ONLINE PROCESSING OF WH-DEPENDENCIES IN ENGLISH BY NATIVE SPEAKERS
OF SPANISH

BY

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Abstract

      This study investigated if, Spanish-speaking learners of English are capable of processing wh-dependencies incrementally and observing the grammatical constraints that regulate wh-extraction in English, similar to native speakers. The study included two self-paced reading experiments run in a word-by-word non-cumulative moving window paradigm (Just et al., 1982). Experiment 1 tested if second language (L2) learners process wh-dependencies incrementally by looking at wh-extraction from positions licensed by the grammar. Experiment 2 focused on testing if learners respect syntactic constraints that forbid wh-extraction from positions not licensed by the grammar, to be specific, extraction out of relative clause islands. The data collected in both experiments were subject to a residual reading times analysis. The results of the two experiments suggest that Spanish-speaking learners of English process wh-dependencies incrementally and that they abide by grammatical constraints in the course of online processing which prevent them from extracting a wh-element outside of a relative clause island. At the theoretical level, our findings suggest that the claim of the Shallow Structures Hypothesis (Clahsen & Felser, 2006 a,b) that adult second language learners are 'shallow processors' who do not have access to abstract syntax during parsing is too strong.

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1. Introduction

A question that has guided a lot of the research in second language (L2) acquisition is to what degree adult learners of a second language are capable of approximating the native speakers' knowledge of language. At the theoretical level, it has been proposed that humans' ability to acquire language is subject to a biologically-determined critical period, an idea proposed by Lenneberg (1967). At the core of the critical period hypothesis for first language (L1) learning is the belief that there is a window of opportunity (critical period) in which human beings can successfully acquire a language/or languages in the presence of rich-enough input. According to Lenneberg, after the offset of this period, around the beginning of puberty, learning a language will become a more conscious and effortful task.

The second language literature is rich in studies that have put the critical period hypothesis to the test by exploring second language learners' knowledge of the L2 in several areas, yet usually regarding command of the grammatical system as the main index of proficiency. One of the most widely cited studies in favor of the critical period hypothesis for L2 acquisition is Johnson & Newport (1989). This study found a negative correlation between age of arrival to the United States of Korean and Chinese English learners and their performance on a grammaticality judgment task; crucially, the correlation was significant for early learners (who were within the Critical Period) and not for late learners. The authors interpreted this finding as evidence that the critical period for language acquisition holds true for second language acquisition as well.

The strength of the critical period hypothesis for L2 acquisition still remains controversial. Birdsong & Mollis (2001) carried out a study that used the same design and materials of Johnson and Newport's and added an L1 Spanish group. Their results showed an

overall strong correlation between performance on the grammaticality judgment task and age of arrival for the L2 learners. In line with this finding, Bialystok and Hakuta (1994) propose that it is not necessarily the case that the ability to learn language per se is subject to maturation, instead, human ability to learn in general declines as we age. In other words, age effects are seen across the lifespan, not within a specific critical period.

Going back to Birdsong and Mollis' study, a different pattern of results emerged when the data for the L2 groups were analyzed individually instead of collectively. The correlation between age and performance was found to be significant only for late learners and not for early learners (within critical period), i.e., the opposite pattern of results observed in Johnson and Newport (1989).   Birdsong & Mollis suggest that having found age-related effects beyond the alleged critical period constitutes evidence against it. In addition, Birdsong & Mollis present modest evidence that native-like attainment is possible as one late learner scored in the range of native speakers and thirteen late learners had scores of 92% or above (as compared to only one late learner at this level in the Johnson & Newport study). This finding is in line with Singleton (1995) who proposes that even though the younger the learning of the L2 the better, there are exceptional L2 adult learners who can attain native-like proficiency.

Amidst the debate over the reality of a critical period for language learning, there is variability in terms of how it may affect different language sub-domains, i.e., it seems to be the case that some linguistic abilities are more susceptible than others to maturation. The areas in which adult L2 learners underperform in comparison to native speakers have raised the question of whether their deficiencies are due to lack of grammatical knowledge (representational deficits) or processing issues (computational deficits).

Evidence from psycholinguistic studies suggests that knowing the grammar is not always equivalent to being able to use it effectively in real time. For example, Hopp's (2010) study on German inflection showed that both German natives and advanced learners of German (L1 English, Dutch or Russian) were able to access grammatical knowledge in offline tasks, but under the increased processing burden of a speeded grammaticality judgment task, their accuracy declined.

Hopp's study is just one example of a relatively new line of inquiry that focuses on sentence processing in real time, a complex activity that is critical for language acquisition. A key question in the current literature addressing this issue is whether adult second language learners can process sentences in real time similarly to native speakers. A possible answer to this question was put forward by Clahsen & Felser (2006 a,b) in their formulation of the Shallow Structures Hypothesis. At the center of this proposal is the belief that L2 online processing is deficient because L2 grammar itself is deficient. Adult L2 learners are considered "shallow processors" meaning that during their online sentence processing they can't build/access native-like syntactic representations. It is the aim of the present study to address the aforementioned question of whether L2 learners can process sentences in real time similarly to native speakers while also testing the validity of the Shallow Structures Hypothesis. In order to shed some light on these current issues in the field of second language acquisition, this study will focus on the L2 processing of wh-dependencies online.

1.1 Wh-movement and L1 processing of wh-dependencies

Wh-movement is a type of syntactic operation that takes place when the canonical or basic order of the elements in a construction is modified by displacing a wh-expression to a new position. When this operation applies, the displaced element is referred to as *filler* and the "empty" space left behind after moving is called a *structural gap* or *trace* in the theoretical literature. For example, in a sentence like (1b) the filler *who* is believed to have moved from its base position as the object of the verb *visited* in (1a) to surface as the subject of the embedded clause. The wh-word *who* illustrates a filler and the position it left behind or gap is usually signaled in the literature by a blank space or a trace symbol (*t*). The relationship between the wh-moved element and its trace is called a wh-dependency.

(1) a. Peter visited Mary.

b. I wonder who Peter visited ___.

There are, however, positions from which wh-movement is not allowed. Following Ross (1967), these positions are called "syntactic islands." For example, when the declarative sentence in (2a) is transformed into a question in (2b), attempting to extract the wh-word contained within a relative clause results in an ungrammatical construction. By means of two experiments on processing of wh-movement in real time, the present study tests whether L2 learners can successfully process filler-gap dependencies generated by wh-movement from grammatical positions like (1b) and also respect the grammatical constraint that disallows extraction from syntactic islands like (2b).

(2) a. I saw [the woman that brought the book.]

   b. *What did you see [the woman that brought ___] ?
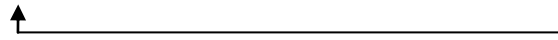
Exploring how the parser processes wh-dependencies can provide some insights about how humans process language in general, the sources of information they utilize and how they implement them. During the processing of wh-dependencies, the parser must establish an association between the extracted element and the empty category or trace it left behind. The mechanism that allows for the establishment of such association is known as gap-filling (Fodor, 1978). There are two ways in which gap-filling is likely to take place. On the one hand, the parser may link the filler to its trace (indirect association), a procedure driven by syntactic information (see Clifton & Frazier, 1989; Crain & Fodor, 1985; Bever & McElree, 1988; Stowe, 1986). On the other hand, the parser may link the filler to its subcategorizer, usually a verb (direct association), a procedure driven by lexico/semantic information (see Pickering & Barry, 1991; Pickering, 1993; Traxler & Pickering, 1996).

In order to illustrate how L1 parsing of wh-dependencies is widely believed to take place, a summary of the key points of Stowe (1986) is provided next. The present study builds on this experimental design. Stowe (1986) included two self-paced reading experiments. The first experiment examined whether parsing is incremental. The second experiment examined whether parsing is guided by syntactic constraints. In Experiment 1, Stowe examined whether the parser, upon encountering a filler like *who* in (3a), would start actively searching for a gap to associate the filler with.

(3) a. My brother wanted to know **who** Ruth will bring us home to ___ at Christmas.

   b. My brother wanted to know if Ruth will bring us home to mom at Christmas.

The first potential gap site the parser would look at is the subject position, a position that is not structurally empty; it is instead already filled by the noun phrase (NP) *Ruth*. Since that position was already filled and the gap-licensor (verb) has not been encountered yet, the parser will continue the gap search and when it comes upon the verb *bring*, it will make a strong prediction that what follows should be the gap site. However, this position is filled by the pronoun *us*. Stowe investigated whether finding a noun phrase in lieu of a gap site generates a disruption in reading time, suggesting that reanalysis is necessary. This is what has been referred to as a 'filled-gap effect.' To test if wh-dependencies are solved incrementally, Stowe compared reading times at the object position (*us*) in sentences containing wh-extraction like (3a) and sentences without wh-extraction like (3b). It was predicted that if wh-dependencies are processed incrementally, there should be object filled-gap effects in the shape of longer reading times at *us* for in the wh-extraction sentence condition (3a) relative to the same region in the non-extraction sentence condition (3b). As predicted, the results of Experiment 1 revealed significantly longer reading times at the object filled-gap position (*us*) in the wh-extraction condition relative to the non-extraction condition. This provides evidence in favor of incremental L1 parsing of wh-dependencies.

   While Experiment 1 tested for incremental processing of wh-dependencies by looking at wh-extraction out of positions licensed by the grammar, Stowe's Experiment 2 explored accuracy in parsing of wh-dependencies by exploring whether the parser will avoid positing gaps in positions not licensed by the grammar such as complex NP islands. Experiment 2 included

control non-extraction sentences like (4a) and sentences containing a wh-word contained within an NP island like (4b).

(4) a. The teacher asked if the silly story about Greg's older brother was supposed to mean anything.

b. The teacher asked what the silly story about Greg's older brother was supposed to mean.

The critical region in Experiment 2 was the object of the preposition *(Greg's)*. Similar to verbs, prepositions are potential gap licensors. Therefore, upon encountering the filler *what* in (4b), the first potential gap site the parser will come across is the object of preposition position (*Greg's*). However, this position is contained within a complex NP island from which wh-extraction is not allowed. An accurate parser, one that respects island constraints, would not attempt to carry out a wh-extraction out of an NP island; therefore, it should not be surprised to find the object of preposition position to be filled since no gap should have been posited there in the first place. In other words, if the parser is accurate, there should not be evidence of a filled-gap effect. Thus, there should no significant difference in reading times at the object of preposition position (*Greg's*) in the NP island condition (4b) relative to the same region in the non-extraction condition (4a). This prediction was in fact borne out by the results of Experiment 2, implying that the parser respects syntactic island constraints, like the complex NP constraint, and avoids positing gaps in grammatically unlicensed positions. Taken together, the results of Stowe's experiments show that L1 parsing of wh- dependencies is both incremental and accurate. The next key question to ask is whether L2 parsing is also incremental and accurate. This question is addressed in the next section.

2. Literature Review on L2 Processing

2.1 The Shallow Structures Hypothesis

The Shallow Structures Hypothesis (Clahsen & Felser, 2006 a,b) is a theoretical proposal about L2 acquisition. Clahsen & Felser explain that there are two possible parsing routes available for sentence processing in real time. On one hand, the full parsing route requires full representation of the grammatical system of the language at hand and is guided by syntactic information. On the other hand, the shallow processing[1] route relies on non-syntactic information (e.g. surface structure, lexico-pragmatic information). Regarding L1 sentence processing in real time, Clahsen & Felser believe that children use the same parsing mechanisms as adults; however, children's parsing tends to over rely on syntactic information, a phenomenon they attribute to children's limited working memory capacity, smaller lexicon and less-automatized lexical retrieval ability. Regarding L2 parsing, adult learners show the opposite pattern of L1 children, i.e., learners tend to rely more on lexico-semantic than syntactic information during online sentence processing.

Under a Shallow Structures Hypothesis account, L2 parsing is believed to follow the shallow route because the syntactic representations the learners are capable of building/accessing during online sentence processing are not native-like due to L2 grammatical deficiencies. In other words, because the L2 grammar is deficient, online processing is not guided by syntactic principles and constraints. Clahsen & Felser believe that parsing in a native-like manner

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[1] The term "shallow parsing" comes from computational approaches to language processing (e.g. Abney, 1991). It refers to the 'task of recovering only a limited amount of syntactic structure from natural language sentences' (Hammerton et al., 2002; p. 552)

depends on the learners' ability to acquire the grammar in a native-like manner and that since the L2 grammar is considered deficient, so is L2 parsing. Despite the syntactic deficiencies, Clahsen & Felser acknowledge that L2 parsing can make use pragmatic notions like plausibility. This possibility is presented next.

2.2 Evidence that learners use plausibility information online

As mentioned above, advocates of the Shallow Structures Hypothesis believe that while detailed syntactic information can't be utilized by L2 learners during online sentence processing, learners do make use of plausibility information. Two studies that provide evidence in favor of learners' access to plausibility information during online processing are Williams et al. (2001) and Dussias and Piñar (2010). Note that these two studies do not 'test' the Shallow Structure Hypothesis, but rather simply provide evidence that plausibility information can be used by L2 learners in the course of processing.

Williams et al. (2001) tested how sensitivity to plausibility constraints affects reanalysis processes while reading wh-questions in English. The participants recruited were English natives and learners who spoke Chinese, German or Korean as their L1. This study included a stop-making-sense task in which the participants were asked to read sentences one word at a time and push a button whenever they thought the sentence had stopped making sense. The participants read sentences like (5a) in which the filler (*which car*) was a plausible object of the verb (*buy*) and sentences like (5b) in which the filler (*which friend*) was an implausible object of the verb (*buy*).

(5) a. Filler plausible as the object of the verb (plausible-at-V)

   Which car did the tourist buy the radio for ___ two months ago?

   b. Filler implausible as the object of the verb (implausible-at-V)

   Which friend did the tourist buy the radio for ___ two months ago?

There were two critical regions in this study. The first critical region was the verb (*buy*). In this region, it was expected that if the participants were sensitive to plausibility information online, they would make the decision that the sentence had stopped making sense there more frequently when the filler (*which friend*) was not a plausible object for the verb (5b) compared to when the filler (*which car*) was a plausible object for it (5a). The second critical region was the direct object position (*the radio*) which is located in the first potential gap site the filler could be associated to. In this region, it was expected that if the participants were positing gaps incrementally regardless of plausibility, they will show an object filled-gap effect in both the plausible and implausible conditions; hence no reading time difference should emerge between them. However, if gap positing procedures are modulated by plausibility information, the participants would show evidence of an object filled-gap effect in the plausible condition (5a) but not in the implausible condition (5b). This was predicted because, for the object filled-gap to emerge, it was necessary that the filler be considered a plausible object for the verb. This effect was to become evident in the shape of longer reading times at (*the bike*) in (5a) relative to (5b). Williams et al. explained that given that the filled-gap effect was to appear only in the plausible at-verb condition (5a), no control conditions without extraction were needed.

