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Language Use Contributes to Expressive Language Growth: Evidence from Bilingual Children

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Abstract

The unique relation of language use (i.e., output) to language growth was investigated for 47 30-month-old Spanish-English bilingual children (27 girls, 20 boys) whose choices of which language to speak resulted in their levels of English output differing from their levels of English input. English expressive vocabularies and receptive language skills were assessed at 30, 36, and 42 months. Longitudinal multi-level modeling indicated an effect of output on expressive vocabulary growth only. The finding that output specifically benefits the development of expressive language skill has implications for understanding effects of language use on language skill in monolingual and bilingual development, and, potentially, for understanding consequences of cultural differences in how much children are expected to talk in conversation with adults.

It is widely believed that children's language development benefits more from adult-child conversations in which the children are active participants than from conversations in which children are passive listeners. Confidence in this view is such that it has shaped the content of current interventions aimed at improving language skills in disadvantaged groups by changing parents' behavior. Programs encourage parents to ask questions in order to "create a back and forth exchange between parent and child" (www.talkwithmebaby.org), "take turns" (Suskind, 2015), and "give them (the children) the opportunity to respond" (http://laup.net/take-time-talk.aspx). The aim of the present study is to directly test the hypothesis that must underlie such advice – that children's own language use, not just their exposure, makes a contribution to their language development. Despite its wide acceptance, this hypothesis has not been directly tested, nor has it been seriously considered in theoretical treatments of first language acquisition.

In current theories of first language acquisition, children's productions are of interest primarily as evidence of what children know and not as a potential contributor to the

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development of language. Depending on the theoretical approach, language development is held to be the result of different contributions from innate structure, analytic abilities, and information provided in the speech children hear (Hoff, 2015). There is no theoretical claim that output does not matter; rather, it is just not given much attention as a potentially relevant factor. A theory that output matters has been proposed in the field of second language acquisition. According to the Output Hypothesis, producing speech is part of the process of acquiring a language and input alone does not result in the same level of language proficiency as does input plus output (Swain, 1985, 1995, 2005). Discussions of this output hypothesis suggest two mechanisms of influence that are potentially relevant to first language acquisition as well. One is that producing speech confronts learners with what they do not know—presumably thereby prodding linguistic analysis; a second is that producing speech allows learners to receive feedback, and thereby to test linguistic hypotheses.

The literature on first language acquisition includes many findings that are consistent with the hypothesis that output plays a role in language acquisition: The frequency with which adults pose certain types of questions that elicit talk from children is positively associated with children's language growth (Hoff-Ginsberg, 1985, 1986; 1990; Rowe, Leech, & Cabrera, 2016). The number of conversational turns in adult-child interaction, recorded and analyzed using the LENA system (Xu, Yapanel, & Gray, 2009), is a better predictor of children's later scores on an omnibus measure of language skills than the amount of talk produced within the child's range of hearing (Zimmerman et al., 2009). Judges' ratings of the connectedness of mother-child conversation at 24 months, using a measure that takes into account children's uptake of adult conversational bids, is a positive predictor of children's expressive vocabulary scores one year later (Hirsh-Pasek et al., 2015).

Other findings also suggest that children's output contributes indirectly to their language growth via the input it elicits. Some of the types of adult utterances that support child language growth are utterances that respond to or pick up on prior child utterances in some way, including expansions and recasts of prior child utterances (Hoff, 2006). Child productions are also necessary for the indirect feedback that E. Clark (2014) has suggested supports language growth. Finally, there are findings that talkative children have better language skills than reticent children (Evans, 1996; Landon & Sommers, 1979), which are consistent with the hypothesis that output benefits language skill, although they suggest nothing about mechanism or even causal direction.

Bilingual children and adults potentially provide a unique kind of evidence on the role of output in acquisition because bilinguals have a choice of which language to use when speaking, and, as a result, their input and output can differ. Several studies of 4- to 5-year-old Spanish-English bilingual children in the U.S. have found that measures of use are related to measures of skill and can be stronger correlates of skill than measures of language exposure. Hammer et al. (2012) found a concurrent correlation between children's reported use of English and Spanish and their expressive vocabulary in both languages and also of story recall, though only in Spanish. Bohman, Bedore, Peña, Mendez-Perez, & Gillam (2010) found that a combined measure of exposure and use was concurrently related to Spanish-English bilingual children's scores on tests of their semantic and morphosyntactic knowledge of each language. Bedore et al. (2012) found that measures of bilingual

children's use of English and Spanish were concurrently related to their English and Spanish skills and that use accounted for more variance in the children's English skills than did age of first exposure.

Two other phenomena described in bilinguals may also have something to do with the effect of output on acquisition. One, observed in bilingual children, consists of using a different language from one's interlocutor when taking one's conversational turn. This appears most frequently in environments in which one language is a minority language and the other is the language of the dominant culture (De Houwer, 2007; Hurtado & Vega, 2004). The typical pattern is that parents address their children in their heritage language, and the children reply in the majority language. In the U.S., Spanish-English bilingual children are more likely to switch to English when addressed in Spanish than vice versa when tested in school (Gutiérrez-Clellen, Simon-Cereijido, & Leone, 2009). At home, preschool age Spanish-English bilingual children are more likely to switch to English when their parents speak to them in Spanish than vice versa (Hurtado & Vega, 2004; Ribot & Hoff, 2014).

