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Comprehension Skills of Chinese-English Dual Language Learners: Relations across Languages and Associations with Language Richness at Home

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Abstract

Chinese dual language learners (Chinese DLLs) are a growing population in the U.S. Existing studies of preschool-aged Chinese DLLs mostly focused on single-word vocabulary and rarely explored other skills important for school readiness. In the current study, we examined Chinese DLLs' development of receptive vocabulary and comprehension of semantic concepts (i.e., spatial and quantification expressions) in both English and Chinese (Mandarin/Cantonese) during a preschool year. Results indicated that while semantic concept comprehension in both English and Chinese showed significant growth during the year, only English, but not Chinese, receptive vocabulary showed a significant increase. Furthermore, DLLs' semantic comprehension, but not receptive vocabulary, showed cross-language transfer. Finally, the richness of DLLs' language experiences (e.g., frequency of book reading, multimedia exposure) at home was a significant predictor of Chinese DLLs' receptive vocabulary and semantic comprehension in the respective language. Supporting families to provide rich language experiences in both English and the home language may hold key to fostering successful dual language development.

Keywords: dual language learners (DLLs), Chinese, language richness, vocabulary, spatial terms, quantifiers

Word count: 8151 words

In the U.S., over 11.5 million or 31.7% of children 0-8 years are dual language learners (DLLs), who are learning both their home language and English simultaneously (Park et al., 2018). To date, much of the research has focused on Spanish-English DLLs (Castro, 2014). Chinese is the second most spoken language by DLLs' parents (3.3% nationwide; Park et al., 2018), with Mandarin and Cantonese being the two dominant dialects in the U.S. (we use "Chinese" to refer to the broad category that contains both of the Chinese dialects in the current study). However, there is a dearth of studies on young Chinese-English (hereafter Chinese) DLLs' language development. To better understand the development of Chinese DLLs and inform practices that support diverse DLL groups, we examined the developmental profiles of Chinese DLLs' English and Chinese comprehension skills during a preschool year and the relation between language richness at home and DLLs' dual language skills.

Compared to Spanish-English DLLs, Chinese DLLs may have more difficulties in learning English due to significant linguistic differences (Melby-Lervåg & Lervåg, 2011; Namaziandost, 2017; Odlin, 1989). The considerable morphological and syntactic differences between English and Chinese contribute to common lexical and grammatical errors among Chinese learners of English (Lam & Sheng, 2016; Yip, 2006). Social and educational factors also influence Chinese DLLs' language development. Many Chinese DLLs face poverty and language barriers in schools (Asian American Federation, 2014). There is also a lack of support for Chinese learning at both home and preschool (Song et al., 2021), contributing to the stagnation of home language skills for Chinese DLLs (Sheng et al., 2011). The attrition of home language skills would mean a missed opportunity for Chinese DLLs to develop strong bilingual and biliterate skills, which are shown to confer cognitive, academic, social-emotional, and economic benefits (Gándara, 2018).

Comprehension skills are essential to young DLLs. Larger receptive vocabulary in both the home language and the language of instruction at (pre)school (e.g., English) is associated with better reading abilities in elementary school (e.g., August & Shanahan, 2006). Comprehension of semantic concepts also lays the foundation for school readiness and later academic learning. For example, language that describes spatial relationships (e.g., "Put the ball *next to* the bin.") or indicates quantity (e.g., "*All* of you will go to the park tomorrow.") is used frequently by teachers to direct behaviors and teach subject-specific contents (Zhou & Boehm, 2001). Comprehension of spatial terms is linked with math skills (Bower et al., 2020) and the comprehension of quantifiers is linked with numeral acquisition, deductive reasoning, and concept development (Barner et al., 2009). However, very few studies have examined the comprehension of spatial terms and quantifiers in DLLs.

DLLs' Receptive Vocabulary

Previous research shows that DLLs in the U.S. make gains in English vocabulary during the preschool years; however, results about their home language vocabulary development are mixed. Some studies found that DLLs grew in their receptive vocabulary in the home language, although the growth in English was greater than the home language (Hammer et al., 2008; Maier et al., 2016). Other studies found stagnation of the home language vocabulary during or soon after preschool years (Kan & Kohnert, 2005; Palermo et al., 2017). There is evidence of Mandarin-English DLLs' continued gains in English receptive and expressive vocabularies but stagnation of Mandarin vocabularies in elementary years (Sheng et al., 2011; Sheng, 2014).

DLLs' Comprehension of Spatial Terms and Quantifiers

The comprehension of spatial terms and quantifiers is an important component of conceptual development that undergirds children's school learning (Zhou & Boehm, 2001).

Monolingual English-speaking children generally comprehend simple spatial terms (typically prepositions or prepositional phrases, e.g., *in*, *on*, *under*, *behind*, *beside*, and *next to*) by 3 years of age (Fenson et al., 1994; Johnston & Slobin, 1979; Rivière et al., 2009). Comprehension of more complex spatial terms (e.g., *between*) continues to improve throughout preschool years until almost all children master them by kindergarten or first grade (Internicola & Weist, 2003; Johnston & Slobin, 1979). Studies on Chinese suggest a similar acquisition sequence by Mandarin- or Cantonese-speaking children (Cheung, 1992; Deng & Yip, 2016).

Monolingual English-speaking children typically acquire the easiest quantifiers such as *all* and *some* by preschool years (Barner et al., 2009; Fenson et al., 1994; Katsos et al., 2016). By age 7, Mandarin-speaking children show adult-like interpretation of the universal quantifier 所有 suǒyǒu (*all* in English) (Brooks et al., 1998). Katsos et al. (2016) showed that the majority of monolingual 5-year-olds across 31 language communities including English, Cantonese, and Mandarin correctly comprehended quantifiers *all* and *some* (Katsos et al., 2016).

Studies examining the semantic knowledge of spatial terms and quantifiers among DLLs are still quite limited. Using a sentence comprehension task with eye-tracking technology, Christou et al. (2021) found that despite some differences in efficiency compared to adults, Spanish-Catalan simultaneous bilingual children (i.e., children exposed to both languages from birth) aged 4 to 9 years can comprehend Spanish prepositions and prepositional phrases.

