The Effect of Recent L1 Exposure on Spanish Attrition: An Eye-Tracking Study

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1. Introduction

The phenomenon of first language attrition refers to those changes that take place in certain aspects of a speaker's L1 as the result of the acquisition of an L2 at an adult age when the L1 acquisition process has been completed.

First language attrition and to a greater extent bilingual first language acquisition and adult second language acquisition have been widely explored in relation to many factors, such as the stages in which they take place, the contexts in which they occur and the factors affecting them. More recent research has focused on the effect of the *Interface Hypothesis* (Sorace & Filiaci 2006), which postulates that structures that involve an interface between syntax and other cognitive domain, such as syntax-semantics or syntax-pragmatics, will be more difficult to be completely acquired (or more vulnerable to undergo attrition) than structures that do not involve such interface. The current hypothesis is that individual L1 attrition affects only the ability to process interface structures but not knowledge representations themselves (Sorace 2011).

The prediction made by the Interface Hypothesis has been supported by many studies exploring cross-linguistic influence effects at the mentioned interfaces in different bilingual groups, which addressed aspects such as the effects of semantic or discourse factors in the acquisition of word order (Hertel 2003, Montrul 2004a, Belletti et al. 2007, Lozano 2006, Hopp 2009, Wilson 2009), or the influence of pragmatics in the acquisition of null versus overt pronominal subjects and objects (Paradis & Navarro 2003, Tsimpli et al. 2004, Serratrice et al. 2004, Montrul 2004b, Belletti et al. 2007, Argyri & Sorace 2007, Sorace et al. 2009, Lozano 2009, Rothman 2009, Serratrice et al. 2011).

This paper will specifically deal with two issues in relation to L1 attrition. First, it will investigate the kind of structures that are more likely to undergo this phenomenon, addressing the effects of attrition in a structure at the syntax-pragmatics interface, pronominal subjects, in speakers of Spanish L1 with a prolonged exposure to English L2, in order to investigate whether attrition effects occur with structures involving interfaces.

Secondly, this study will explore whether attrition constitutes permanent changes in speakers' L1 grammatical representations or just a lack of online

sensitivity when processing these structures in real time. Following the Activation Threshold Hypothesis (Paradis 1993), which predicts that L1 attrition will occur when an element in the L1 is disused and it has a corresponding "competing" element in the L2 that is used more frequently, a second group of attriters will be tested after being recently exposed exclusively to their L1, Spanish, to see whether attrition can decrease or disappear after a prolonged exposure to the L1. This issue is a novel and an important one because it directly tackles the cognitive effects that attrition has in the bilinguals' L1 and the effects of input and exposure in the maintenance of their L1. If results show less or no attrition after L1 exposure, this will suggest that bilinguals are sensitive to input changes and that attrition effects are due to a lack of online sensitivity with interface structures in real time rather than to a permanent change in the attriters' L1 grammatical representations.

2. Subject pronouns and anaphora resolution in null-subject languages

Null subject languages are characterized by allowing the subject position of a finite clause to be phonetically empty. Therefore, whereas pro-drop languages, such as Spanish, Italian or Japanese, allow for either a null or an overt subject to appear as the subject of a sentence, as (1a) illustrates for Spanish, in non-null subject languages, such as English, German or Dutch, the use of a null subject is usually ungrammatical, as (1b) shows for English. Moreover, the Null Subject Parameter (Rizzi 1982, 1986; Borer, 1989) establishes other properties associated with null-subject languages apart from allowing empty pronouns: the possibility for subject-verb inversion and the lack of *that*-trace effects.

(1) a.   Pedro/*pro* salió del restaurante.

     b.   Peter/**pro* left the restaurant.

The distribution of null and overt subjects is pragmatically constrained by the features *topic* and *focus*. Specifically, in Spanish a null subject will be used when the referent has been previously introduced (i.e. when it is a topic), whereas a subject will be overt if there is a change of referent or it introduces new information (i.e. when it is the focus).

The distribution established for null and overt subjects can also be extended to pronominal subjects. That is, in pro-drop languages a null subject pronoun will be used when the referent has been previously introduced, whereas an overt subject pronoun will be used in focused contexts. For non-null subject languages, Luján (1986) establishes that the distinction between unstressed and stressed pronominal subjects is equivalent to the distinction between null and overt subject pronouns found in pro-drop languages. That is, null pronouns in Spanish would correspond to unstressed pronouns in English, whereas overt pronouns in Spanish would correspond to stressed pronouns in English.

