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Processing of Spanish-English Code-Switches by Late Bilinguals

Rosa E. Guzzardo Tamargo and Paola E. Dussias

1. Introduction

The role of age of acquisition on ultimate linguistic attainment has been the object of much research on first (L1) and second (L2) language acquisition. Work on L1 acquisition (e.g., Curtiss, 1977; Lenneberg, 1967; Penfield & Roberts, 1959) has led to the proposal of the Critical Period Hypothesis, which states that there is a particular period of time early in life when the brain displays a superior predisposition to attend to certain experiences in the environment and learn from them. Language is considered one of these experiences. In other words, the brain can be easily influenced by those experiences, but only if they take place within a biologically specified time period (Ortega, 2009).

Researchers in the L2 acquisition tradition have also focused on age effects, investigating whether adults can attain native-like competency in a second language (e.g., Hyltenstam & Abrahamsson, 2000; Birdsong, 2005; Long, 2005; Marinova-Todd, 2004; Singleton & Ryan, 2004). Some studies have reported important differences between native speakers and second language learners (e.g., Johnson, 1992; Johnson & Newport, 1989; Oyama, 1976; Patkowski, 1980, 1994) in favor of the notion of a fundamental difference between the mechanisms that subserve L1 and L2 acquisition. The idea of a fundamental difference between first and second language acquirers has also been recently proposed in the domain of language processing to explain purported qualitative differences between the performance of native and second language speakers (e.g., Clahsen & Felser, 2006).

There is, however, some recent evidence arguing against a fundamental difference hypothesis between L1 and L2 speakers, at least in its strongest

* Rosa E. Guzzardo Tamargo, Universidad de Puerto Rico, rosa.guzzardo@upr.edu. Paola E. Dussias, The Pennsylvania State University, pdussias@psu.edu. We thank the members of The Center for Language Science at Penn State for their helpful suggestions and comments on the issues raised here. This research was supported by NSF Dissertation Award BCS-1123874 to Rosa E. Guzzardo Tamargo, NSF Grant BCS-0821924 to Paola E. Dussias and Chip Gerfen, NSF Grant BCS-0955090 to Judith F. Kroll, Janet van Hell, and Paola E. Dussias, NSF PIRE Grant (OISE-0968369) to Judith F. Kroll, Janet van Hell, Paola E. Dussias, and Ping Li, and NIH Grant 1 R21 HD071758-01A1 to Paola E. Dussias.

version. A number of acquisition studies have shown that some adult L2 learners achieve levels of L2 proficiency that make them indistinguishable from native speakers (Bongaerts, 1999; Bongaerts, Mennen, & van der Slik, 2000; Bongaerts, van Summeren, Planken, & Schils, 1997; Ioup, Boustagui, El Tigi, & Moselle, 1994; van Boxtel, 2005; White & Genesee, 1996). Similarly, recent processing studies provide evidence that L2 learners can demonstrate behaviors during L2 processing that are qualitatively similar to those of native speakers (e.g., Gillon Dowens, Vergara, Barber, & Carreiras, 2010).

Although the effect of age of onset of acquisition has been extensively studied in terms of ultimate attainment in the L2, to our knowledge research has not examined this question with respect to attainment of native-like code-switching performance. Code-switching refers to the smooth alternation between two (or more) languages. This phenomenon is more frequently studied in early bilinguals, that is, speakers who acquire both languages from birth or early childhood. However, early bilinguals are not the only individuals who code-switch. Speakers who acquire one of their two languages during adulthood can also engage in code-switching, although the available evidence suggests that they do not always engage in the same type of code-switching behavior as do early bilinguals. Poplack (1980) studied the oral code-switching practices of Puerto Rican speakers of varying degrees of bilingual ability who lived in a stable Puerto Rican bilingual community in East Harlem, New York. She found that, while the early bilinguals produced more complex intrasentential switches, Spanish speakers who were less proficient in their second language (English) produced more emblematic switches (e.g., interjections, fillers, tags, idiomatic expressions). Poplack interpreted these results as support for the use of code-switching practices as an indicator of bilingual ability. These findings could, in turn, suggest that code-switching patterns can differ depending on the age at which speakers begin to acquire their L2, and hence, their code-switching behavior.

