

The Role of Study Abroad and Inhibitory Control on Processing Redundant Cues

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1. Introduction

When adult second language (L2) learners are faced with redundant cues in the L2, there is mounting evidence that native speakers of English, a language with poor verbal morphology, prefer lexical cues (adverbs) to morphological cues (verbs) when assigning temporal reference in a morphologically rich language, such as Spanish or Italian (e.g., Bardovi-Harlig, 1992; Cadierno, Glass, Lee, & VanPatten, 1991; Lee, 1999, 2002; Lee, Cadierno, Glass, & VanPatten, 1997; Leeser, 2004; Musumeci, 1989; Rossomondo, 2003; Sagarra, 2007; VanPatten, 1996, 2004). In contrast, native speakers of morphologically richer languages, such as Spanish, use morphological cues instead of lexical cues to assign temporal reference (Ellis & Sagarra, 2010; Sagarra, 2007).

This preference can be difficult to overcome for adult learners, especially if they are exposed to an overuse of lexical cues in the classroom. It is well documented that one of the differences between classroom and naturalistic input consists of the overrepresentation of some linguistic features in the classroom and an underrepresentation of other linguistic features (Santilli, 1996; Sanz, 1999; Schinke-Llano, 1986; VanPatten & Sanz, 1995). As learners are overexposed to lexical cues in the classroom and show a preference for them over morphological ones (Ellis & Sagarra, 2010), it is valuable to consider whether classroom learners exposed to naturalistic input through an immersion experience can overcome these challenges and come to rely more on morphological cues to assign temporal reference, just as native speakers of Spanish do.

2. Review of Literature

2.1. Redundant Cues

At early stages of acquisition for both L1 and L2 learners, the tendency is to focus on only one cue at a time and to choose cues based on their availability rather than their reliability (acquisition of artificial languages: Blackwell, 1995; MacWhinney & Bates, 1989; Matessa & Anderson, 2000; McDonald & MacWhinney, 1991; L1 acquisition: MacWhinney, Pléh, & Bates, 1985; L2 acquisition: VanPatten, 1996; 2004; Lee, 1999, 2002; Lee, Cadierno, Glass, & VanPatten, 1997). As most cues appear paired with other cues, learners need to determine which cues are most predictive for each circumstance. However, as language proficiency increases, so does the number of cues that will be attended to and processed, following selective attention preferences (Ellis, 2006a, b).

Verbal morphology that is accompanied by a temporal expression is redundant and of low reliability because both the adverb and the morphology encode the same concept of time. Moreover, verbal morphology tends to encode much more information than just pastness (e.g., person, mood, tense, and aspect), whereas temporal expressions only provide information about when an action occurs. These characteristics decrease the chances that learners pay attention to the morphological cues of verbs.

In an eyetracking study, Ellis & Sagarra (2010) examined the cues that monolingual Spanish speakers and beginning and intermediate level L2 Spanish learners use when processing redundant morphological and lexical items (i.e., verb and temporal adverb), and report that native Spanish

* I am grateful to Nuria Sagarra and to two anonymous reviewers for their helpful comments and insights. I would also like to thank my participants.

speakers rely more on morphological than lexical cues, whereas the opposite applies to intermediate English-Spanish learners. Beginning learners are not sensitive to this adverb-verb incongruency.

Based on the aforementioned evidence suggesting that both the L1 and L2 play a role in the processing of morphological and lexical cues (Ellis & Sagarra, 2010), and that the classroom environment generally provides an overuse or underuse of lexical cues to L2 learners (Dracos, 2010; Goodall, 2010), it is important to examine whether a study abroad experience can alter the cues that L2 learners use when processing redundant morphological and lexical cues. Usage-based theories of language acquisition (Tomasello, 2003) state that linguistic competence emerges from all of a learner's previous experience with the utterances that he/she has heard in his/her entire lifetime of using the language, and that repeated usage causes structures and forms to be learned. That is, exposure to the (L2) input affects how the language is learned and used. The following section examines how exposure to naturalistic input in a study abroad setting affects L2 learning and development.

2.2. *Study Abroad*

Most adults begin the task of learning the L2 in a classroom context, and only later decide whether or not to study abroad and immerse themselves in the L2 environment. A study abroad or immersion experience is defined as a period of time immersed in the target speech community. Research investigating the effects of study abroad on Spanish SLA has produced conflicting results. Some studies indicate that learners who have studied abroad are faster or better at acquiring L2 fluency (García-Amaya, 2009; Segalowitz & Freed, 2004) than those who have not studied abroad. In contrast, study abroad learners perform equally-well or worse than those who did not go abroad on their pronunciation abilities (Díaz-Campos, 2004), on using communicative strategies (DeKeyser, 1991; Lafford, 1995), and on their ability to accurately monitor and use certain grammatical forms (Collentine, 2004; DeKeyser, 1986, 1990, 1991; Torres, 2003; cf. Isabelli & Nishida, 2005). However, these results measuring grammatical abilities were obtained using offline measures, and may not have been sensitive enough to capture the processing changes that occur while abroad.

2.3. *Inhibitory Control*

Inhibitory control is a cognitive individual difference that has been related to the acquisition of L2 grammar in general, and has been defined as the mechanism responsible for determining what will and will not enter into working memory (Rosen & Engle, 1998; Engle, Conway, Tuholski, & Shisler, 1995). It is the ability to maintain and process task pertinent information while suppressing extraneous information. Individual differences in inhibitory control in adult monolinguals have been proposed to explain variation in memory failures, working memory span, reading comprehension, problem solving, and general cognitive ability (Friedman & Miyake, 2004). Bialystok, Martin, & Viswanathan (2005) found that early bilinguals are better able to control their attention when misleading information is presented, even in the face of an incorrect but compelling alternative, and Michael & Gollan (2005) concluded that working memory and suppression (i.e., inhibition) are important factors in L2 processing. Ellis (2007) suggests that the ability to inhibit or block linguistic input may play a role in what gets processed and the final level of L2 attainment. Linck et al. (2009) found that the L1 is inhibited while L2 learners are abroad, and remains so even upon returning from an immersion experience.

