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Research Article

Phonological Skills in English Language Learners

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Purpose: The purpose of this study was to examine the English phonological skills of English language learners (ELLs) over 5 time points.
Method: Sound class accuracy, whole-word accuracy, percentage of occurrence of phonological patterns, and sociolinguistic correlational analyses were investigated in 19 ELLs ranging in age from 5;0 (years;months) to 7;6.
Results: Accuracy across all samples was over 90% for all sound classes except fricatives and increased for all sound classes across time. Whole-word accuracy was high and increased across time. With the exception of cluster reduction, stopping, and final consonant deletion, the frequency of occurrence for phonological patterns was less than or equal to 5% at every time point. Sociolinguistic variables such as age of arrival, age of exposure, and age were significantly related to phonological skills.
Conclusions: The results were consistent with the hypotheses outlined in Flege's (1995) speech learning model in that the phonological skills of ELLs increased over time and as a function of age of arrival and time. Thus, speech-language pathologists (SLPs) also should expect phonological skills in ELLs to increase over time, as is the case in monolingual children. SLPs can use the longitudinal and connected-speech results of this study to interpret their assessments of the phonological skills of ELLs.

Key Words: phonology, bilingualism, cultural and linguistic diversity

The language skills of English language learners (ELLs) are important to investigate because of the increasing number of ELLs in school systems in the United States and in Canada. In 2010–2011 in the United States, 4.7 million school-age children (10% of school-age population) were ELLs (National Center for Education Statistics, 2013). Further, in Canada (the country of origin for the participants in this study), there are over 320,000 children ages 5 to 9 who speak a language other than English or French (over 17% of this age group; Statistics Canada, 2007). The purpose of this study was to examine English phonological abilities over time in ELLs from a variety of first-language backgrounds. In contrast to the number of studies focused on the phonological development of monolingual children, there have been relatively few studies examining the phonological skills of ELLs. Thus, speech-language pathologists (SLPs) do not always have the information needed to properly identify speech sound disorders in ELLs. Without reliable developmental information, ELLs are at a disadvantage when it comes to assessment and intervention.

Theoretical Framework

Flege's (1995) speech learning model (SLM) provides the context for this investigation, although the model itself is not tested directly. For the purposes of this study, we focus on the SLM's discussion of production accuracy in English only, although the model incorporates both perception and production and comparison to the first language (L1). Two important tenets of the SLM are that second-language (L2) skills increase as a function of age of arrival, referred to as *age of learning* (AOL) in the SLM, and that such skills increase also as a function of time. Flege hypothesized that AOL plays an important role in L2 speech production. For example, Italian phonology does not include interdental fricatives /ð/ and /θ/, and many native Italian speakers produce these sounds in English as /d/ and /t/. However, Flege, Munro, and MacKay (1995) reported that children who began learning English before the age of 10 produced these two English phones with the same accuracy as did native English speakers. Thus, learning a second language earlier in life increases one's ability to produce

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L2 phonemes more accurately. With respect to Flege's hypothesis that phonological skills of L2 learners increase with time, it is argued that phonetic differences can be learned with practice. According to the SLM, then, young children (i.e., those in the sensitive period), like those in the current study, are capable of learning a second language with native-like accuracy. Children appear to have a superior ability to discern phonemic differences between two languages (Flege, 1995), which facilitates the accurate production of phonemes from both languages, suggesting that L2 speech production skills will increase with time and practice.

Prior to examining the literature related to the phonological skills of ELLs, it is necessary to comment on the terms *English language learners* and *bilinguals*. The term *English language learner* is used typically when only the English skills of a multilingual population are under investigation (Paradis, Genesee, & Crago, 2011). *Bilingual,* then, is used when both L1 and L2 skills are examined. Researchers often divide bilingual speakers into bilingual first-language acquisition (acquiring both languages from birth), simultaneous (exposed to L2 before age 3), and sequential (exposed to L2 after age 3; Gildersleeve-Neumann & Wright, 2010; Goldstein, Bunta, Lange, Rodriguez, & Burrows, 2010). In reviewing this literature, we use the terms adopted by the authors of the individual articles cited.

Vowel and Consonant Accuracy

Consonant and vowel accuracy is commonly measured in studies of phonological skills. To understand the phonological skills of ELLs, it is important first to examine studies focusing on typically developing monolingual English speakers. Comparisons to monolingual English speakers must be analyzed with caution, however, as bilingual speakers demonstrate a unique language development process and are not equivalent to monolingual speakers in each language (Grosjean, 1989).

Most of the data on phonological acquisition in monolingual English speakers involve consonants instead of vowels because vowels commonly are acquired by the age of 4 (McLeod, 2013). Vowel accuracy can be measured using percentage-of-vowels correct (PVC), a quantitative measure of vowel accuracy. Austin and Shriberg (1996) found PVC to be 96.1% in typically developing children ages 3;0–5;11 (years;months) and 98.4% for children ages 6;0–8;11. Consonant accuracy can be quantified in the same manner using percentage-of-consonants correct (PCC). For typically developing children ages 3;0–5;11, PCC was 83.8%, and for children ages 6;0–8;11, PCC was 92.6%. Phonological accuracy also can be assessed by examination of individual phonemes or phonemic sound class. Smit, Hand, Freilinger, Bernthal, and Bird (1990) investigated speech sound skills in typically developing children ages 3;0–9;0 using a single-word instrument. Children acquired nasals, stops, and glides by age 3;6 and subsequently began to slowly develop affricates, fricatives, and liquids. The last sounds to develop were /r, ŋ, θ, z, l/ at age 6;0.

In general, investigation of phonological development in ELLs has indicated that even though bilingual speakers are acquiring two phonological systems, consonant and vowel accuracy in typically developing bilingual children is similar but not identical to that of monolingual children (e.g., Bunta, Fabiano-Smith, Goldstein, & Ingram, 2009; Fabiano-Smith & Goldstein, 2010; Goldstein, Fabiano, & Washington, 2005). Bunta et al. (2009) and Fabiano-Smith and Goldstein (2010) reported that 3- and 4-year-old bilingual Spanish-English speakers had consonant accuracy in English (PCC) that was slightly lower for bilingual than monolingual children. Mean PCC for the bilingual children's English was 72.85% and 72.31% in the Bunta et al. (2009) and Fabiano-Smith and Goldstein (2010) studies, respectively, and for the monolingual children's English, it was 84.88% and 84.10%, respectively. These studies suggest that consonant accuracy in both of the bilingual children's two languages is relatively high at a young age. Much of the information on bilingual speakers has been gathered from bilingual Spanish-English speakers (Hambly, Wren, McLeod, & Roulstone, 2012). Studies of other language pairs exist as well (e.g., Keshavarz & Ingram, 2002; Preston & Seki, 2011), but these investigations are case studies and focus on one child who is younger than those in the current study (Keshavarz & Ingram, 2002) and one who is older (Preston & Seki, 2011).

Whole-Word Measures

In addition to measures of consonant and vowel accuracy, phonological skills have been analyzed using whole-word measures. Whole-word measures represent an approach to analyzing phonological skills by taking into account the entire production of a word, instead of individual phonemes. Whole-word measures also may be classified as a manner of measuring "ultimate attainment" of phonological skills, that is, achieving the same level of whole-word complexity as that of monolingual individuals. Phonological mean length of utterance (pMLU) measures "the length of a child's words and the number of correct consonants" (Ingram, 2002, p. 715), thus examining the production as a whole entity. Ingram has suggested that pMLU be separated into five qualitative stages: Stage 1, pMLU = 2.5–3.5; Stage 2, pMLU = 3.5–4.5; Stage 3, pMLU = 4.5–5.5; Stage 4, pMLU = 5.5–6.5; and Stage 5, pMLU = 6.5–7.5. A *Beyond Stage 5* category also exists for those who exceed a pMLU of 7.5. To obtain a quantitative measure for whole-word approximation, proportion of whole-word proximity (PWP) provides a percentage of accuracy based on the child's pMLU in comparison to the target pMLU (details can be found in the Method section).