The potentially related phenomenon observed in adults is receptive bilingualism. Many adults who were raised in Spanish-English bilingual homes in the U.S. describe themselves as able to understand both languages, but able to speak only English (Hurtado & Vega, 2004; Valdés, 2001). Perhaps the effect of output on the development of expressive language skill is a link between children's choices to speak English more than Spanish and adults' abilities to speak and understand English but to only understand Spanish. In fact, the original motivation for the Output Hypothesis in the field of second language acquisition was the observation that Anglophone elementary school students in French immersion programs scored equivalently to native speakers on tests of listening and reading comprehension, while being clearly identifiable as nonnative in speaking and writing, and that the children in these programs had rich exposure to French but actually spoke French very little (Swain & Lapkin, 1995).

There are other data consistent with the hypothesis that use (or output) has a particular benefit for the development of expressive language skills. First, all the foregoing evidence for output effects in both monolingual and bilingual children comes from studies that used measures of expressive language skill or measures that included expressive language skill. None of the previous studies used measures of receptive skill alone. Second, a profile of skill that could be described as nascent receptive bilingualism has been observed in bilingual children. Gibson, Oller, Jarmulowicz, and Ethington (2012) have documented a receptive-expressive gap in bilingual children's language skills. Specifically, school aged children who came from Spanish-speaking homes, but who used English in school, showed balanced expressive and receptive skills in English but in Spanish they had weak expressive skills relative to their receptive skills. Ribot and Hoff (2014) described a similar skill pattern in Spanish-English bilingual 30-month-olds using a different approach. Because such direct comparison of expressive and receptive skill depends on the comparability of independently normed tests of expressive and receptive skill, which may be problematic (Gibson, Oller, & Jarmulowicz, 2016; Hoff & Rumiche, 2012), Ribot and Hoff (2014) used raw scores on parallel tests of expressive and receptive skills in English and Spanish. They found that the bilingual children's receptive skills were comparable across languages but their expressive

skills were significantly higher in English than in Spanish. Like adults who describe themselves as receptive bilinguals, these children were equally able to understand English and Spanish, but they were much better at speaking English than they were at speaking Spanish. And, consistent with Swain and Lapkin's (1995) description of exposure and use of French by the second language learners they studied, the Spanish-English bilingual children in this study had equivalent levels of Spanish and English exposure at home, but in speaking they used English more than they used Spanish.

While the foregoing evidence is consistent with the hypothesis that producing speech benefits the development of language, and particularly expressive language, much of it admits other interpretations. Caregivers' questions and the resultant conversational participation by children may be a positive predictor of language growth because they are an indicator of adult talk that engages the child's attention and benefits language growth for that reason. The finding that conversational turns are a better predictor of language growth than amount of talk in LENA analyses (Zimmerman et al., 2009) may merely reflect that the count of conversational turns better captures how much speech was addressed directly to the child than does the measure of how many words were produced within the range of the microphone the child wore. Finally, the findings from bilingual children that use is related to skill level are all concurrent correlations. They could merely reflect that children choose to speak in their stronger language rather than indicating that speaking benefits language development.

Longitudinal data would provide a stronger test of the hypothesis that output benefits the development of language skill, and that is the approach of the present study. Using parental reports of bilingual children's language choices at the age of 30 months, we identify two groups: one for whom English output is greater than English input because the children reliably answer English with English but also sometimes switch to English when addressed in Spanish; another for whom English output is less than English input because the children reliably answer Spanish with Spanish but also sometimes switch to Spanish when addressed in English. (This is the less frequent pattern, but it exists.) We make use of data collected at 30, 36, and 42 months to ask whether these differences in English output at 30 months predict English language growth over the subsequent year, beyond effects of input. Finally, we ask this question in separate analyses of growth in expressive and receptive skills, testing the hypothesis that talk specifically benefits growth of expressive language skill. This study is a follow-up of some of the children reported on in Ribot and Hoff's (2014) study of concurrent correlates of conversational-code switching, with additional children added to the sample as part of an ongoing longitudinal study.

Method

Participants

The participants were 47 children (27 girls, 20 boys) selected from a larger sample of 90 bilingually developing children based on their pattern of language use in conversation. The selected children were those who were described by their primary caregivers as sometimes switching to English when addressed in Spanish but consistently answering English with English (*Switch to English*, $n = 26$), or as sometimes switching to Spanish when addressed

in English but consistently answering Spanish with Spanish (*Switch to Spanish*, $n = 21$). The other children in the sample were described as sometimes switching in both directions ($n = 33$) or never switching ($n = 10$). The first two groups were selected because they were two groups of children whose amount of English output differed from their amount of English input. For the first, output exceeded input; for the second, output was less than input. Children who switched in both directions were excluded because we did not have data on the relative frequency of switches in each direction and therefore did not know how different their output was from their input. Children who always answered in the same language as their conversational partner were excluded because there were too few of them to estimate their growth trajectories.