It is important to point out that the choice of a null or an overt pronoun depends on the linguistic context and that it leads to interpretative differences. In order to account for the antecedent preferences of null and overt subject pronouns, Carminati (2002) proposed the Position of Antecedent Hypothesis (henceforth, PAH) for Italian intra-sentential anaphora. The PAH postulates that null pronouns prefer to be assigned to the antecedent in the highest SpecIP (generally the subject), as (2a) shows, whereas overt pronouns prefer to be assigned to an antecedent in a syntactic position that is lower than the SpecIP (generally the object), as illustrated in (2b).

(2) a. Quando Mario$_i$ ha telefonato a Giovanni$_j$, *pro*$_i$ aveva appena finito di mangiare.
    'When Mario has telephoned Giovanni, (he) had just finished eating.'

b. Quando Mario$_i$ ha telefonato a Giovanni$_j$, lui$_j$ aveva appena finito di mangiare.
    'When Mario has telephoned Giovanni, he had just finished eating.'

The PAH was shown by Alonso-Ovalle et al. (2002) to be true also for Spanish.

Many studies on L2 acquisition have shown that bilingual children (Paradis & Navarro 2003 on Spanish-English, Serratrice et. al 2004 on English-Italian, Argyri & Sorace 2007 on English-Greek, Sorace et al. 2009 on English-Italian and Spanish-Italian), near-native speakers (Belletti et. al 2007 on English L1/Italian L2, Lozano 2009 on English L1/Spanish L2, Rothman 2009 on English L1/Spanish L2), and L1 attriters (Gürel 2004 on Turkish near-native speakers of English, Tsimpli et. al 2004 on Greek and Italian near-native speakers of English) overextend the use of overt pronouns in the pro-drop language to contexts in which monolinguals would use null pronouns. Nevertheless, overextension of null pronouns in the pro-drop language is rarely found. Most of this research concluded that the indeterminacy shown by L2 learners and L1 attriters with structures at the syntax-pragmatics interface, such as pronominal subjects, is related to processing difficulties as the result of speakers having to integrate several sources of information from different cognitive domains.

Moreover, the overextension of overt pronouns could also be related to bilinguals' executive functions. As it has been demonstrated in the psycholinguistic literature, monolinguals are different from bilinguals in their executive functions, not only because bilinguals' both languages are simultaneously active, but also because bilinguals have to switch between languages and therefore need to exercise inhibition to avoid interference from the undesired language (Green 1998, Costa et al. 2000, Sorace & Serratrice 2009). In relation to anaphora resolution, the accessibility of the reference changes all the time when bilinguals speak because of the different linguistic contexts in which pronouns are used, so a constant update of the mental model is needed. That is, not only do bilinguals need to inhibit the unwanted language,

but they also have to have the ability to update the representation of the context in order to use the appropriate pronoun and interpret the appropriate antecedent, which is a costly cognitive process. And sometimes the need to inhibit the undesired language may take attentional resources away from the linguistic task, resulting in the bilinguals interpreting the wrong antecedent (Sorace 2011).

Finally, it should be mentioned that these processing difficulties caused by pronoun resolution has also been revealed by studies using on-line methodology, which directly reflects processing in real time (Roberts et al.'s 2008, Kaiser & Trueswell 2008, Wilson 2009, Wilson et al. 2009).

3. L1 attrition with pronominal subjects

As mentioned above, research on L2 acquisition has focused to a lesser extent on the influence that the L2 might have in the L1 of bilinguals or near-native speakers. This phenomenon is known as *L1 attrition*, and it refers to the change of certain aspects of a speaker's L1 as the result of the acquisition of an L2 at an adult age, when the L1 acquisition process has been completed. More specifically, L1 attrition will normally occur in the L2 environment (i.e. immigration), as the consequence of the speaker being exposed to a great amount of L2 input together with a restricted (or non-existent) L1 input.

Paradis' (1993) Activation Threshold Hypothesis (henceforth, ATH) establishes a correlation between the frequency of use of a language element and its availability (or activation) to the speaker. In particular, it proposes that when an item is not used, the threshold of activation would rise, and when it is used, the threshold of activation would be low. Therefore, a linguistic item that has not been frequently used would have a high activation threshold and it would be difficult to activate, which would lead to the attrition of the item. This suggests that different language elements, depending on their frequency of use, would have different threshold of activation, so that some would be more likely than others to undergo attrition. More specifically, the ATH predicts that L1 attrition will occur when an element in the L1 with a high activation threshold (i.e. disused) has a corresponding "competing" element in the L2 with a lower activation threshold (i.e. used more frequently).

