Childhood Language Memory in Adult Heritage Language (Re)Learners

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41.1 Introduction

Early linguistic experience is widely considered critical for attaining native-like abilities in a language, especially when it comes to phonology and morphosyntax (Fromkin, Krashen, Curtiss, Rigler, & Rigler, 1974; Oyama, 1976; Johnson & Newport, 1989; Newport, 1990). Such childhood language experience seems to have long-lasting benefits, even when it is limited only to early childhood. In this chapter, we first review a series of our investigations into the potential benefits of early childhood experiences with a heritage language on later language (re)learning among immigrant-background adults. We then turn to our newer investigation on how these findings might extend to individuals who were internationally adopted as infants and then re-exposed to their childhood language in adulthood.

41.2 Heritage language loss among immigrant-background children

Many immigrant-background children in countries such as the United States and Canada grow up with a non-majority, heritage language at home. For example, the most recent estimates indicate that 22% of school-age children in the United States speak a language other than English at home. More specifically, 59% of Asian American and 63% of Latino/a school-age children speak a non-English language at home (U.S. Census Bureau, 2013). However, as they begin schooling, these children often lose their heritage language. Some try to relearn their heritage language in adulthood, and they seem able to capitalize on their childhood language memory to

acquire proficiency more quickly than their peers without such early experiences. For instance, adult beginning learners of Hindi who had had early experience with the language (during just the first two years of life) were better able to distinguish a difficult Hindi stop consonant distinction (retroflex vs. dental) than their peers who had no such early experience. Moreover, the beginning relearners performed much like adults who had no childhood exposure to Hindi but had been learning Hindi for five years (Tees & Werker, 1984).

41.3 Language memory among childhood overhearers

In one series of studies, we examined the success of childhood overhearers of Spanish in learning Spanish in high school or university classes (Au, Knightly, Jun, & Oh, 2002; Knightly, Jun, Oh, & Au, 2003; Au, Oh, Knightly, Jun, & Romo, 2008; Au, 2012). We collected very detailed language background information on all of our research participants, including a specially designed survey, as well as a follow-up interview. This language background assessment revealed a common pattern of childhood language exposure among many adult heritage language learners of Spanish: they only overheard the heritage language as children, hence we called them 'childhood overhearers'. That is, they only had passive exposure to the language until school age (about age 6) and very little, if any, such experience thereafter, throughout childhood. Like the typical late learners of a second language, they did not begin learning Spanish formally until high school or university. More specifically, overhearers typically reported that they heard their parents speaking Spanish with their grandparents during early childhood, but that no one spoke directly to them in Spanish. On average, they reported overhearing Spanish for about nine hours per week for at least three years before they started school, and thereafter they experienced a sharp drop in such overhearing experience. At the time

of their participation in our study, the overhearers were enrolled in second-year university-level Spanish language classes in Los Angeles, California, U.S.A.

We compared childhood overhearers to two other groups: 1) native Spanish speakers who had spoken Spanish regularly throughout their lives, in order to assess how native-like the childhood overhearers' accents were, and 2) novice Spanish learners who had no prior experience with Spanish until high school or university language classes, in order to compare childhood overhearers against typical late first-time Spanish learners in the U.S. On a number of measures, we found that childhood overhearers speak with a more native-like accent than novice learners of the language who had not had any prior experience with Spanish. More specifically, the overhearers were similar to native Spanish speakers, and more native-like than novice Spanish learners, in their production of Spanish stop consonants, by phonetic measures such as voice onset time (VOT) and the degree of voicing during the consonant. They also sound more native-like according to accent ratings made by native speakers on speech samples, when compared to novice Spanish learners. Together, these findings suggest that even early passive exposure to a language can provide lasting benefits to the adult language learner. In particular, it is important to note that although these adult learners did not speak Spanish as children, they nonetheless demonstrated benefits in their production of Spanish.

