Qualitative differences in L3 learners' neurophysiological response to L1 versus L2 transfer

Alejandra Keidel Fernández
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Abstract

In the present study, the influence of morphosyntactic aspects of L1 and L2 on L3 comprehension is investigated using ERP (Event-Related Brain Potentials). The study examines the processing of verb and gender agreement incongruences in Spanish by native Swedish speakers that are fluent in English and learning Spanish, in comparison to a control group of native Spanish speakers. The study investigates the relevance of morphosyntactic transfer from L1 and/or L2 to L3, as well as language processing in third language acquisition. Language acquisition is considered as an individual process, different in acquisition of the first, second and third language. EEG (Electrocephalography) had been used in the present study to examine the processing of verb and gender agreement. Different views on L3 learning have been shown in previous studies according to whether L1 or L2 have a stronger influence on the acquisition of L3.

Regarding native like processing of language, the study showed that L3 learners process language differently in comparison with native like speakers. In particular, adjective agreement engender a specific brain reaction (a P300) in L3 learners only and not in L1 speakers. Verb agreement, on the other hand, do not engender the P300 in any of the of the groups. The P300 effect is related to strategic processing of language, which leads to the possibility of considering that the morphosyntactic transfer of their first language (Swedish) to the third language is processed in a less automatic mode than L2 (English).

Keywords
EEG, Language acquisition, Morphosyntax, TLA, grammar, P300
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1. Introduction

Language constitutes a unique human characteristic that conceptualizes our environment and society. The acquisition of language shapes our understanding and communication inside a community or society. The acquisition of language commonly refers to first language acquisition (L1), second language acquisition (L2) and third language acquisition (L3), etc. which is based on the acquiring processes of a language. Acquiring a language implies acquiring the language semantics, syntax, pragmatics, phonology, morphology among many other traits.

According to different studies, 97% of Swedes speak more than one language, compared to the rate in the European Union where 56% of the population speak more than one language (Europeans and their languages, 2012). Moreover, 44% of the Swedish population speak more than two languages (ref). Usually this is the most common language combination according to (European and their languages, 2012): Swedish (L1), English (L2) and German (L3), Spanish(L3) or French (L3).

Due to the high amount of L3 speakers and the increasing demand of L3 learners, the understanding of how a third language is processed and comprehended in comparison to the second and the first language is of great relevance and will furthermore improve the understanding of language.

Despite the importance of this field the phenomenon of multilingual acquisition has not been researched thoroughly until the last decade even though it affects a large part of the population (Canagarajah, 2007).

The present study investigates the processing of verb and adjective agreement in third language (L3) learners. Initially, it seeks to understand to what extent the L1 or the L2 influences the learning of the L3. The chosen language combination for this study is Swedish as L1, English as L2, and Spanish as L3. Spanish is used as the experimental language of the study. Since “it” shares with English the inflection of the verb and with Swedish the agreement on nouns and adjectives it is an excellent test language.

This study applies electroencephalography (EEG) method in order to investigate language processing and comprehension in two groups of speakers: L1 speakers of Swedish with English as L2 and Spanish as L3, on the one hand, and L1 speakers of Spanish, on the other group.
2. Background

2.1. L1 and L2/L3

The acquisition of a language refers to the human ability to obtain language and its features. The manner in which acquisition of a language in humans occurs has been strongly under discussion and research. In accordance with Chomsky (1965) humans are born with an innate ability, also called the language acquisition device, which is located in an area in the brain that facilitates language learning as a natural event. According to this theory the optimal age of learning a language is in the first few years of the infant. In contrast to the theory advocated by Chomsky, Tomasello (2009) claims that language is acquired by children through extracting words from utterances as well as meaningful grammatical patterns. On the same line of this theory, contemporary research on language acquisition suggest that instead of having a language specific mental ability, acquisition is based on the use of general cognitive principles and learning mechanisms, that are not particular for language, as well as on the environment of the infant. However, both theories of language acquisition agree on an early stage of life in which the first language (L1) is acquired by the infant, as well on the fact that in both frameworks the acquiring processing is unconscious.