The children's input and output were assessed at 30 months and their receptive and expressive English language skill was assessed at the ages of 30, 36, and 42 months. Mean ages at assessment were 30.51 months ($SD = 0.38$) at the first time point, 36.59 months ($SD = 0.36$) at the second time point, and 42.52 months ($SD = 0.38$) at the third time point. All 47 children were tested at 30 months, 33 children were tested at 36 months, and 43 children were tested at 42 months. Data were collected between January 2010 and March 2014. All families were residents of South Florida, in the U.S. All children were full term and healthy at birth, with normal hearing based on parent report of otoacoustic emissions tests performed in the hospital. All children were screened for evidence of communicative delay at 30 months. Participants were recruited through advertisements in local magazines and at programs for parents with young children, as well as through word of mouth. All the children were born in the U.S. At 30 months, all children were exposed to both Spanish and English at home; the less frequently heard language constituted at least ten percent of their language exposure, and no more than ten percent exposure was in any language other than English or Spanish. On average, the parents were well educated, with 50 percent of mothers and fathers having a college degree or higher, reflecting the somewhat unique nature of the Spanish-speaking immigrant population of South Florida (Oller & Eilers, 2002). Additional demographic data are provided in Table 1.

All 47 children had at least one parent who was born in a Spanish-speaking country; 7 mothers and 9 fathers were born in the U.S. The mean age of arrival to the U.S. for immigrant parents was 18.25 years ($SD = 11.65$) for the mothers, and 16.65 years ($SD = 12.10$) for the fathers. Additional demographic information regarding parents is provided in Table 2.

Procedure

As part of the larger study, children were tested across three sessions during a window of six weeks around the ages of 30, 36, and 42 months. Detailed information regarding the children's dual language exposure and language use was collected during the first session via interview with the parent(s) or other primary caregiver. The second and third sessions included administration of the measures of children's language skill.

Measures

Language exposure (input)—English input was measured as the relative amount of speech addressed to the children that was in English, as estimated by the children's primary caregivers. Previous research suggests such measures are reliable and are strongly related to diary-based measures of language use, and to bilingual children's language skill (Hoff et al., 2012; Place & Hoff, 2011). For children living in two households, a weighted average of the percentage of English heard in each home was calculated. The mean percentage of children's relative home English input was 43.09% (*SD* = 23.19%) at the first time point, 42.35% (*SD* = 27.03%) at the second time point, and 43.32% (*SD* = 26.33%) at the third time point. A one-way repeated measures ANOVA indicated that English input in the home did not change significantly over time, $F(2, 56) = 1.06$, *ns*, $\eta^2 = .04$. Pairwise correlations between time points suggested individual stability in input balance, all *r* values were greater than .69, all *p* values < .001.

Language use (output)—In the initial interview primary caregivers were asked what language their children used to reply when addressed in English and when addressed in Spanish. Answers were coded as *Always responds in the same language* and *Does not always respond in the same language*. The children included in the present study were those who showed clear asymmetries in their language use: one group reliably responded to English with English and also sometimes switched to English when addressed in Spanish (*Switch to English* group; *n* = 26); whereas another group showed the opposite pattern, reliably responding to Spanish with Spanish and sometimes switching to Spanish when addressed in English (*Switch to Spanish* group; *n* = 21).

Language growth—The outcome variables were measures of children's expressive vocabulary and receptive language skill in English. We focus on English, and not Spanish, because previous research with Spanish-English bilingual children in South Florida, including our own work, indicates that all the children are acquiring English, with individual differences in the rate of acquisition, thus meeting the assumption of a variable-centered approach to identifying sources of individual differences. In contrast, not all the children who are bilingual in Spanish and English at age 2 continue to acquire Spanish (Eilers, Pearson, & Cobo-Lewis, 2006; Hoff, Rumiche, Burridge, Ribot, & Welsh, 2014). Person-centered analyses that are in progress seek to describe different profiles of Spanish growth and to identify their correlates.

Expressive vocabulary: Measures of the children's English expressive vocabulary were collected at each age using the *Expressive One Word Picture Vocabulary Test - Spanish-Bilingual Edition* (EOWPVT; Brownell, 2001). This edition of the EOWPVT is an experimenter-administered picture naming measure, norm-referenced for use with individuals aged 2 to 80 years and above who speak English and/or Spanish with varying levels of proficiency. As part of the larger study, this instrument was administered to the children separately in English and Spanish to obtain expressive vocabulary scores in each language. Only English responses were counted in the English score, and only Spanish responses were counted in the Spanish score. Only measures of English are outcome variables in the present study.

Receptive language skill—Measures of receptive English language skill at each age were obtained using the auditory portion of the English version of the *Preschool Language Scale, Fourth Edition* (PLS-4; Zimmerman, Steiner, & Pond, 2002). The PLS-4 is a widely-used instrument, normed in monolingual English populations, that assesses language skills in children from birth to 6 years and 11 months. The test is individually administered and includes a picture book and series of toys with which the experimenter presents tasks that assess skills in the areas of semantics, morphology, syntax, integrative language skills, and preliteracy skills. Extensive reliability and validity evidence have been previously reported, albeit with monolingual samples (Zimmerman et al., 2002).