The majority of studies with variables based on whole-word measures have focused on children younger than those in this investigation. For example, Garlant (2001) reported that 2-year-old bilingual Spanish-English children had pMLU and PWP scores commensurate to those of monolingual Spanish peers. Three-year-old monolingual English speakers in Bunta et al. (2009) displayed an average pMLU of 6.24 and PWP of 92%. Bilingual Spanish-English children in the same study had slightly lower average pMLU (5.85) and PWP (86%) scores for their English productions when compared with monolingual English children. Results from this study suggest that bilingual children are capable of ultimate attainment, although they may develop skills at a somewhat slower rate.

Few investigators have examined phonological skills longitudinally with whole-word measures (e.g., Ingram, 2008; Saaristo-Helin, 2009). To our knowledge, only MacLeod, Laukys, and Rvachew (2011) have examined whole-word measures longitudinally in a bilingual population study of English-French bilingual children who were 18 and 36 months of age at study outset. Over a 6-month period, the authors found that pMLU increased significantly for the 18-month-old group, but the increase in PWP was not statistically significant. In the 36-month-old group, however, both pMLU and PWP increased significantly over the 6-month period. For the 36-month-old group, pMLU increased from 4.29 to 4.47, and PWP increased from 80% to 91%. The whole-word skills of the bilingual children did not differ significantly from those of monolingual peers at 18 and 36 months. Results from the MacLeod et al. (2011) study suggest that pMLU and PWP increase over time in a bilingual population and eventually reach ultimate attainment.

Phonological Patterns

Phonological patterns are defined as systematic errors in a child's speech. In their study of phonological patterns in typically developing monolingual English children, Dodd, Holm, Hua, and Crosbie (2003) found gliding, deaffrication, and cluster reduction to be the only phonological patterns still present at age 4;0. By age 5;0, only gliding was still produced. Additional studies have found that gliding, final consonant deletion, cluster reduction, weak syllable deletion, and epenthesis may still be present in children over age 5;0 (Haelsig & Madison, 1986; Peña-Brooks & Hedge, 2007; Roberts, Burchinal, & Footo, 1990). Thus, it is possible to see certain phonological processes still declining in older monolingual children.

Bilingual and ELL children produce many of the same phonological patterns in English as their monolingual peers, but they also produce patterns that are not identical to those of monolingual children (e.g., Dodd, So, & Wei, 1996; Goldstein & Washington, 2001; Hambly et al., 2012). For example, in their study of Spanish-English 4-year-olds, Goldstein and Washington (2001) found that the most common patterns in the 4-year-olds were stopping (6.9%), final consonant deletion (4.2%), and cluster reduction (3.2%); these patterns are typical of monolingual children as well. However, percentage of occurrence (POC) of phonological patterns differed for bilingual and monolingual children. For example, bilingual children produced cluster reduction, liquid simplification, unstressed syllable deletion, and stopping less frequently than did monolingual children (Goldstein & Washington, 2001). Gildersleeve-Neumann and Wright's (2010) study found that Russian-English 3- to 5-year-olds exhibited significantly higher POC on final devoicing, vocalization, trill substitution, and stopping compared with monolingual peers. In a quasi-longitudinal design, Ha, Johnson, and Kuehn (2009) examined the phonological skills of three bilingual Korean-English children, ages 3;10, 6;0, and 11;0, who had varying degrees of English exposure. Both age and length of exposure had an effect on the use of phonological patterns; as age and length of English exposure increased, phonological patterns' POC decreased. Phonological patterns produced included stopping, vowel errors, voicing errors, sibilant distortions, cluster reduction, and final consonant deletion. In sum, the results of these studies demonstrate that phonological skills in bilingual children are similar, although not identical, to those of monolingual children. Once again, the assumption is that, over time, the number of phonological errors and POCs of phonological patterns will decrease.

Sociolinguistic Variables and Phonological Skills

A number of studies, using varying methods, have investigated the relation between phonological skills and sociolinguistic variables, such as chronological age, age of arrival, frequency of output, age of acquisition, and age of exposure. As the speech learning model (Flege, 1995) suggests, there should be a relation between these sociolinguistic factors and phonological skills.

Goldstein et al. (2005) studied the effects of frequency of output (the percentage of time that the children used each of the two languages) based on parent report of the phonological abilities of 15 children of Latino descent (ages 5;0–5;5) with varying degrees of language output—predominantly Spanish, predominantly English, and bilingual. In English, overall PCC was more than 90% for both bilingual and predominantly English-speaking children. The only manner class whose accuracy was less than 90% was affricates (86.66%), which was only slightly lower than affricate accuracy in monolingual children based on retrospective comparisons (Prather, Hedrick, & Kern, 1975; Smit et al., 1990). Alternatively, other studies have reported that amount of output (as measured by parent report) did not have an effect on phonological accuracy in bilingual children (Goldstein et al., 2005, 2010).

Age is another factor that has been found to have an effect on phonological skills. In a study of Russian-English bilingual children ages 3;3–5;7, age was found to be related to phonological skills (Gildersleeve-Neumann & Wright, 2010). Children over age 5;0 produced English phonemes more accurately than did the under-5;0 group; both groups included bilingual first-language acquisition, simultaneous, and sequential bilingual speakers. Further, the overall number of sounds in the vowel and consonant inventories of bilingual children was not significantly different from that of their monolingual peers. Thus, over time, English phonological skills become commensurate to those of monolingual children.

The few longitudinal studies of phonological skills and sociolinguistic variables in bilingual children and ELLs have found that phonological skills increase across time. Holm and Dodd (1999) studied two typically developing

Cantonese-English bilingual children, ages 2;3 and 2;9 at the beginning of the study, for 9 months. Prior to the study, the children had been exposed to English for approximately 3 months. Over the course of 9 months, the children's consonant repertoires increased (Holm & Dodd, 1999). In a study of Korean-English children ages 3;10–11;0 with varying lengths of English exposure, Ha et al. (2009) found that as length of exposure and age increased, fewer phonological patterns were present. Gildersleeve-Neumann, Kester, Davis, and Peña (2008) divided 33 children ages 3;1–3;10 (at Time 1) into three groups—predominantly English, English only, and balanced Spanish-English bilingual children. After 8 months, overall PCC and overall PVC had increased. All three groups produced stops, nasals, glides, fricatives, and liquids at Time 1 and Time 2. Similar to Holm and Dodd's (1999) study, most sounds had already been acquired at Time 1, and the rest of the sounds developed across time. Although these longitudinal studies examined phonetic inventory and not sound class accuracy, it was still apparent that phonological skills increased over time. Bilingual children and ELLs, then, are not necessarily at risk for less advanced phonological skills compared with monolingual speakers simply because they are acquiring more than one language. Overall, phonological skills are relatively high and increase over time.