In a recent study (Guzzardo Tamargo & Dussias, 2013), we investigated the existence of processing costs in Spanish-English code-switches by a group of early bilinguals. Two types of intrasentential code-switches were examined: a switch between the Spanish progressive auxiliary *estar* 'be' and an English present participle versus a switch between the Spanish perfect auxiliary *haber* 'have' and an English past participle. Despite their superficial similarities, *estar*+English participle switches are more frequent in natural bilingual production than *haber*+English participle switches (Guzzardo Tamargo, 2012). The early bilinguals participated in an eye-tracking study in which they read code-switched sentences and answered comprehension questions. The results showed that the more frequent *estar*+English participle switches were processed more easily (as measured by fixation durations) than the *haber*+English participle switches, reflecting the tendencies found in natural production. The results were taken as support for experienced-based models of sentence processing that attribute a key role to frequency of previous exposure in

modulating processing ease (e.g., Gennari & MacDonald, 2009; MacDonald & Thornton, 2009).

2. Purpose of the present study

In the present study, we test Spanish-English late bilinguals to determine if their processing patterns differ from those of the early bilinguals in our previous study. Findings showing performance differences could provide evidence for a critical period in the acquisition and processing of code-switched language.

3. Method

3. 1. Participants

Eighteen participants took part in this study. They were Spanish native speakers who were born in Spanish-speaking countries and who spoke Spanish from birth. Participants reported the onset of L2 learning to start after age 13 (in a classroom setting) and their mean age of arrival in the United States (US) to be 18 years. For comparison purposes, Table 1 displays the characteristics for the group of speakers in this study, as well as those of the early bilinguals in our previous study (Guzzardo Tamargo & Dussias, 2013).

Table 1. Mean participant characteristics of early and late bilinguals

Participant characteristics	Early bilinguals n = 18	Late bilinguals n = 18	Differences between groups
Age	21	22	$p = .500$
Age of arrival in US	2	18	$p < .001$
Years spent in US	19	4	$p < .001$

Both the early bilinguals from our previous study and the late bilinguals from the present study were undergraduate or graduate students at a large US institution. As shown in Table 1, there were no significant differences between groups with respect to mean age at time of testing. However, there were significant differences between groups in age of arrival in the US and, consequently, in the amount of years spent in the country.

Participants were administered three tasks to assess language proficiency and use in both languages. First, in a Language History Questionnaire (LHQ), participants provided self-ratings of their English and Spanish proficiency across reading and writing production as well as speaking and listening comprehension. They also answered questions about their history with both languages, their language learning experiences, their daily experience with both languages, and their code-switching practices. Crucially, responses to the LHQ revealed that the late bilinguals reported regular use of and exposure to both languages in oral and written modes. Moreover, they reported frequent code-switching, mostly with bilingual family members and friends. Participants also completed a vocabulary test as a measure of lexical access, vocabulary size, and naming performance.

For this test, they were asked to name 60 outline drawings (first, 30 in Spanish and, then, 30 in English) as quickly and as accurately as possible. In addition, participants were administered two standardized 50-item grammar tests (one in each language) to evaluate grammar, vocabulary, and reading competence in isolated sentences and longer stretches of discourse.

Table 2 shows the mean ratings and scores for both groups of bilinguals on the proficiency measures. From Table 2, it is evident that the late bilinguals were proficient in both Spanish and English. When comparing the scores of the late bilinguals with those of the early bilinguals, the late bilinguals seem to be slightly more balanced in terms of language proficiency, at least with respect to the measures used here.