With regard to the Interface Hypothesis, it is also supported by recent research on L1 attrition, which reveals that the structures at the syntax-pragmatics interface are the most vulnerable ones to undergo attrition, causing "emerging optionality" in attriters' L1. As for L2 acquisition, emerging optionality in L1 attriters has also been shown to occur with subject pronouns (Sorace 2000 on Italian near-native speakers of English, Tsimpli et al. 2004 on Greek and Italian near-native speakers of English, Gürel 2004 on Turkish near-native speakers of English). In these studies, attriters also reveal indeterminacy with the overt pronoun in the L1, but not with the null pronoun.

As for L2 acquisition, the emerging optionality revealed by L1 attriters with pronominal subjects has also been attributed to speakers' processing difficulties when integrating the different sources of information in real time. However,

unlike in L2 acquisition research, not many studies have addressed the source of attrition and just a few have implemented on-line methods (Pallier et al. 2003, Wilson 2009). Moreover, to the best of my knowledge, the hypothesis that attrition may decrease or disappear under prolonged exposure to L1 input has never been tested before. Therefore, this study will investigate the hypothesis that attrition effects may reverse under L1 exposure, and the implications that this might have in relation to the source of attrition, which will reveal whether attrition effects lie at the processing level or whether they are the consequence of a permanent change in the speakers' L1 grammatical representations.

4. Research questions

Considering the mentioned phenomena under investigation, this study will address the following research questions:

(i)   Following the Interface Hypothesis (Sorace & Filiaci 2006), will attriters show indeterminacy with an interface structure like pronominal subjects?

(ii)   If they do, does attrition affect online sensitivity when processing interface structures in real time or is it due to permanent changes in attriters' L1 grammatical representations?

(iii)   Considering the Activation Threshold Hypothesis (Paradis 1993), does attrition decrease or disappear due to frequency and recency of (re)exposure to the L1?

5. Methodology
5.1. Participants

In order to investigate the proposed research questions, three groups of participants were tested: "monolinguals", "attriters" and "exposed". They were all from Spain and had no knowledge of any other language from birth (Spanish speakers from regions in which another L1 was spoken, such as Catalan, Basque or Galician were excluded from the experiment).

The control group of "monolinguals" (MON) were 24 Spanish native speakers (14 females, 10 males) who had recently arrived in Edinburgh (the mean number of weeks spent in the UK was 7.958, SD = 7.117), and had no (or very little) knowledge of English. Participants were asked to rate their use of the L1 and the L2 on a 5-point scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always) in three different settings (at home, in their social circle and at their job or professional/educational setting) and the monolingual group clearly used the L1 more often than the L2 (for the L1, the mean use was 4.312, $SD =$ .639; for the L2, the mean use was 2.708, $SD =$ .908).

The group of "attriters" (ATT) consisted of 24 Spanish native speakers (16 females, 6 males) who had been residing in the UK for a minimum of five years and were near-native speakers of English (the mean number of years spent in the

UK was 7, $SD = 2.844$). This group, unlike the monolinguals, used the L2 more often than the L1 (for the L1, the mean use was 3.417, $SD = .843$; for the L2, the mean use was 4.333, $SD = .434$).

Finally, another group of attriters was tested after being recently exposed exclusively to their L1 to explore whether attrition can decrease or disappear after a prolonged exposure to L1 input. This "exposed" group (EXP) was formed by 24 Spanish native speakers (12 females, 12 males) who, as the ATT group, had been living in the UK for a minimum of five years and were near-native speakers of English (the mean number of years spent in the UK was 5.833, $SD = 1.736$). Also, like the attriters, the exposed group clearly used the L2 more often than the L1 (for the L1, the mean use was 2.583, $SD = .880$; for the L2, the mean use was 4.417, $SD = .565$). However, this group had been exposed exclusively to Spanish for a minimum of a week in a Spanish-speaking environment (i.e. Spain) during their Christmas holidays right before they were tested (the mean number of days that they were exposed to the L1 was 13.083, $SD = 4.745$).

5.2. Stimuli

In order to explore whether structures at the syntax-pragmatics interface will undergo attrition in the L1 under prolonged exposure to an L2, as predicted by the Interface Hypothesis (Sorace & Filiaci 2006), 32 intra-sentential semantically-neutral anaphora as the ones illustrated in (3) below were used. Each sentence consisted of a main clause, which contained a subject and an object antecedent of the same gender, and a subordinate clause always introduced by *cuando* ('when') and followed by the subject pronoun, either overt or null, and a verb conjugated in third-person singular. The pronoun could refer to either the subject or the object antecedent, so one carried singular number and the other plural number in order to disambiguate. Since the pronoun and the verb were always in singular, they would co-refer with the antecedent in singular.