3. **The Current Study**

In light of the above findings, the following research questions guided the current study:

1. Do classroom learners from a morphologically poor L1 learning a morphologically rich L2 attend more to morphological cues after a period of study abroad, specifically when the morphological cues compete with lexical cues to assign temporal reference within a sentence?
2. Does inhibitory control modulate study abroad (SA) and non-study abroad (AH) classroom learners' ability to process redundant morphological cues?

3.1. Participants

The sample pool consisted of 60 intermediate learners: 36 classroom learners with immersion or study abroad experience (SA) and 24 without immersion experience (AH). The SA group had been back from their experience abroad for approximately three months at the time of data collection. To be included in the study, participants had to be university students and complete all tasks. In addition, they had to be native speakers of English who began learning Spanish after puberty. Furthermore, the L2 learners could not have knowledge of another foreign language. The participants were seventh or eighth semester Spanish students at a large public university on the east coast of the United States who had had similar L2 learning experiences at the university. In addition to these characteristics, the SA group lived 16 weeks with a monolingual host family in a monolingual community. In summary, the two groups of participants were comparable in terms of type of instruction, proficiency level as operationalized by performance on a discrete-point proficiency exam, and age of acquisition. Participants received a combination of extra credit and \$15 for their participation in the study.

3.2. Materials

The participants completed multiple screening tests (language background questionnaire, L2 proficiency test, and tense and verb recognition tests), one eyetracking task, and one test of cognitive individual differences (Simon test).

3.2.1. Screening Tests

The language background questionnaire evaluated the participants' L2 learning experiences and was administered in the participants' L1 to ensure they fully understood each question.

The second screening test consisted of a Spanish proficiency test similar in format to that from the grammar portion of the Diploma de Español como Lengua Extranjera (DELE), which examines broad, general knowledge of the L2 at the intermediate level. For this task, the participants read a passage written in Spanish and chose from three options the correct answer for 20 items. The participants also gave a self-rating of their L2 proficiency and their ability to read, write, aurally comprehend, and speak the target language on a scale ranging from 1 (minimum ability) to 5 (native-like proficiency). Moreover, the participants reading times (RTs) on N-1 (the word immediately preceding the critical region) was examined to determine L2 processing speed, and their accuracy on the filler comprehension questions was also considered as an objective measure of their L2 proficiency.

The third screening test, the verb recognition test, required the learners to match Spanish verbs in the infinitive with their English translation equivalents (e.g. *hablar* → 'to talk'). The verbs corresponded to those employed in the experimental sentences. Finally, for the tense recognition test, participants matched conjugated Spanish verbs with their English translation equivalents (e.g., *hablé* → 'I talked'). The present and simple past tense Spanish verbs were conjugated for the first person singular, second person singular, and third person singular and plural.

3.2.2. Eyetracking Task

Eyetracking measures the location and time that the eye fixates at a certain point on a computer screen. Rayner, Sereno, Morris, Schmauder, & Clifton (1989) note that reading rates and comprehension levels obtained in the presence of eyetracking are the same as those obtained during natural, silent reading. Another benefit of eyetracking is that it provides richer details about the data and may also allow for subtle differences to be captured (Mitchell, 2004). Furthermore, it provides information about the nature of a problem at a specific point in the sentence and not simply that there was a problem (as indicated by an increased reading time). Diagnosis of a problem area is revealed by different, but commonly recorded, measures, such as first-pass gaze duration or reading time, cumulative (e.g., total) reading time, and percentage of regressions, which, for purposes of the current study, are crucial to determine what cues learners use to resolve adverb-verb tense incongruencies.

The eyetracking data for this experiment were collected in a laboratory setting using an EyeLink 1000 machine designed by SR Research. For the eyetracking task, participants read two-line sentences

in Spanish presented one by one on a computer screen and answered a yes-no comprehension question after each sentence. Each participant randomly received one of four sets of 146 sentences: six practice trials, 40 experimental sentences (10 per condition), and 100 fillers. All sentences were controlled for length (9 to 15 words) and the vocabulary and grammar were adequate for the participants' L2 proficiency level. In order to avoid experimental sentences from appearing next to each other within a set, they were randomized using a Latin square design, which is an experimental design that allows the researcher to control for variation in two directions. Each set contained 10 blocks of four experimental and 10 filler sentences each.

The experimental sentences followed an ADV-NP-V-NP-PP-PP or NP-V-NP-ADV-PP-PP structure and sentences broke onto the next line after the first preposition preceding the NP. Adverbs and verbs did not appear at the end of sentences to avoid wrap-up effects (Just & Carpenter, 1980). Half of the experimental sentences contained adverb-verb tense agreement, and the other half had adverb-verb tense disagreement, as shown in (C1) and (C3) and (C2) and (C4) below, respectively. The complex NP as the subject of the sentence was included so that the participants' perceptual span would not interfere with the results. Also, the location of the temporal adverb varied, and was either the first word of the sentence as in (C1) and (C2), or was placed before the first prepositional phrase as in sentences (C3) and (C4). This structure replicates that from Ellis & Sagarra (2010).

(C1) *Ayer el profesor de economía cocinó el arroz en la cocina para su mujer.*

'Yesterday the professor of economics cooked rice in the kitchen for his wife.'

(C2) **Ayer el profesor de economía cocina el arroz en la cocina para su mujer.*

*'Yesterday the professor of economics cooks the rice in the kitchen for his wife.'

(C3) *El profesor de economía cocinó el arroz ayer en la cocina para su mujer.*

'The professor of economics cooked the rice yesterday in the kitchen for his wife.'

(C4) **El profesor de economía cocina el arroz ayer en la cocina para su mujer.*

*'The professor of economics cooks the rice yesterday in the kitchen for his wife.'

Regardless of the condition, the comprehension question that followed was based on the content of the previously read sentence, and not its grammaticality, so as not to draw the participant's attention to the incongruency. As such, a comprehension question for above sentences would be *¿Era un profesor de economía?* 'Was he a professor of economics?'. Half of the comprehension questions required a yes response, and the other half required a no response. This was also true for the practice sentences.