41.4 Language memory among childhood speakers of a heritage language

In another line of research, we studied adult heritage language learners of Korean (Oh, Au, & Jun, 2002; Oh, Jun, Knightly, & Au, 2003). In this group, the most common language exposure pattern involved adults who had spoken their heritage language regularly during early childhood, until they started school (about age 5 or 6), whom we refer to as 'childhood speakers'. That is, they were monolingual or virtually monolingual speakers of Korean as their first

language, but when they started school, they quickly shifted to become virtually monolingual speakers of English. At the time of our study, participants were enrolled in first-year university-level Korean language classes in Los Angeles.

Childhood speakers of Korean were compared to native Korean speakers, childhood addressees (those who had only heard but never spoke Korean as children), as well as novice learners of Korean on their perception and production of Korean stop consonants. Korean utilizes a three-way laryngeal contrast in stop consonants, unlike English, which utilizes a two-way voicing contrast. These distinctions are, therefore, difficult for English monolingual speakers to hear and produce. Childhood speakers of Korean in our studies not only outperformed childhood addressees and novice learners of Korean in their production of these stop consonants, they were actually quite native-like in both their perception and production.

Our analogous research in Spanish revealed that both childhood speakers and childhood overhearers of Spanish were more native-like in their accent than typical late learners of Spanish as a second language. With regard to areas of grammar particularly difficult for late language learners to master (namely, morphosyntax), childhood speakers of Spanish—although not quite native-like—outperformed their peers who were childhood overhearers or late learners of Spanish (Au, Oh, Knightly, Jun, & Romo, 2008).

41.5 Evidence of childhood language memory among adults internationally adopted as infants

Our prior research therefore indicates that early childhood language memory can be accessed after a long hiatus, through the process of relearning the language later in life. However, individuals growing up in immigrant families, even if they stop speaking or hearing a heritage language regularly may continue to overhear the language or at least the phonemes of the language in the accented speech of their family or community members. Such continued

exposure could potentially help maintain their childhood language memory. However, if childhood language exposure is completely discontinued, its memory may become inaccessible by adulthood. Indeed, international adoptees who had been adopted from Korea to France between ages three and eight years were no better than native French speakers without prior exposure to Korean at discriminating Korean phonemes or identifying Korean sentences among sentences in several unknown languages (Pallier et al., 2003; Ventureyra, Pallier, & Yoo, 2004). In this case, the childhood language memory of Korean adoptees seemed inaccessible according to both behaviorial and fMRI brain activation assessments.

On the other hand, research on children who had been adopted internationally from China to France as infants revealed that, when hearing Chinese lexical tones, the French monolingual adopted children showed brain activation patterns matching those of Chinese-French bilingual children, despite the adopted children having no conscious memory of their childhood language (Pierce, Klein, Chen, Delcenserie, & Genesee, 2016). Why was early memory detectable for Chinese lexical tones but not Korean phonemes or the Korean language in general (Pallier et al., 2003; Ventureyra et al., 2004)? Further research is needed to sort out these contrasting findings. For example, researchers need to better understand how such access to early language memory may be associated with age of adoption. Further, some of these differences may have to do with when suprasegmentals such as lexical tone vs. segments such as consonant and vowel phonemes are acquired; there is some research indicating that infants acquire lexical tones earlier than segments (Li & Thompson, 1977, Yeung, Chen, & Werker 2013).

One way to render long-ago memory more accessible is to build up its retrieval strength via relearning (Ebbinghaus, 1964; Bjork & Bjork, 1996). Indeed, there is growing evidence that although childhood language memory may become inaccessible in adulthood due to lack of use,

it can become more accessible through relearning. For instance, after substantial perceptual training of target phonemes, a subsample of English-monolingual adults (those under age 40) who had been exposed to Hindi or Zulu during childhood while living abroad with their parents relearned the phonemic distinctions in these languages, whereas those without childhood exposure showed little learning (Bowers, Mattys, & Gage, 2009).