At first sight, a disruption in reading times at the post verbal NP (*the radio*) in both conditions seemed to indicate that both groups were oblivious to plausibility information online; and that this triggered object filled-gap effects not only in the plausible condition, where they had been predicted, but also in the implausible one. Nevertheless, both groups made the decision about where the sentence stopped making sense at the verb or the post-verbal NP region (*the radio*) more frequently in the implausible than in the plausible condition (correct choice). Also, looking just at the object position (*the radio*), the data showed a reduction of the filled-gap effect for both groups in the implausible condition. However, the difference between groups was that the reading times were shorter for the natives than for the learners meaning that the natives could access plausibility information, that facilitated recovery from an initial misparse (filled-gap effect), sooner than learners.

Williams et al.'s findings are highly relevant to the present study as they provide evidence that during the online processing of sentences containing wh-dependencies, L2 learners are sensitive to filled-gap effects. In addition, their results also indicate that L2 learners are capable of accessing plausibility information online.

A similar study, Dussias & Piñar (2010) tested how a measure of working memory (reading span) and plausibility information affect reanalysis of wh-dependencies in English natives and Chinese learners of English. In a non-cumulative moving window self-paced reading task, the participants were asked to read four types of sentences. In the implausible conditions (6a,b) the filler (*who*) was an implausible NP object filler for the main verb in the sentence (*declare*); however, the filler (*who*) was an acceptable filler for the verb in the embedded clause (*killed*) in subject position in (6a) and object position in (6b). In the plausible conditions, the filler (*who*) was a plausible NP object for the main verb in the sentence (*know*), however, it

originated as the subject of the verb in the embedded clause (*killed*) in (6c) and as its object in (6d).

(6) a. Subject extraction – implausible

Who$_i$ did the police declare t_i killed the pedestrian.

b. Object extraction – implausible

Who$_i$ did the police declare the pedestrian killed t_i ?

c. Subject extraction – plausible

Who$_i$ did the police know t_i killed the pedestrian?

d. Object extraction – plausible

Who$_i$ did the police know the pedestrian killed t_i ?

The results of this study showed a similar use of plausibility information for both subject and object extractions for high-span learners and English natives. For these two groups, subject extraction sentences were more difficult to process than object extraction sentences in both plausibility conditions. This effect emerged in the shape of longer reading times at the word immediately following the main verb in both subject extraction sentences relative to the same position in object-extraction sentences. In addition, it was noticed that for both natives and high-span learners, the latency was even greater when the filler was a plausible NP object for the main verb, i.e., when *who* was initially misanalyzed as the object of *know* instead of the subject of *killed* in (6c) or the object of *killed* in (6d) which would be the correct analysis. In these cases,

even longer reading times in the plausible conditions show that reanalysis was in effect. Interestingly, the effects described above were not found for the low span learners, suggesting that they were not able to access plausibility information successfully in parsing. It seems to be the case then, that working memory may to a certain degree modulate the access to plausibility information in L2 parsing.

2.3 Processing of wh-dependencies as evidence for Shallow Structures Hypothesis

The L2 processing of filler-gap dependencies, the issue addressed in the present study, has been explored in light of the predictions of the Shallow Structures Hypothesis. Marinis et al. (2005) explored sentence processing in multiple-embedded complex clauses like (7 a,b) by English natives and English learners from L1s that instantiate wh-movement (German, Greek) and L1s that do not (Chinese, Japanese).

(7) a. The nurse who$_i$ the doctor argued t_i that the rude patient had angered t_i, is
         refusing to work late.

     b. The nurse who$_i$ the doctor's argument about the rude patient had angered t_i is
         refusing to work late.

The study tested whether wh-dependency resolution of the gap after the verb *angered* in (7a) would be facilitated by the presence of a previous (intermediate) gap located after the verb *argued*. If so, faster reading times would be expected for the gap after *angered* for condition (7a) relative to the same gap position in condition (7b) where there was no intermediate gap.

The results showed a facilitation effect for the English natives but not for the L2 learners regardless of their native language. These results lead Marinis et al. to conclude that unlike native speakers, learners, regardless of native language, do not have access to abstract syntactic representations during online sentence processing; hence, this study has been taken to support Shallow Structures Hypothesis.

A similar conclusion to Marinis et al. (2005) was also reached in a cross-modal picture priming task study by Felser & Roberts (2007). In this study, L1 English-speaking children and adults and a group of Greek learners of English were asked to listen to a series of sentences containing indirect-object relative clauses like the ones in (8 a-d) and simultaneously make judgments on pictures that would appear on a screen.

(8) Fred chased the squirrel to which the nice monkey explained…

   a. the game's difficult rules [SQUIRREL] in the class …   -Identical gap
                           Gap

   b. the game's [SQUIRREL] difficult rules in the class…   -Identical pre-gap
               Pre-gap

   c. the game's difficult rules [TOOTHBRUSH] in the class … -Unrelated, gap
                        Gap

   d. the game's [TOOTHBRUSH] difficult rules in the class … -Unrelated, pre-gap
                Pre-gap

As soon as a picture of an animal or an object appeared on the screen (shown below in capital letters), the participants had to push a button to indicate whether the picture displayed an entity

that was 'alive' or 'not alive'. The pictures were displayed in synch with either the indirect

object gap position of the sentence the participants were listening to (target position) or a

position which appeared before the gap position and served as a control. The researchers

expected that if the participants were associating the wh-extracted element (filler) with its trace,

there should be priming effects at the position of the indirect object gap (right after *rules*).

According to the syntactic analysis we reviewed earlier, it is in this position that a trace should

be posited because this is where the filler was extracted from. The predictions for the study are

as follows. In the conditions where the gap and the picture were identical, i.e., the gap

represented a squirrel and the picture was of a squirrel (8a,b), there should be evidence of a

facilitation effect when the picture was presented at the indirect object gap position (8a) and not

when the picture was presented in a pre-gap position in the control condition (8b). Hence, faster

response times for the animacy judgment are expected at the critical region (word after *rules*) in

(8a) relative to the same position in (8b). Also, at the indirect object gap position, there should

be faster responses at the critical region in the identical condition (8a) relative to the same

position in the unrelated condition (8c). However, when the picture was presented in pre-gap,

there should not be differences in response times at the critical region regardless of whether the

picture was identical (8b) or unrelated (8d). Therefore, in pre-gap position there should be no

facilitation effect even if the picture was identical to the antecedent (*squirrel*).

The results showed high accuracy in the picture animacy decision for all the groups (adult

natives 94%, child native speakers 97% and learners 96.3%) showing that as L1 speakers, the L2

learners had no problem understanding the sentences or meeting the demands of the dual-task.

Regarding response times, the results for learners differed significantly from both high-span and

low-span native speakers. A comparison of high-span natives and learners found evidence of a

position-specific advantage for identical targets at the gap position; i.e., faster response times at the critical region for condition (8a) relative to (8b) only for native speakers. This facilitation effect is attributed to the natives' ability to reactivate a trace at the gap position. On the other hand, learners' responses to identical targets showed shorter response times relative to unrelated targets both at the gap (8a) and at the pre-gap control position in (8b). Since the facilitation effect found for natives was not found for learners, it is believed that learners were not capable of reactivating the trace at the indirect object gap position. The learners also differed from the low-span native groups in that they responded to identical targets faster than to unrelated ones. Crucially, this facilitation occurred regardless of the position at which the pictures were displayed (pre-gap or at-gap positions). The fact that learners showed indistinctive semantic reactivation (no difference between pre-gap and gap positions) has been interpreted by the authors as evidence that the learners keep the filler active in working memory instead of reactivating it at the gap position. Therefore, in line with Marinis et al. (2005), Felser & Roberts (2007) concluded that L2 learners' mental representations during online processing lack abstract linguistic structure such as movement traces. This has been taken as evidence to support the Shallow Structures Hypothesis (Clahsen & Felser, 2006 a,b), which proposes that post-critical period L2 learners do not make use of abstract syntax in parsing. Instead, their online processing mechanisms are believed to be mainly driven by semantic/pragmatic information.

Hara (2009) believes that letting semantic information instead of syntactic information guide the parser may be the result of overloaded computational resources, a phenomenon that is more likely to affect second language learners than native speakers. However, there is also evidence based on processing of wh-movement that shows that L2 learners do have access to syntax during online processing. These studies are discussed next.

2.4 Evidence against Shallow Structures Hypothesis

Omaki & Schulz (2011) acknowledge that there are several differences between L1 and L2 parsing; however, they challenge the Shallow Structures Hypothesis' tenet that L2 learners can only construct shallow representations that lack structural details. Their study included an offline acceptability judgment task and a self-paced reading task that tested the knowledge of the relative clause island constraint (Ross, 1967) by English natives and Spanish learners of English. The design of their stimuli was based on a previous study by Traxler & Pickering (1996). The offline task tested knowledge of RC island constraints by means of a seven-point acceptability scale. The sentences included in this task were similar to those in the online task but used different lexical items.

The self-paced reading task included four conditions which were subject to two kinds of manipulation. First, plausibility was manipulated by using different filler nouns, *city* vs. *book* for example, which either matched or not the selective properties of the first verb in the sentence. For instance in (9a) the filler *the city* is not a plausible argument of the verb *wrote* because an author cannot write a city; on the other hand, the filler *the book* (9b) is a plausible argument of the verb *wrote*. The other type of manipulation was islandhood. The non-island conditions (9 a,b) have only one relative clause while the island conditions (9c,d) have two relative clauses, one of which is embedded inside the other one. What is crucial in the island conditions, is that the there should not be any attempt to associate the filler (*city* or *book*) to the verb (*wrote*) given that the verb is contained within a relative clause island from which extraction is not allowed.

(9) **a. Non-island, implausible**
    The city that the author wrote regularly about was named for an explorer.

    b. Non-island, plausible
    The book that the author wrote regularly about was named for an explorer.

    c. Island, implausible
    The city that the author who wrote regularly saw was named for an explorer.

    d. Island, plausible
    The book that the author who wrote regularly saw was named for an explorer.

The results of the offline task confirmed that both natives and learners correctly accepted

sentences with licit wh-extraction and rejected ungrammatical sentences with illicit extraction.

According to Omaki & Schulz (2011) this offline task, not present in previous studies, is highly

important as it "provides an independent measure of whether L2 learners had the relevant

grammatical knowledge to demonstrate the expected processing behaviors" (9). In this way, it is

possible to control for factors that may affect the learners' performance in an online task such as

cross-linguistic differences in the processing of wh-dependencies in local vs. long-distance

conditions or differences in the interpretation of argument structure of some verbs.

The results of the online task showed longer reading times for the implausible non-island

condition (9a) at the critical region (*wrote*) relative to the same region in the plausible non-island

condition (9b) suggesting that the parser attempts to locate a gap at *wrote* and thus experiences a

processing difficulty in the presence of a plausibility mismatch. On the other hand, in the island

conditions (9 c,d) no evidence for active gap positing was found (no difference in reading times

at *wrote* or the spillover region *regularly*) for neither the natives, nor the learners which suggests

that they both respect island constraints.

Another study in favor of the learners' ability to access syntactic information during

online processing of wh-dependencies is Cunnings et al. (2010). As in the case of Omaki &

Schulz (2011), this study was based on the eye-tracking study by Traxler & Pickering (1996). Cunning's et al. tested sensitivity to island constraints in native speakers of English, and two groups of learners, L1 German and L1 Chinese. The experimental design included the manipulation of two factors, islandhood and plausibility yielding four sentence types as seen in (10 a-d)

(10) The big city was a fascinating topic for the new book.

a. Non-island Constraint, Plausible

Everyone liked the book that the author wrote continuously and with exceptionally great skill about whilst waiting for a contract.

b. Non-island Constraint, Implausible

Everyone liked the city that the author wrote continuously and with exceptionally great skill about whilst waiting for a contract.

c. Island Constraint, Plausible

Everyone liked the book that the author who wrote continuously and with exceptionally great skill saw whilst waiting for a contract.

d. Island Constraint, Implausible

Everyone liked the city that the author who wrote continuously and with exceptionally great skill saw whilst waiting for a contract.

Cunnings et al. looked at dependency formation in two potential gap sites indicated above inside rectangular figures. The first critical region was the verb at the first potential gap site plus

the following word (*wrote + continuously*). In this region, it was expected that dependency formation would be blocked in the island conditions (10 c,d) but not in the non-island conditions (10 a,b). Consequently, the authors predicted longer reading times at the first potential gap site (*wrote + continuously*) for the implausible sentence (10b) relative to the same region in the plausible sentence (10a).

The second critical region was the verb or preposition at the second gap site plus the word following it (*about/saw + whilst*). In this region, where the true gap turns out to be located, the authors predicted a reversal pattern of the plausibility effect observed in the first critical region as an indicator of reanalysis. In other words, for the non-island conditions, the authors predicted longer reading times for the initially plausible condition (10a) relative to the initially implausible condition (10b). On the other hand, no differences should be observed between in the two island constraint conditions (10 c,d) in any of the two critical regions.

The results for two out of four eye-tracking measurements (rereading and total viewing time) showed an effect of plausibility, longer reading times for implausible than plausible sentences, only in the non-island conditions (10 a,b). On the other hand, no effect of plausibility was found for any group in the island conditions. Based on this data, Cunnings et al. concluded that learners, as well as natives, did not attempt to form filler-gap dependencies in syntactic islands, which means that L1and L2 parsing is guided by syntactic information. At the second critical region, where the actual gap is located, the learners showed longer reading times in the island than the non-island conditions when compared to the natives. The authors interpreted this finding as an indication of complexity effects for the learners, meaning that it is difficult for them to link fillers to their subcategorizers if there is a long distance between them. In brief, this study shows that learners' parsing can be syntax-driven yet sensitive to structural complexity.

As mentioned earlier, the idea that structural complexity may play a role in the learners' ability to process long-distance dependencies is also shared by Hara (2009) who reported a decline in otherwise efficient syntactic gap processing when it overloads the learners' computational resources. By means of a self-paced reading study, Hara explored processing of syntactic gaps in Japanese by two groups of learners (L1 Korean and L1 Chinese). He found that the advanced Korean learners of Japanese were capable of processing syntactic gaps in Japanese correctly when reading short-scrambling sentences; however, when processing long-scrambling sentences, the Korean speakers could not meet the demands of the task because, according to Hara, they were beyond their computational capabilities. Along similar lines, Juffs & Harrington (1995) and Juffs (2005) concluded that processing of subjects gaps was less efficient than processing of object gaps because of parsing deficits, not competence deficits.