Syrett et al. (2017) used a forced-choice picture selection task to compare the comprehension of Spanish quantifiers *todos* (*all* in English) and *algunos/unos* (both corresponding to *some* in English) among monolingual Spanish-speaking preschool children (ages 3 to 5 years) from Spain and Peru, as well as Spanish-English simultaneous bilingual children (also ages 3 to 5 years) and Spanish-English bilingual adults from the U.S. They found that while the older bilingual children comprehended *todos,* similar to the monolingual children and bilingual adults, all child groups showed similar performance on *algunos/unos,* which was different from the bilingual adults.

In sum, DLLs may show similar development of their semantic knowledge of spatial terms and quantifier as monolingual children, although specific environments and dual language experiences may pose challenges for them (Syrett et al., 2017). The existing data are still too limited to allow for any general conclusions, especially considering the vast sociocultural and linguistic differences among DLLs in different contexts. Both Christou et al. (2021) and Syrett et al. (2017) only examined comprehension in one language. Here we examined Chinese DLLs’ comprehension of spatial terms and quantifiers in both the societal and the home languages, and the effects of language experiences at home on their semantic knowledge.

Cross-language Relationship of DLLs’ Comprehension Skills

A positive correlation between DLLs’ skills across languages would indicate a potential cross-language transfer, which is consistent with the Common Underlying Proficiency (CUP) model of bilingualism. This model posits that exposure to either language supports the development of the whole cognitive system or the CUP, and allows knowledge and skills to transfer across languages (Cummins, 1981; Goodrich & Lonigan, 2017). In addition, the contrastive analysis proposes that structural similarities and differences in phonology, syntax, and semantics between L1 and L2 can either facilitate or impede the acquisition of L2 (Melby-Lervåg & Lervåg, 2011). This would mean that not all knowledge or skills are readily transferred across languages.

Previous studies suggest that the cross-language relationship varies for different aspects of language skills, with stronger cross-language relationship for phonology (e.g., decoding and phonological awareness) and syntax/grammar than for vocabulary (Melby-Lervåg & Lervåg, 2011; Pace, Luo et al., 2021). Because the pronunciation of words in a language is typically arbitrarily linked to the underlying concepts (e.g., *banana* in English and *xiāngjiāo* in Mandarin Chinese) and DLLs must learn the idiosyncratic mappings in each language (Goodrich & Lonigan, 2017), where the language pair contains less phonological similarity, such as English and Chinese, children's vocabulary skills are more likely to be unrelated across languages. Furthermore, because DLLs experience the two languages in different contexts, the majority of their early vocabularies tend to be words known in one or the other language, rather than both (Rinker et al., 2017). Yang et al. (2017) found that the meta-correlation between DLLs' Chinese and English vocabulary is .10, much lower than the meta-correlations for decoding, phonological awareness, and morphological awareness, which ranged from 0.37 to 0.46.

In contrast, DLLs' comprehension of spatial terms and quantifiers may show a different pattern. As spatial terms and quantifiers encode a set of largely universal concepts, both the CUP model and the contrastive analysis would predict a positive cross-language relationship. The acquisition of spatial terms and quantifiers in English and Chinese may be comparable to the acquisition of translational equivalents, or words known in both languages. Spanish-English DLL preschoolers were more likely to acquire a word in one language if they already knew it in the other language (Goodrich et al., 2016; Sheng et al., 2016).

Effect of Language Richness at Home on DLLs' Language Development

The bioecological model of development asserts that development is embedded in a nested system of social contexts (Bronfenbrenner & Morris, 2006). DLLs' language development is thus shaped and influenced by their experiences with multiple languages in different social contexts. One primary social context for young DLLs is the family context, involving both the quantity and quality of experiences in each language at home (McCabe et al., 2013). The quantity of language experiences refers to the relative amount (percentage) of exposure to each language, whereas *the quality* or *richness of language experiences* is often indicated by DLLs' engagement in language and literacy activities such as book reading, storytelling, singing songs, and multimedia exposure (Paradis, 2011; Sheng et al., 2021).

A number of studies have demonstrated the important and unique role of language richness at home in supporting DLLs' language development beyond relative amount of exposure (Cheung et al., 2019; Farver et al., 2013; Lewis et al., 2016; Paradis, 2011). A study of Cantonese-English DLLs from low-income backgrounds in the U.S. found that the relative amount of home language and English used by family members was not significantly related to the DLLs' vocabulary skills (Cheung et al., 2019). However, the relative amount of home language used in specific home activities such as dinner, playing with family, and reading aloud predicted DLLs' vocabulary in both languages. Other studies that examined the frequency of activities carried out in each language have found that DLLs' engagement in language and literacy activities at home in either the home or societal language was positively related to their language skills (e.g., vocabulary) in the same language (Farver et al., 2013; Song et al., 2012).

The Current Study

To date, only a handful of studies have examined Chinese DLLs' vocabulary skills, and no study to our knowledge has examined their semantic knowledge of spatial terms and quantifiers, which is key to their communication and learning in preschool. Examination of the cross-language relationships of Chinese DLLs' skills is also rare. Furthermore, only a few studies have examined the respective effects of language use (i.e., relative exposure) and language richness (i.e., language and literacy activities) at home on DLL preschoolers' language outcomes (Farver et al., 2013; Lewis et al., 2016; Paradis, 2011; Sheng et al. 2021). The large variations in DLLs' relative language exposure may have overshadowed the effect of language richness at home (Lauro et al., 2020). The weak development or stagnation of Chinese despite a Chinese-dominant environment at home (Sheng et al., 2011) signifies the important and unique role of language richness for Chinese DLLs.

In this study, we focused on Chinese DLLs who are exposed to either Mandarin or Cantonese at home, the two main Chinese dialects in the U.S. city where the study took place. We asked three research questions. 1) What is the developmental profile of Chinese DLLs' comprehension skills (i.e., receptive vocabulary and comprehension of spatial terms and quantifiers) across a preschool year? We expected children's comprehension skills to grow in both languages over the preschool year, although the development of Chinese may show signs of weakening. 2) Are Chinese DLLs' comprehension skills in English related to those in Chinese? We predicted positive cross-language associations for the comprehension of spatial terms and quantifiers, but not for receptive vocabularies. 3) Does language richness at home (i.e., engaging in language and literacy activities) account for unique variances in Chinese DLLs' comprehension skills over and above language use at home? We expected language richness at home to be a significant predictor of DLLs' language outcomes when controlling for language use at home.