Table 2. Mean participant ratings and scores of early and late bilinguals

Participant ratings and scores	Early bilinguals n = 18	Late bilinguals n = 18	Differences between groups
English self-ratings	9.4	8.5	$p = .004$
Spanish self-ratings	8.1	9.4	$p = .001$
English vocabulary test	21	17	$p = .003$
Spanish vocabulary test	12	21	$p < .001$
English grammar test	45	41	$p = .013$
Spanish grammar test	33	42	$p < .001$

3.2. Materials and design

The materials used in this study were the same as those used in our previous study with the early bilinguals (Guzzardo Tamargo & Dussias, 2013). The experimental stimuli comprised 32 item sets, each consisting of four experimental sentences representing four conditions (see Table 3). Condition 1 and 2 were code-switched conditions with the progressive structure. In Condition 1, the switch occurred at a phrasal boundary, that is, right at the progressive auxiliary. Condition 2 contained a switch within the auxiliary phrase (between the Spanish auxiliary *estar* and the English present participle). Conditions 3 and 4 were analogous to Conditions 1 and 2, but involved the perfect structure instead. Conditions 2 and 4 are the crucial conditions under examination in this study because, as mentioned in section 1, the former is more frequent in naturalistic corpus data than the latter. However, because of lexical differences between the two conditions, it was not possible to compare them directly. Instead, each condition was compared to its own baseline condition (Conditions 1 and 3, respectively). These conditions included switches at a phrasal boundary (in this case, between a subject and a predicate), a very frequent Spanish-English switch site (Guzzardo Tamargo, 2012). Because the only difference between the experimental conditions and their corresponding baseline conditions is the language of the auxiliary, any processing differences found between the two are likely to be due to the code-switch type.

The 32 item sets were divided into four reading files, each of which included 32 experimental code-switched sentences (eight sentences for each condition). Participants were never exposed to the same sentence in more than one condition. In addition to the experimental sentences, 32 code-switched sentences were added as fillers. Both the experimental sentences and the filler sentences were controlled as much as possible for lexical frequency and length to ensure that extraneous factors were not responsible for the pattern of results. In addition, the sentences within each of the four reading files were pseudo-randomly interleaved to avoid order effects.

Table 3. Example of experimental item set

Condition	Sample sentence
1. Progressive structure-Switch at auxiliary	*El director confirmó que los actores* are rehearsing their lines for the movie.
2. Progressive structure-Switch at participle	*El director confirmó que los actores están* rehearsing their lines for the movie.
3. Perfect structure-Switch at auxiliary	*El director confirmó que los actores* have rehearsed their lines for the movie.
4. Perfect structure-Switch at participle	*El director confirmó que los actores han* rehearsed their lines for the movie.
'The director confirmed that the actors are rehearsing / have rehearsed their lines for the movie.'	

3.3. Procedure

Data was collected with an SR Research EyeLink 1000. A chin rest was used to provide head support and restrain head movement. Sentences were displayed on a computer screen. After each sentence, participants answered a comprehension question by pressing a "yes" button or a "no" button on a game pad. After the experiment proper, participants completed the LHQ, the vocabulary tests, and the standardized grammar tests. The experiment lasted approximately one hour and 30 minutes and participants received $15 for their participation.

4. Results

The critical region for which reading measures were extracted was the participle (the present participle in the case of the progressive structure and the past participle in the case of the perfect structure) in the experimental sentences (underlined in Table 3). The participle was selected as the critical region because it constitutes the point in the sentence where the participants have processed the complete auxiliary phrase. It is also the point where all code-switches, both the code-switches at the auxiliary and the code-switches at the participle, have occurred. Three eye-tracking measures were extracted for analysis: gaze duration, regression path time, and total time. Gaze duration

refers to the sum of all fixation durations in the critical region (i.e., the participle) from first entering it until leaving it. Regression path time is the sum of all fixation durations in the critical region from first entering it until leaving it to proceed further in the sentence by moving beyond the critical region. This reading measure includes any leftward movements to words that precede the critical region. Total time represents the sum of all fixation durations in the critical region, including all regressive fixation durations to it. These three eye-tracking measures were chosen because they reflect both early and late comprehension processes (Clifton, Staub, & Rayner, 2007; Rayner, 1998; Rayner, Sereno, Morris, Schmauder, & Clifton, 1989).

In addition to the reading measures, accuracy data in the comprehension task was also extracted. Table 4 shows the late bilinguals' proportions of correct responses to the comprehension questions for each experimental condition. The results show that, overall, the late bilinguals answered most comprehension questions correctly, which demonstrates that they paid attention to the task and that they understood the content of the code-switched sentences.