(3) a. Condition 1: **?Overt/subject match**[1]
         La madre saludó a las chicas cuando ella cruzaba una calle con mucho tráfico.
         The mother greeted[sing.] to the girls when she crossed[sing.] a street with a lot of traffic
         'The mother greeted the girls when she crossed a street with a lot of traffic.'

     b. Condition 2: **Overt/object match**

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[1] The notation "?" expresses that the antecedent the verb agrees in number with in the sentences of that condition is the unpragmatic choice, not that those sentences are ungrammatical.

Las madres saludaron a la chica cuando ella cruzaba una calle con mucho tráfico.

The mothers greeted[plural] to the girl when she crossed[sing.] a street with a lot of traffic

'The mothers greeted the girl when she crossed a street with a lot of traffic.'

c. Condition 3: **Null/subject match**

La madre saludó a las chicas cuando *pro* cruzaba una calle con mucho tráfico.

The mother greeted[sing.] to the girls when *pro* crossed[sing.] a street with a lot of traffic

'The mother greeted the girls when she crossed a street with a lot of traffic.'

d. Condition 4: **?Null/object match**

Las madres saludaron a la chica cuando *pro* cruzaba una calle con mucho tráfico.

The mothers greeted[plural] to the girl when *pro* crossed[sing.] a street with a lot of traffic

'The mothers greeted the girl when she crossed a street with a lot of traffic.'

Thus, two factors were manipulated, each containing two levels: *Pronoun* (overt or null) and *Antecedent* (subject or object), which resulted in the four conditions shown in (3) above.

5.3. Procedure

In order to explore the interpretation and processing of overt and null subject pronouns, which will reveal whether the source of attrition lies at the processing or at the representational level, participants carried out two tasks: an offline naturalness judgement task and an online eye-tracking-while-reading task. However, the experimental session was designed to be carried out as a single task, in which participants had to read the sentences that were shown in a computer screen, which was used as the online eye-tracking data, and then rate each sentence in terms of its naturalness, which was used as the offline judgment data.

The experiment was run using an Eyelink 1000 tower-mounted eye-tracking system. Sentences appeared in a computer monitor, and participants were instructed to read each sentence and then press a button on a game pad once they had comprehended it. When they pressed the button, the question *¿Cómo de natural te suena esta frase?* ('How natural does this sentence sound to you?') followed and they were asked to rate the previous sentence on a 5-point scale in terms of their perceived naturalness (1 = not natural at all; 2 = not very natural; 3

= more or less natural; 4 = very natural; 5 = totally natural). Their responses were recorded.

6. Results
6.1. Offline experiment

Overall, participants from the three groups show score means that follow what we expected for the offline experiment, as Table 1 illustrates.

Table 1: Score means and (SD) for offline anaphora resolution by all groups

	MON		ATT		EXP	
C1-?ov/subj	3.2604	(2.9115)	3.1510	(3.1510)	2.9115	(.71616)
C2-ov/obj	3.6034	(3.4531)	3.4896	(3.4896)	3.4531	(.82407)
C3-null/subj	3.7158	(3.6399)	3.5781	(3.5781)	3.6399	(.73356)
C4-?null/obj	3.6082	(3.5417)	3.5937	(3.5937)	3.5417	(.77290)

