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Effects of cumulative language exposure on heritage and majority language skills

Spanish and Mandarin heritage speakers in the USA

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This study investigated the effects of the amount of cumulative heritage language (HL) exposure during three time periods, on heritage and majority language performance in young adulthood, among two distinct groups of immigrant populations in the USA. Within each time period, exposure from three different sources were examined, and amount of cumulative exposure was calculated encompassing exposure from preceding periods. Factors that may modulate exposure effects were also assessed. Results showed that greater cumulative HL exposure from people at home during all three time periods significantly predicted HL skills for both language groups. For effects on English skills, only the Spanish group showed any influences of exposure. These effects were modulated by parental English proficiency. Input from other sources had less impact. The present findings support the role of parental input throughout childhood, adolescence, and early adulthood in improving HL skills, with less noticeable consequences for the majority language.

Keywords: heritage language, language exposure, language maintenance, picture naming, verbal fluency

1. Introduction

Over the past three to four decades, there has been a steady increase in population mobility, resulting in increasing numbers of immigrant communities, particularly those with a mother tongue that differs from the majority or official language of

the host society. Heritage speakers are, thus, members of a linguistic minority community who has grown up with a minority or heritage language (HL) in their homes, whether they were born in the majority language country, or immigrated in childhood (Montrul, 2010). Among such immigrant populations, a dilemma that often arises is integrating to the majority language environment while still preserving their HL. For the second-generation children, who grow up in the host society, the challenge of learning and maintaining the HL becomes greater (Hoff, Rumiche, Burridge, Ribot, & Welsh, 2014; Nesteruk, 2010; Protassova, 2008).

Previous research has surveyed such HL populations in regard to HL acquisition and development, mostly in children and adolescents. A general trend is one of decline in HL competence and shift towards the majority language as the children get older, particularly after starting school (e.g., Alba, Logan, Lutz, & Stults, 2002; Benmamoun, Montrul, & Polinsky, 2013; Cho, Shin, & Krashen, 2004; De Houwer, 2007; Montrul, 2008; Nesteruk, 2010; Polinsky, 2006; Polinsky & Kagan, 2007; Rothman & Treffers-Daller, 2014). However, there are also cases of high bilingual proficiency among HL speakers, particularly in the European context (Bayram, Rothman, Iverson, Kupisch, Miller, Puig-Mayenco, & Westergaard, 2017; Flores, 2015; Kupisch, 2013; Kupisch & Rothman, 2016; Protassova, 2008). Nevertheless, HL speakers, whether proficient or not, have been found to differ from both monolingual speakers of the target language (Bayram et al., 2017; Benmamoun et al., 2013; Flores, 2015; Scontras, Fuchs, & Polinsky, 2015) and second language learners (Au, Oh, Knightly, Jun, & Romo, 2008; Csire & Laakso, 2011; Montrul & Perpiñán, 2011), presenting a unique group of bilinguals. Yet, individuals in this unique group, given their diverse backgrounds and experiences, show diverse patterns of language competence. For example, some studies have found that HL speakers have disadvantages in aspects of morphosyntax compared to monolinguals, but are proficient in phonological aspects (Au et al., 2008; Montrul & Perpiñán, 2011), while other studies have observed the reverse pattern (Kupisch, 2013).

Immigrant parents often hold the view that HL should be maintained, that they as parents should help their second-generation children maintain HL, and that HL use at home is the most important factor for their children's HL maintenance (Lao, 2004; Nesteruk, 2010; Park & Sarkar, 2007; Protassova, 2008; Zhang & Slaughter-Defoe, 2009). Correspondingly, parents often make efforts to expose their children to HL as much as possible. The children, however, typically (though not always) do not share their parents' views that HL can be a resource. This is especially so after starting school or daycare, since a greater part of their day is spent in majority-language-dominant environments, with some expressing strong desire to integrate into the majority culture (Cho et al., 2004; Nesteruk, 2010; Zhang & Slaughter-Defoe, 2009). Furthermore, the additional activities imposed

on the children to help them learn and maintain HL (e.g., weekend schools, home study sessions) are usually seen as burdensome and unbeneficial by the children (Nesteruk, 2010; Zhang & Slaughter-Defoe, 2009). In a small number of cases, the parents may also place greater importance on the mastery of the majority language, in order for the children to achieve greater academic success. As such, the parents may choose not to enforce extra tasks associated with learning and maintaining a non-majority language, and may even speak to the children in the majority language from an early age to optimize their school readiness (Nesteruk, 2010; Suarez, 2002; Yu, 2013).