Methods

Participants

Participants were recruited from two Chinese-concentrated communities in a U.S. city. Fifty-four Chinese DLLs (28 girls) and one parent of each child participated. Families with at least one parent growing up speaking Chinese (34 Mandarin and 20 Cantonese) were recruited (see Table 1). Forty-one children were taught by English-speaking preschool teachers who did not speak either Mandarin or Cantonese, whereas 13 children were taught by bilingual Chinese-English speaking teachers. All preschool programs had English as the language of instruction.

------ Table 1 ------

We were unable to schedule interviews with three parents, so their three children were excluded from analyses involving family context. One child missed the Chinese vocabulary assessment at the first assessment time (Wave 1) and another child missed this assessment at the second assessment time (Wave 2). All other children completed all assessments at both waves.

Procedures

Child assessments were conducted in both English and Chinese (Mandarin or Cantonese) at the preschools, once around the middle of the preschool year (Wave 1) and once toward the end of the preschool year (Wave 2). The two waves were four months apart (see ages at the two waves in Table 1). Parent interviews were conducted at Wave 1 at the preschools.

Child Assessments

Children's comprehension skills were assessed in both English and Chinese (Mandarin or Cantonese) within a one-week window. The order of the assessments were counterbalanced across participants.

Receptive Vocabulary. Earlier versions of the *Peabody Picture Vocabulary Test* (PPVT) have been translated and adapted to assess Mandarin- or Cantonese-speaking monolingual children in China. However, none of these older versions were available to us, nor would they be valid or appropriate for assessing the DLLs in the current study. Due to a lack of Chinese tests, researchers have translated PPVT-III and PPVT-4 (Dunn & Dunn, 2007) and used them to assess Cantonese-English bilingual children in Canada (Rezzonico et al., 2016) and Mandarin-English bilingual children in Australia (Tsoi et al., 2019). Given these precedents, we translated the items on the PPVT-4, the latest version that was available at the time of the study which had updated items and colored images, as a pragmatic solution to the problem.

The first author, a native Mandarin speaker, and a research associate, a native Cantonese speaker, translated the English version of the PPVT-4 (Dunn & Dunn, 2007) into Mandarin and Cantonese. The PPVT-4 testing procedure was followed. We used the growth scale values (GSVs, provided by PPVT-4's scoring tables) in the analyses. GSVs are raw-score transformations that are superior to raw scores for statistical comparisons and useful for examining developmental change (Dunn & Dunn, 2007). In the current study, children's raw scores and GSV scores were highly correlated (all r's$\geq$.97 for both languages, p's<.001). Children's GSV scores were significantly correlated across the two waves for both English ($r(54)=.74$, $p<.001$) and Chinese ($r(53)=.82$, $p<.001$), indicating good consistency/reliability over time and across parallel forms. However, because the Chinese items had not been validated, the analyses and results were exploratory and interpretations of the results must be cautious.

Comprehension of Spatial Terms and Quantifiers. Test items assessing the comprehension of spatial terms and quantifiers were drawn from the experimental version of the Mandarin English Receptive Language Screener (MERLS, Sheng & Wang, unpublished). Pilot data from the test developers showed that the experimental version of the MERLS has good test-retest reliability (.92) and concurrent validity scores with existing English (.60) and Mandarin (.85) comprehension tests (Sheng et al., 2021). The Mandarin items were independently translated into Cantonese and confirmed by three Mandarin-Cantonese-English trilingual adults. The MERLS uses a sentence-picture matching task presented using slideshow on a laptop or tablet. We selected 12 test sentences out of the 200-item pool in each language that specifically target spatial terms and quantifiers as they bear directly on the current research question of comprehension of semantic concepts. The average number of syllables across the 12 sentences was 8.58 for English (range: 8-9), 8.75 for Mandarin (range: 7-11), and 10.25 for Cantonese (range: 8-13).

In both English and Chinese, there were 4 sentences testing spatial terms (i.e., *between*, *behind*, *under*, and *next to*) and 8 sentences testing the quantifiers *all* and *some*. Each sentence was presented with 3 or 4 pictures on a slide, accompanied by an audio recording of the sentence voiced by a young female bilingual adult, matching one of the pictures (see Table 2). Children were asked to "point to the picture that goes with what the girl says" after hearing the sentence. If children did not respond in 15 seconds after hearing the sentence the first time, the researcher would play the audio recording one more time. If children still did not respond, the item received a score of zero. The rate of correct responses out of the 12 items in each language was used in the analyses. Children's correct rates of MERLS showed acceptable test-retest reliability across the two waves for both English ($r(54)=.69$, $p<.001$) and Chinese ($r(53)=.71$, $p<.001$). The internal consistency measured by Cronbach's alpha was also acceptable for English (Wave 1: $\alpha=.53$; Wave 2: $\alpha=.64$) and Chinese (Wave 1: $\alpha=.68$; Wave 2: $\alpha=.69$).

------ Table 2 ------

Parent Interview

At Wave 1, one parent (the mother in most cases) of each child was interviewed about demographic information, language use, and language richness at home, using the Alberta Language Environment Questionnaire (Paradis, 2011). This questionnaire had been used with Chinese immigrant parents in Canada (Paradis, 2011) and the U.S. (Song et al., 2021). The interview was conducted in parents' preferred language and lasted for 10 to 30 minutes.

Demographic Information. Each parent reported the language(s) both parents spoke growing up, their English fluency, education level, and whether they were working/studying, as well as DLLs' date of birth, birth order, and age of first consistent and significant exposure to English (see Table 1).

Language Use at Home. Parents reported DLLs' English and Chinese (Mandarin/Cantonese) exposure and use with different family members (i.e., mother, father, siblings, and others; see note of Table 1). A proportion score of language use at home, ranging from 0 to 1, was calculated by dividing the sum of all responses by the maximum score. A score of 1 would indicate 100% English use whereas 0 means 100% Chinese (Mandarin/Cantonese) use at home; and a score of .50 would indicate equal English and Chinese (Mandarin/Cantonese) use (Paradis, 2011).