International adoptees have also successfully accessed their childhood language memory through relearning. Hyltenstam, Bylund, Abrahamsson, and Park (2009) compared grammaticality judgments and phoneme discrimination in two groups of adults in Sweden who had been studying Korean: one group had been adopted from Korea to Sweden as young children (between three months and 10 years) and one group had been born and raised in Sweden without prior exposure to Korean until adulthood. Although the native-born Swedes had been studying Korean longer, on average, than the adoptee group (4.1 vs. 2.1 years) and were better at Korean grammaticality judgments, they were no better at phoneme discrimination. In fact, one third of the adoptees actually outperformed the highest-performing native Swede in Korean phoneme discrimination.

Short-term intensive relearning can also help activate childhood language memory. With about 1,000 perceptual training trials spreading over 10 to 12 days focusing on Korean consonants, Dutch adults who had been adopted from Korea as infants and had not learned Korean after adoption improved significantly more across the training period for both perception and production of Korean consonants, when compared to Dutch adults without any prior exposure to Korean (Choi, Cutler, & Broersma, 2017). Moreover, relearning may not have to be extensive to activate early language memory. Children (mean age = 12 years) who had been adopted from India to the U.S. between six months and five years were comparable to age-

matched non-adoptee English speakers in distinguishing a difficult Hindi contrast (retroflex vs. dental stop consonants) at pretest, but adoptees improved significantly after just 64 perceptual training trials with feedback, whereas non-adoptees showed no improvement (Singh, Liederman, Mierzejewski, & Barnes, 2011).

Not only does relearning not have to be extensive, it may not even require focused perceptual training. In an earlier study (Oh, Au, & Jun, 2010), we have shown that just two weeks into a beginning college Korean language class, students who had been adopted as infants (all but one prior to age one year) from Korea to the U.S. outperformed their classmates who had had no such early experience in Korean phoneme perception. In this case, re-exposure did not focus exclusively on phoneme discrimination as with the perceptual trainings conducted by Bowers et al. (2009), Singh et al. (2011), and Choi et al. (2017). However, although the adoptees in our study showed a sizable advantage in phoneme perception, we did not include baseline measurements. It therefore remains unclear whether adoptees' advantage existed even prior to starting their Korean language class.

41.5.1 Re-accessing childhood language memory through relearning: The case of Korean-American adopted adults in Minnesota

We have built on these prior findings to better understand whether a brief re-exposure to the target language, in the form of a language class, can help adults who were internationally adopted as infants to access their early childhood language memory. We compared the phoneme perception among four groups: (1) Learner-adoptees: adults adopted from Korea to Minnesota as infants and taking beginning university-level Korean language classes (using an expanded sample that included most of the adoptees in Oh et al., 2010); (2) Comparison-adoptees: adults from the same community and comparable to the "learner-adoptees" by age and age-of-adoption

from Korea but having never taken any Korean language class; (3) Novice learners: classmates of the learner-adoptees in Korean language classes; (4) Native speakers of Korean.

We predicted a phoneme perception advantage for those adoptees relearning Korean over those who were not relearning. This study also set out to break new ground by exploring whether the advantage would extend beyond phoneme perception, to phoneme production. Given the age at adoption of our sample (all but one under age 13 months), it is unlikely that they would have had early speaking experience in Korean, but in light of the evidence that improved phoneme perception would improve phoneme production (e.g., Bradlow, Pisoni, Akahane-Yamada, & Tohkura, 1997; Choi et al., 2017), we explored this possibility as well.

41.5.1.1 Participants

Two groups of adopted Korean Americans were recruited. The target sample ('learner-adoptees') included 19 students (mean age = 20;4 years; range: 18 to 33 years; 13 female) who were enrolled in first-semester Korean language classes at a large public university in Minnesota, U.S.A. The language classes met for about five hours each week. Most participants took part in the study during their second week of class (with three participants assessed during the third week of class due to scheduling conflicts). We targeted only those participants who had been adopted before age one year (mean age at adoption = 6 months; with one participant adopted at 13 months). Phoneme perception (but not production) data have been reported for 11 of the 19 target participants by Oh et al. (2010).