Several longitudinal studies have examined further the use of phonological patterns over time in bilingual children and ELLs. It is important to note that many of the longitudinal studies are based on small sample sizes—typically, one or two children. For example, the two children discussed above in Holm and Dodd's (1999) study produced typical patterns (i.e., those commonly exhibited by monolingual speakers; e.g., cluster reduction, stopping, weak syllable deletion, fronting, final consonant deletion). In addition, atypical patterns (i.e., those not commonly exhibited in monolingual speakers) were also present (initial consonant deletion, voicing, backing, affrication, and deaspiration). After 7 months, however, both children produced more atypical patterns than at Time 1. The older child produced fewer typical phonological patterns over time, whereas the younger child produced the same number as before. Gildersleeve-Neumann et al. (2008) found cluster reduction, final consonant devoicing, final consonant deletion, and gliding to be the most common phonological patterns among Spanish-English 3- and 4-year-olds. However, all patterns with a POC of greater than 5% decreased in frequency between Time 1 and Time 2, again illustrating that the skills of bilingual children become more like those of monolingual children across time.

Although previous studies examining phonological development in ELLs provide some information about skills, the extant knowledge base is limited in four important ways. First, previous studies have demonstrated that sociolinguistic variables such as length of exposure and time have an effect on second-language acquisition and are important independent variables to include when studying this group. However, these two variables have been conflated without examining their individual contribution to the development of phonological skills. Second, the extant knowledge base has been derived largely from cross-sectional studies but not longitudinal studies. Studying phonological skills developmentally is important because it quantifies growth over time at the individual and cohort levels and controls for cohort effects (Diggle, Heagerty, Liang, & Zeger, 2002). Third, many previous studies included a limited number of phonological measures and thus do not present a complete representation of the children's phonological skills. Similarly, most data on phonological accuracy have been acquired from single-word measures, not from connected-speech samples. Data from connected-speech samples will reveal more accurately how bilingual children typically are producing English sounds. Finally, most studies, especially the longitudinal ones, included a relatively limited number of participants. Including a larger number of participants increases the power of the analyses (i.e., finding significant results) and the generalizability of the results. The current investigation obviates these limitations by examining the effect of sociolinguistic variables on phonological skills, using a longitudinal approach, and measuring a relatively large number of phonological skills.

Purpose of the Study

The purpose of the study was to examine the phonological development of typically developing ELLs. We asked one research question: What are the English phonological skills of ELLs across time? On the basis of the extant literature, we hypothesized that (a) phonological skills would increase at each time point, (b) phonological skills of ELLs would be comparable to those of monolingual peers at Time 5, and (c) the sociolinguistic variables age of arrival, age of exposure, English use, months of exposure, and age would be significantly related to phonological skills.

Method

This study was approved by the institutional review board of Temple University (Philadelphia, PA).

Participants

The extant data analyzed in this study were from Paradis and colleagues' investigation of grammatical morphology and vocabulary development in ELLs (Golberg, Paradis, & Crago, 2008; Paradis, 2005). Participants (see Table 1) included 19 ELLs living in Canada who were between the ages of 4;2 and 6;9 (M = 5;4; SD = 9.84) at the time of the first data collection (Time 1). At the time of the last data collection (Time 5), the children were between the ages of 6;2 and 8;9 (M = 7;4; SD = 9.88).

The study included only sequential bilingual children who were not exposed to English until at least age 3;3, seven of whom were over age 5;0 when first exposed to English. At Time 1, the children had between 2 and 18 months of English exposure, with an average of 9.05 months (SD = 4.52). At the Time 5 collection, they had between 26 and 42 months of English exposure, with an average of 33.6 months (SD = 4.56). The average age of arrival was 40.32 months (SD = 26.79),

Table 1. Participant demographics.

					Age (mos)					Months of exposure					MLU–m					Number of utterances				
Child (C)	First language	Age of arrival (mos)	Age of exposure (mos)	English use	Time 1	Time 2	Time 3	Time 4	Time 5	Time 1	Time 2	Time 3	Time 4	Time 5	Time 1	Time 2	Time 3	Time 4	Time 5	Time 1	Time 2	Time 3	Time 4	Time 5
C1	Arabic	1	47	0.55	58	64	70	75	82	11	17	23	28	35	3.22	3.11	4.58	3.12	2.81	499	396	196	263	463
C2	Arabic	1	42	0.61	50	56	61	67	79	8	14	19	25	37	2.22	3.66	4.27	4.21	3.75	779	430	522	526	394
C3	Arabic	1	57	0.74	59	65	70	77	83	2	8	13	20	26	4.15	4.23	3.99	4.97	3.75	201	645	623	379	489
C4	Cantonese	1	48	0.25	62	68	73	79	86	14	20	25	31	38	3.23	3.69	3.27	3.97	2.98	561	280	541	522	613
C5	Cantonese	1	40	0.33	56	62	68	74	80	16	22	28	34	40	2.68	4.11	3.95	4.51	3.58	332	382	410	363	366
C6	Farsi	64	66	0.47	78	84	90	96	102	12	18	24	30	36	3.86	3.38	4.11	4.35	4.17	576	424	511	547	641
C7	Farsi	37	39	0.45	50	57	62	68	74	11	18	23	29	35	2.99	3.99	3.88	4.79	4.44	432	291	503	552	467
C8	Japanese	26	42	0.72	51	56	62	68	74	9	14	20	26	32	4.93	4.22	5.60	6.49	6.61	625	383	669	399	327
C9	Korean	48	60	0.5	62	68	75	80	86	2	8	15	20	26	3.98	4.11	4.44	5.34	3.57	539	292	563	649	510
C10	Mandarin	73	73	0.46	81	86	93	99	105	8	13	20	26	32	3.93	6.39	6.92	5.73	5.42	574	410	331	402	352
C11	Mandarin	53	55	0.43	64	69	75	83	89	9	14	20	28	34	3.25	4.02	4.63	6.05	5.23	842	560	491	450	498
C12	Mandarin	42	47	0.37	54	61	67	72	79	7	14	20	25	32	4.88	6.56	4.71	5.40	5.64	475	316	383	469	431
C13	Mandarin	53	53	0.5	71	77	83	88	95	18	24	30	35	42	3.06	3.74	5.22	5.44	4.69	270	325	306	211	586
C14	Mandarin	56	56	0.35	60	66	72	78	84	4	10	16	22	28	3.47	3.57	4.22	4.73	4.16	438	386	396	512	520
C15	Mandarin	68	70	0.33	77	83	89	96	103	7	13	19	26	33	4.33	4.05	4.12	5.50	4.42	765	509	495	576	528
C16	Romanian	69	69	0.29	74	82	89	94	101	5	13	20	25	32	5.22	5.11	4.79	5.25	5.03	509	494	707	844	822
C17	Spanish	67	67	0.52	75	82	87	93	99	8	15	20	26	32	4.29	4.66	5.93	5.71	5.37	528	268	279	512	656
C18	Spanish	45	46	0.56	61	67	73	80	86	15	21	27	34	40	4.33	4.66	5.52	4.63	4.96	354	463	427	560	775
C19	Spanish	60	60	0.46	66	73	79	85	89	6	13	19	25	29	3.28	4.08	5.67	5.13	4.20	502	416	579	586	656
M		40.32	54.57	0.47	63.63	69.78	75.68	81.68	88.21	9.05	15.21	21.1	27.1	33.63	3.75	4.28	4.72	5.01	4.46	515.84	403.68	459.57	490.631	525.73
SD		26.78	10.91	0.13	9.84	9.9	10.19	10.21	9.88	4.51	4.44	4.35	4.31	4.56	0.806	0.901	0.885	0.79	0.963	165.69	100.21	130.03	141.1	143.04

Note. mos = months; MLU–m = mean length of utterance—morphemes.

and the average age of exposure (i.e., the time when the children first experienced English) was 54.59 months (*SD* = 10.91). English use (i.e., the parents' rating on a 5-point scale of their children's production of English at home; see below) ranged from .25 to .72 (*M* = .47; *SD* = .13). All children attended preschool or school in an English-majority city (i.e., not a French-majority city) in Canada.