So what are the effects of parents speaking to their children more in HL as opposed to the majority language? Are there differences in language abilities during *adulthood* as a result of *early* language exposure amounts? Many studies investigating the effects of language exposure on bilingual or HL development have assessed children's language use and proficiency levels, often using caregiver-report methods (e.g., David & Wei, 2008; De Houwer, 2007; Dixon, Zhao, Quiroz, & Shin, 2012; Fogle & King, 2013; Place & Hoff, 2011; see Hoff & Core, 2013; Unsworth, 2016, for reviews). For example, parental input factors have been found to be associated with young (aged between 1 to 3 years) bilingual children's vocabulary size and language dominance (David & Wei, 2008; Pearson, Fernandez, Lewedeg, & Oller, 1997). There have only been limited studies that systematically investigated the role of input exposure in shaping the development and outcome of both HL and majority language, directly assessing the second-generation immigrants on language task performance. Two such studies found that those who were exposed mostly to English (even though in nonstandard form from nonnative parents) in the home environment during early childhood, performed more like monolingual speakers in aspects of English processing during young adulthood, including vocabulary, pronunciation, and comprehension of certain types of speech stimuli, compared to those who had been exposed more to HL (among participant groups that covered a wide range of HL backgrounds). However, the latter group, who had greater proportion of HL exposure, were able to retain some HL abilities (based on self-ratings), whereas the former group reported minimal HL competence, suggesting that increased exposure to English in the home reduces opportunities for HL use, and vice versa (Tao & Cai, 2018; Tao & Taft, 2017).

Other research on the impact of early language experience have often investigated the interference arising from early exposure to one language on the acquisition and development of a second (e.g., Bosch & Sebastián-Gallés, 2003; McCarthy, Mahon, Rosen, & Evans, 2014; Puig-Mayenco, Cunnings, Bayram, Miller, Tubau, & Rothman, 2018; Sebastián-Gallés & Bosch, 2002, 2009; Sebastián-Gallés, Echeverría, & Bosch, 2005). For example, studies of the bilingual population in the Spanish region of Catalonia, where participants are exposed to both Catalan

and Spanish from an early age, have shown that greater amount of exposure to one language over the other produces better perceptual discrimination of speech sounds in that language, for both children (Bosch & Sebastián-Gallés, 2003; Sebastián-Gallés & Bosch, 2009) and adults (Sebastián-Gallés et al., 2005), even when participants are matched on lexical knowledge. In addition, there is greater sensitivity to restrictions in a given language on the permissible combinations of phonemes (i.e., phonotactic constraints) for both children and adults (Sebastián-Gallés & Bosch, 2002). These findings indicate an impact of language exposure in the early home environment on aspects of first and second language performance, both during the developmental period and in the longer term. Interference effects of a HL on majority language learning have also been examined in immigrant populations (e.g., McCarthy et al., 2014), where bilingual children show perception and production skills in the majority language that reflect the phonetic properties of the HL they had been exposed to during childhood.

These abovementioned studies examined “internal” factors in regard to effects of language input, that is, the impact of cross-language contact within the individual. There have also been studies that have investigated “external” factors relating to linguistic input, including both the quantity as well as the quality of input (e.g., Chondrogianni & Marinis, 2011; Ebert, Lockl, Weinert, Anders, Kluczniok, & Rossbach, 2013; Hoff et al., 2014; Paradis, 2011; Paradis & Navarro, 2003; see Hoff & Core, 2013; Unsworth, 2016; for reviews). For example, Chondrogianni and Marinis (2011) found that internal (age/time) and external (environmental) factors affected the development of vocabulary and complex syntax, among Turkish-English bilingual children (aged between 6 and 10 years). Specifically, the environmental factors of parental self-rated English proficiency (quality) and parental English use at home (quantity) had an impact. Other studies have highlighted the importance of input quality over quantity. For example, the amount of English use at home only predicted the development of English expressive vocabulary (from 22 to 48 months of age) for Spanish-English bilingual children with one native English-speaking parent, and not for those whose both parents are native Spanish speakers (Hoff et al., 2014). Aside from parental proficiency, the “richness” of the language environment (e.g., the variety of games, television exposure, books, organized activities, and peers) has also been shown to have greater impact than proportion of language use at home, on vocabulary and morphological development among bilingual children (between 4 and 7 years of age; Paradis, 2011).

The majority of studies that have investigated the effects of input factors during early childhood have examined language acquisition or childhood developmental outcomes. It has been suggested that there is a “critical mass” effect of exposure on language acquisition (for monolingual as well as bilingual acquisition), where

input data has to be accumulated up to a certain threshold for acquisition to occur, beyond which further exposure no longer matters (see e.g., Gathercole, 2002; Pearson, 2007). In line with this view, Gathercole and Thomas (2005) found that the effects of different levels of bilingual language exposure was greater at younger ages (i.e., 3 and 5 years), but diminished as the children grew older (i.e., by 7 and 9 years). This does not mean, however, that exposure in later years has no impact on continued development in various aspects of language. A later study examined Welsh vocabulary and idiom knowledge among Welsh-English bilingual adults, and found that those who had experienced only Welsh at home during childhood performed better than those who had English-only or Welsh-English early home environments (Gathercole & Thomas, 2009). More importantly, Gathercole and Thomas (2009) reported that adults from Welsh-only early home environments with a partner who also came from Welsh-only origin showed the best performance (i.e., better than those with English-only or Welsh-English origin partners). The same pattern, however, was not observed for English. Nevertheless, there may still be effects of early language exposure on different language outcomes later in life.