Results

Means and standard deviations for the observed expressive vocabulary and receptive language scores at each age are presented in Table 3. The Output Groups also differed in input at 30 months: for the *Switch to English* group the mean percent exposure to English was 55.38 ($SD = 19.69$) and for the *Switch to Spanish* group the mean percent exposure to English was 27.86 ($SD = 17.65$), $t(45) = 4.99$, $p < .001$. Therefore, input was included as a predictor in the models. Because input was consistent and stable over time, input measured at 30 months was treated as a time invariant predictor.

The role of output in accounting for growth in expressive vocabulary and receptive language skill was assessed in a series of longitudinal multi-level models for each outcome, as follows: In the first, base models, Age (with 3 time points), Input (measured as a continuous variable), and Age × Input were entered. Next, Output Group was entered into each model as a level 2 predictor. The measure of Input and assignment to Output Group was based on data at 30 months. All possible age, input, and code-switching group interactions were added to the models, and model fit was assessed (see Appendix 1 for a list of all full model equations, including interaction terms). Comparisons of fit between models were accomplished using Chi-square difference tests using the −2 Log Likelihood model fit index from each model. The Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) model fit indices are also reported. All models were run in IBM SPSS Statistics Version 22.0 software. The models of expressive language growth (EOWPVT) were computed using maximum likelihood estimation and unstructured covariance structures; the models of growth in receptive skills (auditory PLS-4) were computed using a simpler covariance structure (i.e., variance component structure) due to the small variance components in the models. The base and final models are presented below. All Base and Full Model (including all potential predictors and interactions) formulas are presented in Appendix 1.

English Expressive Vocabulary

The multi-level base model for English expressive vocabulary tested whether bilingual children's relative percentage of English Input in the home significantly predicted growth in EOWPVT raw scores from 30 to 42 months (−2LL: 805.62, $df = 4$). There was a significant main effect of Age ($p < .001$), such that all scores increased significantly over time. There was also a significant main effect of relative amount of English Input ($p < .001$); on average,

higher English input was associated with higher English EOWPVT scores. The Age × English Input interaction was not significant ($p = .453$).

When Output Group was added to the model, results indicated significant improvement in model fit (−2LL: 757.14, $df = 7$). The effects of Age ($p < .001$) and English Input ($p < .001$) remained significant. There was a significant main effect of Output Group ($p = .005$); on average, children who *Switch to English* had higher English scores than children who *Switch to Spanish*. Additionally, there was a significant Age × Output Group interaction ($p = .013$), such that children who *Switch to English* showed increases in expressive vocabulary at a faster rate than children who *Switch to Spanish*, controlling for English input at home. Information about fixed effects is presented in Table 4. Plots of estimated growth curves are shown in Figure 1. For all models, inclusion of a quadratic effect of time did not significantly improve model fit.

English Receptive Language Skill

The multi-level Base Model for English receptive language skill tested whether bilingual children's relative percentage of English Input in the home significantly predicted growth in their English PLS-4 raw scores from 30 to 42 months (−2LL: 673.48, $df = 4$). There was a significant main effect of Age ($p < .001$), such that all scores significantly increased over time. There was a significant main effect of English input ($p < .001$); on average, higher English input was associated with higher English PLS-4 scores. There was also a significant Age × Input interaction ($p < .001$), such that children with higher input in English grew at a faster rate than children with lower input in English.

When Output Group and all potential interactions were added to the model, the change in model fit over the Base Model was not significant (χ^2 difference in −2LL = 6.27, $p = .180$). Output Group did not significantly predict variance in receptive skills over time, over and above the effects of input. Information about fixed effects is presented in Table 5. Plots of estimated growth curves are shown in Figure 2.

In sum, from the ages of 30 to 42 months, these children grew significantly in both English expressive vocabulary and English language receptive skill. Both base models suggested that language growth on these measures of English skill was related to the relative amount of English in the children's input. Including Output Group in the models indicated that the development of expressive language skills was also related to children's use of the language. Use (i.e., output) did not contribute to growth in receptive skill.

Discussion

The results of the present study support the hypothesis that language use (i.e., output) contributes to the development of expressive language skill. On the basis of parent-reported patterns of their children's language choices in conversation, two groups of Spanish-English bilingual children were identified: one who produced more English than they heard and the other who produced less English than they heard. Multilevel modeling of growth in measures of English expressive vocabulary and English language receptive skill revealed that, in addition to effects of Age and Input which were observed for both measures, there

was a significant Output Group × Age interaction in the model of expressive vocabulary. Children whose English output was greater than their input grew in expressive skill at a faster rate than the children who spoke English less than they heard it. The same group difference in English output did not significantly influence children's growth of receptive skills. These findings have implications for understanding basic processes underlying language development, for understanding influences unique to bilingual development, potentially for understanding the influence of cultural practices associated with child talk on language development, and, finally, for designing and implementing interventions that seek to increase support for children's language development by modifying the conversational behavior of their caregivers.

The implication of the present finding for understanding basic processes of language development is to add language use to language exposure, analytic abilities, and, arguably, innate structure to the list of factors that contribute to language development. The present findings do not identify the mechanism or mechanisms responsible for the benefit of output, however. In fact, the present findings do not distinguish between the possibilities that (a) output provides a general benefit, which was seen only in expressive skill here because expressive skill is more difficult to achieve or (b) output specifically benefits expressive skill. The literature includes many suggestions of both general and expressive-specific mechanisms.