The parents reported that the children displayed typical L1 skills (for further information, see Golberg et al., 2008, and Paradis, 2005). All children scored within normal limits on a nonverbal IQ test taken before the first data collection point (Columbia Mental Maturity Scale; Burgemeister, Hollander Blum, & Lorge, 1972; range = 94–133, *M* = 111.37, *SD* = 12.0; Paradis, 2005). Mean length of utterance—morphemes (MLU–m) scores were reported for all children for all times (see Table 1). Average MLU–m was 3.75 at Time 1, peaked at 5.01 at Time 4, and averaged 4.46 at Time 5. MLU–m averaged 4.44 across all samples across all times. According to Brown's stages, children over 4 years old should have an MLU of at least 4.5, placing them in the Beyond Stage 5 stage of language development (Brown, 1973). One might expect MLU to increase more significantly as age increased, but it is important to keep in mind that these MLU norms are for monolingual English speakers.

The 19 children spoke eight different non-English languages: Arabic (3), Cantonese (2), Farsi (2), Japanese (1), Korean (1), Mandarin (6), Romanian (1), and Spanish (3). Exploring the possible effects of L1 on English skills was not possible because of (a) the variety of first languages spoken by the children, (b) the few number of participants who spoke each language, and (c) the inability to determine the specific dialect of language spoken by each child because the specific region within each child's country of origin was not known (i.e., participants' L1 phonetic inventories may vary based on dialect). In general, the most variation among the L1s compared with English occurs within the fricative, affricate, and liquid manners of articulation. Stops, nasals, and glides are relatively similar (although these vary among languages as well; Lipski, 2008).

A brief explanation of each of the eight phonetic inventories follows, concentrating on the major differences between each language and English. It should be noted, however, that all phonemes in English were analyzed in the current study. Although dialectal variations are to be expected within each language, we focus on general representations of each language's phonetic inventories. English fricatives that are not found in Mandarin are /v, θ, ð, z, ʃ, ʒ, h/. Mandarin does not include the English voiced stops /b, d, g/, affricates /ʧ, ʤ/, or glides /w, j/ (McLeod, 2007). Arabic differs from English in that it does not contain stops /p, g/, nasal /ŋ/, liquid /ɹ/, or fricatives /v, ʒ/. Further, English affricates /ʧ, ʤ/ are not produced in native Arabic words in the same manner as in English. Spanish phonetics differ from English mainly in fricatives and liquids. The English fricatives /v, θ, ð, z, ʃ, ʒ, h/ do not exist in Spanish, nor do the liquid /ɹ/, affricate /ʤ/, or nasal /ŋ/ (McLeod, 2007). Cantonese phonology includes only three fricatives, /f, s, h/, and is missing English /v, θ, ð, z, ʃ, ʒ/. Other English sounds not present in Cantonese include voiced stops /b, d, g/, affricates /ʧ, ʤ/, and liquid /ɹ/ (McLeod, 2007). Farsi (also called Persian) contains almost all of the English consonants in its inventory. The sounds that differ are the English interdental fricatives /θ, ð/, nasal /ŋ/, and liquid /ɹ/ (Keshavarz & Ingram, 2002). The Romanian phonetic inventory has many of the same sounds as English. English sounds that are not present in Romanian are fricatives /θ, ð/, nasal /ŋ/, and liquid /ɹ/ (Chiţoran, 2001). The Japanese inventory includes three of the English fricatives, /s, z, h/, and does not contain /f, v, θ, ð, ʃ, ʒ/. Japanese has all of the English stops but does not have the English affricates, nasal /ŋ/, or liquids. Korean's only fricatives are /s, h/, meaning that English /f, v, θ, ð, z, ʃ, ʒ/ do not exist in that language. Further, Korean does not have English stops /b, d, g/, affricates /ʧ, ʤ/, liquid /ɹ/, or glides /w, j/. Although some L1s are relatively similar to English, all of the eight first languages spoken by the study participants differ from English in some way.

Procedure

Every 6 months (± 2 weeks), the children were given semistructured interviews at home over a total of 24 months (i.e., five total visits). The parents were interviewed at Time 1 about their language background, the language background of the child, and the language used at home. An interpreter was present as needed. In the current study, age of arrival refers to the age of the participant when he or she arrived in Canada. Age of exposure refers to the participant's age when he or she first began hearing English. Months of exposure are the number of months the child had been exposed to English. It is possible to have an age of exposure greater than age of arrival if the participant was exposed to English before moving to Canada. "English use" refers to a 5-point scale representing the amount of English used in the home (1 = *native language only;* 5 = *English only*). The parent assigned an English use score to each person in the household, and the average percentage of English use in each household was derived from these scores.

Sessions lasted 45 min, during which a research assistant and the child discussed a variety of habitual, past, and future events. These sessions occurred in the child's home with objects, books, and games that the child had. In general, the child and the research assistant were alone during the sessions, although at times a parent or sibling interacted with the child for a few conversational turns. The free-play sessions were videotaped for later transcription. For further information on data collection methods, see Paradis (2005) and Golberg et al. (2008). The children's speech samples were transcribed broadly using Logical International Phonetic Program (LIPP; Oller & Delgado, 2000), a computer program for phonological analysis. Two graduate and two undergraduate students trained in phonetics and phonology transcribed all of the videos, and the second author was consulted when questions arose. All transcribers had taken a semester-long course in phonetics and were trained to distinguish non-English phonemes (e.g., flap, trill, /x, β, ts/, etc.). Two practice connected-speech samples were transcribed by each student and inspected by the second author for accuracy before students transcribed videos for the current study. LIPP allowed for the comparison of the children's productions across all times. Except for one child (Participant C1; no opportunities to produce /θ/) at Time 1, all children had the opportunity to produce each phoneme (excluding /ʒ/) at least once at each time, with an average of 43.38 opportunities (*SD* = 40.58).

Analyses

This study analyzed all five home visits for each child. The children were not separated by age group for the analyses because no significant differences between consonant accuracy and age group for any of the five times were found. To account for the difference in number of participants per age group and differences in variance associated with that disparity, we completed a Kruskall-Wallis nonparametric test on consonant accuracy by age group. A Bonferroni correction for multiple comparisons was calculated, resulting in an effective p value of .01. Results were as follows: Time 1, $H(1) = 0.051$, $p = .821$; Time 2, $H(1) = 3.457$, $p = .063$; Time 3, $H(1) = 2.064$, $p = .151$; Time 4, $H(1) = 1.829$, $p = .176$; Time 5, $H(1) = 0.377$, $p = .539$.

Phonological analyses included all utterances of all 19 children across all five times using LIPP (Oller & Delgado, 2000). Relational phonological analyses included (a) consonant accuracy, (b) consonant accuracy by sound class (stops, fricatives, affricates, nasals, liquids, and glides), and (c) percentage of occurrence of phonological patterns (unstressed syllable deletion, cluster reduction, final consonant deletion, stopping, backing, palatal fronting, velar fronting, final devoicing, final voicing, assimilation, and spirantization).