The present study aimed to holistically investigate the effects of the amount of HL exposure on HL and majority language performance, which in the present case was English. Although HL speakers typically end up being dominant in the majority language as mentioned (particularly if born in the majority language environment like the present pool of participants), early and extended experience with HLs may still impact English skills (Gollan, Starr, & Ferreira, 2015; Tao & Cai, 2018; Tao & Taft, 2017). English skills, therefore, were also assessed. Data collected in the course of an earlier study examining two distinct groups of HL speakers in the USA – Spanish HL and Mandarin HL – were analyzed (Tao, Taft, & Gollan, 2015). This earlier study mainly investigated the relationship between bilingualism and cognitive task switching among the two HL groups. The present study, on the other hand, investigated language exposure effects on heritage and majority language skills. Questionnaire data on language history and language task performance data previously collected were thus utilized for the present purpose. The two language groups were both included, as these two groups present two of the biggest immigrant HL populations in the USA (Kim & Chao, 2009; King & Ennser-Kananen, 2013; Nagano, 2015), yet differ in many characteristics, including language use, cultural, and socioeconomic aspects, as well as typological distance between their heritage and majority languages (Kim & Chao, 2009; Nagano, 2015; Tao et al., 2015; Tomoschuk, Ferreira, & Gollan, in press).

Proportion of language exposure (HL vs. English) was determined via retrospective self-report for three time periods (from birth to before starting school, throughout primary and secondary schooling, and from end of high school to now), and from three different sources (people at home, others in the community,

and various forms of media). We adopted a cumulative exposure approach (see Serratrice & De Cat, in press; Unsworth, 2013) to obtain a more holistic view of participants' language exposure history, since language abilities at subsequent time periods are not only determined by language experience at that time period, but also by experience accumulated over all preceding periods. Additionally, factors that may influence exposure effects were taken into consideration, including parental English proficiency (e.g., Chondrogianni & Marinis, 2011; Hoff et al., 2014), parental attitude to language use (e.g., Nesteruk, 2010), and socioeconomic status (SES; e.g., Alba et al., 2002; Portes & Rumbaut, 2006). HL ability was assessed using a multilingual picture naming task that has been shown to be valid for both Spanish and Mandarin (Gollan, Weissberger, Runnqvist, Montoya, & Cera, 2012; Sheng, Lu, & Gollan, 2013). English abilities were assessed using picture naming and verbal fluency.

2. Method

2.1 Participants

As mentioned, the present study analyzed data from Tao et al. (2015). There were 160 participants included, belonging either to Spanish HL ($n = 80$) or Mandarin HL groups ($n = 80$). Participants in the two groups had parents who came from Spanish-speaking or Mandarin-speaking backgrounds respectively. All were either born in the USA or had arrived at or before age 1, and were raised and educated in the USA. Those who had spent 1 year or more in another country (including those who arrived after age 1) were excluded. This was to examine the effects of relative amounts of language exposure, while removing potential confounds of age of arrival/acquisition and length of residence.

Table 1 presents the general sociodemographic and language characteristics for the two groups. Participants in both language groups reported, on average, moderate proficiency in HL, near-ceiling proficiency ratings in English, and more frequent use of English than HL. Those in the Spanish group reported higher proficiency and greater usage of their HL than those in the Mandarin group. None of the participants reported having any hearing or speech impairments. The participants were all students undertaking an undergraduate psychology course, originally recruited via the online participant recruitment system provided by the Department of Psychology at the University of California San Diego (UCSD). They received course credit in exchange for participation.

Table 1. General characteristics of participant groups (standard deviation in parentheses)

	Spanish HL group	Mandarin HL group
Mean age	20.9 (2.5)**	19.8 (1.1)
Age range	18–36	18–22
Gender distribution (F:M)	60:20	60:20
Number of years of tertiary education completed	2.1 (1.4)	1.5 (1.1)
Age of arrival in USA	0.004 (0.04)	0.01 (0.1)
Age of learning English	1.6 (2.1)**	0.8 (1.6)
Age of learning HL	0.5 (1.3)	1.0 (2.4)
Years of study in English	14.2 (1.7)	14.9 (2.4)
Years of study in HL	3.0 (2.0)**	6.4 (4.8)
Self-rated spoken English proficiency ^a	6.8 (0.5)**	6.98 (0.2)
Self-rated spoken HL proficiency ^a	5.0 (1.5)*	4.4 (1.5)
% daily use of HL currently	13.0 (12.7)**	5.9 (9.4)
% daily use of HL when growing up ^b	31.7 (20.2)**	24.2 (15.9)
Hours/week mostly speaking HL currently	16.4 (16.3)**	5.7 (10.2)
Hours/week mostly speaking HL when growing up ^b	48.0 (29.3)**	34.4 (29.0)
Parental age of arrival in USA ^c	15.1 (8.8)**	22.6 (8.6)
SES (parental education, years) ^c	11.1 (3.9)**	16.2 (3.6)

Note. HL = heritage language. SES = socioeconomic status.

a. 1 = Not at all, 2 = Very poor, 3 = Poor, 4 = Functional, 5 = Good, 6 = Very good, 7 = Native-like.

b. When growing up = from birth through high school.

c. Responses were averaged across two parents/caregivers, except where only one parent/caregiver was indicated.

** Significant difference between the two groups, $p < .01$.

* Significant difference between the two groups, $p < .05$.