Participants rated condition 1 (overt/subject match) lower (i.e. as being less "natural") than condition 2 (overt/object match), and condition 4 (null/object match) lower than condition 3 (null/subject match), as revealed in Figure 1.
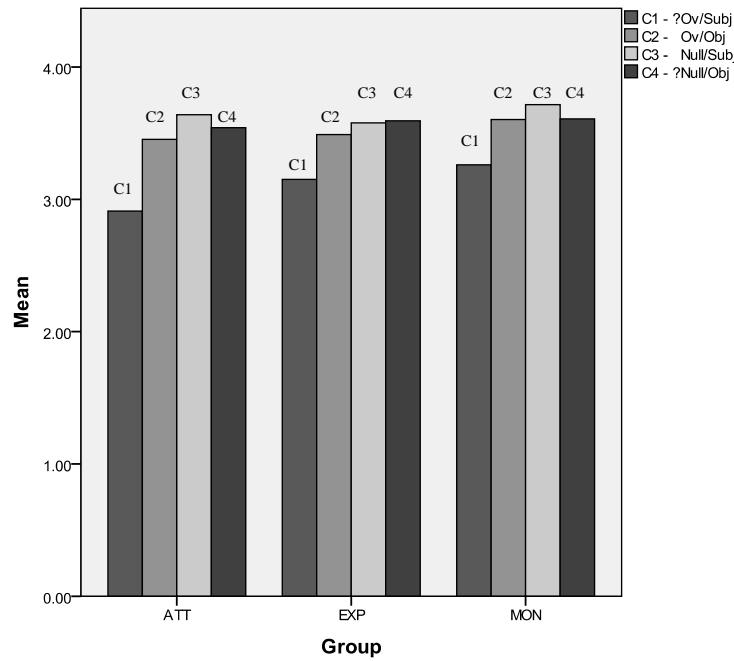

Figure 1: Score means for offline anaphora resolution by the three groups

As expected, the repeated-measures ANOVA tests run revealed significant Pronoun by Antecedent interaction effects for all groups' ratings of anaphors: MON ($F_1(1, 23)$ = 12.328, p = .002; $F_2(1, 31)$ = 3.880, p = .058), ATT ($F_1(1, 23)$ = 16.468, p < .001; $F_2(1, 31)$ = 19.936, p < .001) and EXP ($F_1(1, 23)$ = 5.403, p = .029; $F_2(1, 31)$ = 2.793, p = .105). This indicates that the three groups of participants reacted to the mismatching conditions when interpreting subject pronouns offline.

Moreover, the t-tests run for all groups of participants indicated that the interpretation of the overt pronoun was more reliable than the interpretation of the null pronoun: with the overt pronoun, all three groups rated significantly lower scores for the subject antecedent than for the object antecedent, and although the ratings for the null pronoun overall revealed higher scores for the subject antecedent than for the object antecedent, this difference was not significant for any of the groups.

Finally, group comparisons were run and, as expected for the offline results, the ANOVA tests revealed no three-way interaction of Pronoun by Antecedent by Language Group for any of the group comparisons: MON vs. ATT ($F_1(1, 46)$ = .867, p = .357; $F_2(1, 31)$ = 1.483, p = .232), MON vs. EXP ($F_1(1, 46)$ = .456, p = .503; $F_2(1, 31)$ = .112, p = .740) and ATT vs. EXP ($F_1(1, 46)$ = 2.275, p = .138; $F_2(1, 31)$ = 3.355, p = .077). These results clearly indicate that there are no significant differences between any of the groups in terms of their offline interpretation of subject pronouns.

6.2. Online results

Before reporting the results from the online task, it should be noted that items were divided into seven regions, as (4) below illustrates. The critical region (region 5) contains the pronoun and the verb.

(4)   La madre/ saludó a/ las chicas/ cuando/ ella cruzaba/ una calle/ con mucho tráfico./
'The mother greeted the girls when she crossed a street with a lot of traffic.'

On the other hand, three different eye-movement measures will be reported: first pass time (*fp*), go-past time (*gp*) and total time (*tt*).

Unlike for the offline task, the results from this online task differ between the groups. As predicted, the repeated-measures ANOVA tests run revealed significant Pronoun by Antecedent interaction effects only for MON and EXP, but not for ATT. Monolinguals revealed significant interaction effects in the critical region for *fp* ($F_1(1, 23)$ = 12.391, p = .002; $F_2(1, 31)$ = 6.199, p = .018), *gp* ($F_1(1, 23)$ = 4.889, p = .037; $F_2(1, 31)$ = 1.962, p = .171) and *tt* ($F_1(1, 23)$ = 11.896, p = .002; $F_2(1, 31)$ = 1.016, p = .321). The exposed group revealed significant interaction effects for *gp* in the final region ($F_1(1, 23)$ = 4.261, p = .050; $F_2(1, 31)$ = 7.550, p = .010) and for *tt* in the pre-critical ($F_1(1, 23)$ = 4.590,

p = .043; F_2(1, 31) = 3.582, p = .068), critical (F_1(1, 23) = 9.963, p = .004; F_2(1, 31) = 11.502, p = .002) and post-critical regions (F_1(1, 23) = 4.644, p = .042; F_2(1, 31) = 3.906, p = .057). Finally, the attrited group did not reveal any significant interaction effects in any of the regions for any of the measures. This indicates that during online anaphora resolution, MON and EXP were sensitive to the mismatching conditions, but not ATT.