Language Richness at Home. Parents were asked how often the DLLs engaged in language and literacy activities (i.e., reading, storytelling, singing, using a computer, and watching TV/movies) and extracurricular activities (e.g., sports, music) in English and Chinese (Mandarin/Cantonese) on a scale of 0-2 (0-almost never/never, 1-at least once a week, and 2-almost every day/every day; see Table 3). Parents also reported whether the DLLs received formal Chinese (Mandarin/Cantonese) instructions on a scale of 0-2 (0-no formal instruction, 1-once a week, and 2-more than once a week). Finally, parents indicated how often the DLLs used English with their friends when playing outside of preschool on a scale of 0-4 (0-Chinese always and English never and 4-English always and Chinese never). A composite score of language richness was calculated for each language, by dividing the sum of the English or Chinese items by the maximum score (see Table 3 for an example). Thus, the range of the composite scores of language richness is 0-1. A higher score would indicate richer experiences in English or Chinese (Paradis, 2011).

------ Table 3 ------

Results

On average, the DLLs were predominantly exposed to Chinese at home but there were large variations (Table 1). The Chinese DLLs had richer language and literacy experiences in English than in Chinese (Table 3). A paired sample *t*-test of the composite language richness scores (presented in Table 1) indicated that Chinese DLLs experienced significantly higher language richness in English than in Chinese, M_{diff}=.22, *SD*=.34, $t(50)=4.66$, $p<.001$.

Developmental Profile of Chinese DLLs' Comprehension Skills across a Preschool Year

Receptive Vocabulary

Children's PPVT GSVs for English were on average 99.62 (SD=17.32) at Wave 1 and 106.06 (SD=16.44) at Wave 2. Their mean Chinese PPVT GSVs were 104.44 (SD=28.12) at Wave 1 and 105.06 (SD=25.72) at Wave 2. A 2 (Language) × 2 (Wave) repeated measures ANOVA revealed a significant main effect for Wave, $F(1,51)=6.39$, $p=.015$, $\eta^2=.11$, but no significant main effect of Language ($p=.661$). However, there was a significant Language × Wave interaction, $F(1,51)=4.03$, $p=.050$, $\eta^2=.07$. Post hoc comparisons showed although DLLs' English PPVT GSVs increased significantly from Wave 1 to Wave 2 (M_{diff}=6.44, *SE*=1.70, $p<.001$), their Chinese PPVT GSVs showed no significant change (M_{diff}=0.62, *SE*=2.29, $p=.789$) (see Figure 1).

------ Figure 1 ------

Comprehension of Spatial Terms and Quantifiers

Correct rates of the English MERLS items were on average .48 (SD=.20) at Wave 1 and .55 (SD=.21) at Wave 2. Correct rates for the Chinese MERLS items were .49 (SD=.22) at Wave 1 and .54 (SD=.22) at Wave 2. A 2 (Language) × 2 (Wave) repeated measures ANOVA revealed a significant main effect for Wave, $F(1,53)=10.29$, $p=.002$, $\eta^2=.16$. The main effect for Language ($p=.935$) and the Language × Wave interaction ($p=.709$) were not significant. Post hoc comparisons showed that the correct rates increased significantly from Wave 1 to Wave 2 for both English ($M_{\text{diff}}=.06$, $SE=.02$, $p=.008$) and Chinese ($M_{\text{diff}}=.05$, $SE=.02$, $p=.031$) (see Figure 2).

------ Figure 2 ------

Cross-language Relationships of Chinese DLLs' Comprehension Skills

To examine the cross-language relationships, we conducted partial correlation tests between English and Chinese PPVT scores, and between English and Chinese MERLS scores, at each wave, controlling for child's age; Bonferroni correction ($\alpha=0.05/4=0.0125$) was used to adjust for multiple testing. Results showed that DLLs' PPVT scores in English and Chinese were not significantly correlated at Wave 1 ($r=-.28$, $p=.044$) or Wave 2 ($r=-.11$, $p=.450$). In contrast, although DLLs' MERLS scores in English and Chinese were not correlated at Wave 1 ($r=.22$), they were significantly positively correlated at Wave 2 ($r=.36$, $p=.008$). This suggests that, at Wave 2, children who showed good comprehension of English spatial terms and quantifiers also scored relatively high in Chinese, and children who showed poor comprehension in one language scored relatively low in the other language as well.

Relating Language Richness at Home to DLLs' Comprehension Skills

Hierarchical linear regressions were conducted to examine how English and Chinese richness at home at Wave 1 related to receptive vocabulary (PPVT) and comprehension of spatial terms and quantifiers (MERLS) concurrently (at Wave 1) and predictively (at Wave 2). We first tested the bivariate correlations between background variables and DLLs' language outcomes. The background variables included mother's and father's age, education level, and self-rated English fluency as well as whether they were working/studying outside home and what language(s) they spoke growing up, and child's age, gender, firstborn status, and age of first exposure to English. Significant background variables were included in the respective models as control variables, entered in Step 1 of the regressions. Language use at home was entered in Step 2 and English and Chinese Richness were entered in Step 3.

Receptive Vocabulary

English PPVT. At the two waves, the background variables accounted for 28% and 24% of the variance of English PPVT in Step 1 respectively, both of which were significant (see Table 4). When entered in Step 2, language use at home did not account for any significant additional variance and was not a significant predictor in either wave's model. Finally, when entered in Step 3, English richness at home was a significant predictor of English PPVT at Wave 1 (*B(SE)*=37.29(16.48), *Beta*=.43, *p*=.029; a *Beta* between 0.2 and 0.5 is considered to be a moderate effect according to Acock, 2014), accounting for a significant, additional 10% of the variance. However, English richness at home was not a significant predictor of English PPVT at Wave 2 (*B(SE)*=16.04(16.57), *Beta*=.19, *p*=.338; small effect size). Chinese richness was not a significant predictor of English PPVT at either wave.

------ Table 4 ------

Chinese PPTV. The background variables accounted for a significant 47% of the variance of Chinese PPVT in Step 1 at both waves (see Table 4). Language use at home was not a significant predictor of Chinese PPVT at either wave when entered in Step 2. However, at both waves, Chinese richness at home was a significant predictor of Chinese PPVT after controlling for background variables as well as language use at home (Wave 1: *B(SE)*=53.38(20.54), *Beta*=.37, *p*=.013; Wave 2: *B(SE)*=50.98(17.28), *Beta*=.40, *p*=.005; moderate effect sizes), contributing a significant, additional 7% and 10% of the variance respectively. English richness did not relate to Chinese PPVT scores at either wave.