2.2 Materials and procedure

The series of tasks completed by participants are detailed below. Participants were tested individually in one testing session lasting approximately 1 hour. All tasks were completed in English, except the second part of the picture naming task. (see Subsection 2.2.4. below). Instructions for each task were given in the same language as that used for completion of that task. The protocol was approved by the UCSD Human Research Protection Program.

2.2.1 Language history questionnaire

The questionnaire was used to collect information regarding estimated proportion of HL exposure during three time periods (using retrospective self-report):

from birth to before starting school (Time 1), throughout primary and secondary schooling (Time 2), and from the end of high school to now (Time 3). Within each time period, participants provided estimates for exposure from three different sources (i.e., a 3×3 grid): people at home, others in the community, and the media (including television, videos, music, internet, and so on). To calculate cumulative exposure within each period, the HL exposure proportions were first multiplied by the number of years within that period (i.e., five years for from birth to before starting school, 13 years for throughout primary and secondary schooling, and for the period from end of high school to now the number of years is determined as current age minus 18). For the two later time periods, cumulative exposure from previous period/s were added to the calculations, so that Time 2 cumulative exposure included that from Time 1, and Time 3 included both Time 1 and Time 2.

The questionnaire also collected information regarding participants' language experience, including estimated age of learning of HL and English, years of study in HL and English, self-ratings of proficiency in spoken HL and spoken English (using a 7-point scale, from 1 = Not at all to 7 = Native-like), percentage of HL use both currently and when growing up, and hours per week mostly speaking HL both currently and when growing up. In addition, participants provided estimates of their parents'/caregivers' (separately for each parent/caregiver) language proficiency (using the same 7-point scale as above), attitude to language use at home (using a 5-point scale, from 1 = Very strongly encouraged me to avoid speaking English to 5 = Preferred that I speak English), and number of years of education received as an index of SES (following Tao & Taft, 2017). Parental proficiency, attitude, and SES may impact children's language outcomes (e.g., Alba et al., 2002; Nesteruk, 2010; Portes & Rumbaut, 2006), therefore these factors may be taken into account during statistical analysis when examining the effects of language exposure.

2.2.2 *Verbal fluency (English)*

In the Controlled Oral Word Association Test (COWAT; Benton, 1969), participants are given one minute to produce as many words in English as possible in a particular category, while avoiding proper nouns, numbers, and swear words, as well as repetition and morphological variants (e.g., after saying "create", not to say "creating", "creator", and so on). Participants completed three letter categories (C, F, and L) and one semantic category (*Animals*). The total number of accepted words produced for the three letter categories combined provided an index of letter fluency, while the number of accepted words produced for the semantic category was used as an index of semantic fluency.

2.2.4 *Picture naming (English and HL)*

Picture naming was assessed using the Multilingual Naming Test (MINT; Gollan et al., 2012), which consisted of 68 black-and-white line drawings, arranged in approximate increasing difficulty in producing the picture names. Pictures in the MINT were presented to participants on a printed page, six images per page. Participants were first asked to name each picture in English as accurately as they could. The same 68 images in the MINT were then presented again to be named in either Spanish or Mandarin. Although language of testing order can affect performance on timed tests, accuracy rates on the MINT are not influenced by testing order (Van Assche, Duyck, & Gollan, 2013). An experimenter fluent in Spanish or Mandarin administered this part of the task in the relevant language. All other interactions with participants were in English. The MINT scores provided objective measures of both HL and English proficiencies, superior to self-ratings (Tomoschuk et al., in press). The task was designed to be used with speakers of English, Spanish, Mandarin, or Hebrew, and has been shown to be a valid indicator of HL proficiency in Spanish and Mandarin, having robust correlations with other indicators of proficiency (e.g., Oral Proficiency Interviews; Gollan et al., 2012; Gollan, et al., 2015; Sheng et al., 2013).

3. Results

Table 2 presents the language exposure characteristics of the participant groups, and Table 3 the mean scores for the two groups on each of the outcome measures. Effects of the amount of cumulative HL exposure were examined via three separate sets of multiple regression analyses, one for each time period. Cumulative exposure to HL from each of the three sources (people at home, others in the community, the media) within one period were entered as three predictor variables, and each of the outcome measures was a criterion variable. The Spanish and Mandarin groups were examined separately, since they differed on a number of sociodemographic and language use characteristics (see Table 1). Table 4 presents the results for the regression analyses.

Since parental language proficiency, parental attitude to language use, and SES may modulate home exposure effects, separate follow-up analyses were carried out controlling for these covariates via hierarchical multiple regression (see Table 5 for correlations between covariates and other variables). Parental English proficiency (participants' ratings of each of their parents' spoken English proficiency, averaged across both parents), parental attitude (participants' ratings of their parents' attitude to language use at home on a five-point-scale, averaged across both parents), or SES (parental education: participants' estimations of the number of years of education their parents received, averaged across both parents) was entered in the

first step, and cumulative exposure to HL from the three sources were entered as predictor variables in the second step.