Proposals for why output would have a general benefit for children's language growth include the suggestions that the requirement to talk challenges children and prods them to figure out the parts of the linguistic system they need to produce replies (Hoff-Ginsberg, 1985; 1986; 1990; Rowe et al., 2016), and that talking "forces the learner to process the language in a way that only hearing it does not" (Bohman et al., 2010, p. 339). Perhaps output also benefits language learning because output is essentially retrieval. Research in learning and memory has found that the process of retrieval benefits learning, although the mechanism underlying that benefit is not clear (Karpicke & Roediger, 2008; Roediger & Butler, 2011).

Proposals consistent with the view that output specifically benefits expressive skill include the proposal, from discussion of the Output Hypothesis as applied to second language learning, that talking moves language knowledge from declarative to procedural memory (de Bot, 1996). Although this proposal does not explain how this happens, it is consistent with ideas that have been proposed to account for phonological properties of monolinguals' very early word production—that the representations underlying recognition are based on input and that different representations, which depend on output, are used in production (Menn & Matthei, 1993). The idea is that word production requires lexical representations that are connected to articulatory instructions, and input alone may not suffice for creating those connections. This proposal may not only be relevant to explaining the variable phonological properties of young children's productions and the gap between bilinguals receptive and expressive skills, but it may also explain the phenomenon Menn and Matthei (1993) pointed out, that monolingual adults have passive vocabularies that exceed their active vocabularies. The present finding also implies that monolingual children with reduced output—for reasons

of shyness or speech disorder—should show a greater discrepancy between their receptive and expressive skills than children who talk more.

One implication of the present finding for understanding bilingual development in particular is that bilingual children's language choices have consequences. The pattern of selective use of one language in speaking, which is characteristic of many bilingual children, could be the source of a gap between receptive and expressive skills in the less-used language, which is also characteristic of many bilingual children (Gibson et al., 2012). The extreme of this gap between the ability to understand and the ability to speak is receptive bilingualism, and the present findings suggest an antecedent of receptive bilingualism may be the choice to use only one language in production.

Another implication is that cultural differences in adult-child interaction patterns may create cultural differences in the relation of children's receptive to expressive skills. Discussions of cultural differences in the literature on talk to children have tended to focus on differences in how adults talk to children (Hoff, 2006). There are also differences in how much adults expect and encourage children to talk. In some cultures, children are expected to listen to adults more than talk to adults (Crago, Annahatak, & Ningiuruvik, 1993). The present findings suggest the prediction that it will be normative for children in such cultures to develop receptive skills in advance of expressive skills to a greater degree than is characteristic of children in cultures where they are expected and encouraged to talk. There are findings that suggest Latino-Anglo differences on this dimension of mother-child interaction and related differences in children's language skill. A study of mother-child conversation in Latino mother-child dyads speaking Spanish, and Anglo mother-child dyads speaking English, drawn from the same larger study as the present sample, found that Anglo children took more turns than the Latino children (Shanks, 2016). Perhaps relatedly, a study of 2-year-old children in Mexican immigrant families described them as appearing "to understand more than they produce" and having "skills not captured by measures of expressive language" (Tamis-LeMonda, Song, Leavell, Kahana-Kalman, & Yoshikawa, 2012).

The present results may also help explain a persistent and somewhat puzzling finding in the literature on Spanish-English bilingual development: it appears to require more Spanish input to learn Spanish than English input to learn English (Pearson, Fernández, Lewedeg, & Oller, 1997). Several studies that have assessed Spanish-English bilingual children's expressive language skills in both languages find that children with balanced input tend to be English dominant (Hoff et al., 2012; Pearson et al., 1997; Ribot & Hoff, 2014) and that children who show balanced English and Spanish expressive skills tend to come from Spanish-dominant environments (Hoff & Ribot, 2016). Of course, measures of input may underestimate English exposure, but it may also be that the seeming preference for using English among Spanish-English bilingual children in the U.S. and, in addition, a cultural practice of expecting less child talk in Spanish language interactions may reduce children's levels of Spanish output relative to their Spanish input. To the degree that output is a contributor to expressive skills, these factors that reduce the amount of Spanish output might explain the gap between how much Spanish input children receive and the level of Spanish expressive skill they display.

The implication of the present findings for intervention programs is to endorse the widespread practice of encouraging parents both to talk to their children and to encourage their children's talk, but the reason for that endorsement is that the aim of the interventions is to prepare children to succeed in school in the U.S. A variety of cultural practices in American schools, including circle time and teachers' calling on students, require very young children to be able to express themselves. This expressive skill requirement of schools means that interventions must aim to support children's development of both expressive and receptive skills and therefore interventions must target both parents' talk to children and parents' encouragement of talk by their children. It may be worth realizing, however, that these aims serve a culture-specific requirement.

Limitations and Future Directions

The present findings offer evidence that language use contributes to the development of expressive language skills. There are limitations in the current evidence, however, that arise from limitations in the measures of language use and language skills. It would be desirable to have a measure of the frequency with which children choose to use one language over the other, as opposed to the binary measure of code switching obtained in this study. It would also be desirable to have more extensive measures of children's expressive language skill than simply expressive vocabulary and to have more nearly comparable measures of expressive and receptive skill than were available in the present data. Such measures would allow future research to specify more precisely the contribution of children's language use to their development of the ability to understand and speak the language or languages that they hear.