There is some evidence indicating that language acquiring is divided by two stages (Lenneberg’s 1967, Brainard 1998, among others). The initial stage, called the critical period (Robson 2002), refers to infant language acquisition in the earliest stages of life. This is a consequence of the highly sensitive nervous system during that period, in respect to language stimuli (Robson 2002). Languages acquired after the critical period are subsequent languages, second language (L2), third language (L3) etc. that are not processed as L1. There is an increasing trend indicating that the critical period is active during a certain time frame, once this timeframe is over the acquisition of a languages are more problematic to acquire.

In the last decades L2 and subsequent language acquisition have been increasingly under focus in research. The main division between the field of study of L1, L2 and L3 is established according to the acquiring process of the language distinction (Karshen, 1979). Karshen (1979) formulated the first crucial distinction as a division of the concepts of acquiring and learning a language. Language acquisition occurs according to Kashen (1979) without awareness of the learning process, whereas language learning implies awareness of this process. Therefore, first language (L1) has been acquired in a natural unaware manner, whereas the second (L2) third (L3) languages, show awareness of the learning process of the language. The different periods in which a language has been therefore acquired as an effect on where these languages are ‘located’ in the brain. In line with Ullman’s (2001) research on language acquisition, takes place during the critical period in the child’s life, and is automatically learned, it is ‘stored’ in procedural memory which is related with automaticity and implicit learning, the subsequent languages are acquired at a later age and are consciously stored in the declarative memory.
since they have been acquired under a conscious process. Declarative memory stands for aware actions, whereas procedural memory stands for actions that are preformed automatically. It has been shown in studies (e.g. Ullman 2001) that the understanding of the information that is in the declarative memory is more accessible in terms of being simpler to understand and explain (e.g. L3 learner will be able to explain a grammatical aspect of L2 more likely than of L1 speakers). The same is applicable to the findings of this study.

2.2. Language transfer and its relevance for the present study

This study examines how transfer occurs from L1 and/or L2 to the L3 language, therefore it is of great relevance to underline what transfer involves. The differences in transferring from L1 to L2 and/or L3 provides an insight into similarities and differences of the influence of L1 and L2 on L3. In general terms language transfer concerns the process of applying previous knowledge from one language to a subsequent language (see Weinreich 1952). Transfer is divided into two aspects: when features and/or structures from one language are transferred to another language, also called positive transfer. On the contrary when the transfer fails and features and/or structures are not transferred to another language the transfer is called negative transfer (Schwartz & Sprouse, 1996, Hawkins & Chan (1997). The following examples, (1) and (2) illustrates positive transfer:

(1) María promete a Juan leer el libro.
   Maria promise.3P.SG to-DAT Juan read.INF the.ART book.ACU
   ‘María promise Juan to read the book’

This example shows that English and Spanish share the infinitive verb form (to read), and allows therefore the transfer from Spanish into English and vice versa. Specifically, if L1 is Spanish and L2 English, the infinitive verb form is transferred from L1 to L2. If on the contrary L1 is English and L2 Spanish, the infinitive verb from can be transferred from L1 to L2. Example (2) shows a negative transfer. The L1 Spanish speaker has transferred syntactically from Spanish into English (*I want that my sister talks with me), but both languages do not share this syntactical feature with each other: The subordinate clause in English formed with the infinite verb is not headed by a subjunction ("that"), in contrast in Spanish, the corresponding subordinate clause is finite and headed by the subjunction "que". The subjunction is there erroneously transferred from Spanish to English.