The adoptee comparison sample included 19 participants recruited from the same university as well as the surrounding community who had not taken any Korean language classes. The comparison sample was chosen from a larger sample to roughly match the composition of the target sample on age (mean = 21;10 years; range: 18 to 26 years), gender (14

female), and age at adoption (mean = 6 months; range: 4 to 13 months). The two groups did not differ reliably on these variables (age: t (36) = 1.53; gender: χ^2 (1, N = 38) = 0.13; age at adoption: t (36) = .03; all *n.s.*)

Novice learners (n = 19) were also recruited from the learner-adoptees' Korean language classes. These participants were not adopted and had not previously taken Korean language classes. This sample was chosen from a larger sample of novice second-language learners of Korean to match the composition of the learner-adoptee target sample on age (mean = 20;1 years; range: 18 to 25 years) and gender (12 female) and did not differ reliably from the target sample on these demographic variables (age: t (36) = .22; gender: χ^2 (1, N = 38) = 0.12; all *n.s.*). Like the learner-adoptee sample, the novice learners were assessed during their second week of class (with one participant assessed during the third week due to a scheduling conflict).

In addition, 12 native Korean speakers (mean age = 21;2 years, range: 19 to 30 years; 8 female) were recruited. They were born in Korea and immigrated to the U.S. in adolescence or later (mean age at immigration = 17;0 years)

41.5.1.2 Procedure

All participants completed a language background questionnaire, followed by a Korean language abilities test, and then a follow-up interview. The computerized language abilities test was programmed in E-Prime (Psychology Software Tools, Inc.; http://www.pstnet.com/eprime) and included a phoneme identification task and a phoneme production task.

41.5.1.3 Language background assessment

The language background questionnaire is a self-report of prior experiences with Korean. In previous research, independent reports from informants who had known the participants as young children largely corroborated the participants' self-reports using this language background

questionnaire (Au et al., 2002, 2008). The questionnaire includes general questions about language background (e.g., participant's first language, parents' languages) as well as specific questions about the participant's experiences with Korean since birth. Questions address both the quantity (how much they heard, were spoken to, and spoke Korean) and quality (words/short phrases/sentences; extent of mixing with English) of their linguistic experiences during various periods of their lives. A follow-up interview was conducted to clarify and confirm questionnaire responses.

41.5.1.4 Phoneme identification task

During each trial of the phoneme identification task, participants heard one speaker saying two different words (A and B), followed by another speaker saying one of the first two words (X). The participant's task was to identify whether X matched A or B (ABX technique; Harris, 1952; Liberman, Harris, Hoffman, & Griffith, 1957). A and B always came from a minimal triplet which varied only in the target consonant. The task was presented once with target phonemes in phrase-initial position (i.e., target word only) and once in phrase-medial position (i.e., target word preceded by /i/, 'this', or /ne/, 'my').

As mentioned earlier, the Korean language utilizes a three-way laryngeal distinction in stop consonants (lenis, tense, aspirated), while English utilizes a two-way voicing distinction (voiced, voiceless). Target phonemes were the three denti-alveolar (lenis: /t/, tense: /t*/, aspirated /t^h/) and the three velar (lenis: /k/, tense: /k*/, aspirated: /k^h/) Korean stop consonants. Words were drawn from six minimal triplets of single-syllable Korean words that varied only on the target consonant: three triplets that started with denti-alveolar consonants (e.g., /tal/, /t*al/, /t^hal/) and three that started with velar consonants (e.g., /kong/, /k*ong/, /k^hong/).

41.5.1.5 Phoneme production task

The phoneme production task utilized the same set of minimal triplets from the phoneme identification task. Participants heard a sentence in Korean ("ige ____", English gloss: 'this is a ____') and were then asked to repeat the sentence after a three-second pause (a beep indicated when they should begin speaking). As in the phoneme identification task, target phonemes appeared in both phrase-initial and phrase-medial positions (separate blocks). Utterances were recorded and speech analysis software (*Praat*; Boersma & Weenink, 2012) was used to display spectrograms, pitch tracks, and waveforms of the utterances, from which phonetic measurements of voice onset time (VOT) and closure duration (CD) of target consonants, as well as fundamental frequency (f0) of the following vowel, were taken.