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APPENDIX. Multi-Level Base and Growth Model Formulas

Base Model Formula

$$\mathrm{DV}_{\mathrm{it}} = \pi_{0\mathrm{i}} + \pi_{01}(\mathrm{Age}_{\mathrm{it}}) + r_{\mathrm{ij}} \quad \text{Level 1)}$$

$$\pi_{0\mathrm{i}} = \gamma_{00} + \gamma_{01}(\mathrm{Input}) + u_{0\mathrm{i}} \quad \text{Level 2)}$$

$$\pi_{1i} = \gamma_{10} + \gamma_{11}(\text{Input}) + u_{1i}$$

Combined Equation: $DV_{it} = \gamma_{00} + \gamma_{01}(\text{Input}) + \gamma_{10}(\text{Age}) + \gamma_{11}(\text{Age}\cdot\text{Input}) + u_{0i} + u_{1i} + r_{ij}$

Full Model Formula (including all fixed effects)

$$DV_{it} = \pi_{0i} + \pi_{01}(\text{Age}_{it}) + r_{ij} \quad \text{Level 1)}$$

$$\pi_{0i} = \gamma_{00} + \gamma_{01}(\text{Input}) + \gamma_{02}(\text{Group}) + \gamma_{01\cdot 2}(\text{Input}\cdot\text{Group}) + u_{0i} \quad \text{Level 2)}$$

$$\pi_{1i} = \gamma_{10} + \gamma_{11}(\text{Input}) + \gamma_{12}(\text{Group}) + \gamma_{11\cdot 2}(\text{Input}\cdot\text{Group}) + u_{1i}$$

Combined Equation: $DV_{it} = \gamma_{00} + \gamma_{01}(\text{Input}) + \gamma_{02}(\text{Group}) + \gamma_{01\cdot2}(\text{Input}\cdot\text{Group}) + \gamma_{10}(\text{Age}) + \gamma_{11}(\text{Age}\cdot\text{Input}) + \gamma_{12}(\text{Age}\cdot\text{Group}) + \gamma_{11\cdot2}(\text{Age}\cdot\text{Input}\cdot\text{Group}) + u_{0i} + u_{1i} + r_{ij}$

Parameter Estimates of Fixed Effects Symbol Legend

γ_{00}: Intercept

γ_{10}: Age

γ_{01}: English Input

γ_{02}: Output Group

γ_{11}: Age × English Input

γ_{12}: Age × Output Group

$\gamma_{01\cdot2}$: English Input × Output Group

$\gamma_{11\cdot2}$: Age × English Input × Output Group

u_{0i}: Level 1 residual variance (error)

u_{1i}: Level 2 residual variance (error)

r_{ij}: Overall residual variance (error)