The next study we describe, Aldwayan et al. (2010), constituted the point of departure for the development of the present L2 study. The goal of Aldwayan et al. (2010) was to test if native speakers and second language learners are capable of processing wh-dependencies incrementally and if they are aware of syntactic constraints that apply to the processing of wh-movement. The results provide some insight towards answering the question of whether the parser is both incremental and accurate in L1 and L2 processing. At the theoretical level, this study tested the proposal of the Shallow Structure Hypothesis (Clahsen & Felser, 2006 a,b) that unlike native speakers, second language learners are not capable of accessing abstract syntactic representations in parsing,. Given that previous studies have reported mixed results, some in favor and some against the Shallow Structure Hypothesis, the current study, as well as Aldwayan et al. is a contribution to a controversial line of research in the field of second language acquisition.

Aldwayan et al.'s study included a control English speaking group and a group of advanced adult learners of English whose L1 is Najdi Arabic. As explained in the introduction, English is a language that instantiates wh-movement, yet wh-movement is constrained in syntactic islands. On the other hand, Najdi Arabic is a wh- in situ language. Questions are not formed by movement, instead, a resumptive pronoun '*ih*' is used in lieu of a gap and is obligatory except in subject position as seen in (11). In addition, sentences that violate subjacency constraints in English are considered grammatical in Najdi Arabic as seen in (12).

(11) min   alli   arsal-t   ar-rasalah   li-ih
       Who   C   send.PERF.2SG.MASC   the-letter   to-him
       'Who did you send the letter to (him)?'

(12) hatha   ar-rjal   alli Mary   9alima-t-ni   mita   ib-ti   zor-ih

       This   the-man   C   Mary   tell.PERF.3SG.FEM-me   when   will-she   visit-him

       (cf. *This is the man who Mary told me when she will visit ___.)

Following the design of Stowe (1986) for studying the processing of filler-gap dependencies in English natives, Aldwayan et al.'s study developed two experiments to explore this issue with L2 learners as well. Experiment 1 included a non-extraction condition (13a) with two sentences and an extraction condition (13b) with two sentences as well. For both conditions, one sentence contained a pronoun (*us*) and the other one a proper name (e.g. *Sam*) after the critical gap-licensing verb (*photograph*).

(13) a. My brother asked if Barbara will photograph us/Sam beside mom at the graduation.
        b. My brother asked who Barbara will photograph us/Sam beside ___ at the graduation.

As explained earlier, the logic of the filled-gap effect paradigm is as follows. Upon encountering a filler like *"who"* in (13b), an active parser will immediately start looking for the gap associated with it. The first position it will check is the subject position, a position that happens to be filled by "*Barbara*"; therefore, the search for the gap continues. When the parser gets to the verb "*photograph"*, it reaches a gap licensor and predicts that what follows should be the object of gap position from which "*who*" originated; however, this expectation is not satisfied because the gap is actually filled by *"us/Sam".* This generates a disruption in reading times that indexes the beginning of structural reanalysis. Therefore, in the extraction condition, a slowdown in reading time was expected to emerge for natives and learners at the grammatical object filled-gap position in the extraction condition (13b) relative to the same position in the non-extraction one (13a) evidencing sensitivity to a filled-gap effect.

While Aldwayan et al.'s Experiment 1 tested whether the parser processes sentences incrementally by looking at wh-extraction in grammatically licensed positions; Experiment 2 tested whether the parser avoids positing gaps in grammatically unlicensed positions such as complex NP islands from which extraction is not allowed. This experiment included a control condition like (14a) and an extraction condition like (14b).

(14) a. My sister wondered if the boring comments about John's used car were intended to
          entertain the group.   **Complex NP Island**

      b. My sister wondered who the boring comments about John's used car were intended to
          entertain ___.   **Complex NP Island**

For this experiment, under a Shallow Structures Hypothesis account, it was expected that natives would not show a slowdown in reading time in the extraction condition (14b) compared

to non-extraction condition (14a) at the critical region (*John*) because they would not posit a gap

in a grammatically unlicensed position. Learners, on the other hand, would show a slowdown in

reading time at the illicit prepositional object filled-gap position in the extraction condition,

relative to the non-extraction condition if they are shallow processors. In other words, Shallow

Structures Hypothesis predicts that since learners do not have access to abstract syntax, they will

posit a gap in a grammatically unlicensed position which will become evident in the disruption in

reading time triggered by a filled gap effect. In brief, if L2 parsing is not guided by syntactic

constrains, learners will posit gaps in both grammatically licensed (Experiment 1) and unlicensed

positions (Experiment 2).

The results for Aldwayan et al. are summarized in Table 1. The results for Experiment 1

showed longer overall reading times for the learners. At the critical region *us/Sam* (post-verbal

object filled-gap) both groups slowed down in the wh-extraction condition (13b). There was also

a marginal subject filled-gap effect at Region 5 (*Barbara*) which was similar for learners and

natives. This provides evidence that both natives and learners process gaps incrementally.

However, under a Shallow Structures perspective, the presence of an object filled-gap does not

necessarily mean that the learners have access to abstract syntax given that the evidence provided

is about post-verbally filled gaps[2]. An alternative explanation for the filled-gap effect found for

the learners is thematic reanalysis derived from matching the verb to its theme argument (see

Marinis et al., 2005; Pickering & Barry,1991; Pickering, 1993).

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[2] Evidence of pre-verbal gap filling has been reported in Japanese studies such as Nakano et al. (2002) and Aoshima et al. (2004). Given that Japanese is a head final SOV language, subcategorization information provided by the verb will not be available to the parser until it reaches the end of a sentence. Hence, it is argued that the observed pre-verbal filled gap effects are undoubtedly driven by syntactic, instead of semantic information (see also Wagers and Phillips, 2009 for discussion of the processing of wh-dependencies in sentences with coordinated constructions and parasitic gaps).

Table 1. Mean Reading Times at the critical regions for native speakers and L2 learners
(by participants analysis)

	Experiment 1		Experiment 2	
NATIVES	Subject (Region 5)	Object (Region 8)	Subject (Region 5)	Object (Region 9)
If	398.93	394.24	396.71	403.15
Wh	**414.99	*423.82	392.60	405.45
LEARNERS	Subject (Region 5)	Object (Region 8)	Subject (Region 5)	Object (Region 9)
If	686.77	533.62	471.43	670.87
Wh	**739.26	*565.94	*507.12	697.72

*Significant effect, **Marginal effect

(Modified from Aldwayan et al., 2010)

The results for Experiment 2 showed no slowdown for natives or learners at region 9 (not grammatically licensed extraction site). This finding clearly indicates that learners respect island constraints that disallow wh-extraction from within a complex NP. There was also a marginal effect at filled-subject position when comparing (14a) vs. (14b) but upon further analysis, it turned out to be significant only for the learners.

Taken together, the results of Experiments 1 and 2 show that second language learners posit gaps incrementally in online processing and avoid positing gaps in grammatically unlicensed positions. This constitutes evidence against the claim of the Shallow Structures Hypothesis that second language learners do not have access to abstract syntax in online processing.

2.5 Motivation for the present study

By looking at processing of wh-movement in English by Spanish natives, the current study will expand on a line of research that aims at better understanding how adult learners can process a second language, an endeavor that previous L2 online processing studies have addressed, but with mixed results. While testing for the validity of the Shallow Structures Hypothesis for L2 processing in real time, this study will address two key questions. First, it will investigate if as widely assumed for L1 parsing, L2 parsing takes place incrementally by testing if learners posit gaps online. Secondly, this study will test if L2 parsing is also accurate by examining if learners avoid positing gaps in positions not licensed by the grammar as in the case of syntactic islands. The present study was developed following and improving the design of Aldwayan et al. (2010). It addresses a methodological limitation of Aldwayan et al. in which Experiment 1 the potential gap licensor was a verb while in Experiment 2, the potential gap licensor was a preposition. The problem with their design is the possibility that the observed patterns for learners may be the result of using different gap licensors, hence preventing a fair comparison.

The following section provides the linguistic background relevant to the processing of wh-dependencies for English and Spanish. Section 4 describes the methodology implemented in the present study, including improvements made to the design of Aldwayan et al.'s study. In section 5, we will report the findings of the present study and in section 6 we will provide a general discussion about the findings and their implications to the field of Second Language Acquisition.

3. Linguistic Background

3.1 Wh-Movement in English

English is a Subject-Verb-Object (S-V-O), primarily head-initial language that instantiates wh-movement. As explained in the introduction, wh-movement alters the basic order of the elements in a construction by displacing a wh-expression to a new position. For example, when the declarative sentence in (15a) undergoes transformation into a question (15b), the wh-word *who* moves from its base position as the object of the verb *surprise* and surfaces preverbally at the front of the overall structure. In this example, wh-movement and *do*-support apply in order to form a question.

(15) a. Mary surprised John.   Declarative sentence

b. Who did Mary surprise ___ ?   Question
    Filler   Gap
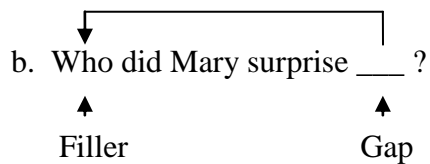
3.1.1 Wh-movement from object positions

The displaced element in a wh-transformation can be extracted out of a matrix or an embedded clause and from either a subject or an object position. Extraction from object positions will be presented first. In the present study, both experiments focus on wh-movement

out of object positions, yet wh-movement out of subject positions will also be addressed in the discussion section .

3.1.1.1 Object extraction in matrix clauses

The sentence in (16a) illustrates a matrix clause whose main verb is *entertained*. The NP *the children* is the object of that verb. When the object is extracted as in (16b), the wh-word *who* (asking about *the children*) moves from its original post-verbal position and surfaces on the left edge of the clause.

(16) a. The clown entertained the children with a balloon.   Declarative sentence

     b. Who did the clown entertain _____ with a balloon?   Matrix question

3.1.1.2 Object extraction in embedded clauses

Wh-extraction is also possible from an embedded clause as seen in (17b) in which the wh- word moved from the object position in the embedded clause to subject position.

(17) a. Bill thinks that the clown entertained the children with a balloon

     b. Who does Bill think that the clown entertained ___with a balloon?

3.1.1.3 Wh-extraction from object of a preposition position

The objects of prepositions can also be wh-moved. In wh-movement of the object of a preposition, English allows two options. The preposition can be stranded, as in (18b) or the preposition can be pied-piped, as in (18c):
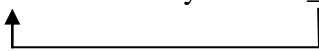
(18) a. The butcher cut the bone with a knife.

     b. What did the butcher cut the bone with?   Stranding

     c. With what did the butcher cut the bone?   Pied Piping

Notice that in (18b) only the wh-word is displaced from its position while the preposition is "stranded" at the end of the question. On the other hand, in (18c) both the wh-word and the prepositional phrase are moved together in an operation called "pied piping". Even though these two ways of wh-movement out of an object of preposition are available in English, preposition stranding is strongly preferred over pied-piping.

3.1.2 Subject extraction in matrix questions

When an interrogative wh-word serves as the subject of a matrix question, it must stay at the front as in (19b). However, in matrix questions in which the wh-word is not the subject of the matrix clause, wh-movement applies and the displaced element moves to the left-most position. When movement applies, an auxiliary verb must follow the wh-word; if there is no auxiliary verb, matrix questions require the presence of do-support as seen in (20b).

(19) a. Barney broke the mirror.   Non-subject extraction

   b. Who broke the mirror?

(20) a. Mary believes (that) Barney broke the mirror.   Subject extraction

   b. Who does Mary believe ___ (*that) broke the mirror?

3.1.2.1 Subject extraction in embedded questions

Unlike matrix questions like (20b), embedded questions like (21a,b) do not require do-support. However, the non-subject extraction embedded question (21a) resembles the matrix question in that the order of the elements is canonical (S-V-O). On the other hand, in the subject extraction embedded question (21b), the order of the elements on the surface is O-S-V (…*who Mary believes…*).

(21) a. I wonder who broke the mirror.   Non-subject extraction

   b. I wonder who Mary believes ___ broke the mirror?   Subject extraction

3.1.3 Island Constraints

Ross (1967) establishes the existence of "islands", i.e. structures from which extraction is not allowed. Islands are typically classified as either "weak" or "strong". Weak islands forbid extraction out of some phrase types but not others, a reason why they are also called "selective" islands. For example, the wh-islands illustrated below are considered weak because even though

extraction is taking place out of the same type of phrase, the judgments on grammaticality vary

depending on what is being extracted. While extraction of an argument degrades the

acceptability of a sentences it does not lead to ungrammaticality as seen in (22b); however,

extraction of an adjunct does lead to ungrammaticality as in (22c).

(22) a. Mary wondered whether Bill read the book yesterday.

     b. ?What did Mary wonder whether Bill read *t* yesterday.   Argument extraction

     c. *When did Mary wonder whether Bill read the book *t* ?   Adjunct extraction

     Strong islands are domains which block extraction of all wh-elements, both arguments

and adjuncts. Updating the terminology, Ross' Complex Determiner Phrase (DP) Constraint[3]

says that no material can be moved out of a definite DP. Therefore, attempting to extract the wh-

word in argument position in (23b) or the wh-word in adjunct position in (23c) is, with no

exception, considered ungrammatical.

(23) a. Mary believed [$_{DP}$ the gossip that John married Sue last year].

     b. *Who$_i$ did Mary believe the gossip that John married *t*$_i$?   Argument

     c. *When did Mary believe [$_{DP}$ the gossip that john married Sue *t*]   Adjunct

     Relative clauses present another kind of 'strong island'. As seen in (24b), extraction out

of the object position in the relative clause island will be ungrammatical.

(24) a. Mary met [the man [that/who wrote the book]]   Relative clause

---

[3] Originally labeled Complex NP Island Constraint in Ross (1967).

b. *What did Mary meet [that man [that/who wrote t]]

3.1.4 The Subjacency Principle in English

The subjacency principle (Chomsky, 1973) establishes that a constituent like a wh-phrase may only cross one bounding node in a single step. The bounding nodes denote syntactic frontiers that may be crossed in an extraction. Chomsky (1973, 1977) proposes that in English, the bounding nodes are NP and S (currently DP and IP). For example, in (25) the wh-phrase *who* crosses only one bounding node (IP) before it surfaces at the beginning of the question.

(25) a. Mary met John at the store.

   b. Who$_i$ [$_{IP}$ did Mary meet t_i at the store?]
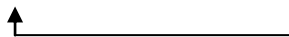
While in (25) there the wh-word crossed only one bounding node, in (26) the who-word crosses two bounding nodes, however, the displacement occurs one step at a time, i.e., only one bounding node is crossed every time the wh-word moves thus respecting the subjacency condition. On the other hand, in (27b) the wh-word *which* crosses two boundaries (DP and IP) in a single movement which yields the construction ungrammatical.

(26) a. Mary believes that John bought a jacket at the store.

   b. What$_i$ [$_{IP}$ does Mary believe [$_{CP}$ t_i that [$_{IP}$ John bought t_i ?]]]

(27) a. Mary loves the teacher in her yoga class.

      b. *Which$_i$ class [$_{IP}$ does Mary love [$_{DP}$ the teacher in t_i ?]]

