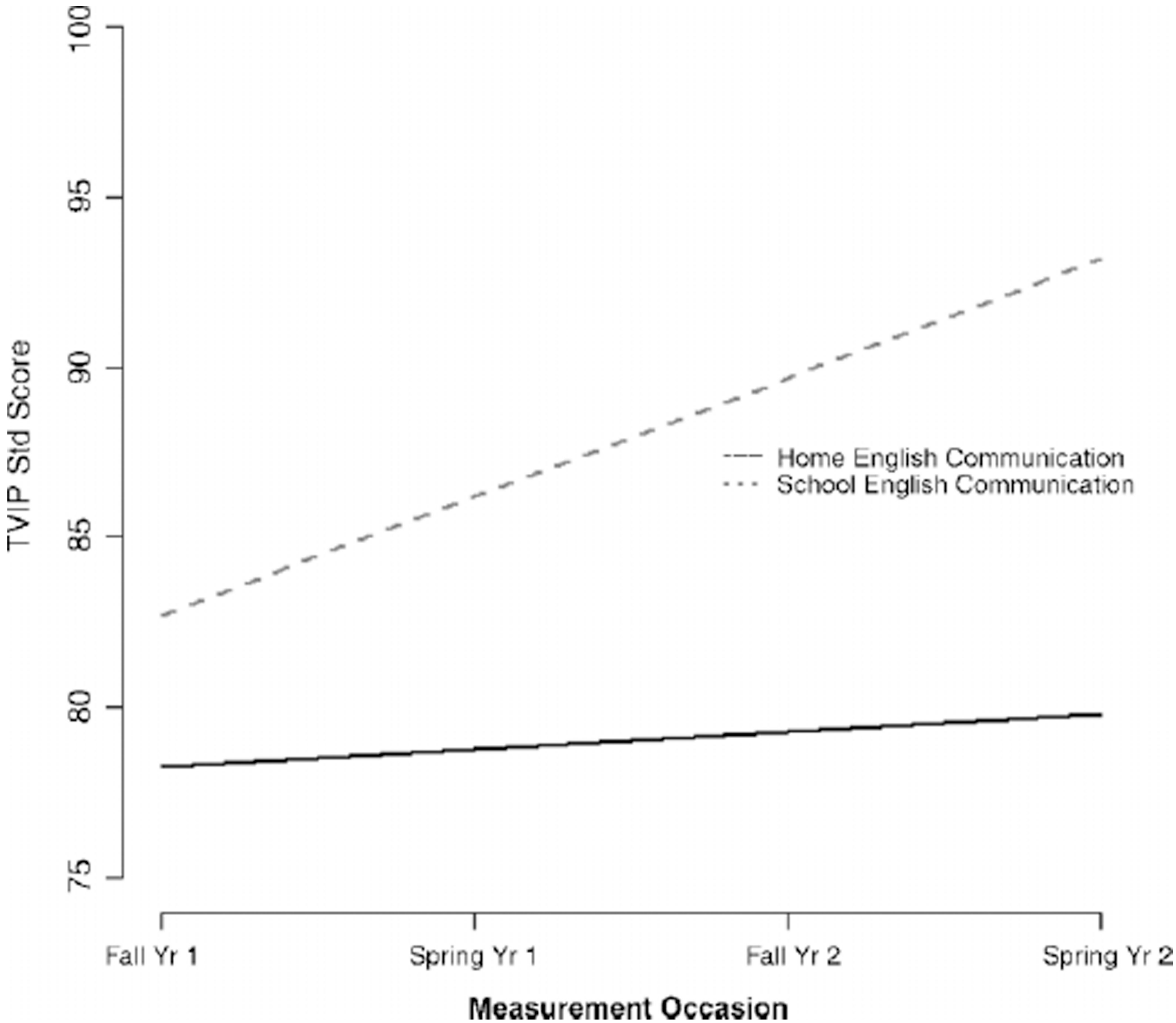

Figure 8.
Trajectory for TVIP standard score by bilingual status

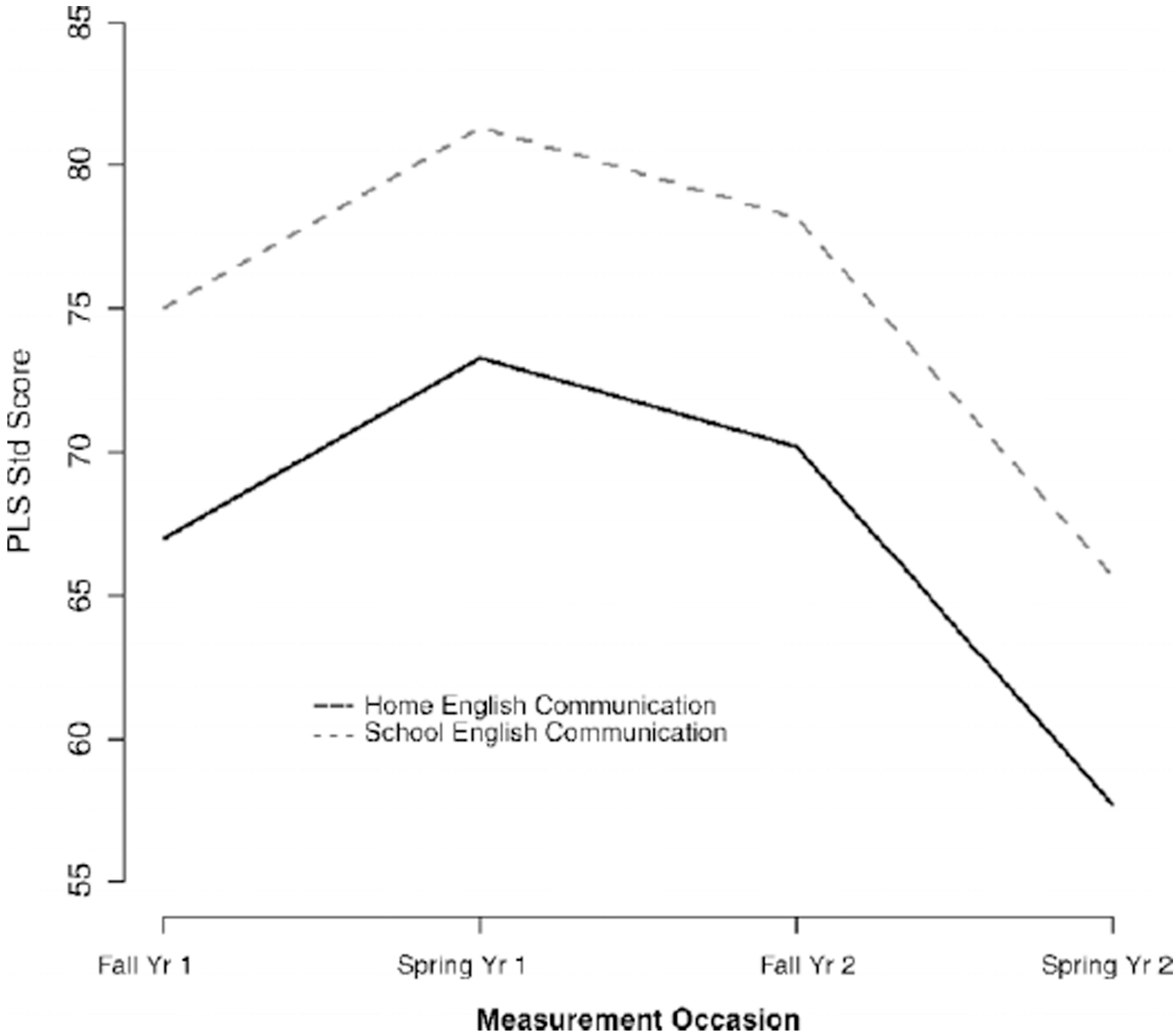

Figure 9.
Trajectory for PLS-3 standard score by bilingual status

Table 1

Sociodemographic characteristics of mothers

Variable	SEC (n=31)	HEC (n=52)
	Mean (SD) or percentage	**Mean (SD) or percentage**
Children's age (years)	3.9 (0.44)	3.9 (0.41)
Children born in Puerto Rico	32%	6%
Mothers born in Puerto Rico	88%	47%
Maternal education (years)	11.1 (1.9)	11.6 (1.4)
Mothers employed outside the home	40%	60%
Language usage (Spring Yr 1 of Head Start)		
Language mother uses to child		
All Spanish or More Spanish than English	68%	17%
Equal Spanish and English	24%	47%
All English or More English than Spanish	8%	36%
Language child uses to mother		
All Spanish or More Spanish than English	52%	2%
Equal Spanish and English	18%	26%
All English or More English than Spanish	30%	72%
Language Usage (Spring Yr 2 of Head Start)		
Language mother uses to child		
All Spanish or More Spanish than English	45%	13%
Equal Spanish and English	36%	42%
All English or More English than Spanish	19%	45%
Language child uses to mother		
All Spanish or More Spanish than English	36%	8%
Equal Spanish and English	26%	26%
All English or More English than Spanish	38%	66%