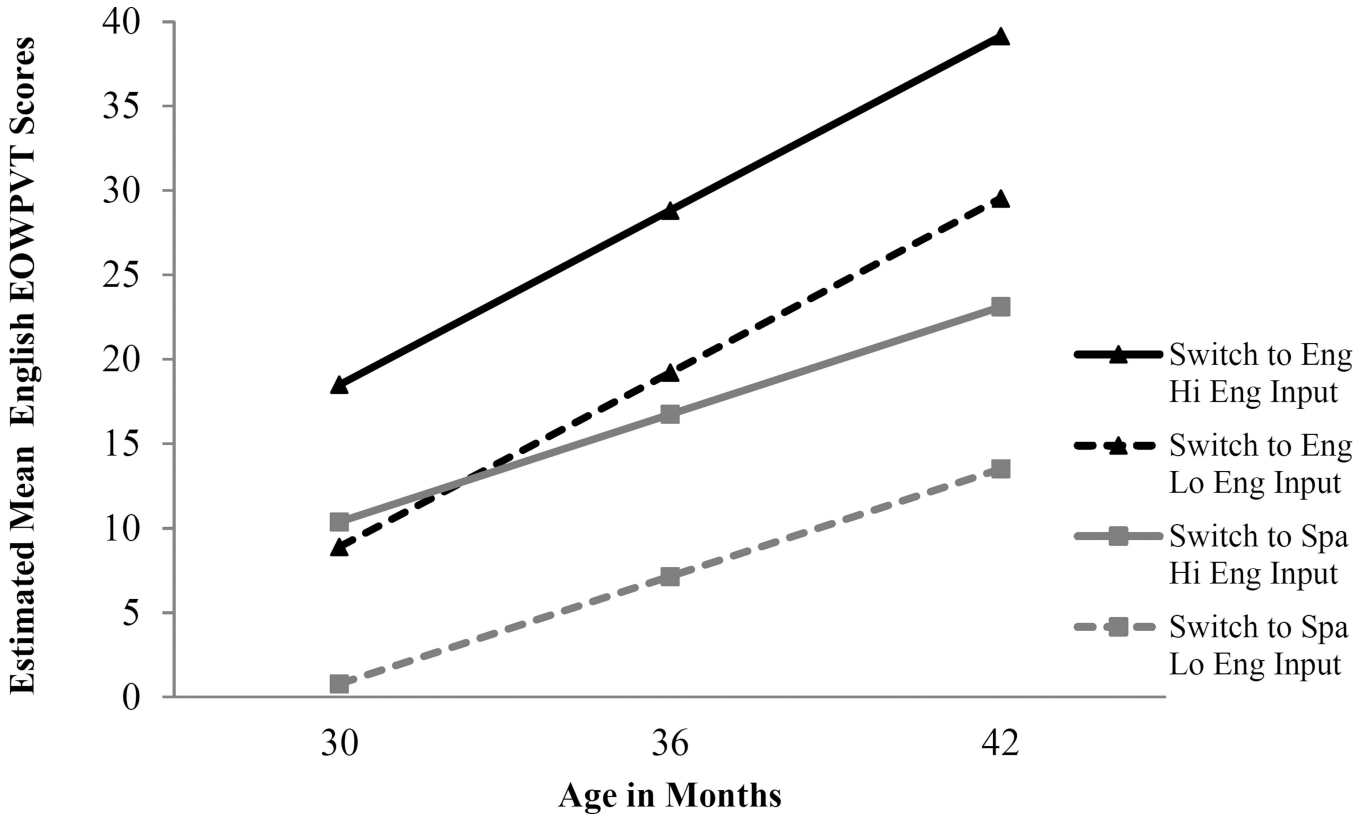

Figure 1.

Longitudinal English EOWPVT estimated raw scores for children who switch to English and switch to Spanish and have high and low relative English input at home ($N = 47$).

For Figures 1 and 2, high English input was equal to 60% English, based on the upper 75th percentile, and low English input was equal to 20%, based on the lower 25th percentile; age was calculated as 0 for 30 months, 1 for 36 months, and 2 for 42 months; and group was either 0 for "Switch to English" or 1 for "Switch to Spanish." English (Eng), Spanish (Spa), High (Hi), and Lo (Low) are abbreviated. These estimated scores were based on the formula: $EOWPVT\_English_{it} = 4.09 + 0.24(input) + -8.12(group) + 10.32(age) + -3.95(group \cdot age)$. See also Table 4 and Appendix 1.