(2) Quiero que mi hermana hable conmigo
   want.1P.SG. that my sister talk.3P.SG with.me
   ‘I want my sister to talk to me’
2.3. Language acquisition theories

Recent literature has shown that there are differences in L1 acquisition, L2 acquisition and L3 acquisition. According to most studies the first language, L1 is acquired, whereas second and third, etc. are learned, nevertheless a consensus on the terminology whether if L2 is learn or acquired is under debate. However, the main scientific focus on language acquisition has so far been made on first and second language acquisition (“SLA”), (Dechert et al. 1989; Odlin 1989; Schwartz et al. 1996, among others), but less on L3 learning. However, current research suggests to differentiate L1 from L2 and L3 (Edwards & Dewaele, 2007). The current literature on L3 acquisition shows mainly two views on the transmission of features in particular, which language is transferred from L1 and L2 to L3.

One of these views states that the transfer of features is equal from L1 and L2 to L3. Evidence for this view is, for example, provided by a study of Flynn et al. (2004). Flynn and colleagues investigated how transfer from L1 Kazakh and L2 Russian into L3 English occurs, showing that the transfer happened equally from L1 and L2 to L3. The influence of L1 Kazakh and L2 Russian on the oral production of relative clauses in L3 English was investigated. They found that L1 Kazakh and L2 Russian transferred to L3 English equally and concluded that previous knowledge of both L1 and L2 is accessible during the acquisition of L3. Consequently, this study indicates that both languages L1 and L2 equally influences L3 acquisition.

The other view, often referred to as L2 Status Factor (e.g., Bardel & Falk 2011), states that the transfer of features mainly occur from L2 to L3. A study conducted by Jaensch (2001), for example, showed that the transfer of features into L3 German are dependent on the proficiency of L2 English. In this study L3 acquisition of German adjectival inflection was examined. The results of the study showed that the gender and number on German attributive adjectives are related with third language acquisition. The study compared L1 Japanese speakers that have different L2 English proficiencies and are L3 learners of German. The task showed different results in terms of correct responses of the groups depending on the proficiency of L2 English. These results show evidence for the L2 Status Factor, in that the L2 takes a more relevant role of transmission to L3 than L1, since the results depended on the L2 and not L1 language proficiency. In respect to this view, L2 acts like a “filter” making L1 inaccessible, due to the fact that L2 and L3 are more similar in terms of being learned and not acquired, that is, have been learned less automatically than L1, in line with the assumption of Ullman (2001), that L1 is implicitly acquired and stored in procedural memory, whereas L2 and L3 are consciously learned and stored in declarative memory.

In accordance with this view Bardel & Falk (2011) showed that L2 is more dominant during the transfer to L3, presumably because L2 is stored in the declarative memory and thus more accessible in the context of L3 learning, whereas L1 is stored in the procedural memory. The transfer differences of L1 and L2 to L3 of this result reflects that not all third language learners acquire their L3 in the same way, and indicates that L3 learning partially depends on the level
of the L2. Bardel & Falk (2007) found results that indicated a qualitative difference between L1, L2 and L3 acquisition. The results of their study indicated that L1 and L2 have a stronger cognitive similarity than L1 and L3. In the study L2 English speakers and L2 German/Dutch speakers were compared with respect to the placement of sentence negation. These two groups of speakers were tested in L3 Swedish on placement of sentence negation. The results showed that the L2 German speaking group did not show any difficulties with negation placement. On the contrary the L2 English speaker group often misplaced the negation in the utterances. Thus, the results provide evidence for a qualitative difference between the acquisition of L2 and the subsequent L3. Importantly, the results also indicate that the transfer occurred stronger from L2 to L3 than from L1 to L3, in line with the L2 Status Factor view.