Table 2

Descriptive statistics for raw scores

Time	HEC		SEC	
	Mean	**SD**	**Mean**	**SD**
PPVT-III				
Fall Yr 1	23.79	13.31	13.20	9.20
Spring Yr 1	28.30	15.28	19.66	12.17
Fall Yr 2	39.32	14.88	30.35	13.83
Spring Yr 2	50.49	16.41	44.70	12.77
TELD-3				
Fall Yr 1	13.81	5.69	10.13	4.13
Spring Yr 1	16.88	7.06	14.41	6.60
Fall Yr 2	21.78	5.53	18.16	5.92
Spring Yr 2	23.91	5.80	21.50	4.30
TVIP				
Fall Yr 1	3.40	3.12	7.87	6.50
Spring Yr 1	5.14	6.22	9.39	8.56
Fall Yr 2	7.62	8.83	14.00	10.31
Spring Yr 2	7.00	8.81	17.38	13.35
PLS-3				
Fall Yr 1	21.87	7.44	26.10	5.93
Spring Yr 1	24.60	9.95	30.81	7.77
Fall Yr 2	30.73	10.31	35.84	5.79
Spring Yr 2	31.40	9.02	36.28	6.70

Table 3

Descriptive statistics for standard scores

Time	HEC		SEC	
	Mean	**SD**	**Mean**	**SD**
PPVT-III				
Fall Yr 1	76.98	15.00	61.53	14.43
Spring Yr 1	77.74	16.88	67.56	13.55
Fall Yr 2	82.35	13.84	73.10	13.62
Spring Yr 2	87.06	13.07	81.50	11.28
TELD-3				
Fall Yr 1	83.70	15.00	72.87	9.49
Spring Yr 1	86.37	19.54	78.25	17.02
Fall Yr 2	92.19	17.28	80.16	13.94
Spring Yr 2	94.46	19.61	85.13	13.01
TVIP				
Fall Yr 1	78.62	5.75	83.67	8.90
Spring Yr 1	75.74	9.69	79.55	12.87
Fall Yr 2	69.32	12.76	77.94	15.14
Spring Yr 2	62.23	13.06	75.07	18.46
PLS-3				
Fall Yr 1	67.62	14.63	74.97	13.69
Spring Yr 1	69.16	18.09	79.84	14.98
Fall Yr 2	74.14	19.93	80.68	15.98
Spring Yr 2	69.00	15.05	77.24	12.74

Table 4

95% confidence intervals for English raw score model fixed effects estimates

	2.5%	**50%**	**97.5%**
PPVT-III			
(Intercept)	19.394	23.298	26.684
Time	1.583	4.511	7.393
$Time^2$	0.798	1.736	2.752
Bilingual group - SEC	−15.361	−9.582	−3.936
TELD-3			
(Intercept)	12.793	14.262	15.713
Time	−0.006	1.399	2.792
Bilingual group - SEC	−5.558	−3.562	−1.630
Centered age	0.157	0.414	0.664
(Intercept)	12.793	14.262	15.713

Table 5

95% confidence intervals for Spanish raw score model fixed effects estimates

	2.5%	**50%**	**97.5%**
TVIP			
(Intercept)	2.248	3.818	5.299
Time	1.288	2.064	2.858
Bilingual group - SEC	0.922	3.328	5.730
PLS-3			
(Intercept)	18.734	20.786	22.953
Time	1.738	3.003	4.269
Centred age^2	0.030	0.069	0.106
Bilingual group - SEC	2.138	4.705	7.229
Time × centred age^2	−0.032	−0.020	−0.008

Table 6

95% confidence intervals for English standard score model fixed effects estimates

	2.5%	**50%**	**97.5%**
PPVT-III			
(Intercept)	72.065	76.190	80.619
Time	2.340	3.751	5.004
Bilingual group - SEC	−22.412	−15.447	−9.346
Time × Bilingual group - SEC	0.517	2.577	4.750
TELD-3			
(Intercept)	79.539	83.698	87.524
Time	2.346	3.705	4.995
Bilingual group - SEC	−16.337	−10.486	−4.662

Table 7

95% confidence intervals for English standard score model fixed effects estimates

	2.5%	**50%**	**97.5%**
TVIP			
(Intercept)	76.084	78.279	80.433
Time	−2.164	0.517	3.206
Centred age	−1.589	−1.162	−0.774
Bilingual group - SEC	1.134	4.404	7.655
Time × Bilingual group - SEC	1.013	2.986	5.052
PLS-3			
(Intercept)	62.967	66.991	70.798
Time	4.384	10.997	17.150
$Time^2$	−7.158	−4.701	−1.822
Centred age	−1.650	−0.903	−0.110
Bilingual group - SEC	3.565	8.013	13.019
Time×centred age	0.138	0.549	0.928