3.2.3. Inhibitory Control Test

To measure inhibitory control, participants performed the Simon test, which "is a simple means of assessing the degree to which individuals can override a habitual response and replace it with a more intentional choice" (Bialystok et al., 2005). In this task, the participants were asked to ignore the position of a target stimulus in order to respond to its color. The position of the stimulus in some of the trials conflicted with the response key that was required for the correct solution (incongruent), whereas in other trials there was no conflict (congruent). The test consisted of 24 practice trials and three experimental blocks of 42 trials, for a total of 150 trials (126 experimental trials). The trials were presented in random order, and both reaction times and accuracy were recorded. If the participant made an error, the word ERROR appeared in the center of the screen, as a way to encourage accuracy in the test.

3.3. Procedure

Participants completed all tasks in a laboratory in one session that lasted approximately two hours. First, participants filled out the informed consent form and completed the paper-and-pencil language background questionnaire in 10 minutes. After completing the questionnaire, participants took the inhibitory control test, which was presented on a computer via E-Prime software (Schneider, Eschmann & Zuccolotto, 2002). Next, they performed the eyetracking task. They finished the experiment by performing the verb and tense recognition tests. This procedure order in which all of the

English materials were seen during the first part of the experiment was done primarily so that upon beginning the Spanish proficiency test, they could begin to transition from reading and thinking in English to Spanish, and would therefore be ready to read the experimental sentences in Spanish. This follows from the research by Levy et al. (2007) that showed that L2 usage can inhibit certain L1 features.

3.4. Data Scoring

The screening tests were used as a method to eliminate participants so that the participants within and between groups would be as homogeneous as possible. The language background questionnaire was used as a screening measure to eliminate any participants that did not fit the requirements for the experiment. For the language proficiency exam, the participants received one point for each correct answer, and zero points for each incorrect answer, and must have scored between 40 and 60% on the exam (eight to twelve correct out of 20). For both the verb recognition and tense recognition tasks, one point was awarded for each correct response, and zero for each incorrect response. Participants must have received a 90% or better on the test to be included in the experiment.

For the eyetracking task, the reading times for the critical regions were only taken from those sentences in which the comprehension question was correctly answered. Furthermore, only sentences which had corresponding comprehension questions that were answered correctly were included for statistical analysis, to decrease the probability of increased reading times being attributed to a lack of comprehension. Then, for each critical region, the mean reading times were calculated from the individual reading times for each condition, and this number was used for the statistical analysis. Reading times less than 120 ms were excluded from analysis, as is standard in current psycholinguistic procedures (Rayner & Pollatsek, 1989). Mean reading times were calculated for the following critical regions: the adverb and verb, as well as the word immediately preceding and following the adverb (adverb-1, adverb+1, respectively) and verb (verb-1, verb+1, respectively). The mean reading times considered were the gaze duration and total time. Gaze duration includes the first pass reading time (i.e., the amount of time spent on a word or region when first landing on it) and is the total amount of time fixated on the critical word before moving on to the next word. Total time is the sum of the first gaze duration and any other gaze durations or regressions into the region before finishing reading the sentence. The mean reading times for adverb-1 and adverb+1 included the first gaze duration, whereas the reading times for the adverb contained both the first gaze duration and total time. Gaze durations were also obtained for the verb-1, verb+1, and verb regions, and total time on the verb was also included. The critical regions included the item preceding the critical region to ensure there were no differences between the conditions prior to encountering the error. The region following each of the verbs and adverbs was included because of evidence suggesting delayed processing when reading due to concurrent comprehension processes still being carried out, particularly when there is an incongruence or error in the text/input (Dekydtspotter, Schwartz, & Sprouse, 2006).

For the inhibitory control test, one point was awarded for each response in which the participant correctly matched the color to the key (successful inhibition), and zero points for each unsuccessful attempt. Any trial in which the reaction time was greater than 1500ms was excluded from analysis, as were trials immediately following an incorrect response. The mean reaction time was then calculated separately for the congruent and incongruent trials, and the inhibitory control score (i.e., Simon effect) was determined by the difference between the means, or incongruent reaction time minus congruent reaction time. This was used as a between-subjects variable to assess its effect on the participants' ability to notice the incongruence.

3.5. Analysis Procedures

The results presented below were analyzed via a repeated measures fully factorial analysis of covariance (ANCOVA) with a 2 (position: pre/post verbal adverb) x 2 (correctness: correct/incorrect verb morphology) x 2 (group: +/- study abroad) factorial design with inhibitory control score (Simon effect) entered as a covariate for each variable under investigation (adverb and verb gaze duration, adverb and verb total reading time, and gaze duration for the word immediately following the verb and adverb). Pure repeated measures effects are reported from an ANOVA that excludes the covariate when the original model proved to lack the power to explain any main and interaction effects, per the

backward stepwise approach for choosing a model. For this reason, the degrees of freedom (df) may differ for pure repeated measures effects and between participant effects or interactions.

4. Results

Before examining the results of the eyetracking experiment, it is necessary to determine whether the two groups of participants are comparable in all other measures save an immersion experience. In terms of L2 proficiency level, a *t*-test for independent samples was conducted on the means obtained on the language proficiency test. The results reveal no significant differences between the groups, $t(58) = -.152, p = .880$ (Levene's test: $F(.145), p = .705$). These findings indicate that the SA and AH participants had the same level of proficiency in Spanish at the time of data collection. The results from the accuracy on the filler comprehension questions reveal no significant differences between the groups on their performance, $t(58) = -.705, p = .483$ (Levene's test: $F(.004), p = .950$), suggesting that the two groups are similar in their accuracy on correctly answering the comprehension questions as well.