2.4. Research question and purpose of the study

The present study aims to shed further light on the question of whether the transfer into L3 is equally strong from L1 and L2, or whether transfer into L3 primarily occurs from L2. This is investigated on the basis of L3-learners' ERP response. Consequently, it investigates if L3 (Spanish) learners react stronger to verb incongruencies (see Table 1 below) that exist in their L2 (English) but not in their L1 (Swedish), if they are more sensitive to adjective incongruences that are found in their L1 but not in their L2, or if they are equally sensitive to both of these incongruencies. This is investigated by looking at the ERP response to incongruencies in the L3 which either exist in the L1 or the L2. If the influence on L3 is similar for L1 and L2, similar responses should be observed. On the other hand, if the L2 influence is stronger than the L1 influence, the response to L2 incongruencies should be more "native-like" than the response to L1 incongruencies.

2.5. Agreement

2.5.1. Agreement errors

Agreement patterns englobe three main features, number, gender and person (Wechsler 2003). It is defined as “a syntactic covariance between a semantic or formal property of one element and a formal property of another” (Steele, 1978). For example, in 4a below, the subject NP 'The girl' is in the singular and this is marked on the copula verb ('is'). In 4b, on the other hand, the subject NP ('The girls') is in the plural, and this is marked on the copula verb by virtue of its form ('are'):

(4a) The girl is running.
(4b) The girls are running.
Example 4 illustrates the syntactic covariance between the subject NP and the finite copula verb of the sentence. Thus, morphosyntactic disagreement refers to the violation of the syntactic covariance between the formal property of one element and the formal property of another. This is exemplified in (5a). In this example the subject NP is in singular, but the copula verb takes the plural form which causes a morphosyntactic disagreement.

(5a) The girl *are running.
(5b) The girls *is running.

2.5.2. The ERP paradigm and the ERP response to agreement errors

The present study uses EEG (electroencephalogram), a noninvasive method that records voltage variations through the scalp. EEG is a measuring method that underlies the extraction of ERP ("event related brain potential") waves. ERP waves are averages of EEG epochs that are time locked to a specific stimulus. As such, ERPs measure brain responses to specific events that are time-locked to the presentation of a stimulus. ERPs measure the brain’s response to the presented stimuli as changes in microvolts recorded at specific scalp positions. The ERP wave consists of negative and positive shifts in microvolts, whose amplitudes, latencies and scalp locations are characteristic of functionally distinct cognitive processes (Blackwood & Muir, 1990). For example, Kutas & Van Petten (1994) investigated the ERP response to semantically anomalous words in sentences such as "I like my coffee with cream and dog" in comparison to their unanomalous counterparts (i.e., "I like my coffee with cream and sugar"). They found anomalous words (e.g., "dog") to engender a negative shift in the ERP wave with a centro-parietal distribution, peaking around 400ms after its presentation. This ERP effect is known in the literature as the "N400 effect".

The focus of two main ERP effects to agreement processing started with Osterhout & Mobley (1995). They found agreement violations in reflexive pronouns (i.e., "The wealthy queen built himself...") to engender two ERP effects, the so-called Left Anterior Negativity or “LAN” effect and the P600 effect. The LAN effect is a negative deflection in the ERP wave with a left anterior scalp distribution that most frequently is detected in the 300-450 ms time window, in case of the detection of a smaller region in the same time window 300-500 it is also called Incongruent Negativity. The LAN has also been detected in the study carried out for example by Barber and Carreiras (2006). In their study, the effect occurred in the time window of 300-400ms and had a negative polarity with a left anterior scalp distribution. The P600 is a positivity with a centro-parietal scalp distribution that usually is found in the 500-700 ms time window (see e.g. Barber & Carreiras, 2005, Dowens et al. 2012). The literature on agreement processing in adjectives and verbs in Spanish (Carreiras et al. 2012) shows the same biphasic pattern: A LAN effect followed by a P600 effect. Carreiras et al. (2011) differentiated between an early P600 effect with a frontal-parietal scalp distribution in the 500-750ms time window, and a late
P600 with a more anterior distribution in the 750-1000ms time window. This pattern was also detected in a study carried out for example by Díaz et al. (2016). In this study, agreement errors on verbs in Spanish and Basque were tested on native speakers and L2 learners, since the agreement pattern in Spanish and Basque differs. The results of the study showed for the native and L2 learners a left-anterior negativity, the LAN, engendered in the time window of 300-500ms. This was followed by a posterior positive effect in the time frame of 500-700ms, the P600, caused by syntactic reanalysis and repair and also by grammatical errors such as incongruencies. Using the same type of agreement errors, but contrasting gender and number in Spanish, Banón et al. (2012) found a prominent P600 between 400-900 ms related to the morphosyntactic processing of the participants. Banón et al. found no amplitude difference in the response to number and gender violations, suggesting therefore that the mentioned agreements are processed alike.