Again, as it was revealed in the offline task, the t-tests run indicated that the interpretation of the overt pronoun was more reliable than the interpretation of the null pronoun for all three groups of participants: with the overt pronoun, all three groups showed significantly longer RTs for the subject antecedent than for the object antecedent, and although the RTs for the null pronoun revealed shorter RTs for the subject antecedent than for the object antecedent, this difference was not significant for any of the groups.

Finally, group comparisons were run and, as expected for the online results, the ANOVA tests revealed three-way interaction of Pronoun by Antecedent by Language Group for MON vs. ATT for *fp* in the critical region (F_1(1, 46) = 5.064, p = .029; F_2(1, 31) = 2.047, p = .163) and in the final region (F_1(1, 46) = 4.757, p = .034; F_2(1, 31) = 1.827, p = .186), which reveals that there are differences between monolinguals and attriters in terms of how they are affected by the pronoun mismatch in their online processing of these anaphora.

Moreover, no significant three-way interaction effects were found when MON and EXP were compared, which reveals that EXP's attrition effects have decreased as a result of their exposure to the L1. Interestingly, when ATT and EXP were compared, no significant three-way interaction effects were found between these two groups either, which suggests that the exposed group might be somewhere between the monolinguals and the attriters in terms of their online sensitivity to the pronoun mismatch.

7. Discussion

The present study aimed to explore three main research questions. First, whether attriters showed indeterminacy with an interface structure like pronominal subjects, as predicted by the Interface Hypothesis (Sorace & Filiaci 2006). Second, whether attrition affects online sensitivity when processing these interface structures in real time or whether it is due to permanent changes in attriters' L1 grammatical representations. Finally, whether attrition effects decrease or disappear due to frequency and recency of (re)exposure to the L1, as predicted by the Activation Threshold Hypothesis (Paradis 1993).

The results from the offline ratings revealed equal mismatch sensitivity to subject pronouns for all three groups of participants. On the other hand, the results from the eye-tracking while reading task, in which the online processing of pronominal subjects was explored, revealed that attriters did not show online sensitivity with the interface structure and performed differently from the control group of monolinguals. Overall, the results from the online experiment revealed that monolinguals and exposed are reliably more sensitive than attriters

to the pronoun mismatch. Therefore, we can conclude that L1 Spanish attrited speakers show attrition effects with an interface structure like pronominal subjects.

Moreover, the group of attriters exposed to L1 Spanish (i.e. the 'exposed' group) was expected to show online sensitivity to the pronoun mismatch and, consequently, to perform similarly to monolinguals due to the fact that they had recently been exposed to their L1. The results obtained for the exposed group did reveal no attrition effects with pronominal subjects, since this group, unlike the attriters, showed a reliable online sensitivity to the pronoun mismatch when processing this interface structure in real time. Moreover, when they were compared to the monolinguals, no significant differences between the two groups were revealed, which suggests that attrition effects diminish after recent exposure to the L1.

However, when the exposed group was compared to the attriters, no significant differences between the two groups were shown either. Therefore, given the significant differences between monolinguals and attriters, it might be the case that the exposed group is somewhere in between the attriters and the monolinguals; that is, their attrition effects have clearly diminished after having been exposed to the L1 for a prolonged period of time, but not to the point of behaving native-like. The question now is whether attrition effects with interface structures such as subject pronouns just cannot be completely overcome or whether it is a matter of the length of re-exposure to the L1, so that a longer exposure might be needed for attriters to totally overcome attrition and behave more like monolingual speakers.

Finally, based on the offline data, which shows no significant differences between the three groups, and on the fact that monolinguals and exposed do not reveal significant differences in their online results, it is clear that no permanent change in the attriters' L1 grammatical representations takes place. That is, on the one hand, it was revealed that although attriters did not show online sensitivity with the pronoun in the online task, they behaved like monolinguals and exposed in the offline task, with all groups of participants showing an equal sensitivity to the pronoun mismatch. On the other hand, it was found that monolinguals and exposed did not show significant differences in their online results. These results reveal that the exposed group was able to overcome their attrition with recent reexposure to their L1 and therefore, that no permanent changes took place in their L1 grammatical representations.

Considering all the findings obtained from this study, we can conclude that attrition effects decrease as a result of L1 exposure. This reveals that bilinguals are sensitive to input changes and that attrition affects online sensitivity rather than causing a permanent change in speakers' L1 grammatical representations (at least at this first stage of attrition).

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