3.2 Wh-Movement in Spanish

As in the case of English, Spanish is a head initial language that instantiates wh-movement. Spanish is mostly an S-V-O language; however, as shown below, certain constructions require that the canonical order of constituents be altered. To facilitate comparison between how wh-movement operates in English and Spanish, the Spanish section will mimic the organization of the English section presented previously.

3.2.1 Wh-movement from object positions

3.2.1.1 Object extraction in matrix clauses

Unlike English, Spanish matrix questions require subject-verb inversion and there is no do-support. Notice that in the declarative sentence in (28a), the order of constituents is S-V-O while in the question in (28b), wh-movement has applied fronting *que* 'what' and the verb and the subject invert. Failing to invert the subject and verb after wh-movement applies makes the construction ungrammatical as in (28c).

(28) a. Declarative Sentence

     El   payaso entretuvo   a   los niños   con un globo.
     The clown   entertained [to] the children with a   balloon
     'The clown entertained the children with a balloon.'

  b. Wh-movement + inversion

     A quién   entretuvo   el payaso   con   un globo?
     [to] whom   entertained the clown   with a   balloon
     'Who did the clown entertain with a balloon?'

  c. Wh-movement - inversion

     *A quién   el   payaso entretuvo   con   un globo?
     [to] whom   the clown   entertained with a   balloon
     'Who did the clown entertain with a balloon?'

3.2.1.2 Object extraction in embedded clauses

     As in the case of object wh-extraction in matrix clauses, object wh-extraction in

embedded clauses is also possible. However, unlike the subject and the verb in a matrix clause,

the subject and the verb in an embedded clause do not require inversion. For example, in (29a)

the subject of the embedded clause (*el payaso*) 'the clown' appears before the verb in the

embedded clause (*entretuvo*) 'entertained' and the same order is kept in the embedded question

in (29b) in which wh-movement has taken place. Notice, though, that in the embedded question

example (29b), the subject (Bill) and the verb (*piensa*) 'thinks' of the matrix clause do get

inverted.

(29) a. Declarative Sentence

Bill piensa que el payaso entretuvo   a   los niños   con el   globo.
Bill thinks that the clown   entertained [to] the children with the balloon
'Bill thinks that the clown entertained the children with the balloon'

b. Embedded Question

A   quien   piensa Bill que el payaso entretuvo   con   el   globo?
[to] whom thinks Bill that the clown   entertained with the balloon?
'Who does Bill think that the clown entertained with the balloon?'

3.2.1.3 Wh-extraction from object of a preposition position

Another crosslinguistic difference relevant to the processing of wh-dependencies involves complements to prepositions. Recall that English allows preposition and their complements to be separated in two possible ways. The preferred form is stranding illustrated in (30a), but as explained earlier pied-piping is also possible as seen in (30b).

(30) a. What did the butcher cut the bone with?   Stranding

b. With what did the butcher cut the bone?   Pied-piping

However, Spanish does not allow preposition stranding as seen in (31c). Pied-piping of the preposition and its object is obligatory as in (31b).

(31) a. El carnicero cortó el hueso con un cuchillo
          The butcher cut the bone with a knife.

b. Con qué cortó el hueso el carnicero?
   With what (he) opened the door

c. *Qué cortó el hueso el carnicero con?
   What cut   the bone the butcher with
   With what did the butcher cut the bone?

3.2.2 Subject Extraction

3.2.2.1 Subject extraction in matrix questions

As in the case of English, a wh-word that serves as the subject of a matrix question must

stay at front as in (32a) in preverbal position.   The Spanish canonical order of constituents (S-V-

O) must be respected or the construction would be ungrammatical as in (32c).

(32) a. Declarative Sentence

      Non-subject extraction
      Barney broke   the mirror.

   b. Quién quebró el   espejo?
      Who   broke   the mirror?

   c. *Quebró quién el   espejo?
      Broke   who   the mirror

As in the case of English, subject extraction is possible if the wh-word is not the subject

of the matrix clause as in (33b). Unlike English, Spanish does not require a do-support type of

operation. Notice that subject-verb inversion applies in the matrix clause in (33b) but not in the

embedded clause. Also, while the complementizer *that* is usually optional in English, its Spanish

counterpart (*que*) is mostly obligatory.

(33) a. Subject Extraction

Mary cree   que   Barney quebró el   espejo.
Mary believes (that) Barney broke   the mirror.

b. Quién cree   Mary   que   quebró el   espejo?
Who   believes Mary   that   broke   the   mirror.
'Who does Mary believe broke the mirror?'

3.2.2.2 Subject extraction in embedded questions

As in the case of object extraction in matrix and embedded Spanish questions, subject

extraction also requires subject-verb inversion as in (34b) in which the verb *cree* 'believes'

antecedes the NP *Mary*. When wh-movement takes place, the subject of the embedded clause

quien 'who' is moved to the left-most position in the matrix clause.

(34) a. Non-subject extraction

Me pregunto quién quebró el espejo.
I   wonder   who   broke   the mirror.
'I wonder who broke the mirror.'

b. Subject extraction

Me preguntó quién cree   Mary que ___ quebró el   espejo.

44

I   wonder   who   believe   Mary   that   broke   the   mirror.
'I wonder who Mary believes broke the mirror.'

3.2.3 Island Constraints

What is relevant to the present study regarding wh-movement constraints is that just like

English, Spanish observes the relative clause island constraint. For instance, in (35b) it is not

possible to extract *que* 'what'out of its object of the verb *compró* 'bought' position because the

construction will be ill-formed. Learners' awareness of this constraint in online processing will

be tested in experiment 2 of the present study.

 (35) a. Juan visitará al hombre que compró el auto ayer.

       b. *Qué visitará Juan al hombre [que compró ayer *t*] ?

Out of the data presented so far, a crosslinguistic difference that stands out is that Spanish

matrix and embedded question formation requires subject-verb inversion. Hence, the order of

constituents in a matrix question (36b) and an embedded question (36c) is the same (O-V-S).

 (36) a. John comprará un auto   Declarative sentence
           John will-buy a car

       b. Qué   comprará John?   Matrix question
           What will-buy   John?

           Me pregunto qué   comprará John.   Embedded question
           I   wonder what will-buy John.

On the other hand, question formation in English is different for matrix and embedded clauses. English matrix questions require an auxiliary verb like *will* in (37b). If there is no other auxiliary verb, then the verb do is used as an auxiliary (do-support). Notice that while in the declarative sentence (37a) the auxiliary appears after the subject (*John will*), in the matrix question (37b) the positions of the subject and the auxiliary are inverted (*will John*). In embedded questions, English does not allow subject-auxiliary inversion or do-support as shown in (37d).

(37) a. John will buy a car.   Declarative sentence

b. What will John buy?   Matrix question

c. *What John will buy?

d. I wonder what John will buy.   Embedded question

As seen above, in both matrix and embedded clauses in Spanish, wh-extraction is allowed and the same word order surfaces. On the other hand, as seen in the equivalent English constructions, wh-extraction in matrix clauses is not allowed in the absence of subject-auxiliary inversion as in (37c). Hence, when subject-auxiliary applies to make the construction grammatical as in (37b) we can see that a different word order surfaces when we compare it to the embedded question (37d). These differences between Spanish and English are not expected to affect the design of our stimuli given that the two experiments we propose in the present study will look at wh-extraction only in embedded clauses.

3.2.4 The Subjacency Principle in Spanish

Just as English, Spanish also respects the subjacency principle which poses that a wh-

constituent can only move across one bounding node in a single step. However, Torrego (1984) proposed that the bounding nodes may be different in these two languages. The evidence put forward to support this claim comes from Torrego's study of indirect questions in Spanish. Indirect question are considered "weak" islands that allow wh-movement as in (38). According to Torrego (1984), extraction out of indirect questions in Spanish is possible because the bounding nodes are different from those of English, i.e., while in English the bounding nodes are NP and IP, in Spanish, the bounding nodes are NP and CP. Therefore, as seen in the comparative syntactic trees for (38) when the wh-word moves from object of the embedded clause position to a position higher in the tree it crosses two bounding nodes in English in a single movement which violates subjacency, but it only crosses one bounding node at a time in Spanish respecting subjacency

(38) a. *What will you wonder t [$_{CP}$ where [$_{IP}$ he will put t]

b. ¿Qué no sabes t [$_{CP}$ dónde [$_{IP}$ él pondrá t] ?
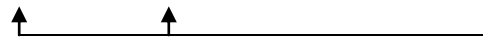
English   Spanish
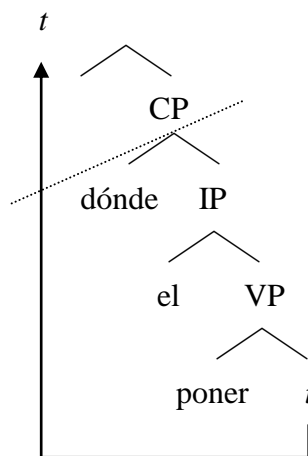
Although both languages are subject to the subjacency principle, the bounding nodes that set the

domains from which wh-movement is allowed are different. While in English the bounding

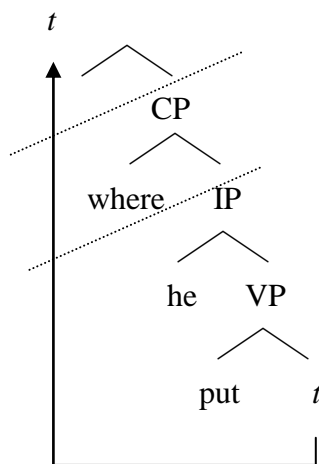nodes are IP and NP, in Spanish the bounding nodes are CP and NP. Regardless of this

difference, both languages observe strong island constraints such as the complex DP island, the

coordinate structure constraint and the relative clause island to name a few. Both languages also

have weak islands. For instance, it is possible to extract a wh-element out of indirect objects in

Spanish and non-finite wh-islands in the case of English.

2.3 Summary of linguistic background

     The crosslinguistic data provided in this section shows that English and Spanish are

typologically similar languages. They are both head-initial and predominantly S-V-O languages

that instantiate wh-movement. They both allow wh-extraction out of embedded clauses; English

requires do support though while Spanish requires subject-verb inversion. Another commonality

is that both languages make use of pied-piping; however, an entire prepositional phrase is

obligatorily pied-piped in Spanish while in English pied-piping is optional. Finally, most

relevant to the present study, both languages respect strong island constraints like the relative

clause island which forbids wh-extraction out of material contained within a relative clause.

4. Methods

4.1 Participants

        This study included two groups of participants. The control group included 59

monolingual native speakers of English recruited at the University of Kansas. As discussed

below,[4] some of the participants were eventually removed from the study; therefore, the data of

48 native participants (32 females and 16 males) was used in the statistical analysis. For this

group, the mean age was 21.75 (range: 18-42; SD: 4.59). Out of the 48 natives, 42 were

undergraduate students, 4 graduate students and 2 staff at the University of Kansas.

        For the English learner group, we recruited 64 native speakers of Spanish in Costa Rica

who did not have significant exposure to English prior to age 12. As in the case of natives, some

participants in the learner group also had to be removed (see below)[5], thus, the data of 54

learners (20 males and 34 females) were used in the statistical analysis. The mean age at which

the learners started to learn English in their native country, Costa Rica, was 12.19 years (SD:

5.09) and the mean age at the time of data collection was 24.54 (range: 20-37; SD: 5.02). All of

the learners were affiliated with the Universidad de Costa Rica; 31 senior undergraduates and 4

graduate students were majoring in either English or Teaching of English as a second language,

16 were English as a Foreign Language instructors and 3 were instructors in fields not related to

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[4] Native participants were removed for several reasons: 4 were removed due to an administration error; 1 was removed because she was raised bilingual; 4 were removed due to overall reading times below 250 ms, meaning they were probably reading too fast to pay attention to the task; 1 was removed due to low accuracy in the answers to the comprehension probe; 1 was removed to balance across presentation lists.
[5] In the learners group, 7 participants were removed because their linguistic background questionnaires showed that they had had significant exposure to English in childhood; 2 learners were removed due to low accuracy in their answers to the comprehension probe; 1 learner was removed because his computer file information got corrupted.

language. The learners' English proficiency was assessed by means of the Listening

Comprehension Test (LCT), a 45-point standardized test developed by the English Language

Institute at the University of Michigan (1972). The learner's mean proficiency was 93.74%

(range: 80% to 98%, SD: 2.20) which shows that they are advanced learners. Regarding

compensation for participating in the study, the native speakers were given extra credit in one of

their classes while the learners were paid and in some cases they also received extra credit in the

class they were recruited from depending on their instructor's wishes. All participants in the

present study had normal or corrected-to-normal vision.

4.2 Self-Paced Reading Task

4.2.1 Stimuli for Experiment 1

This experiment was a partial replication of experiment 1 in Aldwayan et al. (2010). It

contained 20 pairs of sentences. Each pair included a control non-extraction sentence such as

(39a) and a sentence with wh-extraction from the object of the preposition position (region 10)

(39b). Unlike Aldwayan et al. (2010), which included an additional version of each sentence

using a pronoun (*me/us*) in the filled-object position (region 8), our experiment only included the

proper name version. For this experiment, we created two Latin Square presentation lists so that

every participant would read a sentence from each pair, but no participant would read more than

one version of a given sentence.


```
              1       2       3    4        5     6       7      8    9    10  11 12    13
(39)  a. My brother asked  if     Barbara will photograph Sam beside mom at  the graduation
         b. My brother asked who  Barbara will photograph Sam beside ____   at  the graduation.
```

Following the original design of Stowe (1986), the sentences were created using verbs that can take sentential complements (*ask, wonder, reveal, guess, know*). Each of these verbs, located in region 3, was used four times. In the wh-extraction condition (39b), there were three potential gap sites. The first potential gap was in subject position (*Barbara*), a region in which the second language learners in Aldwayan et al.'s study had had been found to show evidence of filled-gap effect sensitivity. The second potential gap site was in object position (*Sam*). In this region, considered the critical region in Experiment 1, all of the proper names were three-letters long in order to control for length; half of them were male and the other half female. The names chosen for regions five and eight were considered common in English as consulted through several baby-naming ranking websites.

The critical region was preceded by a verb (region 7). Each of these verbs was used two times (e.g. *photograph, discover*). As in the case of Aldwayan et al., ditransitive verbs in this position were avoided as they would trigger an additional potential object gap. We also did not use verbs that were optionally transitive as they may not trigger the expectation of an object gap. The last potential gap site was the actual gap site located in object of a preposition position (region 10).

As mentioned above, in this experiment, we focused on the grammatical object filled-gap position in the extraction condition (region 8). Evidence for incremental processing of wh-dependencies is expected to emerge in this region. As a result of a filled-gap effect, we would expect a slowdown in reading time in region 8, i.e. at *Sam,* in the extraction condition (39b) relative to the reading time for the same region in the non-extraction condition (39a) for both natives and learners. As aforementioned, previous findings also suggest the possibility of finding a subject-filled gap effect in region 5 (*Barbara*).