41.5.1.6 Results

41.5.1.6.i Language background assessment

All adoptees were monolingual English speakers (some had learned a language other than Korean in school as adolescents, but none claimed fluency in that language). In the learner-adoptee target sample, six participants had no post-adoption experience with Korean until their university Korean language class, six had minimal exposure in childhood, and seven participants had minimal exposure in adolescence only. In the adoptee comparison sample, eleven participants had no post-adoption exposure to Korean, seven had minimal exposure during childhood, and one had minimal exposure in adolescence only. Minimal exposure typically consisted of participation in culture camps for Korean adoptees, ranging from weekly participation to one week per year. The culture camps primarily provide a place for Korean adoptees to socialize and meet other adoptees and their families. They are conducted in English, and some provide minimal instruction in basic Korean vocabulary as part of their curriculum.

Most of the novice learners had no experience with Korean prior to enrollment in the Korean language class (n = 14). The remaining five had some exposure to Korean only in adolescence—usually overhearing Korean American friends in high school speaking Korean. Among the novice learners, eight were monolingual English speakers (some had learned a language other than Korean in school as adolescents, but none claimed fluency in that language); the remaining 11 grew up bilingually, with English and a non-Korean home language (the most common were Hmong, n = 5, and Chinese dialects, n = 4; none of the languages represented were in the same language family as Korean).

41.5.1.6.ii Phoneme perception

A one-way ANOVA with group as the independent variable revealed a main effect of group in overall accuracy on the phoneme identification task, F (3,65) = 18.27, p< .001 (see Table 1 for means). Tukey's HSD post-hoc tests revealed that native speakers outperformed all of the other groups: learner-adoptee, p < .001, d = 2.38; comparison-adoptee, p < .001, d = 3.54; novice, p = .001, d = 1.59. Importantly, the learner-adoptee sample outperformed the comparison-adoptees, p = .002, d = 1.54. They also performed numerically, although not statistically, better than the novice sample, *n.s.,* d = .40. The comparison-adoptee sample's performance was not significantly different from the novice sample, *n.s.,* d = .63.

The same overall patterns held across consonant types: aspirated, F (3,65) = 5.46, p = .002; lenis, F (3,65) = 14.42, p < .001; tense, F (3,65) = 26.62, p < .001. Post-hoc tests revealed that for aspirated consonants, the native speakers outperformed the comparison-adoptee sample, p = .002, d = 1.69, but not the learner-adoptees, *n.s.,* d = .76, or the novice sample, *n.s.* (marginally significant, p = .050), d = .84, and the learner-adoptee sample outperformed the comparison-adoptee sample, p = .038, d = 1.04. No other group differences were statistically

significant for aspirated consonants. For lenis consonants, the native sample outperformed all other groups: learner-adoptee, $p = .004$, $d = 2.15$; comparison-adoptee, $p < .001$, $d = 2.62$; novice, $p < .001$, $d = 1.80$. The learner-adoptee sample again outperformed the comparison-adoptee sample, $p = .035$, $d = 1.03$, but no other group comparisons were statistically significant. For tense consonants, native participants outperformed all other groups: learner-adoptee, $d = 2.12$; comparison-adoptee, $d = 5.24$; novice, $d = 1.58$; all ps $< .001$. Both the learner-adoptee, $d = 1.48$, and the novice, $d = 1.46$, samples outperformed the comparison-adoptee sample on tense consonants, ps $< .001$.