Comprehension of Spatial Terms and Quantifiers

English MERLS. In Step 1, child's age explained 8% and 24% of the variance of English MERLS at the two waves respectively, both of which were significant (see Table 5). Language use at home was not a significant predictor of English MERLS at either wave in Step 2. Finally, English richness at home was a significant predictor of English MERLS at both waves after controlling for child's age and language use at home (Wave 1: *B(SE)*=0.38(0.19), *Beta*=.38, *p*=.046; Wave 2: *B(SE)*=0.47(0.18), *Beta*=.43, *p*=.011; moderate effect sizes), contributing an additional 10% variance (not significant) at Wave 1 and 11% variance (significant) at Wave 2. Chinese richness did not predict English MERLS.

------ Table 5 ------

Chinese MERLS. Child's age and age of first exposure to English accounted for a significant 25% and 22% of variance of DLLs' Chinese MERLS in Step 1 at each wave respectively (see Table 5). Language use at home was not a significant predictor of Chinese MERLS in Step 2. In Step 3, neither Chinese nor English richness was a significant predictor at Wave 1. However, at Wave 2, both Chinese and English richness had positive regression coefficients with moderate effect sizes, although only Chinese richness reached significance (Chinese richness: *B(SE)* = 0.46(0.18), *Beta*=.40, *p*=.014; English richness: *B(SE)*=0.39(0.21) *Beta*=.34, *p*=.068). The Chinese and English richness together contributed a significant, additional 12% of the variance in Step 3 at Wave 2.

Discussion

In this study, we examined how Chinese DLLs' comprehension skills in English and Chinese developed across a preschool year and how language richness at home uniquely related to their dual language skills. The Chinese DLLs were recruited from Chinese-concentrated neighborhoods in a large U.S. metropolitan, where Chinese was the second most common home language (after Spanish) among DLLs. Although the family members predominantly spoke Chinese at home, the Chinese DLLs experienced higher language richness at home in English than in Chinese, measured as how frequently they engaged in language and literacy activities in each language at home or outside preschool. In this context, three main findings emerged. First, although Chinese DLLs' comprehension of spatial terms and quantifiers improved in both languages across the preschool year, only English, but not Chinese, receptive vocabulary significantly grew. Second, children's comprehension of spatial terms and quantifiers, but not receptive vocabularies, showed cross-language association at Wave 2. Third, controlling for background variables and language use at home, language richness at home in either English or Chinese was a significant predictor of Chinese DLLs' comprehension skills in each language, accounting for unique variances.

Developmental Profile of Chinese DLLs' Comprehension Skills

Due to a lack of validated Chinese vocabulary tests, we elected to translate the items on the English PPVT-4 into Mandarin and Cantonese. We used the raw score-based Growth Scale Values (GSVs) in our analyses to estimate changes in children's performance. The results were exploratory and must be interpreted cautiously. The current results on receptive vocabulary are consistent with previous findings showing stagnation of home language skills among Chinese

DLLs in middle-class homes in the U.S. (Sheng, 2014; Sheng et al., 2011) and among other DLL groups (Kan & Kohnert, 2005; Palermo et al., 2017; Uchikoshi, 2014). The results further suggest that the stagnation of home language skills may begin as early as preschool years. The significant growth of English skills indicates DLLs' learning and development of the societal language during the preschool period. Though the lack of growth in home language receptive vocabulary is frequently reported among heritage speakers (Kan & Kohnert, 2005; Palermo et al., 2017; Sheng et al., 2011), this lack of growth already happening in early childhood is concerning in the context of intergenerational cultural transmission and relationships among family member (Oh & Fuligni, 2010; Wong-Fillmore, 1991). Moreover, the stagnation of home language receptive vocabulary also limits DLLs from effectively learning new concepts through the home language and building the CUP through inputs from both languages (Cummins, 1981, 2008; Goodrich & Lonigan, 2017).

However, the Chinese DLLs demonstrated improved performance in comprehending spatial terms and quantifiers in both English and Chinese over the preschool year. Given that these semantic concepts are shared in English and Chinese, input in the two languages can be mutually reinforcing. This hypothesis is bolstered by the correlation and regression findings. The current results demonstrate that DLLs can simultaneously develop their comprehension of spatial terms and quantifiers in both the societal and home languages during the preschool period in spite of variabilities in the exposure and richness of their language experiences in the two languages.

Cross-language Relationship of DLLs' Comprehension Skills

The lack of cross-language association of the DLLs' receptive vocabularies in English and Chinese were consistent with previous findings with other DLL groups (Marchman et al., 2004; Kohnert et al., 2010) and the contrastive analysis (Melby-Lervåg & Lervåg, 2011; Namaziandost, 2017; Odlin, 1989). Given the lack of phonological similarity across English and Chinese, factors or processes related to phonology such as cognates and phonological memory may play a lesser role in the cross-language relationship of receptive vocabulary between these languages.

In contrast, DLLs' comprehension of spatial terms and quantifiers was positively correlated between English and Chinese after controlling for the effect of age at Wave 2, although the positive correlation at Wave 1 did not reach significance. Similar to Goodrich et al.'s (2016) finding with translational equivalents, the fact that our test items in the two languages tapped into universal spatial and logic concepts encoded by spatial terms and quantifiers may explain this cross-language relationship. According to the CUP model (Cummins, 1981, 2008; Goodrich & Lonigan, 2017), children's exposure to these semantic concepts in either language would have contributed to the development of the underlying cognitive system, which allowed the knowledge of these concepts to be transferred across languages, resulting in a positive cross-language correlation. Moreover, the similarities in the semantics of these spatial terms and quantifiers between English and Chinese may also facilitate the learning of these language structures in each language based on the contrastive analysis (Melby-Lervåg & Lervåg, 2011; Namaziandost, 2017; Odlin, 1989).