4.2.2 Stimuli for Experiment 2

While the focus of experiment 1 was to test if native speakers and L2 learners can process wh-dependencies incrementally, experiment 2 focused on testing if they respect syntactic constraints that restrict wh-extraction during online sentence processing. As mentioned earlier, our experimental design addresses an issue raised by Aldwayan et al. (2010). In their Experiment 2, the object gap licensor (region 8) was a preposition as seen in (40 a,b) while in their Experiment 1, the gap licensor was a verb.

```
                1    2        3     4 5    6        7        8    9     10  11 12      13    14
 (40)  a.  My sister wondered if the boring comments about John's used car were intended to
           entertain the group.


       b.  My sister wondered who the boring comments about John's used car were intended to
           entertain ____.
```

Aldwayan et al. found that both learners and natives showed a slowdown at the critical region in Experiment 1, but not in Experiment 2. In order to rule out differences due to gap-licensing heads (verbs or prepositions) they suggested that a possible follow-up for their study would be to compare "grammatically-licensed vs. illicit extracting from identical licensors" (79). Our version of Experiment 2 does exactly that. In our Experiment 2, we have an island relative clause from which extraction is not allowed, with a verb as an object-gap licensing head. This provides a better basis for comparison with experiment 1 in which the gap-licensing head is also a verb and prevents that possible differences between both experiments be due to the licensor being used instead of the manipulation we developed.

In this experiment, there were 20 pairs of sentences which contained a relative clause. Sentence (a) in each pair was the control non-extraction sentence as in (41a). Sentence (b) in each pair was the wh-extraction sentence. In this condition, the filler (*who*) cannot be associated with the second potential gap position, region 9 (*Jacob*), because even though we have a licensing verb (*suspended*) extraction of material contained within a relative clause is not allowed in English. For this experiment, we created two Latin Square presentation lists so that every participant read a sentence from each pair, but no participant would read more than one version of a given sentence.

```
          1      2        3    4      5   6       7       8        9  10  11       12
 (41)  a. My teacher wondered  if   the principal that suspended Jacob last spring disappointed
          the parents with the news.
```

```
          1       2        3     4    5   6      7       8        9  10  11       12
       b. My teacher wondered who the principal that suspended Jacob last spring disappointed
          with the news.
```

Similar to Experiment 1, in region 3 we used verbs that can take sentential complements (*ask, investigate, question, wonder*). Each one of these verbs was used five times.[6] All proper names at the critical region (*Jacob*) were the same length (five letters); half of them were male and half of them were female as in Experiment 1. We also controlled that the critical gap-licensing verbs (region 8) were neither optionally transitive, as this may not trigger the prediction for an object gap or ditransitive to avoid prediction of an additional object gap.

Since sometimes effects in reading time studies are evident in the spillover region (the word(s) right after the critical region), we included an adverbial phrase like "*last spring*"

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[6] We did not use verbs like "doubt" or "inquire" because native speakers consulted during stimuli development considered that some sentences created with these verbs were grammatical but did not sound natural.

intervening between the key licensor in region 8 "*suspended*" and the next verb (also a potential gap licensor). In addition, for the sake of naturalness, we included a prepositional phrase at the end of each sentence.

For Experiment 2, it was expected that native speakers would not show evidence of a filled-gap effect in region 9 (*Jacob*) because the parser would not have predicted a gap to exist there in the first place. This would yield no significant differences in reading times at (*Jacob*) in the constrained wh-extraction condition (41b) relative to the control non-extraction condition (41a). The same was expected of the learners if they also respect syntactic constraints; however, if that is not the case, i.e., learners would disregard the island constraint and attempt to posit a gap in an unlicensed position. This would trigger a slowdown in reading time at the illicit object filled-gap position (*Jacob*) in the constrained wh-extraction condition (41b) relative to the control non-extraction condition (41a). In brief, if L2 parsing is not guided by syntactic constraints, learners would posit gaps in both grammatically licensed (Experiment 1) and unlicensed positions (Experiment 2).

4.2.3 Fillers

The fillers used in this study were the same as Aldwayan et al. (2010) and included a wide variety of structures to deviate attention from the targets. For instance, some sentences like (42) contained a wh-word but no extraction is supposed to take place given that extraction out of a sentential subject is not allowed; therefore, it is not the case that just because there is a wh-word the participants should start looking for gaps. Unlike the critical verbs used in experiments 1 and 2, some fillers contained verbs that were not obligatorily transitive such as *join* in (43),

verbs that were ditransitive as *deliver* in (44) or intransitive since they do not require the presence of an object.

(42) My boss questioned who will report me to Martha after the meeting.

(43) The teacher revealed who Beth will join with Paul at the cafeteria.

(44) My mother wondered who will deliver me a large vase of fresh flowers.

Some fillers contained sentential complements introduced by complementizers other than *if* and *who* such as *what*, *that* or *whether* to add variety to the sentences and to make *who* less salient. Other structures included expletive forms, proper names or pronouns that could not be coindexed with the wh-word displaced in the sentence as in (45).

(45) The students guessed what Judy will ask us next week on the test.

In brief, there are twelve different types of structures in the fillers. Finally, in our study, we refined the controls on the stimuli to ensure that there would be no repetition of the critical gap-licensing verbs and the proper names in critical positions in neither the experiments, nor the fillers. This avoids possible priming effects emerging from having encountered the same word or a very similar word previously.

4.2.4 Procedure for the Self-Paced Reading Task

The 20 sentences from experiment 1 and 20 sentences from experiment 2 were presented together with the 80 fillers resulting in a 1:2 ratio of experimental sentences and fillers. The stimuli were presented in random order in a word-by-word, non-cumulative moving window self-paced reading paradigm (Just et al., 1982). Under this paradigm, every sentence was masked by a series of dashes equal in length to the word it masked; the masking included words and punctuation, but preserved the spaces between words. As the participant clicked on the mouse to move along the display, a word was unmasked while the previous word was masked again.

This task was administered on personal computers via *Paradigm* (Tagliaferri, 2005). The participants used corded optical mice to control the display of words during the self-paced reading task. The participants were told to hold the mouse with the hand they usually prefer to handle it with.

As in the case of Aldwayan et al. (2010) we included a comprehension probe at the end of every trial (including fillers). The whole sentence the participant just read appeared again unmasked and with a missing word. The participant was asked to indicate which word should fill in the blank space by choosing between two options. One possible word was displayed on the left side on the screen and the other option on the right side of the screen. The participant made his/her choice by hitting either one of two keys labeled as "LEFT" or "RIGHT" on the keyboard. The position of the missing word was varied across trials to avoid directing the attention to a particular region. The position of the correct response was also balanced; half correct answers were on the right side of the screen and the other half on the left side of the

screen. The participants had 10 seconds to provide their answer to the comprehension probe or it would time out. The font used for all trials was Courier New 9.75 pt., black and bold against a white background in the box where the words were displayed; the background of the computer screen was light sky blue[7].

The participants were instructed to read the sentences naturally and answer the comprehension questions as accurately as possible. They were also asked not to take breaks in the middle of reading a sentence. Before starting the task, the participants read a short tutorial that included examples and two practice items for them to get used to the moving window display and an example of the comprehension probe. At this point, the task administrator stepped in to clarify any questions the participants may have had and supervised them as they took three practice trials. If necessary, the task administrator gave the participants feedback on how to take the task or just told them to start as soon as he stepped out of the room/cubicle used for testing. In order to allow the participants to rest their eyes, they were given two breaks (every 40 sentences). The experiment took approximately 30 to 40 minutes to complete.

4.3 General Procedure

The participants were asked to read and sign a consent form and complete a background information questionnaire in their native language. The proficiency level of the second language learners was estimated by means of the Listening Comprehension Test (University of Michigan, 1972) which was administered via the experimental control software Paradigm (Tagliaferri,

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[7] Most of the trials were displayed on a single line, yet nine target sentences from experiment 2 and a few filler sentences few fell into two lines. This was not a problem because it was only one or two words that would appear in a second line and the measurements in the wrap-up portion of them were not relevant to our study.

2005). This test took approximately 12-15 minutes and was given to the L2 learners after they had completed the self-paced reading task. The native control group was tested at the Second Language Acquisition lab at the University of Kansas in small groups (no more than four participants at a time). The second language learners were tested abroad at the Universidad de Costa Rica in a quiet room individually or in pairs but in separate cubicles.

4.4 Summary of predictions for the present study

Our first experiment allows us to test for incrementality of L2 parsing by looking at the presence/absence of filled-gap effects. Based on previous studies that have addressed this issue in L1 processing (Stowe, 1986) and L1/L2 processing (Williams et al., 2001; Aldwayan et al., 2010) it is predicted that both natives and learners would show sensitivity to an object filled-gap effect in a grammatically licensed position evident in longer reading times for region 8 in the wh-extraction condition (46b) relative to the non-extraction condition (46a).

```
            1     2     3    4        5     6        7       8     9     10   11  12    13
(46)  a.  My brother asked  if     Barbara will photograph Sam beside mom at  the graduation

      b.  My brother asked who  Barbara will photograph Sam beside ____  at  the graduation.
```

Moreover, following the findings of Aldwayan et al. (2010) there is a possibility of finding a subject filled-gap effect. If found, this effect will be evident in longer reading times at the subject filled gap position (*Barbara*) for the extraction condition (46b) relative to the non-extraction condition (46a). The same possibility of finding subject filled-gap effects stands for

Experiment 2, where we have also NPs in subject position following the filler *who* such as *the*

principal in (47b).

Experiment 2 tests whether learners, like English natives, are capable of accessing

abstract syntax during online parsing of wh-dependencies. Under a Shallow Structures

Hypothesis (Clahsen & Felser, 2006) view, second language learners' grammar is considered

deficient regardless of L1. No advantage should be expected for Spanish natives on the basis of

their L1 typological similarities to English. Since learners can't access full syntactic

representations, they will not be able to respect island constraints as native speakers do. This

would generate different results for natives and learners. Native speakers are expected to respect

the syntactic constraint that disallows extraction from the object position in a relative clause

island. Therefore, they will show no significant differences in reading times at *Jacob* (region 9)

for the extraction condition (relative clause contained within a wh-clause) as in (47b) relative to

the non-extraction condition (relative clause contained within an if-clause) as in (47a).

	1	2	3	4	5	6	7	8	9	10	11	12

(47) a. My teacher wondered if   the principal that suspended Jacob last spring disappointed
      the parents with the news.

	1	2	3	4	5	6	7	8	9	10	11	12

b. My teacher wondered who the principal that suspended Jacob last spring disappointed
   with the news.

In the case of the learners, the Shallow Structures Hypothesis proposes that adult second

language learners can't access abstract syntax during online parsing. Hence, they are expected to

posit a gap in a grammatically unlicensed position, the object position in the relative clause,

which will trigger a filled gap effect. If this is the case, we will see longer reading times at the

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object position (region 9) within the relative clause in the relative clause (47b) relative to the same region in the non-extraction condition (47a). Conversely, if learners do attend to syntactic constraints during online parsing as suggested by the results of Omaki & Schulz (2011) and Aldwayan et al. (2010), they will behave like English natives, i.e. there will be no significant reading time differences at *Jacob* (region 9) between conditions (47a) and (47b). This would mean that the L2 learners are capable of processing wh-dependencies incrementally in licensed positions and avoid positing gaps in grammatically unlicensed positions. Hence, contra the tenets of the Shallow Structures Hypothesis, L2 parsing is modulated by abstract syntax and not primarily by lexico-semantic/pragmatic information.

5. Results

5.1 Data Processing and Analysis

The data for the self-paced reading task were analyzed in terms of comprehension probe accuracy and reading times. As indicated in the methods section, every trial in the self-paced reading task was followed by a comprehension probe to ensure that the participants were reading for meaning. Participants who scored less than 70% in any condition or whose overall accuracy in the target sentences was below 80% were removed. This resulted in the exclusion of 1 English speaker and 2 English learners. For the remaining participants, we removed the data for trials whose comprehension question was answered incorrectly. We implemented two additional outlier removal procedures based on reading times. First, we excluded the participants whose overall actual mean reading time (including fillers) was below 250 ms because reading at such a

fast rate is highly likely to indicate that the participants were not reading for comprehension and just clicking very fast on the mouse. This procedure motivated the exclusion of 4 native speakers but no learners. The data for the remaining participants (48 natives and 54 learners) were subject to a residual reading times analysis in order to control for differences in word length or individual differences, i.e., some people happen to be faster readers than others. Following standard practice in the literature, we excluded residual reading times that were 2.0 standard deviations above or below a participant's mean for a given region and condition.

5.2 Comprehension Probe Accuracy

All the participants scored above 85% in the comprehension probe which denotes that they were paying attention to the sentences and reading for meaning. The overall mean accuracy (120 trials) for natives was 95.5% (range: 89.2-100; SD: 2.75) and for the learners 95.1% (range: 86.7-99.1; SD: 2.63). These data can be broken down by experiment. In experiment 1, the mean accuracy score for natives was 96.4% (SD: 0.84) and for learners 94.7% (SD: 1.09). In experiment 2, the mean accuracy score for natives was 94.5% (SD: 0.93) and for learners 94% (SD: 1.26). As indicated above, there were no significant accuracy differences between the groups across experiments.

5.3 Reading Time Data Analysis

After data removal by the procedures explained above, the data retained for experiment 1 was 91.79% (SD: 5.85) for natives and 90.82% (SD: 7.14) for learners; for experiment 2, the

data retained was 90.09% (SD: 6.04) for natives and 89.91% (SD: 6.89) for learners. A series

of independent samples t-tests revealed that there were no significant data retention differences

between natives and learners in by condition or by experiment analyses of their comprehension

probe accuracy or reading times. The data were analyzed in two separate analyses of variance

(ANOVA), by participants and by items reported from this point on as F_1 and F_2 respectively. In

Experiment 1, the data were subject to a series of 2 x 2 mixed repeated-measures ANOVAs with

the between-subjects factor Group (native vs. learner) and the within-subjects factor Condition

(wh extraction vs. non-extraction). Similarly, in Experiment 2, the reading time data were

subject to a series of 2 x 2 mixed repeated measures ANOVAs with the between-subjects factor

Group (native vs. learner) and the within-subjects factor Condition (non-extraction vs. relative

clause island). In the results provided below, we interpreted $p < .05$ as significant and p values

between .05 and 0.10 as marginal.

5.4 Experiment 1

5.4.1 Results for Experiment 1

The focus of Experiment 1 was to test natives and learners' sensitivity to an object filled-

gap effect by comparing their processing of English sentences involving wh-extraction like

(39b), repeated here as (48b), to their non-extraction counterparts (48a). The results for this

experiment are reported in Figure 1 for natives and Figure 2 for learners.