We also re-ran the analyses excluding adopted participants who had post-adoption experience with Korean during childhood. The pattern of results for overall accuracy was the same, $F(3,52) = 17.14$, $p < .001$. Further, as with the full sample, the native sample outperformed all other groups, and the learner-adoptee sample outperformed the comparison-adoptee sample, all ps $< .01$. The one difference was that the novice sample outperformed the comparison-adoptee sample, $p = .024$.

TABLE 1 HERE

41.5.1.6.iii Phoneme production

Mean CD, VOT, and f0 by group for each type of consonant are presented in Table 2. As evidenced by the means for the native speakers, CD for tense consonants should be longest, followed by aspirated consonants, then lenis consonants. For VOT, aspirated consonants should be longest, followed by lenis, then tense consonants. As for f0, lenis consonants should have lower f0 as compared with aspirated and tense; f0 does not consistently distinguish between

aspirated and tense consonants (Cho, Jun, & Ladefoged, 2002). Means for all groups numerically followed these patterns.

TABLE 2 HERE

To examine whether each group reliably distinguished between stop consonants on these phonetic features, we conducted a series of planned, paired *t*-tests comparing consonant pairs on each of these measurements, separately by group. Results and effect sizes are presented in Table 3. In all cases, native speakers reliably distinguished lenis, tense, and aspirated stop consonants by CD, VOT, and f0 (as mentioned above, for f0 we are comparing only lenis vs. aspirated and lenis vs. tense consonants). The learner-adoptee participants likewise reliably distinguished among the stop consonants on all three measures. In contrast, the comparison-adoptee sample only reliably distinguished lenis and tense consonants on CD, only the tense vs. aspirated and lenis vs. aspirated distinction on VOT, and both lenis vs. tense and lenis vs. aspirated distinctions on f0. Novice participants reliably distinguished among the three stop consonants on CD and VOT, but only reliably distinguished lenis vs. tense consonants, and not lenis vs. aspirated, on f0.

We re-ran these analyses excluding adoptees who had post-adoption experience with Korean during childhood. In all cases, the pattern of results was the same and statistical significance was the same in most cases, with the exception of the lenis vs. tense distinction on VOT and the lenis vs. aspirated distinction on f0 for the learner-adoptee sample, both *n.s.*, and the lenis vs. tense distinction on CD and the lenis-aspirated distinction on VOT for the comparison-adoptee sample, both *n.s*.

TABLE 3 HERE

41.5.1.7 Relearning as one key to accessing international adoptees' early childhood language memory

The research just reported was to assess whether a brief re-exposure to the target language could help adult learners access their early childhood language memory. We had previously found a sizable advantage for adopted Korean American adults over novice learners in Korean phoneme perception after just two weeks of a beginning university-level Korean language class (Oh et al., 2010). However, that study did not have baseline data for the adoptee relearners, and so it was difficult to ascertain whether the advantage had already existed before the language class. This study therefore compared a similar group of Korean adoptees with a comparison group of adoptees who did not have post-adoption relearning experience for Korean. Further, we not only examined possible advantages in phoneme perception, but also phoneme production.

Overall, there were clear advantages among adoptees after two weeks of re-exposure in both phoneme perception and production, as compared with adoptees who had not experienced such re-exposure. In phoneme perception, the learner-adoptee target sample outperformed the comparison-adoptee sample overall, as well as on each of the three types of stop consonants. It is also worth noting that for all three types of consonants, the comparison-adoptee sample had the lowest mean accuracy of the four groups and was significantly outperformed by even the novice learner sample for tense consonants. As Au and Romo (1997) had speculated, based on language instructors' impressions, novice learners often were the most motivated and diligent

learners in language classes, perhaps driven by a perceived advantage of heritage language learners. This might have in part explained the novice learners' performance on some of the measures in this study. For production, the learner-adoptee sample reliably distinguished among the three consonants on all relevant phonetic measures—just as the native speakers did—whereas the comparison-adoptee sample did so on only some comparisons. Again, even the novice learners did better than the comparison-adoptee sample, at least as measured by stop closure duration and voice onset time.