The results from the verb recognition test reveal no significant differences between the groups, $t(58) = .289, p = .774$ (Levene's test: $F(.334), p = .566$), indicating that the two groups of learners performed similarly on this test and were familiar with the verbs. Finally, the results from the tense recognition test reveal no significant differences between the SA and AH groups, $t(58) = .416, p = .679$ (Levene's test: $F(.691), p = .409$), suggesting that the two groups of learners were familiar with the Spanish past and present tense. The descriptive statistics for the L2 proficiency test, filler comprehension questions, and verb and tense recognition tests are presented in Table 1.

Variable	<i>N</i>	<i>M</i>	<i>SD</i>	<i>Skewness</i>	<i>Kurtosis</i>	<i>Minimum</i>	<i>Maximum</i>
L2 Proficiency Test (DELE)							
<i>(k=20)</i>							
SA	36	10.1	1.7	.56	-.68	8	14
AH	24	10.2	1.8	.45	-.76	8	14
Filler Comprehension							
Question Accuracy							
SA	36	86.63	5.22	-.96	.89	71	94
AH	24	87.63	5.47	-1.12	1.07	73	95
Verb Recognition Test							
<i>(k=36)</i>							
SA	36	35.9	.33	-6.0	36.0	34	36
AH	24	35.9	.41	-4.9	24.0	34	36
Tense Recognition Test							
<i>(k=32)</i>							
SA	36	31.9	.46	-4.1	15.3	30	32
AH	24	31.8	.56	-3.2	9.12	30	32

Table 1 *Descriptive Statistics for the L2 Proficiency Test, Filler Comprehension Questions, and Verb and Tense Recognition Test.*

A repeated measures ANOVA with a 2 (Correctness) x 2 (Group) factorial design was carried out on the reading times (RTs) for the word immediately preceding the adverb to ensure that up to the point before encountering the error, the learners were reading the sentences similarly. As the adverb is sentence initial in sentence type C1 (above) (ayer...cantó) and sentence type C2 (*ayer...canta), no comparisons for N-1 in these conditions can be made. The results reveal no significant main effects within subjects for Correctness, $F(1, 58) = .012, p = .912$ (partial $\eta^2 = 0.0\%$), or for Group between subjects, $F(1, 58) = .803, p = .374$ (partial $\eta^2 = 1.4\%$). No interaction effects are found, $F(1, 58) = .770, p = .384$ (partial $\eta^2 = 1.3\%$). These results suggest that up to the point before encountering the incongruity, there were no significant differences in mean reading times on the word immediately preceding the adverb.

One repeated measures ANOVA with a 2 (Correctness) x 2 (Position) x 2 (Group) factorial design was carried out on the RTs for the word immediately preceding the verb in C1 (ayer...cantó), C2, (*ayer...canta), C3 (cantó...ayer), and C4 (*canta...ayer). The results reveal no significant main effects within subjects for Position, $F(1, 58) = .347, p = .558$ (partial $\eta^2 = 0.6\%$), Correctness, $F(1, 58)$

= .025, $p = .875$ (partial $\eta^2 = 0.0\%$), or between subjects for Group, $F(1, 58) = 2.17$, $p = .146$ (partial $\eta^2 = 3.6\%$). Additionally, no significant interaction effects are found for Position x Group, $F(1, 58) = .423$, $p = .518$ (partial $\eta^2 = 0.7\%$), Correctness x Group, $F(1, 58) = .086$, $p = .770$ (partial $\eta^2 = 0.1\%$), Position x Correctness, $F(1, 58) = .035$, $p = .852$ (partial $\eta^2 = 0.1\%$), or Position x Correctness x Group, $F(1, 58) = .460$, $p = .500$ (partial $\eta^2 = 0.8\%$). These results are evidence that prior to reaching the incongruity, the mean reading times on the word immediately before the verb were not significantly different from each other, suggesting that before reaching the critical region that contains the morphological and lexical incongruity (C1, C2, C3, and C4), everything else was the same.

Multiple repeated-measures ANCOVAs with a 2 (Position) x 2 (Correctness) x 2 (Group) factorial design with Inhibitory Control as covariate were conducted. The ANCOVA for gaze duration at the adverb reveals no significant main effects for any of the variables: Position, $F(1, 56) = 3.043$, $p = .087$ (partial $\eta^2 = 5.2\%$), Correctness, $F(1, 56) = .708$, $p = .404$ (partial $\eta^2 = 1.2\%$), Group, $F(1, 56) = .054$, $p = .817$ (partial $\eta^2 = .1\%$), and Inhibitory Control, $F(1, 56) = .035$, $p = .852$ (partial $\eta^2 = .1\%$). Also, there are no interaction effects. The ANCOVA for gaze duration at the verb reveals no significant main effects within subjects for Position, $F(1, 56) = .869$, $p = .355$ (partial $\eta^2 = 1.5\%$) or Correctness, $F(1, 56) = 3.497$, $p = .067$ (partial $\eta^2 = 5.9\%$), or between subjects for Group, $F(1, 56) = .116$, $p = .753$ (partial $\eta^2 = .2\%$), or Inhibitory Control, $F(1, 56) = .574$, $p = .452$ (partial $\eta^2 = .1\%$). The results for the ANCOVA with a 2 (Position) x 2 (Correctness) x 2 (Group) factorial design with Inhibitory Control as covariate on adverb+1 gaze duration reveal no significant main effects within subjects for Position, $F(1, 56) = .457$, $p = .502$ (partial $\eta^2 = .8\%$) or Correctness, $F(1, 56) = .052$, $p = .821$ (partial $\eta^2 = .1\%$), or between subjects for Group, $F(1, 56) = .102$, $p = .751$ (partial $\eta^2 = .2\%$), or Inhibitory Control, $F(1, 56) = .069$, $p = .751$ (partial $\eta^2 = .1\%$). The results of the ANCOVA with a 2 (Position) x 2 (Correctness) x 2 (Group) factorial design with Inhibitory Control as covariate for gaze duration on V+1 reveal a significant main effect for Position, $F(1, 56) = 5.540$, $p = .022$ (partial $\eta^2 = 9\%$). However, no other significant main effects are found within subjects for Correctness, $F(1, 56) = .071$, $p = .791$ (partial $\eta^2 = .4\%$), or between subjects for Group, $F(1, 56) = .053$, $p = .818$ (partial $\eta^2 = .1\%$), or Inhibitory Control, $F(1, 56) = 2.248$, $p = .139$ (partial $\eta^2 = 3.9\%$). Also, there are no interaction effects. The results for the 2 (Position) x 2 (Correctness) x 2 (Group) repeated measures ANCOVA for adverb total time with Inhibitory Control as covariate reveal no significant main effects within subjects for Position, $F(1, 56) = .643$, $p = .426$ (partial $\eta^2 = 1.1\%$) or Correctness, $F(1, 56) = 2.820$, $p = .099$ (partial $\eta^2 = 4.8\%$), or between subjects for Group, $F(1, 56) = .001$, $p = .970$ (partial $\eta^2 = 0.0\%$), or Inhibitory Control, $F(1, 56) = .382$, $p = .539$ (partial $\eta^2 = .7\%$) are found. There are no interaction effects. A 2 (Position) x 2 (Correctness) x 2 (Group) repeated measures ANCOVA with Inhibitory Control entered as covariate for the total reading time on the verb is run. The results reveal no main effects within subjects for Position, $F(1, 56) = 1.161$, $p = .286$ (partial $\eta^2 = 2\%$) or Correctness, $F(1, 56) = 1.016$, $p = .318$ (partial $\eta^2 = 1.8\%$), or between subjects for Group, $F(1, 56) = 3.412$, $p = .07$ (partial $\eta^2 = 5.7\%$), or Inhibitory Control, $F(1, 56) = .522$, $p = .473$ (partial $\eta^2 = .9\%$). These results, together with the lack of main effects or interaction effects involving Inhibitory Control, indicate that this covariate does not explain a significant amount of variance in Position, Correctness, or Group, and can thus be removed from further models.