(48) a. My brother asked if Barbara will photograph Sam beside mom at the graduation.

    b. My brother asked who Barbara will photograph Sam beside ____ at the graduation.

Evidence of sensitivity to an object filled-gap effect was expected to emerge at *Sam*
(region 8) or in the region (s) immediately after it (spillover region), in the form of longer
reading times in the wh-extraction condition (48b) relative to the same region in the non-
extraction condition (48a).
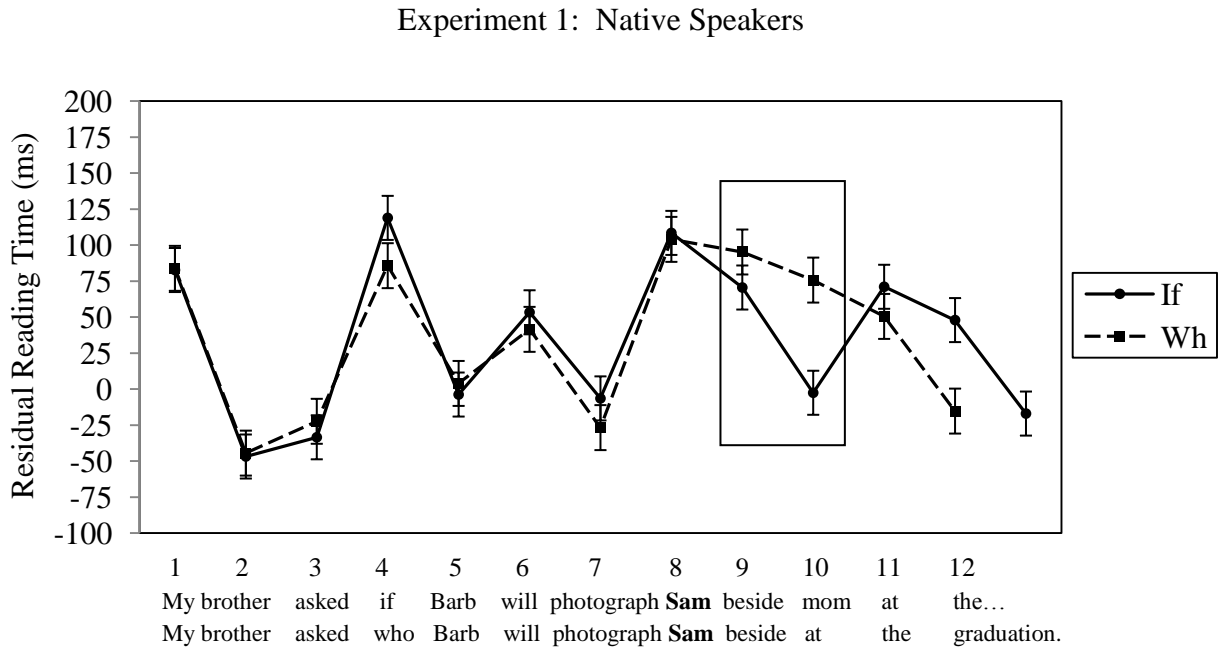
Experiment 1: Native Speakers

Figure 1. Residual reading times (ms) by participants for native speakers of English (n=48) in
Experiment 1. Non-extraction condition (if) and grammaticality-licensed extraction condition
(wh). Standard error is reported by error bars attached to each data point.
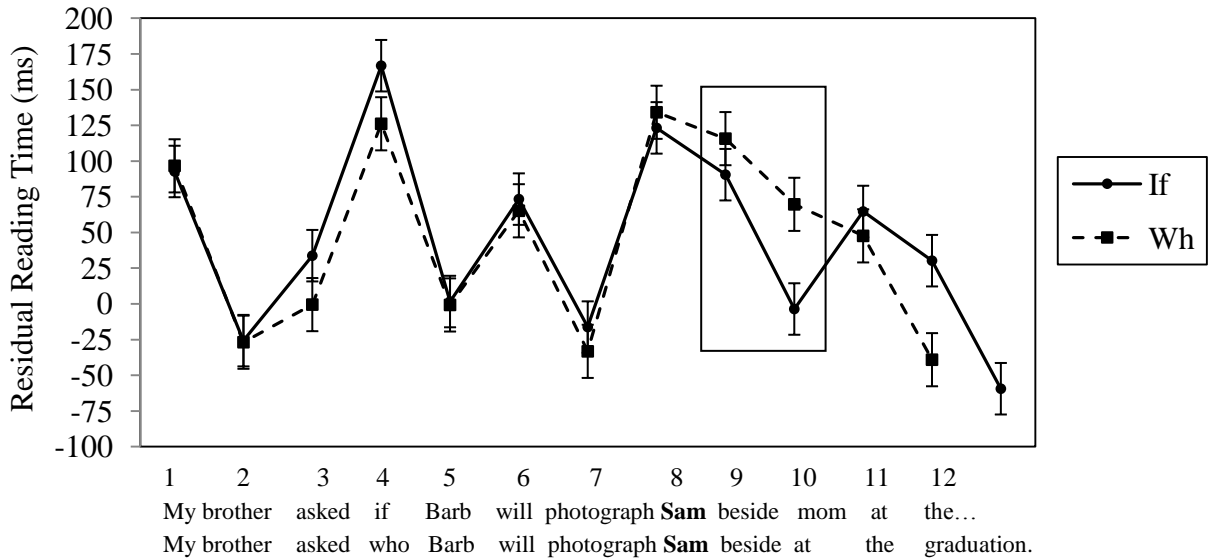
Experiment 1: Spanish Learners of English

Figure 2. Residual reading times (ms) by participants for Spanish learners of English (n=54) in Experiment 1. Non-extraction condition (if) and grammatically-licensed extraction condition (wh). Standard error is reported by error bars attached to each data point.

At the critical region (region 8), there was no main effect of Condition (F_1 (1, 100) = .126, p = .723; F_2 (1, 38) = .016, p = .901). On the other hand, there was a main effect of Group only in the by items analysis (F_1 (1, 100) = 1.910, p = .170; F_2 (1, 38) = 7.710, p = .008). This effect emerges because the learners show overall slower reading times than the native English speakers. Importantly, there was no interaction between Condition and Group (F_1 (1, 100) = .721, p = .398; F_2 (1, 38) = .492, p = .487). This indicates that at the critical region (region 8), both natives and learners did not show any evidence of having detected an object filled-gap. However, such an effect did become evident in the two regions following our critical region. At region 9, there was a main effect of Condition (F_1 (1, 100) = 11.698, p = .001; F_2 (1, 38) = 12.321, p = .001) due to slower reading times at the post object filled-gap region in the extraction

condition (wh) relative to the same region the non-extraction condition (if). There was also a main effect of Group in the by participants analysis (F_1 (1, 100) = 4.106, p = .045; F_2 (1, 38) = 2.470, p = .124) showing slower overall reading times for the learners when compared to the natives. Vitally, there was no interaction between Condition and Group (F_1 (1, 100) = .002, p = .969; F_2 (1, 38) = .026, p = .872) (F_1 (1,100) = .040, p = .843; F_2 (1, 38) = .016, p = .899) which demonstrates that both natives and learners were equally sensitive to the object filled-gap effect in region 9. In agreement with our findings for region 9, reading times for region 10 also evidenced detection of an object filled-gap. In this region, there was a main effect of Condition (F_1 (1, 100) = 78.946, p < .001; F_2 (1, 38) = 35.951, p < .001) due to longer reading times two regions after the object filled-gap position in the wh-extraction condition (wh) relative to the same region in the non-extraction condition (if). There was no effect of Group (F_1 (1, 100) = .198, p = .658; F_2 (1, 38) = .027, p = .870) which shows that the reading times for learners and natives were not significantly different. Crucially, as in the case of region 9, there was no interaction between Condition and Group in Region 10 (F_1 (1, 100) = .085, p = .771; F_2 (1, 38) = .016, p = .899) denoting equal sensitivity to an object filled-gap effect for both English natives and learners two regions after its detection.

As seen above, English natives and learners are sensitive to object filled-gap effects; however, filled-gap effects are potentially detectable in subject position as well. In experiment 1, the possibility of finding a subject filled-gap effect is available in region 5. However, in this region, there was no significant effect of Condition (F_1 (1, 100) = .116, p = .735; F_2 (1, 38) = .229, p = .635) indicating that reading times were similar in the extraction and non-extraction condition. There was also no Group effect (F_1 (1, 100) = .001, p = .973; F_2 (1, 38) = .025, p = .875) as the reading times for natives and learners in this region did not differ significantly.

Finally, there was no interaction between Condition and Group (F_1 (1, 100) = .414, p = .521; F_2 (1, 38) = .863, p = .359).

5.4.2 Discussion for Experiment 1

The key finding of this experiment is that English natives and learners are equally sensitive to object filled-gaps. This effect emerged for both groups in the spillover region in the shape of longer reading times in regions 9 and 10 for the grammatically-licensed wh-extraction condition relative to the same region in the non-extraction condition. This disruption in reading times is due to the finding of an NP (e.g. *Sam)* in region 8, a region where the parser was initially expecting to find a gap. Longer reading times signal that the parser was surprised to find that position filled and was forced to initiate reanalysis. The participants' sensitivity to object-filled gaps suggests that that parsing is incremental, that is, the parser is actively building up and predicting upcoming grammatical structure. Hence, at large, evidence of a filled-gap effect in object position for natives and learners supports the notion that parsing is incremental in L1 and also in L2 online sentence processing. Our finding are in line with previous L1 studies that have also provided evidence for incrementality in L1 processing (Crain & Fodor, 1985; Stowe, 1986; Gibson & Warren, 2004) and in L2 processing (Omaki & Schulz ,2011; Aldwayan et al.,2010).

There is a possibility of finding subject filled-gap effects as well as object filled-gap effects. However, there seems to be an asymmetry between subject and object filled-gap effects. Contrary to the widely reported object filled-gap effects, there are very few studies that report having found subject filled-gap effects in L1 (Lee, 2004; Aldwayan et al., 2010) and L2 (Aldwayan et al., 2010) online sentence processing. In this experiment, we did not find evidence

that supports the identification of a subject filled-gap effect for neither the natives nor the learners.

5.5 Experiment 2

5.5.1 Results for Experiment 2

The aim of experiment 2 was to test if, like English natives, Spanish learners of English would be capable of building/accessing syntactic representations that would be detailed enough to prevent them from attempting to extract a wh-element from a position not licensed by the grammar. For example, in (49a) the phrase '*the principal that suspended Jacob'* forms a relative clause island which forbids extraction out of this phrase. Thus, the parser should not posit a gap following the verb '*suspended*'. If L2 parsing is syntax-driven, we would not expect to find a difference in reading times at *Jacob* in the non-extraction condition (49a) relative to the relative clause island condition (49b).

(49) a. My teacher wondered if the principal that suspended Jacob last spring disappointed the parents with the news.

b. My teacher wondered who the principal that suspended Jacob last spring disappointed with the news.

The results for this experiment are presented in Figure 3 for the natives and Figure 4 for the learners. The critical region will be addressed first.

Experiment 2: Native Speakers

Figure 3. Residual reading times (ms) by participants for native speakers of English (n=48) in Experiment 2. Non-extraction condition (if) and illicit (RC island) extraction condition (RC). Standard error is reported by error bars attached to each data point.
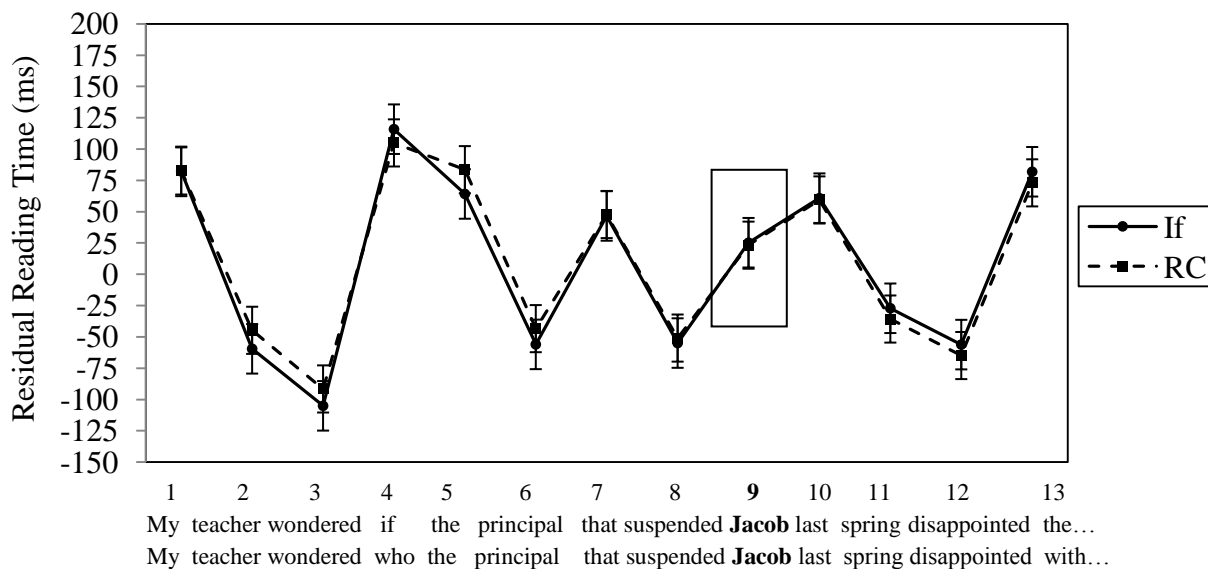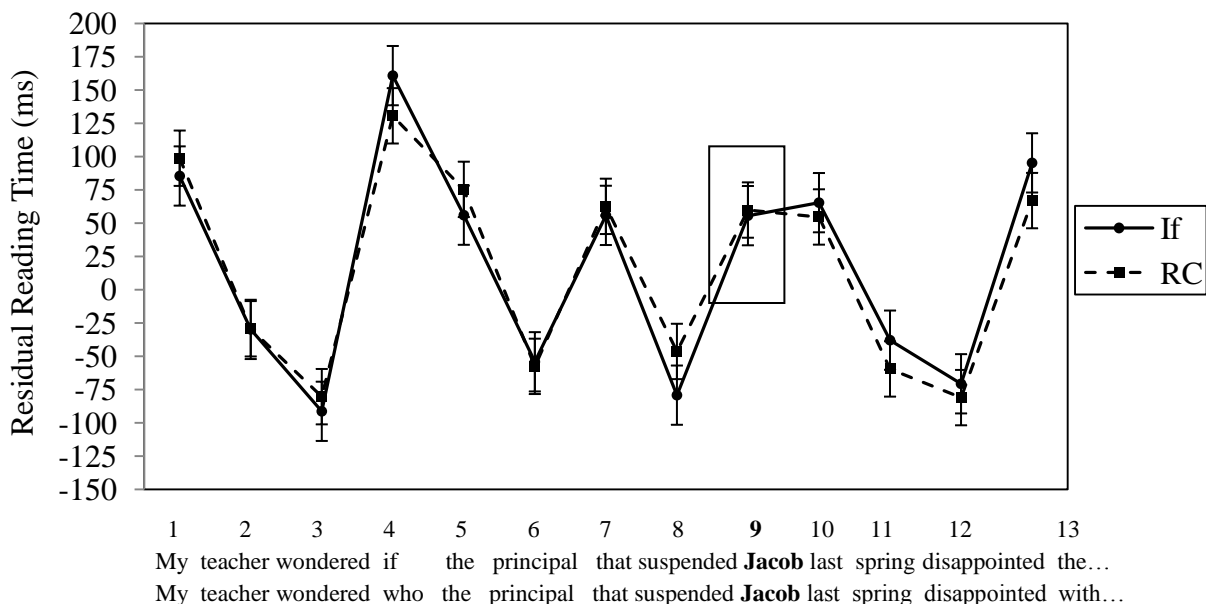
Experiment 2: Spanish Learners of English

Figure 4. Reading times (ms) by participants for Spanish learners of English (n=54) in Experiment 2. Non-extraction condition (if) and illicit (RC island) extraction condition (RC). Standard error is reported by error bars attached to each data point.