We recognize that the comparison-adoptee sample does not represent baseline data per se. Although we matched the learner-adoptee target and the comparison-adoptee samples on key demographic variables, they might nonetheless differ in other potentially important ways. For one thing, the learner-adoptee target sample chose to enroll in Korean language classes whereas the comparison-adoptee sample, at least by the time of this study, had not. Motivation and interest in Korean culture may play a critical role in these group differences. Nonetheless, the present study demonstrated that even very early childhood language memory can become accessible in adulthood. In light of prior findings (e.g., Bowers et al., 2009; Singh et al., 2011; Choi et al., 2017), this is probably due to re-exposure to the childhood language. Although two weeks of relearning in a language class seems a rather brief amount of time to allow for reactivating a long-ago memory, it nonetheless seems sufficient to reveal measurable benefits of early childhood language experience. On some of the phonemic measures, only the learner-adoptee sample, but not the novice-learner sample, outperformed the comparison-adoptee sample. That said, the novice-learner sample also outperformed the comparison-adoptee sample on some measures, despite the former's lack of childhood experience with Korean, indicating that some of the phonemic contrasts are quite learnable even in adulthood (Flege, 2007).

Although our prior findings supported a rather robust adoptee relearner advantage over novice learners in phoneme perception (Oh et al., 2010), this group difference was more attenuated in the present study. Nonetheless, the sample means do consistently—numerically if not statistically—support an adoptee relearner advantage, both overall and separately for lenis and aspirated consonants (note that the statistically significant group differences in the Oh et al., 2010, study were also for lenis and aspirated consonants). Perhaps the trend would become statistically significant with a larger sample and hence more statistical power. Further, in production, both groups reliably contrasted the Korean stop consonants on closure duration and voice onset time, but adoptee relearners also reliably contrasted consonants on f0 whereas novice learners did not reliably contrast lenis vs. aspirated consonants on this measure. This adoptee-relearner production advantage may reflect their early childhood language experiences: there is some evidence to indicate that the lenis-aspirated f0 distinction is acquired before the VOT distinction in Korean stop consonants (Jun, 2006). Hence, adoptee relearners may be tapping into their infant language memory in re-acquiring this distinction, revealing their advantage over novice learners. Clearly, further research is needed to clarify the robustness of these findings.

Our findings therefore support the growing evidence that childhood language memory can become accessible after re-exposure, and that the re-exposure need not be extensive or intensive as in perceptual training focusing on only phonemic contrasts. The benefits of infant linguistic experience for phoneme perception later in life has been demonstrated previously, but the present study is among the first to demonstrate possible benefits for phoneme production as well (see also Choi et al., 2017). This is somewhat surprising given the average age of adoption of our sample was six months, well before children would have started speaking. Perhaps the re-activated childhood language memory offers phonetic representations of what the phonemes

ought to sound like, which in turn helps production of the phonemes (see, e.g., Bradlow et al., 1997; Choi et al., 2017). This finding no doubt needs to be examined further, but it does indicate that early linguistic exposure, even limited just to infancy, may provide a variety of benefits to the language learner later in life.

41.6 The long-lasting benefits of early childhood language experience

The variety of experiences of heritage language learners has brought to light a number of issues related to language experiences. One such issue has to do with an increasingly common experience among children from heritage language backgrounds: the loss of the heritage language early in life, as immigrant-background children often transition to the mainstream language when they begin formal schooling. Much of the existing literature on the importance of early exposure to a language for native-like abilities has assumed that such exposure continues beyond early childhood. The question remained as to whether such exposure, if discontinued after early childhood, could still provide benefits to the adult language (re)learner. There is a growing body of evidence suggesting that the answer is probably yes.

Importantly, our latest research breaks new ground in several ways. First, our findings indicate that very early childhood language memory (i.e., from the first year of life) remains accessible in adulthood even after a long period of disuse of the language. Second, along with Choi et al's (2017) findings, it indicates that such infant language memory can be activated via relearning to help improve not only the perception, but also production, of phonemes. Third, rather than the intensive, focused perceptual training on phonemic contrasts in Choi et al.'s (2017) study, it seems that just two weeks of naturalistic learning in typical university-level language classes can also help re-activate such long-ago infant language memory.