Phonological mean length of utterance (pMLU) and proportion of whole-word proximity (PWP) were computed based on Ingram's (2002) criteria. Phonological mean length of utterance was calculated by counting the total number of phonemes produced in a given word and then adding one point for each consonant that was produced correctly. PWP was calculated by dividing the child's pMLU score by the target pMLU score to obtain a percentage. For example, if the target word was /kot/ ("coat"), and the child produced /ko/, the pMLU is 3. Two of the target phonemes were present (/k/ and /o/), and an additional point was added because the consonant /k/ was pronounced correctly. PWP would then be 60% (3 out of 5) because the target pMLU for "coat" is 5 (two points for each correct consonant and one point for the vowel). Words excluded from pMLU and PWP measures were pronouns, articles, conjunctions, interjections, onomatopoeia, fillers, and child words (i.e., mommy, daddy).

Sixty words per participant were analyzed for whole-word measures because Ingram (2002) suggested that at least 50 words be analyzed for reliable calculations. To equalize complexity among the participants, we analyzed the first 20 mono-, di-, and, multisyllabic words produced by each child in each time for whole-word complexity. For all children in all times, 20 mono- and disyllabic word tokens were produced. However, some children did not produce 20 multisyllabic word tokens at each time (some produced as few as four). Hence, a one-way analysis of variance was computed to determine the effect of number of tokens on whole-word measures. Results indicated a significant difference, $F(1, 93) = 6.57$, $p = .012$, between pMLU scores for participants with 20 multisyllabic words and those with fewer than 20 multisyllabic tokens with a medium effect size ($d = .52$). The number of children with greater than 20 multisyllabic words at the five time points was 7, 7, 14, 15, and 16 children, respectively.

Pearson correlations were computed to determine the relationship between the sociolinguistic variables (age of arrival, age of exposure, English use, months of exposure, and age) and the phonological outcomes (consonant accuracy, vowel accuracy, accuracy by sound class, whole-word accuracy [pMLU and PWP], and percentage of occurrence for phonological patterns). To determine the effect of time on phonological outcomes, a repeated measures multiple analysis of covariance (MANCOVA) was computed. The repeated measures MANCOVA was completed only on the significant correlations and phonological patterns with percentages of occurrence greater than 5%. Thus, the following phonological outcomes were subjected to the repeated measures MANCOVA: percentage of vowels correct (PVC), percentage of consonants correct (PCC), accuracy on stops, accuracy on nasals, accuracy on affricates, accuracy on glides, pMLU, PWP, cluster reduction, final consonant deletion, stopping, and consonant backing. Further, post hoc two-tailed t tests were performed on all significant main effects. Effect sizes for partial eta-squared were completed and interpreted as follows: < 0.01 = negligible; 0.01 = small; 0.06 = medium; > 0.14 = large (Dattalo, 2008).

Reliability

Interjudge and intrajudge transcription reliability were completed using the second 25 utterances in 10 (randomly selected) of the 19 participants at all five times. Interjudge reliability was assessed using the transcriptions of two individuals (one graduate and one undergraduate student in communication sciences and disorders trained in phonetics, phonology, and phonetic transcription) who independently transcribed the samples. Intrajudge reliability was determined using the transcriptions of one student (the first author) that were completed during one week and again one week later. Interjudge reliability for broad transcription was 93.7%, and intrajudge reliability was 96.5%.

Results

Consonant and Vowel Accuracy

Each child's productions of vowels, consonants, and consonants by manner class (stops, nasals, fricatives, affricates, liquids, and glides) were analyzed for accuracy (see Table 2). A general trend for vowel and consonant accuracy (with the exception of fricatives) was that accuracy decreased from Time 1 to Time 2 or Time 3 and then

Table 2. Percent accuracy, whole-word measures, and percentage of occurrence for phonological patterns.

	Time 1		Time 2		Time 3		Time 4		Time 5		Overall	
Variable	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Percent accuracy												
Vowels	97.46	1.08	94.38	1.93	95.43	1.93	97.36	1.02	98.39	0.82	96.60	2.04
Consonants	88.84	4.74	88.37	5.32	90.43	4.17	92.59	3.33	95.49	2.39	91.14	4.82
Stops	91.84	4.30	90.30	4.30	91.85	4.08	93.58	3.86	96.68	2.73	92.85	4.39
Nasals	96.14	2.74	94.62	3.88	95.37	3.46	97.35	1.52	98.68	0.94	96.43	3.05
Fricatives	74.05	12.64	77.08	15.14	82.26	12.13	86.01	6.99	89.71	7.16	81.82	12.44
Affricates	97.93	1.55	95.54	3.32	94.63	5.32	97.16	2.04	98.51	1.37	96.75	3.36
Liquids	91.25	9.17	87.81	8.04	87.71	11.19	90.12	11.15	96.08	4.17	90.59	9.44
Glides	98.00	2.45	95.46	2.85	97.57	1.75	97.49	2.38	99.41	0.92	97.59	2.48
Whole-word measures												
pMLU	7.48	0.43	7.56	0.43	7.65	0.46	7.73	0.36	7.94	0.23	7.67	0.41
PWP	93.0%	0.031	93.1%	0.035	93.4%	0.032	95.9%	0.025	97.0%	0.023	94.0%	0.03
POC of phonological patterns												
Unstressed syllable deletion	0.63	0.40	0.96	0.42	0.87	0.50	0.47	0.25	0.54	0.57	0.69	0.47
Cluster deletion	0.35	0.52	0.65	0.69	0.24	0.38	0.26	0.54	0.06	0.18	0.31	0.52
Initial cluster deletion	0.31	0.39	0.49	0.69	0.53	0.61	0.51	1.01	0.19	0.43	0.40	0.66
Cluster reduction	11.79	6.51	10.10	4.71	7.47	3.48	5.80	3.04	2.96	2.23	7.62	5.22
Final consonant deletion	8.32	6.15	6.81	4.75	6.64	4.34	4.31	4.19	2.74	2.94	5.76	4.92
Stopping	14.14	7.41	9.93	5.86	7.86	4.16	7.59	4.41	5.81	4.94	9.06	6.09
Gliding	2.66	2.67	3.80	3.39	0.37	0.80	1.77	0.44	1.39	0.93	2.00	2.78
Final devoicing	2.44	5.22	0.79	1.76	1.62	3.04	1.16	1.30	0.62	1.03	1.33	2.92
Final voicing	0.35	0.78	0.96	2.05	0.57	0.76	0.40	0.76	0.17	0.54	0.49	1.13
Consonant fronting	0.89	0.61	2.09	2.50	1.39	1.80	0.61	0.50	0.31	0.22	1.06	1.53
Consonant backing	5.53	2.29	4.19	1.90	3.67	2.00	3.34	1.72	2.36	1.85	3.82	2.18

Note. pMLU = phonological mean length of utterance; PWP = proportion of whole-word proximity; POC = percentage of occurrence.

increased again by Times 4 and 5. For all but one child, accuracy scores increased between Time 1 and Time 5, with the highest scores at Time 5. Vowel accuracy was greater than 90% for all children at all times, with an overall average of 96.6%.[1] Consonant accuracy averaged 88.84% at Time 1 and increased across time to 95.49% at Time 5. Overall consonant accuracy for all children across all five times was 91.14%.

Accuracy for all six manner classes was generally high; stops, nasals, affricates, and glides (but not liquids and fricatives) averaged over 90% accuracy at all five times. Further, each individual participant produced stops, nasals, affricates, and glides sound classes with at least 75% accuracy at all times. Alternatively, fricatives were the sound class with the lowest accuracy, but they also experienced the largest increase over time. Fricative accuracy was 74.05% at Time 1 and displayed increases between each time until reaching 89.71% at Time 5. Accuracy for fricatives was less than 70% at Time 1 and Time 2 for four children. By Time 4, however, accuracy for fricatives was greater than 70% for all children. Liquids also were produced with less than 90% accuracy at Time 2 and Time 3 (86.81% and 87.71%, respectively) but reached 96.08% accuracy by Time 5.