At the critical region (region 9) there was no main effect of Condition (F_1 (1, 100) = .014, p = .905; F_2 (1, 38) = .003, p = .958). That is to say, there was no difference in reading times at *Jacob* between conditions. This suggests that our participants did not attempt to posit a gap in a position not allowed by the grammar, i.e., inside a relative clause island. There was also a main effect of Group (F_1 (1, 100) = 7.228, p = .008; F_2 (1, 38) = 15.344, p < .001) showing longer overall reading times for the learners in comparison to the English natives. Critically for our study is the lack of interaction between Condition and Group (F_1 (1, 100) = .108, p = .743; F_2 (1, 38) = .077, p = .783). This suggests that second language learners of English resemble native speakers in that their sentence processing is constrained by syntactic information.

As in the case of Experiment 1, there was also a possibility of finding filled-gap effects in subject position in Experiment 2. At the subject position (region 5), which is also the first potential gap site, there was a significant main effect of Condition in both the by participants and the by items analyses (F_1 (1, 100) = 6.377, p = .013; F_2 (1, 38) = 8.332, p = .006). This effect revealed longer reading times for the first word in the subject NP immediately following the wh-word in the relative clause island condition (RC) compared to the same word in the non-extraction condition (If). In addition, there was no main effect of Group (F_1 (1, 100) = 1.186, p = .279; F_2 (1, 38) = 1.318, p = .258) showing that the reading times in this region did not vary significantly between natives and learners. Crucially, the lack of interaction between Condition and Group (F_1 (1, 100) < .001, p = .999; F_2 (1, 38) = .009, p = .923) shows that both natives and learners showed sensitivity to a subject filled-gap effect in region 5.

In addition, an interesting effect emerged in region 8, the position of the verb right before the critical region. In this position, we found an effect of Condition that was marginal in the by participants analysis yet significant in the by items analyses (F_1 (1, 100) = 3.393, p = .068; F_2 (1,

38) = 5.594, p = .023). This effect evidenced longer reading times for the verb in the relative clause condition (RC) versus the same verb in the non-extraction condition (If). On the other hand, there was no effect of Group (F_1 (1, 100) = .800, p = .373; F_2 (1, 38) = .099, p = .754) indicating no differences in reading times between natives and learners. Noticeably, there was an interaction between Condition and Group which reached significance only in the by items analysis (F_1 (1, 100) = 2.082, p = .152; F_2 (1, 38) = 4.786, p = .035). To further explore this interaction, we carried out t-tests to compare both groups. These follow-up tests revealed no significant difference in reading times in region 8 across conditions for the English natives in neither the by participants (p = .74) nor the by items analysis (p = .89). However, learners' reading times for region 8 in the relative clause island condition were significantly longer than the reading times for the same region in the non-extraction condition in both the by participants (p = .03) and the by items analysis (p = .007). Therefore, the effect of condition observed above is clearly being driven by the learners.

5.5.2 Discussion for Experiment 2

While Experiment 1 looked at wh-extraction from positions licensed by the grammar, Experiment 2 looked at a position that prohibits wh-extraction. Hence, Experiment 2 constitutes an ideal complement for Experiment 1. We have already established, based on the results of experiment 1, that L1 and L2 parsing appear to be incremental; however, it is necessary to explore whether the parser just posits gaps wherever it presupposes their existence or whether the parser's gap positing procedures are subject to constraints. Also, if we assume that parsing is constrained, we have to identify the source of information that mediates language processing.

The Shallow Structures Hypothesis (Clahsen & Felser, 2006) proposes that L1 parsing is guided by syntax, but L2 parsing is guided by lexico-semantic information. Based on this theoretical proposal, the second language learners are expected to fail to respect syntactic constraints during sentence processing. Experiment 2 tested the validity of this prediction by looking at wh-extraction from grammaticality unlicensed positions such as a relative clause island. If the Shallow Structures Hypothesis is on the right track, learners would attempt to extract a wh-element from within a relative clause island which would trigger and object filled-gap effect in region 9, resulting in longer reading times for an NP like *Jacob* in the grammatically unlicensed extraction condition (relative clause island) relative to the same region in the non-extraction condition. However, the results for Experiment 2 revealed no significant differences in reading times at the critical region for neither the natives nor the learners. This result is only possible if the learners, as the natives, are capable of accessing detailed-enough syntactic representations during online parsing.

While Experiment 1 did not provide any evidence of sensitivity to a subject filled-gap effect, Experiment 2 shows that both natives and learners were sensitive to it. This effect was visible in region 5, the article at the beginning of the subject NP (region 5 + region 6). A marginal subject filled-gap had been reported by Aldwayan et al. (2010) in their experiments 1 for both learners and natives but in Experiment 2 the subject filled-gap effect was significant only for the learners Vitally, in the present study, we found a significant subject filled-gap effect for native speakers as well. Evidence of subject filled-gap effects are highly relevant as it calls into question the proposal of Shallow Structures Hypothesis that L2 parsing is mainly driven by lexico-semantic instead of syntactic information. In S-V-O languages like English, object filled-gap effects take place post-verbally, in positions where both syntactic information and the

subcategorizing information of the verb (thematic role assignment) have become available to the parser. Hence, though object filled-gap effects are capable of providing evidence in favor of incremental parsing, they can't tell apart the source of information guiding the process. This limitation is not shared by subject filled-gap effects which crucially take place before the verb is accessed. Hence, subject filled-gap effects are to be driven by syntactic information given that the subcategorizing information provided by the verb has not become available yet. In brief, our finding of subject filled-gap effects for learners shows that they are capable of accessing abstract syntax during online sentence processing.

The main effect of condition found in region 8, though not robust, is important to consider as it may suggest the possibility of association between the filler, in region 4, and the verb in region 8. This association could be driven by semantic information as the subcategorizing information of the verb would assign a thematic role to the filler. This does not seem to be the case for two reasons. First, when the interaction between condition and group in region 8 was explored in detail, it was noticed that only the learners had significantly longer reading times in this region for the illicit wh-extraction condition (RC island) relative to the same region in the non-extraction condition (If). However, the learners did not show the same behavior in experiment 1 as there was no significant difference in reading times between conditions at the gap-licensing verb (region 7) which could have suggested a filler-verb association. Secondly, an alternative explanation is more likely to better account for the effect in region 8 in experiment 2. Foote (2011), following Almor et al. (2001), proposed that verbs appear more frequently after the subject than after a relative clause. If this claim is true, it is possible that the learners were expecting a verb to follow the subject (regions 5 and 6) in our Experiment 2 sentences such as (50). For example, they could have predicted a sentence like

"*My teacher wondered who the principal **fired** last spring*" instead, they encountered a relative clause introduced by the complementizer "*that*".

(50) My teacher wondered who the principal that suspended Jacob last spring disappointed with the news.

Encountering a relative clause instead of the more likely expected verb may be responsible for the longer reading times observed one region after the position of "that" in the illicit wh-extraction condition (RC) compared to the non-extraction condition (If). What remains to be explained though, is why the native speakers didn't show the same "surprise" pattern that the learners did. It is unlikely that crosslinguistic differences are the motivation given that both languages construct relative clauses similarly and extraction is forbidden from this type of structures in both languages. In addition, there is evidence that like L2 learners, native speakers of English may also show a marginal "surprise effect" in constructions similar to the ones in our experiment 2. For instance, Gibson & Warren (2004) reported a marginal effect for English natives at region 3 in the processing of wh-extraction in embedded sentences like (51a) and (51b). These authors propose that in condition (51a), the participants had wrongly postulated a gap in the subject position in the embedded clause, a position that turned out to be filled by the complementizer *that*. This triggered a filled-gap effect which became evident in longer reading times in region 3 in the extraction condition with an intervening NP [*the consultant claimed*] relative to the same position in the extraction condition with an intervening NP [*the consultant's claim*].

	1	2	3	4
(51) a.	The manager who /	the consultant claimed /	that /	the new proposal …
b.	The manager who /	the consultant's claim /	about /	the new proposal…

Gibson & Warren propose that their hypothesis is also supported by the notion that "people prefer to posit a gap in subject position of an embedded clause in a long-distance extraction across clauses rather than in object position" (71), a conclusion reached by Kluender & Cowles (1997). The point of agreement between Gibson & Warren and the present study is that under incremental parsing, unsatisfied predictions generate differences in reading times that suggest the cost of reanalysis. In our study, there was a complementizer in a position where the participants had predicted a verb while in Gibson & Warren's there was a complementizer in a position where the parser was expecting a subject for an embedded clause. However, these effects are by no means robust, probably because both natives and learners can recover easily from their initial misanalysis.

To summarize, our results for experiment 2 have provided evidence that neither natives not learners attempt to extract a wh-element out of relative clause islands. The fact adult learners of English are capable of respecting island constraints shows that they can access detailed grammatical information during processing of long distance wh-dependencies in real time. Hence, L1 and L2 gap positing procedures are incremental as shown by the data from Experiment 1, and also constrained by the grammar as revealed by the data from Experiment 2.

6. General Discussion

The present study explored how English natives and Spanish-speaking learners of English process long distance wh-dependencies in real time. We addressed two key questions. First, we examined whether L1 & L2 processing of wh-dependencies in English takes place in an incremental fashion in agreement with the Active Filler Hypothesis (Clifton & Frazier, 1989). Second, we explored if during the processing of wh-dependencies in real time, L2 learners of English are capable of constructing detailed-enough syntactic representations that allows their gap-positing procedures to be constrained similarly to the native speakers.

The results of this study suggest that L2 learners, as well as English natives, posit gaps incrementally in grammatically-licensed positions (Experiment 1) and avoid positing gaps in grammatically-unlicensed positions (Experiment 2). Taken together, the findings of both of the experiments in the current study constitute a challenge to the tenets of the Shallow Structures Hypothesis (Clahsen & Felser, 2006 a,b) that second language learners are not capable of building native-like syntactic representations and that their online processing of wh-dependencies is guided by lexico-semantic information instead of syntactic information. In this section, we will discuss the results of each experiment separately first. Then, we will comment on the highlights of our experimental design and areas of possible improvement. Finally, we will outline some recommendations for follow-up studies.

The results of Experiment 1 in the present study showed an object filled-gap effect that. Such an effect is only possible if during the online processing of wh-dependencies, gaps are posited in an incremental fashion; hence, when the parser encounters that a site it had predicted to be a gap turns out to be occupied by an NP, it has to abandon its original analysis. This results in the observed longer reading times for both English natives and Spanish learners of English

when the prediction made by the parser was not fulfilled. Our results are then in line with those

of with previous studies that support incremental parsing of wh-dependencies in L1 English (e.g.

Crain & Fodor, 1985; Stowe, 1986) and L2 English (e.g. Aldwayan et al., 2010; Omaki &

Schulz, 2011). Also, we have provided evidence in favor of incremental parsing, i.e., the

linguistic information accessed by the parser is used to predict/build up upcoming material.

However, given that our Experiment 1 is basically a replication of Aldwayan et al.'s Experiment

1, we also share the following observation. In the wh-extraction sentences used in Experiment 1

such as *My brother asked who Barbara will photograph Sam beside*.., the resolution of the filler-

gap dependency takes place post-verbally in a position where both syntactic and lexico-semantic

information have become available to the parser. Hence, it is not possible to tell apart which

source of information is guiding the resolution of the filler-gap dependency. In other words, as

suggested by Marinis et al. (2005) and Felser & Roberts (2007), the observed object filled-gap

effect, though due to incremental parsing, may as well be the result of a failed attempt to try to

directly associate the filler with the its licensing verb (thematic reanalysis) instead of a failure to

try to associate the filler with its gap (syntactic reanalysis).

It is possible, however, to find evidence of syntax-driven parsing within our experimental

design by looking at the subject position, a possibility also suggested by Aldwayan et al. In the

sentences in Experiment 1, the subject appears pre-verbally (canonical order in English); hence,

the thematic role information provided by the verb has not become available to the parser by the

time it attempts to solve the wh-dependency in subject position. Finding a subject filled-gap

effect would suggest that syntactic information, and not lexico-semantic information is being

accessed. Such an effect was not found in our Experiment 1, however, we did find it in

Experiment 2. We will return to the issue of subject filled-gap effects after the results of Experiment 2 are discussed.

Experiment 1 provided evidence in favor of incremental L1 & L2 parsing of wh-dependencies, yet in the absence of a subject-filled gap effect, it is not possible to determine whether syntactic information is guiding L2 parsing. Experiment 2 constitutes a supplement to Experiment 1 in the sense that while Experiment 1 explored wh-extraction from grammatically-licensed positions, Experiment 2 looked at wh-extraction in relative clause islands, from which extraction is not allowed. The results of our Experiment 2 suggest that just as L1 speakers, adult L2 learners of English respect relative clause island constraints on wh-extraction. This is possible only if their syntactic representations are detailed enough to prevent them from positing a gap in a position not licensed by the grammar.

The results of Experiment 2 on subject filled-gap effects provide additional information in favor of incremental syntax-driven processing of wh-dependencies. In more detail, we found a subject-filled gap effect in both the by participants and the by items analyses equally significant for both English natives and L2 learners. It is important to point out that subject filled-gap effects are not found consistently. Aldwayan et al. (2010) reported having found a marginal subject filled-gap effect for both natives and learners in their Experiment 1, but this type of effect was only significant for their learners in their Experiment 2. On the other hand, Stowe (1986) did not find a subject filled-gap effect for English natives in her study. A finding Lee (2004) considers an indication that recovering from a subject-gap misanalysis is fairly easy, in part because the distance between the filler and the potential gap site is not long enough to ensure a major semantic commitment. By testing sentences like "*that is the laboratory which, on two different occasions, Irene used a courier...*" in which there is more intervening material

between the filler (*which*) and the subject (*Irene*), Lee was able to find a significant subject filled-gap effect for English natives, i.e., the name subject (and also *which*) were read more slowly when separated by an adjunct (*on two different occasions*). This type of length manipulation is an open door for future research and may help us answer the question below.