Table 2. Language exposure characteristics (standard deviation in parentheses)

	Spanish HL group	Mandarin HL group
Cumulative exposure to HL from birth to before starting school, from:		
1. People at home	3.7 (1.4) ^m	3.2 (1.6)
2. Others in the community	1.7 (1.7) ^m	1.2 (1.5)
3. The media (include TV, videos, music, internet, etc.)	1.5 (1.5) ^{**}	0.7 (1.1)
Cumulative exposure to HL throughout schooling, from:		
1. People at home	11.3 (4.5)	10.1 (5.6)
2. Others in the community	5.7 (4.7) ^{**}	3.9 (3.7)
3. The media (include TV, videos, music, internet, etc.)	4.7 (4.3) ^{**}	2.6 (3.2)
Cumulative exposure to HL from the end of high school to now, from:		
1. People at home	12.3 (5.0)	10.8 (6.3)
2. Others in the community	6.4 (5.1) ^{**}	4.1 (3.9)
3. The media (include TV, videos, music, internet, etc.)	5.3 (4.8) ^{**}	2.8 (3.6)
Parental spoken English proficiency ^{a, b}	4.8 (1.8)	5.0 (1.3)
Parental spoken HL proficiency ^{a, b}	6.8 (0.5)	6.8 (0.6)
Parental attitude to language use in home ^{b, c}	3.7 (0.7)	3.8 (0.7)

a. 1 = Not at all, 2 = Very poor, 3 = Poor, 4 = Functional, 5 = Good, 6 = Very good, 7 = Native-like.

b. Responses were averaged across two parents/caregivers, except where only one parent/caregiver was indicated.

c. 1 = Very strongly encouraged me to avoid speaking English, 2 = Often encouraged me to avoid speaking English, 3 = Sometimes encouraged me to avoid speaking English, 4 = Allowed me to speak in whichever language I preferred, 5 = Preferred that I speak English.

** Significant difference between the two groups, $p < .01$.

m. Marginally significant difference between the two groups, $p < .10$.

Table 3. Mean scores on outcome measures (standard deviation in parentheses)

	Spanish HL group	Mandarin HL group
Controlled Oral Word Association Test		
Letter fluency	39.3 (9.3) ^{**}	47.9 (11.1)
Semantic fluency	20.9 (4.6) ^{**}	23.6 (4.6)
Multilingual Naming Test		
English picture naming	61.9 (3.0) ^{**}	64.5 (2.4)
HL picture naming	34.9 (14.0) ^{**}	26.8 (16.5)

Note. HL = heritage language.

** Significant difference between the two groups, $p < .01$.

* Significant difference between the two groups, $p < .05$.

Table 4. Regression analyses results (significant predictors only)

Criterion variable	Spanish HL group			Mandarin HL group			
	Predictor variables	<i>b</i>	<i>t</i>	<i>p</i>	<i>b</i>	<i>t</i>	<i>p</i>
Letter fluency							
Time 1: Home	-2.47	-3.11	.003**				
Time 3: Home	-0.49	-2.12	.037*				
Semantic fluency							
None							
English picture naming							
Time 1: Home	-0.88	-3.42	.001**				
Time 2: Home	-0.18	-2.19	.031*				
Time 3: Home	-0.17	-2.25	.027*				
HL picture naming							
Time 1: Home	5.34	5.54	<.001**	6.09	6.34	<.001**	
Time 1: Media	2.66	2.42	.018*				
Time 2: Home	1.65	5.63	<.001**	1.98	7.11	<.001**	
Time 2: Media	0.88	2.30	.024*				
Time 3: Home	1.49	5.51	<.001**	1.78	7.10	<.001**	
Time 3: Media	0.75	2.22	.030*				

Note. HL = heritage language. Time 1 = from birth to before starting school. Time 2 = throughout primary and secondary schooling. Time 3 = from the end of high school to now. Home = people at home. Others = others in the community. Media = the media (include TV, videos, music, internet, etc.).

** Significant at $p = .01$.

* Significant at $p = .05$.

Table 5. Correlations between covariates and other variables

	Spanish HL group			Mandarin HL group		
	Parental proficiency	Parental attitude	SES	Parental proficiency	Parental attitude	SES
Letter fluency	.39**	.06	.21	.11	-.13	.08
Semantic fluency	.18	-.05	.07	.01	-.12	.08
English picture naming	.48**	.12	.32**	.12	-.06	.25*
HL picture naming	-.60**	-.47**	-.42**	-.26*	-.33**	.10
Cumulative exposure to HL during Time 1, from:						
1. People at home	-.54**	-.50**	-.38**	-.51**	-.39**	-.07
2. Others in the community	-.33**	-.39**	-.29**	-.08	-.03	-.02
3. The media	-.39**	-.31**	-.38**	-.05	-.11	-.11

Table 5. (continued)

	Spanish HL group		Mandarin HL group			
	Parental proficiency	Parental attitude	SES	Parental proficiency	Parental attitude	SES
Cumulative exposure to HL during Time 2, from:						
1. People at home	-.48**	-.49**	-.32**	-.47**	-.38**	-.07
2. Others in the community	-.39**	-.34**	-.24*	-.14	-.04	-.07
3. The media	-.43**	-.29**	-.40**	-.07	-.10	-.10
Cumulative exposure to HL during Time 3, from:						
1. People at home	-.47**	-.47**	-.29**	-.46**	-.36**	-.08
2. Others in the community	-.38**	-.35**	-.20	-.14	-.03	-.08
3. The media	-.42**	-.28*	-.39**	-.07	-.10	-.10
Parental spoken English proficiency ^{a, b}		.20	.62**		.10	.46**
Parental attitude to language use ^{b, c}			.16			.02