[1]"Overall" refers to the average scores of all participants across all five sampling times.

Whole-Word Measures

Phonological mean length of utterance (pMLU) and proportion of whole-word proximity (PWP) were calculated to determine phonological complexity (Table 2). In general, whole-word measures were high at all five times. The average pMLU was 7.48 at Time 1 and over time increased to 7.94 at Time 5 and ranged from 7.48 to 7.94. PWP was 93% during the first three times and increased to 97% by Time 5. In each of the first three times, no more than three participants had PWP scores under 90%.

Percentage of Occurrence of Phonological Patterns

Percentage of occurrence (POC) was calculated for 11 phonological patterns for each child at each time (Table 2). Seven of the 11 phonological patterns (unstressed syllable deletion, cluster deletion, initial cluster deletion, gliding, final devoicing, final voicing, and consonant fronting) were produced with an average POC of 5% or less. In addition, these seven patterns had overall POC less than 2% across all times. The four remaining patterns (stopping, cluster reduction, final consonant deletion, and consonant backing) had a POC of more than 5% at each time. Stopping showed the highest POC with an overall average of 9.06%. POC for stopping at Time 1 was 14.14% but decreased to 5.81% by Time 5. Cluster reduction had the second highest overall POC at 7.62%. Cluster reduction decreased from 11.79% at Time 1 to 2.96% at Time 5. In each of the first two times, there was one child with a POC greater than 20% for cluster reduction, but all children had POCs less than 15% the last three times. Final consonant deletion had an overall POC of 5.76%, with the highest occurrence, 8.32%, at Time 1, decreasing to 2.74% at Time 5. At Times 1 through 4, at least one or two children exhibited POCs greater than 15% for final consonant deletion. By Time 5, though, all of the children had POCs less than 10% for final consonant deletion. Finally, consonant backing had an overall POC of 3.82%. The POC of consonant backing decreased from 5.53% to 2.36% from Time 1 to Time 5. Stopping, cluster reduction, final consonant deletion, and consonant backing had the highest POCs at Time 1, and all decreased between each time, with their lowest POCs at Time 5, demonstrating an improvement in phonological abilities.

Relationship Between Sociolinguistic Variables and Phonological Skills

Pearson correlations were computed to determine significant relationships between sociolinguistic variables (age, age of arrival, age of exposure, English use, and months of exposure) and phonological outcomes (vowel and consonant accuracy, accuracy by sound class, whole-word measures, POC of phonological patterns) within each time. Overall, there were few (39 of 525 total) significant correlations between sociolinguistic variables and phonological outcomes. The 39 significant correlations are reported in Tables 3 through 7. The strength of these significant correlations was moderate, with only seven of 39 strong correlations overall. Of the five sociolinguistic variables, age of arrival was the only variable with significant correlations to phonological outcomes at all five times. Age and age of exposure each demonstrated significant correlations at four of the times. English use at home and months of exposure were correlated with relatively few phonological outcomes, suggesting that a greater use of English at home does not necessarily relate to more robust phonological skills.

Changes in Phonological Skills Over Time

A repeated measures MANCOVA with age as a covariate was computed to determine the effect of time on phonological outcomes (see Table 8). Only sound classes with significant correlations (stops, affricates, nasals, glides) and phonological patterns with POCs greater than 5% (cluster reduction, final consonant deletion, stopping, and consonant backing) were included in the MANCOVA analysis. Results indicated significant main effects for PCC, $F(1, 18) = 9.001$, $p = .001$, $\eta^2 = .706$; PVC, $F(1, 18) = 18.853$, $p = 0$, $\eta^2 = .843$; PWP, $F(1, 18) = 5.507$, $p = .006$, $\eta^2 = .595$; stops, $F(1, 18) = 6.963$, $p = .002$, $\eta^2 = .65$; nasals, $F(1, 18) = 5.959$, $p = .004$, $\eta^2 = .614$; affricates, $F(1, 18) = 5.268$, $p = .007$, $\eta^2 = .584$; glides, $F(1, 18) = 8.903$, $p = .001$, $\eta^2 = .704$; cluster reduction, $F(1, 18) = 8.419$, $p = .001$, $\eta^2 = .692$; stopping, $F(1, 18) = 5.802$, $p = .005$, $\eta^2 = .607$; and consonant backing, $F(1, 18) = 6.8$, $p = .002$, $\eta^2 = .645$; at the .01 level; and pMLU, $F(1, 18) = 3.368$, $p = .037$, $\eta^2 = .473$, at the .05 level. The only phonological outcome that did not indicate a significant main effect was final consonant deletion, $F(1, 18) = 2.953$, $p = .055$, $\eta^2 = .441$. Effect sizes across these measures ranged from .441 to .843, indicating large effects.

Discussion

The purpose of the study was to examine the phonological development of 19 typically developing English language learners. This study indicated that overall consonant and vowel accuracy and whole-word measures increased across time, that percentages of occurrence of phonological patterns decreased over time, and that there existed a relation

Table 3. Time 1 significant correlations for phonological skills and sociolinguistic variables.

Variable	Affricates	Unstressed syllable deletion	Initial cluster deletion	pMLU	PWP
Age of arrival					
r	—	—	—	.633	—
p	—	—	—	.004**	—
Age of exposure					
r	—	—	—	.477	.471
p	—	—	—	.039*	.042*
English use					
r	–.617	—	.635	—	—
p	.005**	—	.003**	—	—
Age					
r	—	—	—	.475	—
p	—	—	—	.04*	—
Months of exposure					
r	—	.549	—	—	—
p	—	.015*	—	—	—

Note. Dashes denote no significant correlation.
*p < .05. **p < .01.

Table 4. Time 2 significant correlations for phonological skills and sociolinguistic variables.

Variable	PVC	Affricates	Glides	Unstressed syllable deletion	Cluster deletion	Final consonant deletion	pMLU	PWP
Age of arrival								
r	—	.512	.495	—	−.514	—	.522	.537
p	—	.025*	.031*	—	.024*	—	.022*	.018*
Age of exposure								
r	.47	—	.535	—	−.617	—	—	—
p	.042*	—	.018*	—	.005**	—	—	—
English use								
r	—	—	—	−.548	—	—	—	—
p	—	—	—	.015*	—	—	—	—
Age								
r	—	—	—	—	−.652	−.461	—	—
p	—	—	—	—	.002**	.047*	—	—
Months of exposure								
r	—	—	−.501	—	—	—	—	—
p	—	—	.029*	—	—	—	—	—

Note. Dashes denote no significant correlation. PVC = percentage of vowels correct.
*$p < .05$. **$p < .01$.

between sociolinguistic variables and phonological skill—all as were predicted by the speech learning model (Flege, 1995).

Consonant and Vowel Accuracy

Vowel accuracy was greater than 90% at all five times, reaching 96.7% by Time 5, commensurate with that of monolingual children (McLeod, 2013) or even somewhat greater than that of monolingual children (e.g., Gildersleeve-Neumann et al., 2008). In their longitudinal study of 3- to 4-year-old bilingual children, Gildersleeve-Neumann et al. (2008) found vowel accuracy in the balanced bilingual group to be lower (82.46% at age 3 and 83.45% at age 4) than that of the children in the current study. The monolingual English children in that study produced vowels with 86.72% accuracy at age 3 and with 89.11% accuracy at age 4, lower than the accuracy of the children in the present study. The discrepant findings across the current investigation and published works were likely a result of the children in the Gildersleeve-Neumann et al. (2008) study being somewhat younger than those in the current study. In general, vowels did not appear to be a point of difficulty for the ELLs in the current study.