Table 4. Percent of correct responses to the comprehension questions by experimental condition

Condition	Percent of correct responses
1. Progressive structure- Switch at auxiliary	88.19%
2. Progressive structure- Switch at participle	87.50%
3. Perfect structure- Switch at auxiliary	90.28%
4. Perfect structure- Switch at participle	89.58%

Figure 1 exhibits the mean gaze duration, regression path time, and total time by condition for the late bilinguals. A two-way repeated measures analysis of variance (ANOVA) was conducted to evaluate the effect of auxiliary type and switch site on the three extracted reading measures. Auxiliary type (progressive versus perfect) and switch site (switch at the auxiliary versus switch at the participle) were the within-subjects factors.

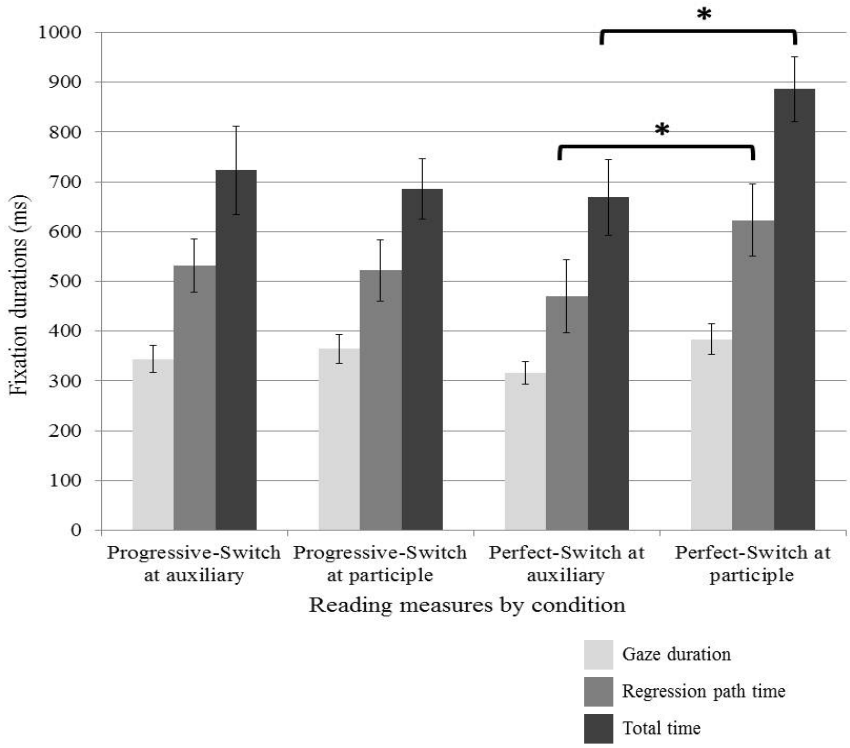

Figure 1. Mean gaze duration, regression path time, and total time by condition

For gaze duration, the results indicated no main effect of auxiliary type, $F(1, 17) = .24$, $p = .877$, no main effect of switch site, $F(1, 17) = .24$, $p = .628$, and no by-participant interaction of auxiliary type and switch site, $F(1, 17) = 1.30$, $p = .270$. Therefore, the late bilinguals displayed no significant participle reading time differences among any of the four experimental conditions. The regression path time results did not display a main effect of auxiliary type, $F(1, 17) = .24$, $p = .628$, but showed a main effect of switch site, $F(1, 17) = 11.80$, $p = .003$. There was also a significant by-participant interaction of auxiliary type and switch site, $F(1, 17) = 4.78$, $p = .043$. Subsequent pairwise contrasts indicated significant mean differences between Conditions 3 and 4, $t(17) = 4.44$, $p < .001$, but not between Conditions 1 and 2, $t(17) = 1.85$, $p = .855$. For this reading measure, the late bilinguals read perfect structures in which the switch occurred at the auxiliary significantly more quickly than the perfect structures in which the switch occurred at the participle. They did not, however, read the two types of switches involving the progressive structure at significantly different reading speeds. Finally, for total time, the results of the ANOVA indicated no main effect of auxiliary type, $F(1, 17) = 2.49$, $p = .133$, and no main effect of switch