We found additional evidence in favor of incrementality for the learners group in our Experiment 2. They showed longer reading times after encountering a complementizer (*that*) in a region where the parser was highly predicting a subject for an embedded clause in sentences like "*My teacher wondered if/who the principal that suspended Jacob…*" However, the native speakers did not show this effect. It is possible that, as suggested by Stowe (1986), natives can recover more easily from misanalysis and that, as suggested by Lee (2004), in order for subject effects to emerge consistently, more distance between the filler and the subject is required.

As a summary, the results of our study have provided evidence that L2 learners resemble native speakers in that they process wh-dependencies positing gaps incrementally (Experiment 1) and also syntactically constraining wh-extraction in relative clause islands (Experiment 2). Crucially, as suggested by Aldwayan et al. (2010), we included the same type of gap licensors for both experiments. This provides more validity to our results given that sticking to only one type of licensor (verbs) ensures that differences between Experiment 1 and Experiment 2 are not due to licensor type but instead are due to island constraints. This constitutes an improvement from Aldwayan et al. because they had gaps being licensed by a verb in one experiment and by a preposition in the other one. Another improvement of the present study is that we carried out a residual reading times analysis of the data instead of using the raw reading times. This allowed us to control for word-length differences and also individual differences in the sense that some people just happen to be faster readers than others.

For studies to come, we also believe worth exploring the role of individual differences like working memory in the processing of sentences in real time. Recall that low span natives in Felser & Roberts' (2007) study did not show trace reactivation. Other studies like Hara (2009) and Omaki & Schulz (2011) have suggested that the complexity of the sentences being processed may exhaust the computational resources available to learners and then force them to rely on non-grammatical information. In addition, given that the Shallow Structures Hypothesis predicts no differences for the L2 learners, regardless of their L1, future studies could explore online processing of wh-dependencies in languages that are more typologically different than Spanish and English just to verify if the L1 plays a role or not.

Omaki & Schulz (2011) suggest that offline testing should accompany online testing to ensure that the L2 learners do have command of the linguistic knowledge they are being tested on also to create experiments that can determine competence or computational deficits are to blame in the instances in which they do not perform well. We did not find necessary to include such a task in the present study given that all the L2 learners were English majors about to complete their Bachelor's degree or English as a Second Language Instructors.

The present study contributes additional information to a relatively new area of inquiry that focuses on L2 sentence processing in real time. The evidence provided by the present study suggests that at least for the online processing of wh-dependencies L2 parsing is incremental and guided by abstract syntax. Our findings suggest that it is possible that the mechanisms used by natives and learners when processing wh-dependencies online may not be qualitatively different.

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Appendixes

Appendix 1. Target sentences for Experiment 1.

1. a. My brother asked if Barbara will photograph Ali beside Mom at the graduation.
    b. My brother asked who Barbara will photograph Ali beside at the graduation.

2. a. My niece guessed if Kelly will photograph Kim with Edward at the parade.
    b. My niece guessed who Kelly will photograph Kim with at the parade.

3. a. My sister knew if Roger will place Pat with Jason at the lunch table.
    b. My sister knew who Roger will place Pat with at the lunch table.

4. a. My nephew revealed if Alex will put Ted near Nancy at the gathering.
    b. My nephew revealed who Alex will put Ted near at the gathering.

5. a. My friend wondered if Julie will recommend Amy to Sarah before the deadline.
    b. My friend wondered who Julie will recommend Amy to before the deadline.

6. a. My mother asked if John will find Rob beside Dad at the restaurant.
    b. My mother asked who John will find Rob beside at the restaurant.

7. a. My aunt guessed if Patrick will film Sue with Kelly at the banquet.
    b. My aunt guessed who Patrick will film Sue with at the banquet.

8. a. My grandmother knew if Adam will find Jen with Rachel at the mall.
    b. My grandmother knew who Adam will find Jen with at the mall.

9. a. My classmate revealed if Jack will meet Moe with Sarah before the dance.
    b. My classmate revealed who Jack will meet Moe with before the dance.

10. a. My cousin wondered if David will put Liz near Jack at the wedding.
    b. My cousin wondered who David will put Liz near at the wedding.

11. a. The manager asked if Ethan will meet Sam with Jeff outside the office.
    b. The manager asked who Ethan will meet Sam with outside the office.

12. a. The student guessed if Ryan will introduce Jim to Heather after the break.
    b. The student guessed who Ryan will introduce Jim to after the break.

13. a. The teachers knew if Michael will discover Ron with Jerry during the game.
    b. The teachers knew who Michael will discover Ron with during the game.

14. a. The secretary revealed if Shawn will introduce Lou to Jared after the speech.
    b. The secretary revealed who Shawn will introduce Lou to after the speech.

15. a. The instructor wondered if Chris will film Tom with Susan at the reception.
    b. The instructor wondered who Chris will film Tom with at the reception.

16. a. The boy asked if Matt will place Ben with Susie at the party.
    b. The boy asked who Matt will place Ben with at the party.

17. a. The babysitter guessed if Christopher will discover Dan with Lindsey in the closet.
    b. The babysitter guessed who Christopher will discover Dan with in the closet.

18. a. The manager knew if Katie will recommend Joe to Patricia after the assembly.
    b. The manager knew who Katie will recommend Joe to after the assembly.

19. a. The girl revealed if Melissa will seat Ann by Susan at the dinner.
    b. The girl revealed who Melissa will seat Ann by at the dinner.

20. a. The teacher wondered if Harry will seat Bob by Rachel in the classroom.
    b. The teacher wondered who Harry will seat Bob by in the classroom.

Appendix 2. Stimuli Sentences for Experiment 2.

1. a. My father asked if the actress that married Tyler last summer kissed the director during the rehearsal.

    b. My father asked who the actress that married Tyler last summer kissed during the rehearsal.

2. a. My manager investigated if the assistant that fired Kylie last June seduced the supervisor before the party.

    b. My manager investigated who the assistant that fired Kylie last June seduced before the party.

3. a. My brother questioned if the journalist that followed Henry last Saturday provoked the guard at the store.

    b. My brother questioned who the journalist that followed Henry last Saturday provoked at the store.

4. a. My teacher wondered if the principal that suspended Jacob last spring disappointed the parents with the news.

    b. My teacher wondered who the principal that suspended Jacob last spring disappointed with the news.

5. a. My brother asked if the woman that defended Dylan last Tuesday slapped the thief on the face.

    b. My brother asked who the woman that defended Dylan last Tuesday slapped on the face.

6. a. The psychologist investigated if the boy that hit Timmy last Thursday offended the teacher after the incident.

    b. The psychologist investigated who the boy that hit Timmy last Thursday offended after the incident.

7. a. My uncle questioned if the man that visited Ellie last night irritated the neighbors with the noise.

    b. My uncle questioned who the man that visited Ellie last night irritated with the noise.

8. a. My wife wondered if the hunter that located Jenny last Sunday contacted the police from the camp.

    b. My wife wondered who the hunter that located Jenny last Sunday contacted from the camp.

9. a. My daughter asked if the clown that scared Eddie last Wednesday delighted the nanny with the balloon.

    b. My daughter asked who the clown that scared Eddie last Wednesday delighted with the

10. a. The prosecutor investigated if the accountant that fooled Maria last December defrauded the investors over the internet.

    b. The prosecutor investigated who the accountant that fooled Maria last December defrauded over the internet.

11. a. The senator questioned if the traitor that exposed Diana last month betrayed the president after the scandal.

    b. The senator questioned who the traitor that exposed Diana last month betrayed after the scandal.

12. a. My nephew wondered if the banker that dated Molly last year shocked the auditor with the report.

    b. My nephew wondered who the banker that dated Molly last year shocked with the report.

13. a. The politician asked if the reporter that challenged Carol last Monday annoyed the moderator at the debate.

    b. The politician asked who the reporter that challenged Carol last Monday annoyed at the debate.

14. a. The Sheriff investigated if the boxer that defeated Peter last March paid the referee for the championship.

    b. The Sheriff investigated who the boxer that defeated Peter last March paid for the championship.

15. a. The reporter questioned if the politician that impressed Peggy last February insulted the senator at the conference.

    b. The reporter questioned who the politician that impressed Peggy last February insulted at the conference.

16. a. The agent wondered if the producer that consulted Lucas last Friday hired the musician after the audition.

    b. The agent wondered who the producer that consulted Lucas last Friday hired after the audition.

17. a. The chief asked if the officer that interviewed James last week angered the lawyer during the trial.

    b. The chief asked who the officer that interviewed James last week angered during the trial.

18. a. The doctor investigated if the nurse that vaccinated Aaron last April harmed the child at the hospital.

    b. The doctor investigated who the nurse that vaccinated Aaron last April harmed at the hospital.

19. a. The director questioned if the singer that bothered Becky last season criticized the pianist after the concert.

    b. The director questioned who the singer that bothered Becky last season criticized after the concert.

20. a. The agent wondered if the spy that shot Megan last evening kidnapped the ambassador f from the hotel.

    b. The agent wondered who the spy that shot Megan last evening kidnapped from the hotel.

Appendix 3. Fillers.

1. My roommate asked who will join us with Chris after our vacation.

2. My brother guessed who will accompany us with Mom to the office.

3. My father inquired who will find us with Vicki at the mall.

4. My boss questioned who will report me to Martha after the convention.

5. My dad wondered who will situate me by Simon at the dinner.

6. My friend asked who Karen will situate beside Bill at the party.

7. The musician inquired who Matt will record with Kevin at the station.

8. The teacher revealed who Beth will join with Paul at the cafeteria.

9. The artist wondered who Mary will paint with Sally at the gallery.

10. The girl guessed who Jessica will situate beside John at the table.

11. My uncle forgot if Calvin will cook us a big dinner on Saturday.

12. My sister wondered if Laura will give me the secret recipe after school.

13. My son asked if John will send us a big package on Monday.

14. My mother inquired if Matt will bake me some chocolate cookies on Friday.

15. My brother questioned if Jim will make me a delicious lunch for tomorrow.

16. My cousin forgot what Bill will cook us next week at the celebration.

17. My mom predicted what Jill will tell me next Monday after the wedding.

18. The students guessed what Judy will ask us next week on the test.

19. My dad questioned what Mary will show me this evening at the party.

20. The manager discussed what Hilary will teach us next Friday at the conference.

21. My aunt forgot who will cook us a big turkey on Thanksgiving day.

22. My sister revealed who will bring me an expensive present on Saturday night.

23. My father asked who will buy me a new costume for the party.

24. My mother wondered who will deliver me a large vase of fresh flowers.

25. The teacher guessed who will bake us an apple pie for the picnic.

26. It was Calvin that revealed if John would dance at the party.

27. It was Tom that asked if Nancy would play in the game.

28. It was John that wondered if Judy would eat at the restaurant.

29. It was Mary that inquired if Matt would run in the marathon.

30. It was Karen that predicted if Todd would sleep at the opera.

31. It was Dennis that said who Bill would see before the big concert.

32. It was Lisa that inquired who Richard would join at the fancy reception.

33. It was Bryan that wondered who Joseph would interrupt at the press conference.

34. It was Christopher that predicted who Frank would bring to the wedding party.

35. It was Donald that asked who Linda would surprise during the family vacation.

36. My brother asked whether Holly would cry during the sad French movie.

37. The girl wondered whether Charles would sleep during the boring class lecture.

38. My sister inquired whether Thomas would return after the long winter break.

39. The manager questioned whether Betty would go to the annual office picnic.

40. The students knew whether George would play for the best football team.

41. The young boy said that Janet and Calvin sang very loudly at the wild party last night.

42. The new student revealed that Saad and Emad studied every day at the public library this week.

43. My gym teacher stated that Calvin and Julie practiced the routine at the old stadium last weekend.

44. The project manager claimed that Tom and Chris left several boxes in the new office yesterday morning.

45. My oldest daughter thought that Nancy and Kathy spent several hours at the big mall last Monday.

46. The scared girl revealed that Sara and Holly bullied many children on the school bus yesterday afternoon.

47. My new neighbor said that Laura and Bill washed the windows of the old house last night.

48. The old librarian claimed that Mike and John stole many books from the library shelf last Saturday.

49. My new coach announced that Betty and George ran several miles on the stadium track yesterday morning.

50. The new chef knew that Sara and Julie cooked various dishes in the busy kitchen yesterday afternoon.

51. The teacher said that his students liked the film about the school system in Paris.

52. The principal thought that his staff loved the summary of the new policy on testing.

53. My daughter revealed that her friends hated the lecture on the political situation in Canada.

54. The teachers stated that their students enjoyed the show about the wild animals in Africa.

55. My friend mentioned that his boss loaned the copy of the computer program to Sally.

56. The manager announced that her staff rejected the revision of the office manual on harassment.

57. My professor said that his son wrote the article about the new theory in physics.

58. My friend thought that his dad liked the story about the native Americans in Oklahoma.

59. The teacher mentioned that her class enjoyed the book about the haunted houses in Massachusetts.

60. My brother stated that his wife liked the movie about the fishing towns in Maine.

61. The news reporter said that the American tourists really liked to dance all night long.

62. My younger brother claimed that the French students really wanted to get much higher grades.

63. The head nurse claimed that the eye doctor truly wanted to perform the risky surgery.

64. The new professor thought that the ambitious athletes really needed to study more after class.

65. My previous landlord revealed that the building owners desperately wanted to increase the monthly rents.

66. The worried parents stated that the angry teachers urgently needed to end the noisy protest.

67. The police officer thought that the young drivers really needed to obey the traffic rules.

68. My local newspaper stated that the insurance companies really needed to lower the monthly rates.

69. My annoyed grandmother complained that the new cashier really hated to help the elderly costumers.

70. The school principal found that the annoying students really needed to receive more strict discipline.

71. Adam and Sara repeatedly asked what their students hated about the chemistry teacher from the prestigious university.

72. Kathy and Sandra always wondered what their friends liked about the red car in the parking lot.

73. Helen and Kevin clearly knew what the principal disliked about the expensive repairs to the new school.

74. Donna and Jason finally discovered what the teachers said about the boring lecture at the education conference.

75. Laura and Paul finally revealed what their parents liked about the famous school in their small town.

76. Jessie and Mark never revealed what their boss mentioned about the employee cafeteria in their office building.

77. Joseph and Thomas easily guessed what the group disliked about the English professor from the famous college.

78. Edward and Daniel specifically asked what the archaeologist wrote about the old temple in the big city.

79. Linda and Christopher constantly wondered what the engineers loved about the electric engines in the new cars.

80. Joan and Matt often questioned what their professor claimed about the new theory in the science book.