Together, the cross-language results present a nuanced picture of the relationship between DLLs' two languages. The dissociation of DLLs' receptive vocabulary in the two languages highlights the need to assess and strengthen DLLs' respective vocabulary skills and language experiences in both the societal and home languages to better support DLL's vocabulary development in both languages. The positive association of DLLs' comprehension of spatial terms and quantifiers suggests a potential, encouraging cross-language transfer. As DLLs build school readiness skills, development in one language may benefit that in the other language when the skills tap into shared conceptual knowledge. Thus, development in both the home and societal languages contributes to preparing DLLs for school learning (Tamis-LeMonda et al., 2014). However, the correlation does not suggest any causal relationship or elucidate the underlying mechanism for the cross-language transfer. Future research is needed to determine whether and how knowledge of spatial terms and quantifiers in one language supports that in the other language.

Language Richness versus Language Use at Home

In 6 of the 8 hierarchical linear regression models, language richness at home in English or Chinese was a significant predictor of DLLs' comprehension skills in the respective language, controlling for the effect of language use at home. For DLLs whose family members used Chinese (versus English) to the same extent, those who engaged in more language and literacy activities at home in the home language or English, had larger receptive vocabulary or better comprehension of spatial terms and quantifiers in the respective language. These results suggest that there is a significant and unique effect of language richness at home, over and above language use at home, and the effect is largely language specific for DLLs' comprehension skills.

It must be noted, however, that these results are correlational and causal relationships cannot be ascertained. Although greater language richness may enhance input thereby causing DLLs to have higher receptive vocabulary and comprehension scores, it is also possible that DLLs who have stronger language skills are more likely to engage in those language and literacy activities. A reciprocal relationship is also likely: While the environment and experiences shape and affect DLLs’ dual language development, DLLs also play an active role in choosing what activities they like to engage in with their dynamically changing dual language skills. Thus, the current results must be interpreted with caution.

In 2 of the 8 regression models, language richness at home was not a significant predictor. In the first case, English richness at home at Wave 1 was not a significant predictor of English PPVT at Wave 2. This could be a result of the DLLs’ increased English experiences outside home (e.g., at preschool), which may have become the primary source for growth in English receptive vocabulary after children had been in preschool for some time, especially when DLLs had limited English exposure at home.

In the second case, Chinese richness at home was not a significant predictor of Chinese comprehension of spatial terms and quantifiers at Wave 1. Comparing the models for Chinese and English, we could see that whereas only English richness predicted English MERLS scores, both Chinese and English richness had positive and appreciable coefficients predicting Chinese MERLS scores at both waves, although only Chinese richness reached significance at Wave 2. Because the test items were based on shared concepts in the two languages, rich experiences in either language may have a positive effect on DLLs’ comprehension of the spatial terms and quantifiers in Chinese.

Although English richness had positive coefficients predicting Chinese MERLS scores, Chinese richness had negative and close-to-zero coefficients predicting English comprehension of the spatial terms and quantifiers. One possibility could be that Chinese richness at home was much lower than English richness, hence the weaker or negligible effects. Alternatively, because spatial and quantity/logic expressions are frequently embedded in learning and communication at school, English richness at home may reinforce school learning and serve as a bridge to induce transfer of school learning to comprehension in Chinese.

Although previous research has shown how the relative amount of exposure to each language and who the speakers of each language are in various contexts affect children's dual language development (De Houwer, 2007; Hoff, 2018), in our models, language use at home was not a significant predictor of DLLs' comprehension skills, after controlling for significant background variables. These results suggest that to support home language development, it may be insufficient to simply speak the home language, as language richness at home plays a significant role (see also Luo, Pace, et al., 2021; Paradis, 2011; Sheng et al., 2021; Song et al., 2021).

The relationship between rich language experiences and positive language development has long been established among monolingual children (Mol & Bus, 2011; Raikes et al., 2006). However, the necessity of providing rich home language experiences beyond simply speaking it is still not widely recognized by DLLs' parents, even though they acknowledge the benefits of bilingualism and home language development (Luo, Song, et al., 2021). Indeed, Festa et al. (2014) found that only 57.5% of parents in immigrant families in California reported daily book sharing with children under 6 years of age, compared with 75.8% of native-born parents, with lower odds of daily book reading especially for Asian and Hispanic children in immigrant families.

To enhance the richness of DLLs' language experiences, families should be provided with more resources such as access to children's books, educational audios and videos, and extracurricular activities in both English and the home language. DLLs' parents should be encouraged to capitalize on their home language skills to engage DLLs in language and literacy activities. Parents and society as a whole should recognize that a *rich home language environment* is critical to home language development and is a boon, rather than hindrance, to DLLs' English learning.

Limitations and Future Directions

This study has several limitations. First, the translated PPVT did not arrange the items in the order of vocabulary acquisition in Chinese, and may have contributed to the lack of changes in the Chinese PPVT scores. However, a previous longitudinal study of Chinese DLLs in the U.S. found significant growth using translated Chinese PPVT (Song et al., 2021), which to some extent lessens this concern. Second, the semantic concepts and number of trials we used were limited. Future studies can build on the current study to include more trials per concept and a wider range of semantic concepts. Third, we used a language environment questionnaire to measure language richness at home. We did not directly measure children's exposure to spatial terms and quantification expressions in the home environment. Therefore, we could only draw a general link between rich language input and children's comprehension of spatial terms and quantifiers. Future studies may further examine finer associations between exposure to these specific concepts and expressions and learning outcomes in bilingual children through direct recordings and detailed analyses of language use in the home.

Conclusions

Over the span of a preschool year, Chinese DLLs demonstrated growth in English receptive vocabulary and comprehension of spatial terms and quantifiers in both Chinese and English. However, Chinese receptive vocabulary showed early stagnation. Language richness at home in each language predicted comprehension skills in the corresponding language. The language-specific effect of high-quality experiences begs for greater awareness among caregivers and more resources to support both the home and societal languages. Nevertheless, the cross-language transfer in spatial terms and quantifier comprehension suggests that rich language experiences in one language may benefit both languages.