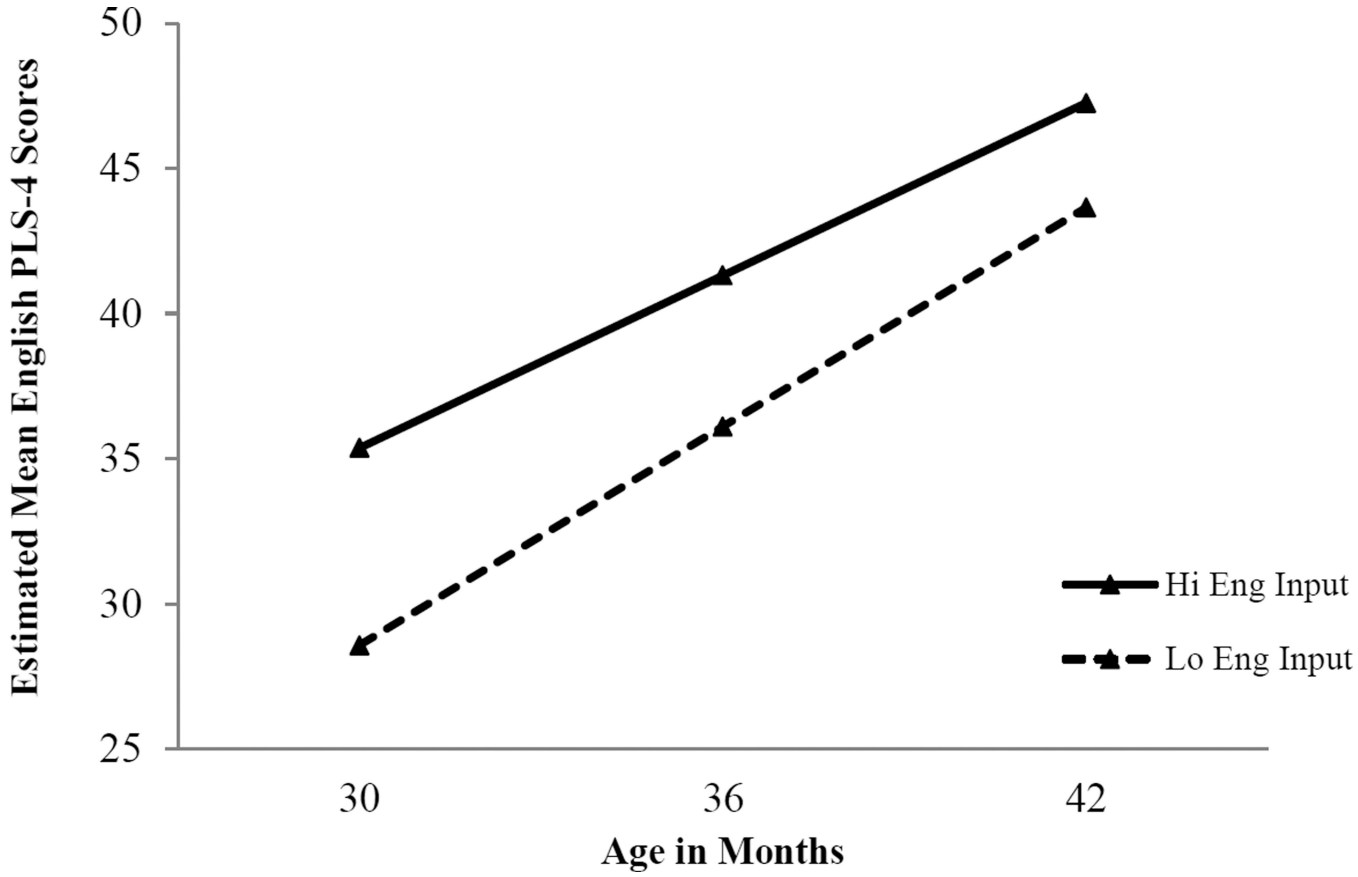

Figure 2.

Longitudinal English PLS-4 estimated raw scores for children who have high and low relative English input at home ($N = 47$). English (Eng), Spanish (Spa), High (Hi), and Lo (Low) are abbreviated. These estimated scores were based on the formula: $PLS4\_English_{it} = 25.17 + 0.17(input) + 8.34(age) + -0.04(input \cdot age)$. See also Table 5 and Appendix 1.

Table 1

Child Characteristics ($N = 47$)

	Switch to English Group ($n = 26$)	**Switch to Spanish Group ($n = 21$)**
Ethnicity		
Hispanic White	22	21
European American	2	0
Hispanic Black	2	0
Parents' Language Backgrounds		
2 Native Spanish or	16	17
Native Bilingual Parents		
1 Native Spanish,	9	4
1 Native English Parent		
Other	1	0

Table 2

Parent Characteristics ($N = 47$)

	Switch to English Group		Switch to Spanish Group	
	Mothers	Fathers	Mothers	Fathers
Native Countries				
Argentina	2	1	2	2
Colombia	3	4	6	4
Cuba	3	2	4	4
Peru	3	2	2	2
U. S.	6	6	1	3
Venezuela	1	2	3	1
Other	8	9	3	5
Native Languages				
English	4	5	1	3
Spanish	20	19	20	18
Spanish-English Bilingual	2	1	0	0
Other	0	1	0	0
Highest Level of Education				
Less Than High School	0	2	1	2
High School Degree	4	8	6	3
2-Year Degree	8	7	2	4
4-Year Degree	7	5	10	9
Advanced/ Graduate Degree	7	4	2	3

Table 3

Observed Mean and Standard Deviation for all English Language Outcome Raw Scores for Children Who Switch to English and Switch to Spanish at Each Age

Age in Months	**30**		**36**		**42**	
	EOWPVT	**PLS-4**	**EOWPVT**	**PLS-4**	**EOWPVT**	**PLS-4**
Switch to English Group						
Mean	16.85	35.61	30.94	43.41	36.19	46.05
(SD)	(10.45)	(6.93)	(12.51)	(7.60)	(14.34)	(7.30)
n	26	23	17	17	21	21
Switch to Spanish Group						
Mean	3.30	28.55	5.93	35.14	16.50	44.12
(SD)	(5.98)	(5.80)	(6.22)	(5.56)	(12.15)	(6.49)
n	20	20	14	14	18	17

Note: Standard Deviation (SD) is abbreviated.

Table 4

Estimates of Fixed Effects and Standard Errors for English Expressive Vocabulary, as Measured by the EOWPVT, for Children Who Switch to English and Switch to Spanish ($N = 47$)

	γ	Standard Error	*p*
Base Model			
Intercept	−4.10	2.59	.120
Age	7.38	1.71	<.001
English Input	0.35	0.05	<.001
Age × English Input	0.03	0.04	.453
Final Model			
Intercept (γ_{00})	4.09	3.65	.268
Age (γ_{10})	10.32	1.03	<.001
English Input (γ_{01})	0.24	0.06	<.001
Code-Switching Group (γ_{02})	−8.12	2.78	.005
Age × Code-Switching Group (γ_{12})	−3.95	1.52	.013

Goodness of Fit	Base Model	Final Model	$\Delta\chi^2$	*p*
−2LL	805.62	792.82	12.80	<.001
AIC	821.62	810.82	---	---
BIC	843.64	835.60	---	---

Note: For all multi-level models in Tables 4–5, predictors were not centered (Age 0 = 30 months; Code-Switching Group 0 = “Switch to English” group; 0% Input = no English input in the home).

Table 5

Estimates of Fixed Effects (and Standard Errors) for English Receptive Skill, as Measured by the PLS-4, for Children Who Switch to English and Switch to Spanish ($N = 47$)

	γ	**Standard Error**	***p***
Base/Final Model			
Intercept (γ_{00})	25.17	1.94	<.001
Age (γ_{10})	8.34	0.79	<.001
English Input (γ_{01})	0.17	0.04	<.001
Age × English Input (y_{11})	−0.04	0.02	.013
Goodness of Fit	−2LL	AIC	BIC
	673.48	687.48	706.51

Note:
The best-fitting, most parsimonious model for the English PLS-4 was the Base Model; therefore, only estimates for this model are provided.