Research with adult heritage language (re)learners constitutes as a rich arena to better identify the nature of early language exposure that can benefit adult language learners. Given the diversity of linguistic experiences among heritage language learners, this research field is poised to yield more insights into the long-lasting benefits of childhood language memory.

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Table 1

Mean Accuracy on Phoneme Identification Task by Group

		Mean	Standard Error
Overall	Target	0.81	0.02
	Comparison	0.69	0.02
	Novice	0.77	0.03
	Native	0.95	0.01
Aspirated	Target	0.84	0.02
	Comparison	0.73	0.03
	Novice	0.78	0.04
	Native	0.90	0.02
Lenis	Target	0.80	0.02
	Comparison	0.70	0.03
	Novice	0.71	0.04
	Native	0.97	0.02
Tense	Target	0.78	0.02
	Comparison	0.65	0.02
	Novice	0.77	0.03
	Native	0.97	0.01

Table 2

Mean (and SE) Closure Duration (CD in msec), Voice Onset Time (VOT in msec), and Fundamental Frequency (f0 in Hz) of Stop Consonants by Group

		Target	Comparison	Novice	Native
CD	Lenis	102.70 (3.65)	116.63 (6.00)	105.90 (5.15)	67.03 (5.11)
	Aspirated	112.04 (4.40)	124.54 (7.06)	113.67 (7.06)	134.69 (5.58)
	Tense	125.43 (4.73)	131.09 (6.93)	141.12 (5.93)	172.60 (5.05)
VOT	Tense	39.19 (1.88)	57.58 (5.49)	31.54 (1.95)	23.87 (2.40)
	Lenis	45.87 (2.78)	61.53 (4.43)	54.19 (2.97)	57.83 (8.91)
	Aspirated	59.50 (3.35)	70.84 (5.96)	75.39 (4.32)	77.87 (7.69)
f0	Lenis	185.52 (10.81)	182.78 (11.64)	174.15 (12.97)	165.80 (15.19)
	Tense	192.35 (10.72)	189.68 (11.62)	180.58 (13.15)	180.18 (17.48)
	Aspirated	192.12 (11.27)	191.69 (11.59)	180.61 (13.93)	204.01 (21.63)

Table 3

t Statistics (and dfs) and Cohen's *d* for Paired *t*-Test Comparisons of Phonetic Measures of Phoneme Production by Group

		Target		Comparison		Novice		Native	
		t (df)	*d*	*t (df)*	*d*	*t (df)*	*d*	*t (df)*	*d*
CD	lenis vs. tense	7.20** (18)	1.65	2.42* (17)	0.57	11.61**(18)	2.66	17.67** (6)	6.68
	lenis vs. aspirated	3.57** (18)	0.82	0.99 (17)	0.23	2.21*(18)	0.51	10.22 ** (6)	3.86
	tense vs. aspirated	3.96** (18)	0.91	1.13 (17)	0.27	9.07**(18)	0.91	18.50** (6)	6.99
VOT	lenis vs. tense	2.37* (18)	0.54	1.62 (17)	0.38	6.28**(18)	1.44	4.39** (6)	1.66
	lenis vs. aspirated	6.39** (18)	1.46	2.91* (17)	0.69	10.56**(18)	2.42	4.12** (6)	1.56
	tense vs. aspirated	7.23** (18)	1.66	4.42** (17)	1.04	8.59**(18)	1.97	8.94** (6)	3.38
f0	lenis vs. tense	4.63** (18)	1.06	5.09** (17)	1.20	3.90**(18)	0.90	2.66* (7)	0.94
	lenis vs. aspirated	2.42* (18)	0.56	3.50** (16)	0.85	1.89 (18)	0.43	4.64** (7)	1.64

*: $p < .05$; **: $p < .01$