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Table 1

Parents' and Children's Demographics and Language Context at Home at Wave 1

	Mother		Father	
	M(SD) or %	Range	M(SD) or %	Range
Age	35.33 (4.14)	29-45	37.47 (4.50)	30-48
Language spoken growing up				
Chinese	100%		84.3%	
English	0%		11.8%	
Other	0%		3.9%	
Self-rated English fluency				
Not fluent	5.9%		15.7%	
Limited fluency	29.4%		27.5%	
Somewhat fluent	21.6%		9.8%	
Quite fluent	23.5%		13.7%	
Very fluent	19.6%		33.3%	
Education level				
Primary	5.9%		5.9%	
Secondary	35.3%		43.1%	
Some college	19.6%		13.7%	
Bachelor's degree	31.4%		29.4%	
Master's degree	5.9%		3.9%	
Doctoral degree	2.0%		3.9%	
Work or study outside home	78.4%		98.0%	

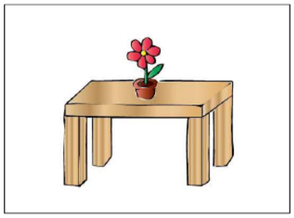
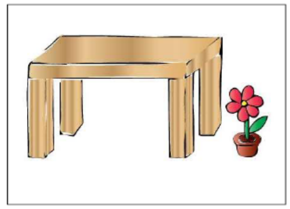
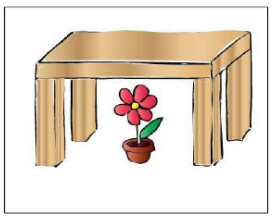
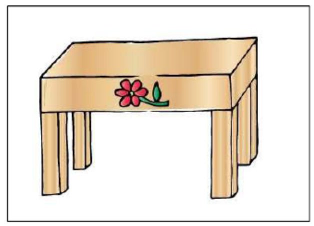
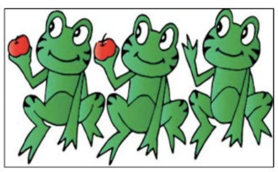
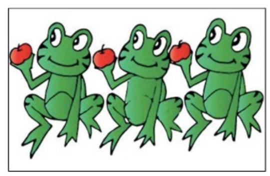
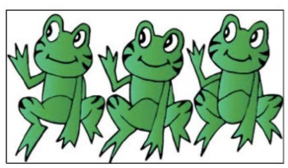
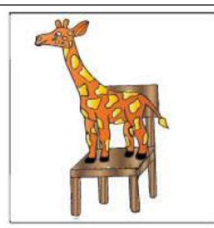
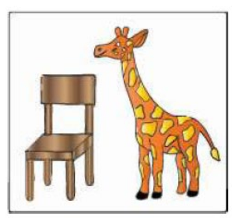
	Children	
	M(SD) or %	Range
Age at Wave 1 (months)	50.44(6.33)	39-60
Age at Wave 2 (months)	54.22(6.40)	42-63
Female	51.9%	
Firstborn	47.1%	
Age of first exposure to English (months)	31.33(15.88)	0-54
Language use at home[a]	0.35(0.25)	0-0.92
Language richness at home[b]		
English	0.52(0.20)	0-0.88
Chinese	0.30(0.19)	0-0.72

[a] English versus Chinese use at home (0-Chinese, 1-English). Sample items based on which the proportion score was calculated: "What language(s) do you speak with the target child?" "What language(s) does the target child speak with you?" 0- Chinese always and English never, 1-

Chinese usually and English seldom, 2-English 50% and Chinese 50%, 3-English usually and Chinese seldom, 4-English always and Chinese never.
[b] The higher the proportion, the more frequently the DLLs engaged in language and literacy activities in a language (English or Chinese).

Table 2

Sample Items of the Comprehension Test of Spatial Terms and Quantifiers

	Children see on the screen	**Children hear the audio-recording say**
English	1  2  3  4 	"The flower is under the table."
	1  2  3 	"Some frogs are holding an apple."
Mandarin/ Cantonese	1  2  3  4 	"长颈鹿在椅子后面。" "隻長頸鹿喺張凳嘅後面。" ("The giraffe is behind the chair.")

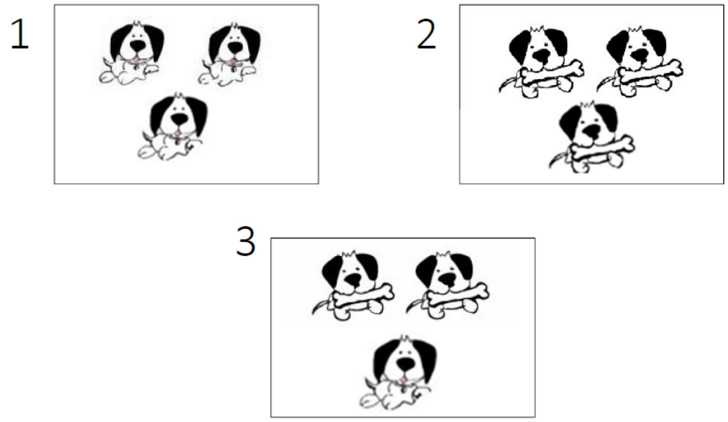
		“有的小狗在啃骨头。” “有啲狗仔喺度食緊骨頭。” (“Some dogs are biting the bone.”)

Table 3

Percentage of Chinese DLLs Engaging in Activities Indicating Language Richness at Home at Wave 1

	English			Chinese		
	almost every day/every day (2)	at least once a week (1)	almost never/never (0)	almost every day/every day (2)	at least once a week (1)	almost never/never (0)
Language and literacy activities[a]						
Reading books or magazines[b]	33.3	41.2	25.5	17.6	19.6	62.7
Using a computer[c]	35.3	23.5	41.2	13.7	27.5	58.8
Watching TV or movies[d]	56.9	27.5	15.7	27.5	29.4	43.1
Storytelling	33.3	23.5	43.1	19.6	33.3	47.1
Singing Songs	51.0	35.3	13.7	17.6	41.2	41.2
Organized extracurricular activities[a]	2.0	23.5	74.5	0	9.8	90.2
Taking Chinese language classes[a]						
No formal instruction (0)	90.2					
Once a week (1)	2.0					
More than once a week (2)	7.8					
Languages spoken with friends outside preschool[a]						
English never, Chinese always (0)	13.7					
English seldom, Chinese usually (1)	17.6					
English 50%, Chinese 50% (2)	17.6					
English usually, Chinese seldom (3)	21.6					
English almost always, Chinese almost never (4)	29.4					

[a] Parents' responses to these four parts were aggregated into the composite score of *language richness at home* (presented in Table 2). For example, if a child engaged in all five language and literacy activities and organized extracurricular activities in English almost every day/every day, they would receive the maximum score of 12 for the six items in English. If they "almost always" spoke English and "almost never" spoke Chinese with their friends when playing outside of preschool, they would receive the maximum score of 4 for this item. The final composite score for the language richness in English for this child would be the sum of 12 and 4 divided by 16, which is 1.