Based on the results of a 2 (Position) x 2 (Correctness) x 2 (Group) repeated measures ANOVA for the adverb gaze duration, a significant main effect is found for Position, $F(1, 58) = 105.95$, $p = .000$ (partial $\eta^2 = 64.6\%$). No significant main effects are found for Correctness, $F(1, 58) = .011$, $p = .915$ (partial $\eta^2 = 0.0\%$) or Group, $F(1, 58) = 0.88$, $p = .768$ (partial $\eta^2 = .2\%$). No interaction effects are found, $F(2.374, 63.013) = .962$, $p = .397$ (partial $\eta^2 = 1.6\%$). Multiple contrast comparisons for the SA group reveal longer RTs on C2 (*ayer...canta) than C4 (*canta...ayer) ($p = .000$), and longer RTs on C1 (ayer...cantó) than C3 (cantó...ayer) ($p = .000$), but there are no significant differences between C3 (cantó...ayer) and C4 (*canta...ayer) ($p = .978$). Similar results are found for the AH group, with longer RTs on C2 (*ayer...canta) than C4 (*canta...ayer) ($p = .000$), and longer RTs on C1 (ayer...cantó) than C3 (cantó...ayer) ($p = .002$), but there are no significant differences between C3 (cantó...ayer) and C4 (*canta...ayer) ($p = .346$). These results suggest that on first gaze duration for the adverb, neither group is sensitive to the adverb-verb incongruity.

The above results reveal a repeated measures ANOVA to best describe the variability for these data on adverb gaze duration. Therefore, a 2 (Position) x 2 (Correctness) x 2 (Group) repeated measures ANOVA for the gaze duration on the verb is run, and reveals no significant main effects within subjects for Position, $F(1, 58) = .014$, $p = .906$ (partial $\eta^2 = 0.0\%$), Correctness, $F(1, 58) =$

1.144, $p = .289$ (partial $\eta^2 = 1.9\%$), or between subjects for Group, $F(1, 58) = .270$, $p = .605$ (partial $\eta^2 = .5\%$). Multiple contrast comparisons reveal no significant differences for C2 (*ayer...canta) and C4 (*canta...ayer) ($p = .964$), C3 (cantó...ayer) and C4 (*canta...ayer) ($p = .492$), C1 (ayer...cantó) and C3 (cantó...ayer) ($p = .859$), and C1 (ayer...cantó) and C2 (*ayer...canta) ($p = .409$) for the AH group. Similar results are obtained for the SA group, with no significant differences for C2 (*ayer...canta) and C4 (*canta...ayer) ($p = .772$), C3 (cantó...ayer) and C4 (*canta...ayer) ($p = .635$), C1 (ayer...cantó) and C3 (cantó...ayer) ($p = .752$), and C1 (ayer...cantó) and C2 (*ayer...canta) ($p = .642$). These results indicate that on the first gaze duration on the verb, the learners are not sensitive to the incongruity between the adverb and verb.

The results of a 2 (Position) x 2 (Correctness) x 2 (Group) repeated measures ANOVA for the gaze duration on adverb+1 reveal significant main effects within subjects for Position, $F(1, 58) = 12.393$, $p = .001$ (partial $\eta^2 = 17.6\%$), Correctness, $F(1, 58) = 11.418$, $p = .001$ (partial $\eta^2 = .164\%$), and no main effects between subjects for Group, $F(1, 58) = .098$, $p = .755$ (partial $\eta^2 = .2\%$). No interaction effects are found, $F(3, 174) = .079$, $p = .971$ (partial $\eta^2 = .1\%$). The results of multiple contrast comparisons for the SA group reveal longer RTs on C4 (*canta...ayer) than both C2 (*ayer...canta) ($p = .000$) and C3 (cantó...ayer) ($p = .000$), and no significant differences between C1 (ayer...cantó) and C3 (cantó...ayer) ($p = .799$). These results suggest evidence of delayed processing in C3 (cantó...ayer) and C4 (*canta...ayer). The results for these comparisons for the AH group are similar to those of the SA group and reveal longer RTs on C4 (*canta...ayer) than both C2 (*ayer...canta) ($p = .004$) and C3 (cantó...ayer) ($p = .000$), and no significant differences between C1 (ayer...cantó) and C3 (cantó...ayer) ($p = .680$) and C1 (ayer...cantó) and C2 (*ayer...canta) ($p = .705$). Again, these results show evidence of delayed processing, or that when the error follows the adverb (i.e., the error is noticed after reading the incongruity between the present tense verb and adverb), as it does in C4 (*canta...ayer), the learner notices the error after leaving it. These results are evidence in favor of examining the total reading time on the verb. This is illustrated graphically in Figure 1.