Participants' consonant accuracy was relatively high, with mean accuracy greater than 90% by Time 3 and all children displaying PCC greater than 90% at Time 5. Previous studies of bilingual children also showed a similar increase in PCC as age increased, indicating that these longitudinal findings verify what has been previously suggested by cross-sectional studies. Fabiano-Smith and Goldstein (2010) found that Spanish-English bilingual children between ages 3;0 and 4;0 had an overall PCC of 72.31%. Spanish-English 4-year-olds in Goldstein and Washington's (2001) study had a PCC of 94.1%. Finally, in Goldstein et al. (2005), children between ages 5;0 and 5;5 displayed an overall PCC of 94.81%. At Time 1 in the current study, the

Table 5. Time 3 significant correlations for phonological skills and sociolinguistic variables.

Variable	PVC	Nasals	Affricates	Unstressed syllable deletion	Cluster deletion	Final consonant deletion	Final devoicing	PWP
Age of arrival								
r	.574	—	.552	−.607	−.489	—	—	.569
p	.01*	—	.014*	.006**	.034*	—	—	.011*
Age of exposure								
r	—	—	—	—	—	−.609	—	.549
p	—	—	—	—	—	.006**	—	.015*
English use								
r	−.475	—	−.478	—	—	—	.53	—
p	.04*	—	.038*	—	—	—	.02*	—
Age								
r	.482	.465	—	—	−.495	−.59	—	—
p	.036*	.045*	—	—	.031*	.008**	—	—

Note. Dashes denote no significant correlation.
*$p < .05$. **$p < .01$.

Table 6. Time 4 significant correlations for phonological skills and sociolinguistic variables.

Variable	Consonant fronting	PWP
Age of arrival		
r	−.597	—
p	.007**	—
Months of exposure		
r	—	−.47
p	—	.042*

Note. Dashes denote no significant correlation.
*$p < .05$. **$p < .01$.

average age was 5;3 and consonant accuracy was 88.84%, which is lower than the PCC in Goldstein et al.'s (2005) study. However, by Time 5, when the average age was 7;4 (ranging from 6;2 to 8;9), PCC increased to 95.49%, which is higher than that of the children in the Goldstein et al. (2005) study. This finding demonstrates the positive effects of time on consonant accuracy. An English monolingual group of the same age had a mean PCC score of 92.6% (Austin & Shriberg, 1996), indicating that the English skills of these ELLs at Time 5 are within the range of those published for monolingual children of a similar age. In addition, the aforementioned studies all used single-word instruments as the data source compared with the use of connected-speech samples in the current study. It has been shown that a child's speech is more similar to that of adults when using a single-word measure (Morrison & Shriberg, 1992). Further, these studies examined only Spanish as L1, whereas the current study examined eight first languages, requiring a cautious interpretation of comparisons. Although overall consonant accuracy was less than 90% at the first sampling time, it is apparent that accuracy improved over time, showing nearly equivalent skills to those published for monolingual children.

Sound class accuracy was greater than 90% for all sound classes except liquids at two time points and fricatives (81.82%). Results for fricatives in the current study are lower than in previous research of bilingual children, which often included children younger than those in the current study or

Table 7. Time 5 significant correlations for phonological skills and sociolinguistic variables.

Variable	Glides	Consonant fronting
Age of arrival		
r	−.5	−.581
p	.029*	.009**
Age of exposure		
r	−.545	—
p	.016*	—
Age		
r	−.471	—
p	.042*	—

Note. Dashes denote no significant correlation.
*$p < .05$. **$p < .01$.

Table 8. Repeated measures analysis of variance for significant correlations and highly occurring phonological patterns.

Variable	$F(1, 18)$	*p*	η^2_p
Percent accuracy			
PCC	9.001	.001**	.706
PVC	18.853	0**	.843
Whole-word measures			
pMLU	3.368	.037*	.473
PWP	5.507	.006**	.595
Percent accuracy by sound class			
Stops	6.963	.002**	.65
Nasals	5.959	.004**	.614
Affricates	5.268	.007**	.584
Glides	8.903	.001**	.704
Percent of occurrence of phonological patterns			
Cluster reduction	8.419	.001**	.692
Final consonant deletion	2.953	.055	.441
Stopping	5.802	.005**	.607
Consonant backing	6.8	.002**	.645

Note. PCC = percentage of consonants correct.
*$p < .05$. **$p < .01$.

with only one first language instead of multiple L1s. In addition, sampling method might have been a factor in that there is some evidence that consonant accuracy is higher in single-word samples than in connected-speech samples (e.g., Morrison & Shriberg, 1992). Four-year-olds produced fricatives with 83.9% accuracy in Goldstein and Washington (2001), and 5-year-olds in Goldstein et al. (2005) produced fricatives with 92.38% accuracy. Again, sampling method (single-word vs. connected speech; Spanish vs. various L1s) could be one reason for such differences among studies. Another possibility for the divergence among fricatives in these studies is individual variation. Several children in this investigation consistently produced fricatives with less than 70% accuracy, which lowered overall accuracy. Although fricatives were the least accurately produced of all the sound classes, they demonstrated the greatest degree of improvement over the five times.

Accuracy on sound classes for this group of ELLs was also similar to that published for monolingual children. For example, Sander (1972) found affricates and fricatives to be among the latest developing sounds in monolingual speakers, with some children not mastering them until age 8;0. Although accuracy for fricatives for the children in this study was below 90%, accuracy increased from 74.05% at Time 1 to 89.71% at Time 5. In addition, accuracy was high for the remaining sound classes, most of which were approaching ceiling by Time 5. Sound class accuracy of these ELLs at Time 5 appeared to be relatively close to that of monolingual children.

Whole-Word Measures

Much like previous longitudinal studies focusing on whole-word measures in monolingual speakers (Hase, Ingram, & Bunta, 2010; Saaristo-Helin, 2009), the current study found pMLU and PWP to increase over time in ELLs as well. These data support the hypothesis that ELLs' whole-word skills improve over time to become like their English-speaking counterparts. Although an age-matched group of monolingual English speakers was not included in the present investigation, the children in the current study did have higher pMLU scores than monolingual English and bilingual English-Spanish 3- to 4-year-olds in Bunta et al. (2009; 7.67 vs. 6.24, respectively). PWP scores were also higher among the children in the current study (94% vs. 92%). Similarly, the children in the current study had higher pMLU and PWP scores than the French-English bilingual children at age 3;6, whose average pMLU was 4.74 and whose PWP was 91% (MacLeod et al., 2011). This discrepancy between pMLU and PWP scores likely demonstrates an age effect; the children in Bunta et al. (2009) and MacLeod et al. (2011) are considerably younger than the participants studied here. It should be noted that children in both MacLeod et al.'s and the current study demonstrated an increase in whole-word complexity over time. However, not all children produced at least 20 multisyllabic words at each time point, and this discrepancy might have affected the results. Finally, based on Ingram's (2002) proposed pMLU stages, average pMLU scores were at Stage 5 or beyond at every time. For example, by Time 5, PWP was 97%, suggesting that these ELLs were at ceiling and could not improve much more. Thus, overall whole-word skills were high and similar to those published for monolingual speakers of the same age, and their skills improved over time.