### 2.6. Grammatical aspects of English, Spanish and Swedish

Swedish adjectives agree with the noun in terms of gender, number, and definiteness. Gender is a lexical property that exists in Swedish and Spanish but not in English as shown in Example 6a and 6b. In Swedish there is congruency between the noun and the adjective, as well as in Spanish. In Swedish this is marked if the noun has the en-gender, the adjective stays in its base form, but if the noun has the ett-gender it has to be added a -t to the adjective. In Spanish this is marked by the article and the ending of the adjective (-o for masculine and -a for feminine) in concordance with the gender of the noun as well as the article.

<table>
<thead>
<tr>
<th>7a.</th>
<th>ett</th>
<th>grön</th>
<th>hus</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.Neutr.SG</td>
<td>green.NEUTR.SG</td>
<td>house.Neutr.SG</td>
<td>'a green house'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7b.</th>
<th>en</th>
<th>Grön</th>
<th>båt</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.UTR.SG</td>
<td>green.UTR.SG</td>
<td>boat.UTR.SG</td>
<td>'a green boat'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8a.</th>
<th>Una</th>
<th>casa</th>
<th>verde</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.INDEF.F.SG</td>
<td>house.F.SG</td>
<td>green-SG</td>
<td>'a green house'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8b.</th>
<th>Un</th>
<th>barco</th>
<th>verde</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.INDEF-M.SG</td>
<td>boat.M.SG</td>
<td>green-SG</td>
<td>'a green boat'</td>
</tr>
</tbody>
</table>
These examples illustrate a correspondence between the indefinite article, the noun and the adjective in Swedish and Spanish, whereas in English there is no such correspondence. On the contrary, in English and Spanish the verb agrees with the subject, but Swedish lacks subject-verb agreement.

8a. I eat apples.
8b. He eats apples

9a. Yo come Manzanas
   I.SG eat.1SG apples.PL
   ’I eat apples’
9b. Él come Manzanas
   he.3SG eat-3P.SG apples-PL
   ’He eats apples’
10a. Jag öter äpplen
    I.3P.SG eat-INF apples-PL
    ’I eat apples’
10b. Han öter äpplen
    He-3P.SG eat-INF apples-PL
    ’He eats apples’

As shown in examples 8 and 9, the verb agrees with the subject pronoun in English and Spanish as indicated by the inflections of the verb. In Spanish, the infinitive form of the verb is marked with –er (i.e., "comer"). In 9a, the verb ("como") instead takes the ending –o, and therefore agrees with the subject pronoun ("Yo") which is the 1st person singular. In 9b, the subject pronoun ("el") instead expresses the 3rd person singular, and the verb is instead marked with –e inflection. This concordance is marked as well in English by using the -s inflection on the verb when the subject pronoun expresses the 3rd person (Example 8b) but not when it expresses the 1st person (Example 8a). In Swedish, on the other hand, the same verb form is used when the subject either is 1st (Example 10a) or 3rd (Example 10b) person.

2.7. P300

The P300 effect is shortly introduced in this section due to the relevance and novel finding of the present study and it will be discussed as well in the sections below. The P300 occurs during the time window of 200-400 ms in form of a positive deflection. Research indicates that a trend of the P300, is related to information processing. Moreover, research shows that it is
tested by task related stimuli. The P300 concerns mainly with information updating and automaticity of information processing (Donchin & Coles, 1988).