Note. HL = heritage language. SES = socioeconomic status. Time 1 = from birth to before starting school. Time 2 = throughout primary and secondary schooling. Time 3 = from the end of high school to now.

a. 1 = Not at all, 2 = Very poor, 3 = Poor, 4 = Functional, 5 = Good, 6 = Very good, 7 = Native-like.

b. Responses were averaged across two parents/caregivers, except where only one parent/caregiver was indicated.

c. 1 = Very strongly encouraged me to avoid speaking English, 2 = Often encouraged me to avoid speaking English, 3 = Sometimes encouraged me to avoid speaking English, 4 = Allowed me to speak in whichever language I preferred, 5 = Preferred that I speak English.

** Significant at $p = .01$.

* Significant at $p = .05$.

3.1 Spanish HL group

During early childhood (see Table 4 “Time 1” predictors), greater cumulative exposure to HL Spanish from people at home significantly predicted fewer number of words produced for English letter fluency, fewer pictures named for English picture naming, and more pictures named for HL picture naming (see Figure 1). These effects remained when controlling for parental attitude to language use ($p = .002$ for letter fluency, $p = .001$ for English picture naming, $p < .001$ for HL picture naming) and when controlling for SES ($p = .007$, $p = .006$, $p < .001$, respectively). When controlling for parental English proficiency, the effect also remained for HL picture naming ($p < .001$), but became marginal for letter fluency and English picture naming ($p = .085$ and $p = .087$ respectively). During the early childhood

period, a greater amount of exposure to HL from the media significantly predicted higher HL picture naming score.

During the schooling years (see Table 4 “Time 2” predictors), greater cumulative exposure to HL from people at home predicted greater number of pictures named for English picture naming and for HL picture naming. The effect for HL picture naming remained when controlling for parental English proficiency, for parental attitude to language use, or for SES (p 's < .001). For English picture naming, the effect remained when controlling for parental attitude to language use ($p = .032$), but became nonsignificant or weakly marginal when controlling for parental English proficiency or for SES ($p = .402$ and $p = .099$ respectively). Like for the early childhood period, greater HL exposure from the media during this period also predicted higher HL picture naming score.

For the third time period (from the end of high school to now; see Table 4 “Time 3” predictors), greater cumulative exposure to HL from people at home predicted lower English letter fluency, lower English picture naming, and higher HL picture naming scores. The effect for HL picture naming remained when controlling for parental English proficiency, for parental attitude to language use, or for SES (p 's < .001). For English picture naming and letter fluency, the effects remained when controlling for parental attitude to language use ($p = .033$ and $p = .028$ respectively), but became nonsignificant when controlling for parental English proficiency ($p = .344$ and $p = .280$ respectively), and became marginal when controlling for SES ($p = .074$ and $p = .068$ respectively). Greater exposure to HL from the media during this period also predicted higher HL picture naming score.