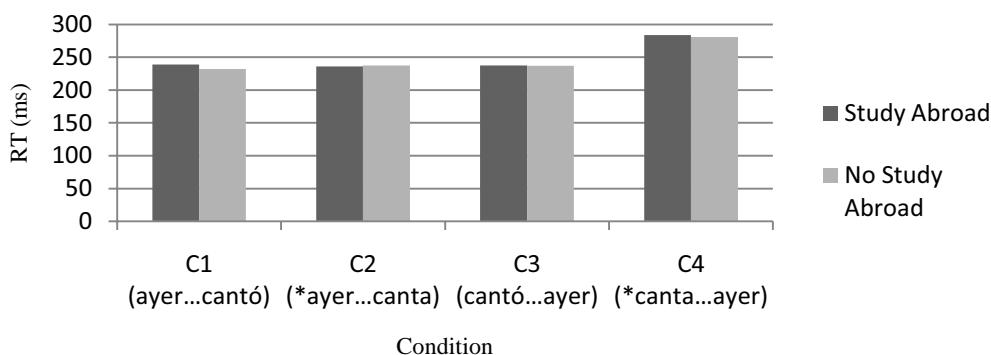


Figure 1. Significant differences for gaze duration on adverb+1 between C3 and C4.

The results of a 2 (Position) x 2 (Correctness) x 2 (Group) repeated measures ANOVA for the gaze duration on the verb+1 condition reveal significant within subjects main effects for Position, $F(1, 58) = 9.151$, $p = .004$ (partial $\eta^2 = 13.6\%$) and Correctness, $F(1, 58) = 8.575$, $p = .005$ (partial $\eta^2 = 12.9\%$), and no main effects for Group, $F(1, 57) = .248$, $p = .621$ (partial $\eta^2 = .4\%$). No significant interaction effects are found, $F(2.52, 146.155) = .469$, $p = .671$ (partial $\eta^2 = .5\%$). Multiple contrast comparisons reveal longer RTs on C2 (*ayer...canta) than both C4 (*canta...ayer) ($p = .002$) and C1 (ayer...cantó) ($p = .008$), and no differences in RTs for C3 (cantó...ayer) and C4 (*canta...ayer) ($p = .367$) and C1 (ayer...cantó) and C3 (cantó...ayer) ($p = .711$) for the SA group. These results are suggestive of delayed processing, and that the learners in this group did not notice the error until after they had read it and moved on to the next word. Similar results are obtained for the AH group, with longer RTs on C2 (*ayer...canta) than both C4 (*canta...ayer) ($p = .027$) and C1 (ayer...cantó) ($p = .009$), and no differences for C3 (cantó...ayer) and C4 (*canta...ayer) ($p = .320$) and C1 (ayer...cantó) and C3 (cantó...ayer) ($p = .452$). These results justify using the total time on the verb, as L2 learners do not always notice an error upon first seeing it. This is represented graphically in Figure 2.

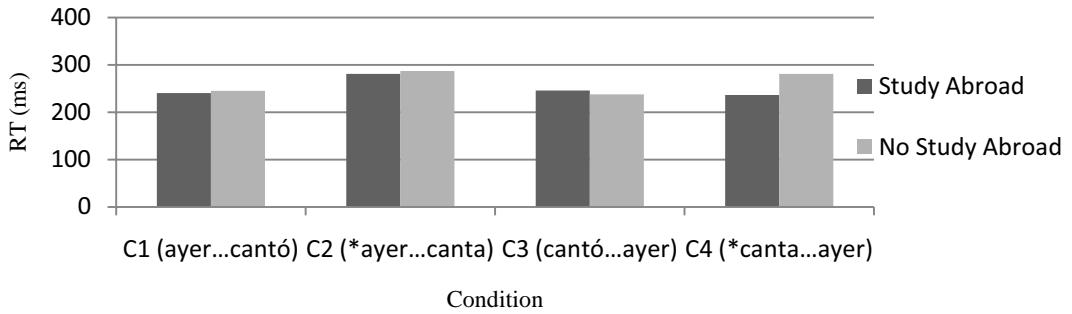


Figure 2. Significant differences for gaze duration on verb+1 between C3 and C4.

The results for the 2 (Position) x 2 (Correctness) x 2 (Group) repeated measures ANOVA for the adverb total time condition reveal significant main effects within subjects for Position, $F(1, 58) = 15.486$, $p = .000$ (partial $\eta^2 = 21.1\%$) and Correctness, $F(1, 58) = 37.815$, $p = .000$ (partial $\eta^2 = 39.5\%$), and no significant main effects between subjects for Group, $F(1, 58) = .015$, $p = .901$ (partial $\eta^2 = 0.0\%$). No interaction effects are found, $F(2.78, 161.221) = .274$, $p = .829$ (partial $\eta^2 = .5\%$). Multiple contrast comparisons for the AH group reveal longer RTs on C4 (*canta...ayer) than C3 (cantó...ayer) ($p = .005$), and longer RTs on C2 (*ayer...canta) than C1 (ayer...cantó) ($p = .000$), and no differences between C1 (ayer...cantó) and C3 (cantó...ayer) ($p = .280$) and C2 (*ayer...canta) and C4 (*canta...ayer) ($p = .060$). These results suggest that the AH learners are sensitive to the error, and that they return to the adverb when there is an incongruity between the verb and adverb. The results for the SA group reveal longer RTs on C2 (*ayer...canta) than C1 (ayer...cantó) ($p = .011$), longer RTs on C4 (*canta...ayer) than both C3 (*cantó...ayer) ($p = .003$) and C2 (*ayer...canta) ($p = .001$), and no differences between C1 (ayer...cantó) and C3 (cantó...ayer) ($p = .068$). These results suggest that the SA learners are sensitive to the incongruity, and the latter results suggest that the position of the adverb for the SA group is important.