[b] Reading includes having books read to children and looking at books.

[c] Computer use includes internet, games, storybooks on CD-ROMs, etc. if they involve language. It also includes similar activities done on a tablet computer, smartphone, or other electronic devices.
[d] Movies also include video or DVD shown on a computer or television.

Table 4

Hierarchical Linear Regressions Predicting Chinese DLLs' Receptive Vocabulary (PPVT GSVs) in English and Chinese

Wave 1	English PPVT B(SE), Beta	Chinese PPVT B(SE), Beta
Step 1: Control variables	3 control variables[a]	5 control variables[c]
R^2, F(df, df)	.28, 6.04(3, 47)**	.47, 7.80(5, 44)***
Step 2:		
Language use at home	1.56(12.93), .02	-26.72(20.85), -.24
R^2_{change}, F_{change}(df, df)	0, 0.02(1, 46)	.02, 1.64(1, 43)
Step 3:		
English richness	**37.29(16.48), .43***	2.19(25.16), .02
Chinese richness	-13.98(13.85), -.16	**53.38(20.54), .37***
R^2_{change}, F_{change}(df, df)	.10, 3.37(2, 44)*	.07, 3.45(2, 41)*
Wave 2		
Step 1: Control variables	2 control variables[b]	6 control variables[d]
R^2, F (df, df)	.24, 7.71(2, 48)**	.47, 6.47(6, 43)***
Step 2:		
Language use at home	-13.74(12.06), -.21	-30.21(17.04), -.30
R^2_{change}, F_{change}(df, df)	.02, 1.30(1, 47)	.04, 3.14(1, 42)
Step 3:		
English richness	16.04(16.57), .19	-8.56(21.91), -.07
Chinese richness	-5.38(14.05), -.06	**50.98(17.28), .40****
R^2_{change}, F_{change}(df, df)	.02, 0.60(2, 45)	.10, 4.81(2, 40)*

Notes. *$p < .05$; **$p < .01$; ***$p < .001$

[a] Model controlled for mother working/studying outside home, mother's English fluency, and age of first exposure to English.

[b] Model controlled for mother's English fluency, and age of first exposure to English.

[c] Model controlled for mother's English fluency, father speaking English growing up, father's English fluency, child's age, and age of first exposure to English.

[d] Model controlled for mother working/studying outside home, mother's English fluency, father's education level, father's English fluency, child's age, and age of first exposure to English.

Table 5

Hierarchical Linear Regressions Predicting Chinese DLLs' Comprehension of Spatial Term and Quantifiers (MERLS) in English and Chinese

Wave 1	English MERLS B(SE), Beta	Chinese MERLS B(SE), Beta
Step 1: Control variables	1 control variable[a]	2 control variables[c]
R^2, F(df, df)	.08, 4.29(1, 49)*	.25, 7.88(2, 48)**
Step 2:		
Language use at home	0.15(0.11), .19	-0.27(0.15), -.31
R^2_{change}, F_{change}(df, df)	.03, 1.66(1, 48)	.05, 3.27(1, 47)
Step 3:		
English richness	**0.38(0.19), .38***	0.31(0.21), .28
Chinese richness	-0.08(0.17), -.08	0.27(0.18), .24
R^2_{change}, F_{change}(df, df)	.10, 2.77(2, 46)	.06, 1.95(2, 45)
Wave 2		
Step 1: Control variables	1 control variable[b]	2 control variables[d]
R^2, F (df, df)	.24, 15.36(1, 49)***	.22, 6.94(2, 48)**
Step 2:		
Language use at home	0.19(0.11), .22	-0.23(0.16), -.26
R^2_{change}, F_{change}(df, df)	.04, 2.91(1, 48)	.03, 2.13(1, 47)
Step 3:		
English richness	**0.47(0.18), .43***	0.39(0.21), .34
Chinese richness	-0.04(0.16), -.03	**0.46(0.18), .40***
R^2_{change}, F_{change}(df, df)	.11, 4.09(2, 46)*	.12, 4.40(2, 45)*

Notes. **p* < .05; ***p* < .01; ****p* < .001

[a] Model controlled for child's age.

[b] Model controlled for child's age.

[c] Model controlled for child's age and age of first exposure to English.

[d] Model controlled for child's age and age of first exposure to English.

Figure 1

Chinese Dual Language Learners' PPVT Scores

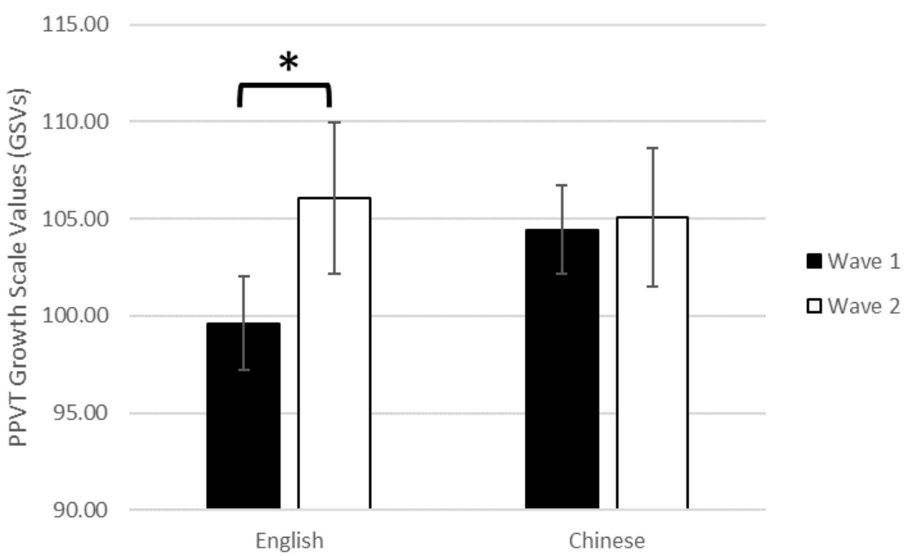


Figure 2

Chinese Dual Language Learners' Correct Rates on MERLS