Phonological Patterns

Of the eleven phonological patterns investigated in this study, none of them had an overall percentage of occurrence greater than 10%. Only stopping and cluster reduction were produced at rates over 10% at any one of the times. In general, the current study found higher rates of stopping and cluster reduction than other studies involving younger children. Four-year-old Spanish-English bilingual children exhibited a lower POC for stopping (6.9%; Goldstein & Washington, 2001), and 5-year-old bilingual children produced stopping rates of 4.48% (Goldstein et al., 2005). However, the ELLs in the current study had an overall stopping POC of 9.06%, with the highest POC at Time 1 (14.14%). Once again, variation in the case of one outlier is likely the reason for such different scores. For example, one of the youngest children in the study (Child 1) had a POC of 34.75% at Time 1 and 27.81% at Time 2. However, by Time 5, this participant had a 0% POC for stopping. Although younger children appeared to produce lower rates of stopping than the children in the current study, POC of stopping decreased between every time, with a final POC of 5.81%. Percentage of occurrence of stopping was high at the beginning of the study, but across time POC decreased.

A similar pattern was seen in rates of cluster reduction. Overall POC for cluster reduction was 7.62%, with the highest POC at Time 1 (11.79%). Similarly to stopping, rates of cluster reduction were lower in 4- and 5-year-old Spanish-English bilingual children (3.2% and 7.27%, respectively) when compared with the ELLs in the current study (Goldstein et al., 2005; Goldstein & Washington, 2001). Again, one of the youngest children in the current study (C5) had a POC of 29.73% at Time 1, which decreased to 2.31% by Time 5. This pattern was seen in several other children in the study as well. The average POC of cluster reduction decreased from 11.79% at Time 1 to 2.96% at Time 5. These findings demonstrate the impact that individual variation could have on POC of phonological patterns. Once again, a single-word versus connected-speech sample and the comparison of only Spanish with English may have contributed to differences in stopping and cluster reduction rates among these studies. Along with stopping and cluster reduction, final consonant deletion and consonant backing decreased in frequency between each time. The most likely reason that POC decreased for these four patterns is that they were the patterns with the highest POC at Time 1. The remaining seven phonological patterns all showed an increase in use sometime during the study. Those seven phonological patterns that displayed some fluctuation had POCs less than 3%, many of which were under 1%. Because the participants demonstrated relatively advanced skills at Time 1, sampling error might be more obvious when POC is low.

When compared with the POC of phonological patterns in monolingual children, ELLs in the current study produced phonological patterns at higher percentages of occurrence. According to Dodd et al. (2003), cluster reduction and stopping were no longer present in the speech of monolingual English speakers at age 4;6. This indicates that ELLs produce some phonological patterns at an increased rate when compared with monolingual speakers of the same age, which was also found in Goldstein and Washington (2001).

Relationship Between Sociolinguistic Variables and Phonological Skills

Results of this study indicate a relationship between phonological skills and sociolinguistic background. Almost all of the relationships illustrate the positive effect of length of English exposure and age on phonological skills. The participants who arrived earlier and were exposed to English earlier tended to have higher accuracy scores and lower percentages of occurrence on some outcomes, as predicted by Flege's (1995) SLM. For example, age of arrival was positively and significantly correlated with accuracy on affricates and glides and negatively and significantly correlated with cluster deletion and unstressed syllable deletion. These findings suggest (not surprisingly) that children who have spent more time in an English-speaking country exhibit higher accuracy and have more difficulty with more marked elements, such as clusters and multisyllabic words. In addition, throughout the study, age of exposure had a significant and positive correlation with various phonological skills, such as pMLU, PWP, PVC, and glides, thus demonstrating the positive effect that exposure age has on phonological skills. In contrast to this finding, Goldstein et al. (2010) found that age of acquisition did not have an effect on accuracy measures. This discrepancy might be related to the inclusion of simultaneous as well as sequential bilingual children. The present study, however, included only sequential bilingual children who were not exposed to English until at least 3;3, seven of whom were over age 5;0 when first exposed to English. In general, older children, those who arrived earlier, and those who were exposed to English at a younger age had the most advanced phonological skills.

Clinical Implications

Results of this investigation demonstrate that ELLs had relatively strong English phonological skills that increased over time and were similar but not necessarily identical to those of their monolingual peers when compared retrospectively with published studies. Such retrospective comparisons have to be made with caution because the conclusions drawn from extant literature typically included investigations of different age groups, language comparisons, and methodologies, precluding direct comparisons. Despite that limitation, SLPs can use the longitudinal and connected-speech results of this study to interpret their assessments of the phonological skills of ELLs. In general, SLPs should be aware that these ELLs demonstrated monolingual-like skills in overall vowel and consonant accuracy (98.39% and 95.49%; Austin & Shriberg, 1996) and on whole-word measures (Ingram, 2002). SLPs should also expect phonological skills in ELLs to increase over time, as is the case in monolingual children (McLeod, 2013). For the children in this investigation, all phonological skills improved between Time 1 and Time 5. As occurs in monolingual speakers as well, some skills showed fluctuations in proficiency over the first three time periods.

In addition, these results suggest that SLPs should examine the phonological skills of ELLs from multiple perspectives (e.g., Scarpino & Goldstein, 2012). Although SLPs typically measure overall consonant accuracy and the percentage of occurrence of a limited number of phonological patterns, it is also advisable to determine accuracy of individual sound classes and percentages of occurrence on a wide range of phonological patterns. As found in this study, sound class accuracy at the beginning of the study was generally high except for fricatives and liquids. Sound class accuracy for stops, nasals, affricates, liquids, and glides all demonstrated at least 95% accuracy by Time 5, fricatives being the only sound class with less than 90% accuracy (89.71%). Typically, the latest developing sounds for monolingual speakers are liquids and fricatives as well (McLeod, 2013). However, published data indicate that monolingual children typically master these sounds by age 5;0–6;5 (Peña-Brooks & Hedge, 2007; Smit et al., 1990). Hence, ELLs might master English sounds slightly later than monolingual children.

The percentage of occurrence of many phonological patterns was low except for cluster reduction, stopping, and backing. But by Time 5, stopping was the only phonological pattern that had a percentage of occurrence over 5%, whereas all other patterns had a POC of less than 3%. For monolingual speakers, the phonological patterns still declining past age 5;0 were gliding, final consonant deletion, cluster reduction, and weak syllable deletion (Haelsig & Madison, 1986; Peña-Brooks & Hedge, 2007; Roberts et al., 1990). Thus, SLPs should also be aware that these ELLs appeared to produce some different phonological patterns as compared with their monolingual peers on the basis of published studies; specifically, stopping persisted for a longer period of time.

Limitations and Future Research

The current study has several limitations that should be considered when studying ELLs in the future. Because the English skills of ELLs were being studied, a comparable monolingual English group would have been ideal for comparisons to the ELLs for both phonological skills and improvement over time. Because a monolingual control group was not available, retrospective studies were used for comparisons, making it difficult to compare directly results from these ELLs with monolingual English-speaking children. Similarly, as phonological skills were not evaluated in the first language, it is possible that some children's English productions were affected by skills in their first language (Brice, Carson, & O'Brien, 2009). Thus, in future work, taking first-language phonological skills into account might supplement some of these findings. Because of the relatively small sample size in this study, individual variation had an impact on the results. A larger sample size would better demonstrate the average skill level for ELLs. Despite the limitations of this study, the findings provide preliminary data for future longitudinal studies in an ELL population. Future research can focus on refining accuracy measures and percentages of occurrence and investigating first-language influence on English to determine phonological development in ELLs.

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