However, the results obtained for the total time on the adverb are of little use if they cannot later be compared with the results for the total time on the verb, for it is the RTs on these regions that reveal which cue is the preferred cue. Therefore, a 2 (Position) x 2 (Correctness) x 2 (Group) repeated measures ANCOVA with Inhibitory Control entered as covariate for the total reading time on the verb is run. The results reveal no main effects (as noted above); however, a significant interaction effect is found for Correctness x Group, $F(1, 56) = 6.059$, $p = .017$ (partial $\eta^2 = 9.8\%$). This is illustrated in Figure 3.

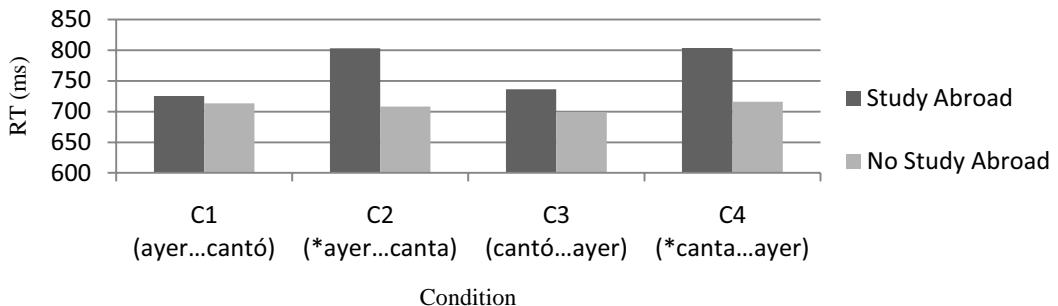


Figure 3. Significant differences for total time on verb between C2 and C4.

5. Discussion

The lack of significant differences between the two groups in the Spanish proficiency test and the verb and tense recognition tests indicates that the sample pool was homogenous in terms of Spanish proficiency and verb and tense knowledge, and that longer RTs in the eyetracking task were not due to these factors. The two groups' accuracy on the comprehension questions for the filler sentences was

similar, suggesting that the two groups were similar in L2 proficiency level. Furthermore, the RT for N-1 (the word immediately preceding the critical region) was included to ensure no differences between the conditions prior to seeing the error, and that L2 processing was proceeding as expected. The lack of significant differences between conditions at the word immediately preceding the adverb or verb (N-1) revealed that everything was equal across conditions before encountering the adverb-verb or verb-adverb incongruency. These findings revealed that the two groups were homogeneous and could be used for comparison.

The first research question investigated whether L2 Spanish classroom learners would show more monolingual processing patterns (i.e., more attention to morphological cues) after studying abroad. The prediction that the SA group would rely more on morphological cues than the AH group was supported. AH learners continued to rely on the lexical cue when an adverb-verb incongruency was present. In contrast, the SA learners began to rely on the morphological cue in addition to the lexical one to assign temporal reference, suggesting a transitional stage in this group.

The results for gaze duration on the adverb for both groups revealed longer RTs in C4 (*canta...ayer) and C3 (cantó...ayer) than C2 (*ayer...canta) and C1 (ayer...cantó). These results suggest that the learners are slower to read the adverb when it follows the verb, and that the position of the adverb in the sentence is important. As for the gaze duration on the verb, they revealed no significant differences for position, correctness, or group, indicating that neither group is sensitive to adverb-verb or verb-adverb incongruencies upon first reading the verb. This lack of significant differences for the gaze duration on both the adverb and verb may be due to delayed processing. Delayed processing occurs when a reader does not notice a problem until after they have already moved on to a different word or region. They then regress back to the region where they believed the error to occur.

The gaze duration for N+1 for the adverb revealed significant differences for both position and correctness. For the SA and AH groups, the RTs on the word immediately following the adverb in C4 (*canta...ayer) were longer than those in both C2 (*ayer...canta) and C3 (cantó...ayer). No significant differences were found between the RTs on C1 (ayer...cantó) and C3 (cantó...ayer), and C1 (ayer...cantó) and C2 (*ayer...canta). The longer RT on C4 (*canta...ayer), compared with both C2 (*ayer...canta) and C3 (cantó...ayer), reveals that L2 learners were not sensitive to the error between the adverb and verb until after they had read the verb and moved on. Finally, no differences were found between C1 (ayer...cantó) and C2 (*ayer...canta) or C3 (cantó...ayer) because there was either no error immediately following the adverb, as in C1 (ayer...cantó) and C2 (*ayer...canta), or because there was no incongruency between the adverb and verb, as in C3 (cantó...ayer).

Finally, both groups also showed evidence of delayed processing on the RT in N+1 for the verb, as illustrated by longer RTs on the word immediately following the verb in C2 (*ayer...canta) than C4 (*canta...ayer) and between C1 (ayer...cantó) and C2 (*ayer...canta). No differences in RTs were found between C1 (ayer...cantó) and C3 (cantó...ayer) or C3 (cantó...ayer) and C4 (*canta...ayer). These latter findings are expected, as there is no reason to have a longer gaze duration on the word immediately following the verb in C3 (cantó...ayer) and C4 (*canta...ayer), for the reader would not yet be aware of an incongruency since the verb precedes the adverb. The revelation of delayed processing is more evidence in favor of using the total RT for the verb, as L2 learners do not always notice the error on first reaching it since their processing mechanisms are less developed in comparison to those of native speakers.