site, $F(1, 17) = 3.63$, $p = .074$. Nonetheless, there was a significant by-participant interaction of auxiliary type and switch site, $F(1, 17) = 9.29$, $p = .007$. Follow-up paired-samples *t* tests revealed significant mean differences between Conditions 3 and 4, $t(17) = 4.02$, $p = .001$, but not between Conditions 1 and 2, $t(17) = .52$, $p = .607$. In other words, in sentences with the perfect structure, late bilinguals read the participles significantly more slowly when the switch occurred at the participle than when it occurred at the auxiliary. However, they read the participles at a similar speed in both types of experimental sentences with the progressive structure.

When compared to the early bilinguals' results from our previous study, both participant groups behaved similarly when processing the code-switched sentences. Figure 2 presents the early and late bilinguals' results for ease of comparison. The early bilinguals' results showed significant by-participant interactions of auxiliary type and switch site for all three reading measures: gaze duration, regression path time, and total time. In all instances, the follow-up paired-samples *t* tests revealed significant mean differences between Conditions 3 and 4, but not between Conditions 1 and 2. Therefore, the early bilinguals also read the past participles more slowly when they appeared in sentences with a switch at the participle, than when they appeared in sentences where the switch occurred at the perfect auxiliary.

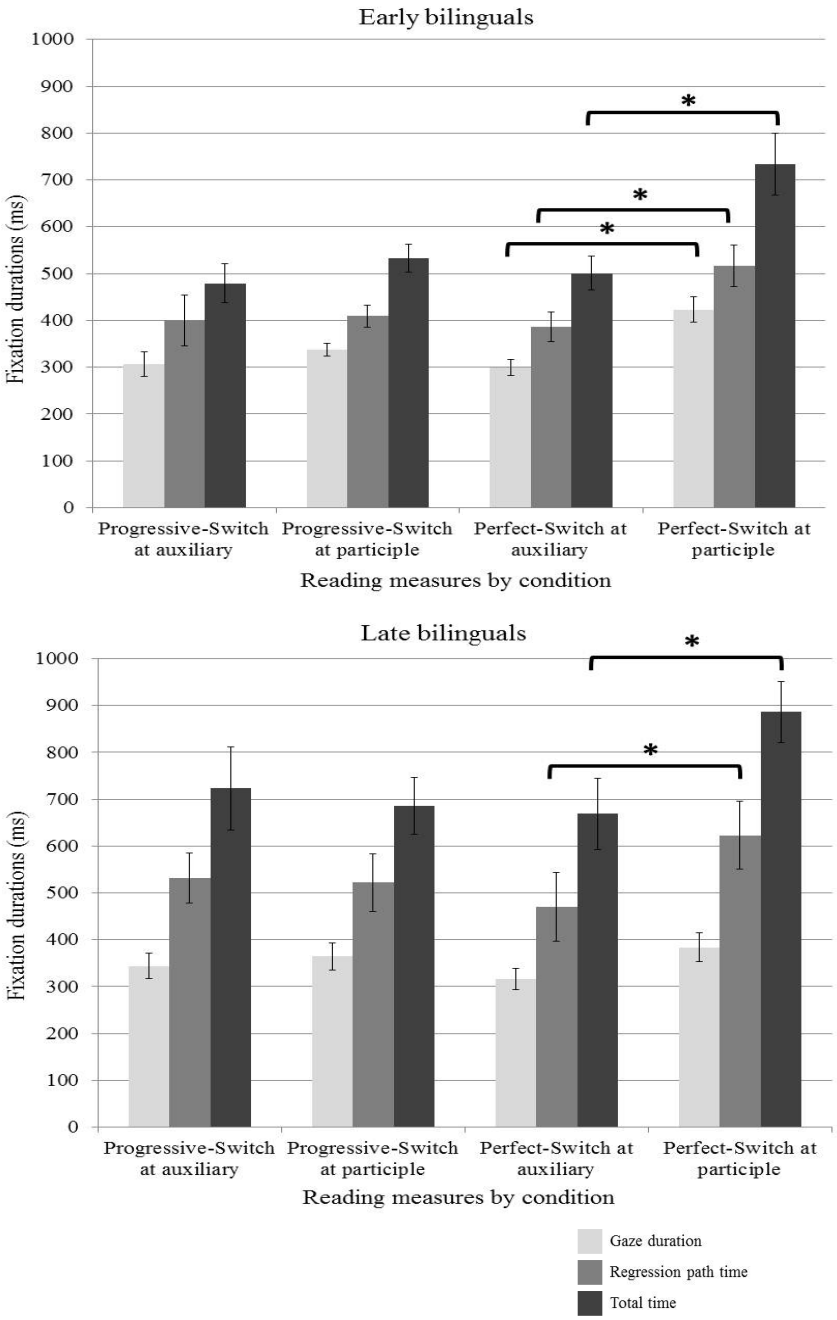

Figure 2. Mean gaze duration, regression path time, and total time by condition and participant group

5. Discussion

In our previous study (Guzzardo Tamargo & Dussias, 2013), we found that more frequently produced types of Spanish-English code-switches (i.e., *estar*+English participle switches) were easier to process by a group of early bilinguals than less frequent types of code-switches (i.e., *haber*+English participle switches). These findings displayed a clear correspondence between code-switching production patterns and comprehension difficulty. The purpose of the present study was to examine if a group of late bilinguals from the same community followed similar comprehension patterns as they completed the same task with the same materials. The results showed very similar processing patterns between both bilingual groups.

Overall, the late bilinguals' fixation durations were longer than those of the early bilinguals (see Figure 2), indicating that the code-switched sentences may have been slightly easier for the early bilinguals to process. However, the crucial finding here is that the comprehension patterns displayed by both groups were essentially the same. Both early and late bilinguals exhibited no significant reading time differences between Conditions 1 and 2. This means that sentences with a switch at the progressive auxiliary (i.e., *los actores* are rehearsing their lines) were processed with the same ease as sentences with a switch at the present participle (i.e., *los actores están* rehearsing their lines). These comprehension patterns are not surprising, given that both switches at the phrasal boundary and switches between the Spanish progressive auxiliary and an English present participle are frequently found in natural production (Guzzardo Tamargo, 2012).