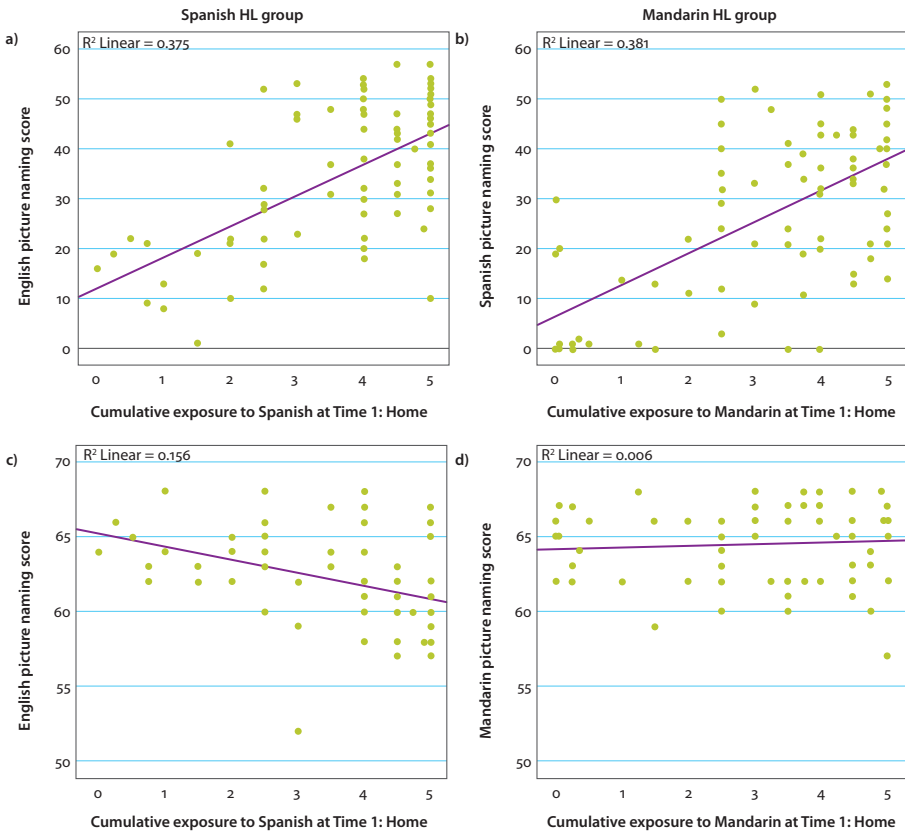


Figure 1. Correlations between cumulative exposure to heritage language (HL) during the period from birth to before starting school (Time 1), from people at home (Home), with HL picture naming scores for Spanish (a) and Mandarin (b) HL groups, and with English picture naming scores for Spanish (c) and Mandarin (d) HL groups

3.2 Mandarin HL group

For the Mandarin group, only HL picture naming was significantly predicted by any of the exposure variables, and only by exposure from people at home (see Table 4). Specifically, greater cumulative exposure to HL from people at home during all three time periods predicted higher HL picture naming scores (see Figure 1). These effects all remained when controlling for parental English proficiency (p 's < .001), for parental attitude (p 's < .001), or for SES (p 's < .001).

4. Discussion

The present study investigated the influences of cumulative HL exposure during three time periods, and from three different sources in each time period, on heritage and majority language performance among young adult second-generation immigrants. Greater cumulative exposure to HL from people at home during all three time periods (i.e., from birth to before starting school, throughout primary and secondary schooling, and from end of high school onwards) predicted higher HL picture naming scores for both the Spanish and Mandarin HL groups. These effects remained when controlling for differences in parental English proficiency, for parental attitude to language use, or for SES. For effects on English performance, the two groups showed different results. For the Spanish group, greater cumulative exposure to HL at home during the first (early childhood) and third (end of high school onwards) time periods predicted lower scores in both English verbal fluency (letter fluency) and picture naming, and exposure during the second time period (throughout primary and secondary schooling) predicted lower English picture naming. These effects all remained after controlling for differences in parental attitude, but became marginal or nonsignificant when controlling for parental English proficiency (i.e., those who had parents with higher English proficiency were less affected by amount of HL exposure). When controlling for SES, the effects for the first time period remained, whereas the effects for the two later time periods between marginal (i.e., those with higher SES were less affected by language exposure amounts). For the Mandarin group, on the other hand, none of the exposure variables predicted any of the English language measures.

While it may be difficult to raise balanced bilinguals among second-generation immigrants (e.g., Alba et al., 2002; Benmamoun et al., 2013; Cho et al., 2004; De Houwer, 2007; Montrul, 2008; Nesteruk, 2010; Polinsky, 2006; Polinsky & Kagan, 2007; Rothman & Treffers-Daller, 2014), the present results show that parents' efforts in speaking to their children more in HL throughout childhood, adolescence, and early adulthood do have significant effects in improving end-state HL skills. Furthermore, not all second-generation immigrants show weak lexical performance in HL. Among the present participant groups, a number of individuals were able to name a substantial number of pictures in HL. Specifically, just under half (35) of the Spanish group and one quarter (20) of the Mandarin group named over 60% of items in the task in their respective HLs, and two from the Spanish group named over 80% of items (which is higher than the lowest score observed for English picture naming).

For majority language performance, only one of the two HL groups showed that English picture naming scores varied as functions of cumulative exposure amounts, and, despite that, both groups attain English proficiency levels that are

close to monolingual speakers (at least by the time they reach young adulthood), which can be seen in both the self-ratings (but see Tomoschuk et al., in press) and English picture naming scores, both of which are near ceiling (see Tables 1 and 3). Furthermore, the effects on English performance was modulated by parental English proficiency, where effects of cumulative language exposure on both letter fluency and English picture naming was substantially reduced when controlling for differences in parental English proficiency ratings. This is in line with previous studies showing that input quality (e.g., parental language proficiency) can modulate the effects of input quantity, and that input quality may have a greater impact on language development over input quantity (e.g., Chondrogianni & Marinis, 2011; Hoff et al., 2014; Paradis, 2011).

In regard to HL exposure from sources other than people at home, higher cumulative exposure to HL from various forms of media during all three time periods predicted higher HL picture naming scores. However, this was found only for the Spanish HL group, and not for the Mandarin group. Nevertheless, relative amount of language exposure from various audio and/or visual media appear to have some influence on HL skills, corroborating previous findings that the richness of the language environment, including games, television, and books, impacts language development (Paradis, 2011). Relative amount of language exposure from people in the community did not significantly predict any of the outcome variables measured. Although a “number-of-speakers effect” has been observed in HL abilities in previous research (Gollan et al., 2015), it may be that the number of speakers in the home environment exerts the most influence, with those outside the home having less impact. There are also relevant methodological differences between the present study and that of Gollan et al. (2015). Firstly, the present study restricted the participant sample to those who were “born in the USA or had arrived at or before age 1”, while Gollan et al. (2015) recruited bilingual samples without such a restriction. Consequently, there are a number of differences in participant characteristics across the two studies, including younger age of learning/acquisition of English, higher English and lower HL proficiencies, and lower percentage of daily use of HL in the present samples than in those of Gollan et al. (2015). Secondly, the questionnaire in the present study did not explicitly ask participants to indicate the number of different speakers, but instead focused on proportion of language exposure from the different categories. In Gollan et al. (2015), on the other hand, participants were asked “how many different people did you regularly speak to only (or mostly) in HL”. These methodological differences likely contributed to the difference in findings as well.