The total time for the adverb revealed significant differences for both position and correctness. For both groups, the RTs for C2 (*ayer...canta) and C4 (*canta...ayer) were significantly longer than those for C1 (ayer...cantó) and C3 (cantó...ayer). However, no significant differences were found between the RTs of C1 (ayer...cantó) and C3 (cantó...ayer) or between C2 (*ayer...canta) and C4 (*canta...ayer) for the AH group, with similar results obtained for the SA group only for C1 (ayer...cantó) and C3 (cantó...ayer), but significantly longer RTs on C4 (*canta...ayer) than C2 (*ayer...canta). These results show that the learners are sensitive to the incongruency between the adverb and the verb, and that they resolve the conflict by returning to the adverb. However, for the SA group, the RT on the adverb when it precedes the verb and there is an adverb-verb incongruency is shorter than when it follows the verb. Even though the AH learners are sensitive to adverb-verb incongruencies, they continue to use L1 processing strategies and prefer to use the adverb as their cue. The SA learners also show sensitivity to adverb-verb incongruencies and use both cues to resolve the

incongruency. This finding suggests SA learners to be in a transitional phase, where they use both cues.

When considering the total time for the verb, recall that significant differences were found within the SA group, and that the RT for C2 (*ayer...canta) was longer than that for C1 (ayer...cantó), and that the RT on C4 (*canta...ayer) was longer compared to that on C3 (cantó...ayer) (although the differences were only significant for the reading times between C1 (ayer...cantó) and C2 (*ayer...canta). This suggests that the SA learners use the verb as a cue, and it is a stronger cue when the adverb precedes the verb. This finding complements the above finding that when the adverb is preverbal, the learners in the present study return to the adverb and use L1 strategies. These SA learners also use the verb to resolve the incongruency, again illustrating a transitional phase, regardless of the position of the adverb. When the verb precedes the adverb, the learners are conflicted as to which cue to use, and one possibility is that they use the morphological cue more than they use the lexical one. Contrary to the findings with the SA group, no significant differences on the total RTs for the verbs in any condition were found for the AH group, indicating that these learners do not prefer to use the verb as a cue when faced with morphological and lexical cues that are paired together.

The findings from both the adverb and verb RTs for total time imply that the SA learners rely on both the lexical and morphological cues when processing in the L2, whereas the same cannot be said for the AH learners, as the results indicate they prefer to use the lexical cue.

This research considered the effects of the learning context (a limitation of Ellis & Sagarra's (2010) work), and revealed that it plays an important role in determining which cues L2 learners use when processing redundant items in the input. A SA experience and exposure to naturalistic input is one way L2 learners can overcome the effects of past instruction and L1 transfer effects. The effects of previous experiences with an L1 and L2 do influence how redundant cues are processed. For the AH learners, the abundance of lexical cues that they receive in the input only reinforces their already selected L1 preference for lexical cues. It appears that exposure to more input that contains both morphological and lexical cues assists the learners in the present study in changing their L2 processing strategies to mirror those of speakers of the target language. This finding is in line with usage based theories of SLA (Tomasello, 2003), in that it shows that experiences with the language affect how it is used and processed.

A role for inhibitory control in altering processing strategies was not found. Recall that a role for inhibitory control has been proposed, and that the ability to block certain items can affect the types of cues that can enter into the L2 learners' linguistic system. If the learners are able to block their L1, then more cues may be able to enter their L2 system. However, the data presented here found no effect for how learners suppress their L1 to allow more cues to enter their L2 system in either learning setting.

The results of the experiment here counter the findings of the scant literature that has examined the role of inhibitory control in SLA. Research by Levy et al. (2007) and Linck et al. (2009) suggest an important role for inhibitory control in inhibiting the L1, especially in an immersion setting. However, the role of inhibitory control in acquiring multiple L2 cues for any of the critical regions was not seen. This may be due to the fact that the inhibitory control data were collected after the participants for this experiment returned from the L2 environment, whereas the research of Linck et al. (2009) was collected while the learners were still immersed in the L2 context. Also recall that Linck et al. (2009) found the effects of the L2 to inhibit the L1 diminished upon returning to the L1 environment. It is therefore possible that inhibitory control did play a role in the cues that these L2 learners acquired, but that after acquiring them and leaving the immersion setting, the effect of inhibitory control was lost.

6. Future Research and Conclusions

Future research should examine the effect of other cognitive individual differences, such as working memory, which is limited in capacity and has been shown to play an important role in second language acquisition. Furthermore, future research should examine the effects of the L2 on L1 processing, and whether a change of processing strategies in the L2 affects L1 processing strategies as proficiency increases. That is, whether L2 Spanish learners begin to use morphological cues to process their L1, and conversely, whether L2 English learners begin to use lexical cues when processing L1 Spanish. This could be investigated by examining the strategies more advanced learners use when processing these types of adverb-verb incongruencies in their L1.

To conclude, this work reveals that L2 learners immersed in a study abroad setting for 16 weeks can start to alter their L2 processing strategies to mirror those of native speakers of the target language, and come to rely on morphological cues more and lexical ones less. This happens for them even when beginning the task with an L1 processor that prefers lexical over morphological cues, and with having been previously exposed to an abundance of lexical cues in the classroom. The SA learners show an intermediate stage of their development, and rely more on the morphological cues, imitating native-like patterns, and less on lexical cues. However, this same result was not found for the AH learners, suggesting that the SA experience can accelerate changes to the L2 processor. For both groups, inhibitory control was not found to interact with the processing of these redundant morphological and lexical cues, suggesting that its role may be limited upon exiting the L2 immersion setting. The results support a usage-based approach to language acquisition, in that immersion in a study abroad context, and being surrounded by an abundance of naturalistic input, and not the type of altered input that is frequently received in the classroom, is a satisfactory way to alter the L2 processing of redundant morphological and lexical items, even in learners who have L1 strategies that prefer one cue over the other.

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Selected Proceedings of the 14th Hispanic Linguistics Symposium

edited by Kimberly Geeslin
and Manuel Díaz-Campos

Cascadilla Proceedings Project Somerville, MA 2012

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LaBrozzi, Ryan M. 2012. The Role of Study Abroad and Inhibitory Control on Processing Redundant Cues. In *Selected Proceedings of the 14th Hispanic Linguistics Symposium*, ed. Kimberly Geeslin and Manuel Díaz-Campos, 228-241. Somerville, MA: Cascadilla Proceedings Project. www.lingref.com, document #2668.