If we turn to the other two conditions, the comprehension costs are different. Here, both early and late bilinguals exhibited significant reading time differences between Conditions 3 and 4. Specifically, it was more costly for participants to process sentences with a switch at the past participle (i.e., *los actores han* rehearsed), compared to sentences with a switch at the perfect auxiliary (i.e., *los actores* have rehearsed). Once again, these reading costs mirror the production patterns that are found in natural bilingual production. In this case, switches at the phrasal boundary are commonly found in naturalistic data while switches between the perfect auxiliary and the past participle are practically nonexistent (Guzzardo Tamargo, 2012). Although the early bilinguals displayed significantly different reading times in all three reading measures, the late bilinguals in the present study displayed them in two of the reading measures. What's important, though, is that both groups exhibited similar processing patterns both in measures of early and later processing.

Given the similarities in the processing patterns for the early and late bilingual groups, the results presented here do not support proposals claiming a fundamental difference between processing by native speakers and processing by adult L2 learners (e.g., Clahsen & Felser, 2006). The late bilinguals in this study acquired their second language past adolescence. With it came the acquisition of code-switching practices in the community. Despite their late

acquisition, these bilinguals still processed code-switched sentences similarly to early bilinguals. A factor that seems to have played a central role in the participants' behavior has to do with their previous linguistic experience, that is, the frequency with which they encountered these code-switches in their daily lives. Even though the late bilinguals were exposed to code-switching later in life, once they arrived in the United States, they received enough input displaying the distributional patterns of the two code-switched structures examined here in order to process them with a sensitivity that is comparable to that of early bilinguals. These results are congenial with experienced-based approaches to second language acquisition (Ellis, 2002, 2006; Goldberg & Casenhiser, 2008; MacWhinney, 1987) as well as constraint-satisfaction models of language processing (Gennari & MacDonald, 2009; MacDonald & Thornton, 2009), in which previous exposure to language plays a more important role than age of acquisition when it comes to monolingual or bilingual linguistic attainment.

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