It appears that parental input, although facilitatory, is typically not sufficient by itself for ongoing maintenance of HLs. Broader, societal support may be necessary for successful development and maintenance of HLs beyond the first generation

of immigration, with many suggesting that support for HL learning in mainstream schools is crucial (Gathercole & Thomas, 2009; Nesteruk, 2010; Park & Sarkar, 2007; Pearson, 2007; Rothman, 2007; Sheng, Lu, & Kan, 2011; Sorace, 2004; Zhang & Slaughter-Defoe, 2009). Recent research has, indeed, demonstrated the role of HL exposure via formal educational settings in developing and maintaining HL skills, with HL education and literacy significantly improving aspects of HL grammar performance among adolescents (Bayram et al., 2017) and adults (Kupisch & Rothman, 2016). In particular, those who received their elementary education in HL performed similarly to monolingual norms, while those who attended school in the majority language differed (Kupisch & Rothman, 2016). However, it may not always be practicable for HL speakers to attend full-time HL schools. In the present study, all participants received their primary, secondary, and ongoing tertiary education in the majority language English. Although both groups indicated some years of study in HL (see Table 1), their HL study were all via weekend language schools or foreign language classes as part of the mainstream school curriculum, both of which have limited learning time (e.g., a few hours per week), and may not provide sufficient support for HL maintenance.

The two language groups in the present study showed a different pattern of results, both in the effects of language exposure and in the task performances themselves. For example, the Mandarin group scored better on tasks assessing English skills (including both letter and category verbal fluency, and picture naming), while scoring significantly worse in HL picture naming compared to the Spanish group (see Table 3). This pattern is also supported by the self-ratings of language proficiency and usage (see Table 1), and is observed despite the Mandarin group showing greater years of study in HL over the Spanish group (6.4 years ranging from 0–19 years vs. 3.0 years ranging from 0–11 years). Nevertheless, this pattern is in line with the notion of trade-offs between heritage and majority language skills (Gollan et al., 2015; Tao & Cai, 2018; Tao & Taft, 2017).

Moreover, the differences between the two groups suggest that there are influences of background variables or group characteristics other than amount of exposure to HL. Firstly, the Mandarin group in the present study had less access to their HL from the environment compared to the Spanish group (namely in Southern California along the border with Mexico), leading to lower maintenance of their HL. Second, Spanish is a typologically closer language to English than is Mandarin (Chiswick & Miller, 2004). Proficiency in a second language has been found to decrease as linguistic distance between the first and second languages increased (Chiswick & Miller, 2004; Isphording & Otten, 2011). Further, switching and mixing between two closer languages may be easier than between more distant languages (Cenoz, 2001; Ortega, 2008), leading to greater daily use of both languages. Third, between-group differences in SES (see Table 1) may also explain

some of the differences observed. Indeed, the effects of exposure on majority language abilities for the Spanish group were reduced (as abovementioned) when controlling for SES, while for the Mandarin group (who had higher SES on the whole) did not show effects of exposure amounts on English performance. Lastly, there are likely to be differences in cultural and parental influences on performance habits and educational practices between the two groups. For example, emphasis on academic achievement is among the highest in the Chinese culture, with parents often having elevated expectations of their children, even among immigrants to Western societies (Byun & Park, 2012; Zhang & Carrasquillo, 1995). These influences impact academic performance (Feniger & Lefstein, 2014; Zhang & Carrasquillo, 1995), and may play a role in the better English task performance of the Mandarin group over the Spanish group. Taken together, these factors may exert greater influence on HL and English skills than relative language exposure amounts.

One limitation with the current study is that language exposure factors were examined using retrospective self-report, which can be unreliable (Tomoschuk et al., in press). Future research could explore longitudinal designs and observational methods (e.g., home visits) for investigating the effects of earlier language exposure on later language outcomes. In the present study, to help gain greater accuracy, participants were provided with more specific time boundaries (e.g., “from birth to birth to before starting school”), rather than simply “childhood”, “adolescence”, or “adulthood”. Future research could also examine influences of other, nonlinguistic, factors on heritage and majority language skills, for example external cultural factors, which may, as abovementioned, impact language and educational practices and attainment (Feniger & Lefstein, 2014; Zhang & Carrasquillo, 1995), and internal cognitive factors such as attention and memory processes, which may play a role in language acquisition and development (Ellis, 2008; Gathercole, 2007; Tomasello, 2003).

Overall, the present findings support the role of parental input throughout childhood, adolescence, and early adulthood in improving HL skills for second-generation immigrants, with less noticeable consequences for the majority language. Further, effects of parental input on majority language performance may be substantially modulated by the parents’ proficiency in that language. Input from other sources appears to have less impact, with exposure via various forms of media having some influence, and exposure via other people in the community not showing significant influences on the present set of measures examined.

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