2.8. Predictions

The sentence conditions used for the present study are divided into Subject-Verb agreement and Subject-Adjective agreement sentences using Spanish as the test language as specified above and illustrated in Table 1. An example set of the experimental sentences are presented in Table 1. Each set consists of 5 different conditions: adjective congruent (AdjCon), adjective incongruent (AdjInc), verb congruent (VerbCon), verb incongruent (VerbInc) and predicative incongruent (PredInc).

The sentences of the AdjCon, AdjInc and PredInc conditions consist of copular constructions with an initial subject consisting of a definite article and a noun, followed by a copular verb, and an adjective which either agrees (AdjCon) or disagrees (AdjInc) with the subject in terms of gender. The sentences of the VerbCon and VerbInc conditions were formed by a transitive verb consisting of two nuclear arguments, an external argument to the verb phrase and an internal argument. In these conditions the verb agrees in terms of number (VerbCon) or disagrees also in terms of number (VerbInc) with the noun.

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>EXAMPLE SENTENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADJCON</strong></td>
<td>1 La the- tierra earth.SG.FM es be- round.SG.FM y and La the- FM Luna moon- SG.FM también and 'the world is round and the moon as well'</td>
</tr>
<tr>
<td><strong>ADJINC</strong></td>
<td>2 La the- tierra earth.SG.FM es be- round.SG.MS *redondo round.SG.MS y and la the- FM luna moon- SG.FM también and 'the world is round and the moon as well'</td>
</tr>
<tr>
<td><strong>PREDINC</strong></td>
<td>3 La the- tierra earth.SG.FM *eres be- round.SG.FM y and la the- FM luna moon- SG.FM también and 'the world is round and the moon as well'</td>
</tr>
<tr>
<td><strong>VERBCON</strong></td>
<td>4 Tú 2SG. Anotas annotate- PRS.2nd la the- SG.FM Cifra cipher-SG.FM 'you write down the cipher'</td>
</tr>
<tr>
<td><strong>VERBINC</strong></td>
<td>5 Tú 2SG. *anota annotate- PRS.3rd la the- SG.FM Cifra cipher-SG.FM 'you write down the cipher'</td>
</tr>
</tbody>
</table>

In the present study, the ERP waves reflect the processing of these experimental sentences in respect to adjective and verb agreement anomalies. The conditions are tested on two groups, a control group of L1 Spanish speakers, and an experimental group of L3 Spanish learners, with
English as L2 and Swedish as L1. These are also compared with each other in each condition. The incongruent adjectives are expected to engender a LAN effect in comparison to their congruent counterparts. As explained in Section 4.2, Barber and Carreiras (2011) found a negative polarity with a left anterior scalp distribution in the time window of 300-400 ms, that is, a LAN. This effect was followed by a positive polarity with a centro-parietal scalp distribution in the time window of 500-700ms, that is, the P600 effect (see Section 4.2).

The incongruent verbs are expected to engender a LAN followed by the P600 effect in comparison to their congruent counterparts (e.g, Diaz et al. 2016, Section 4.2). The data of the present study will show in line with the present studies, in terms of pronounced effects if the L3 learners are more sensitive to adjective agreements errors (found in their L1) or to verb agreement errors (found in their L2). The data of each group, Spanish native speakers and Spanish L3 learners will be compared with each other, as well as each condition by itself. I assume that if the learners have a stronger response to verb agreement errors than to adjective agreement errors, L2 is more important in their L3 learning. If on the contrary the response is more pronounced to adjective agreement errors than to verb agreement errors, L1 plays a bigger role in their L3 learning.

3. Methods

3.1. Participants

The ERP experiment was undertaken by a total of 33 participants divided into two groups (see Table 2). The first group consisted of 18 L3 learners of Spanish that were native Swedish speakers, and had English as their L2 (8 female 10 male). Their age at the time of testing ranged between 21 to 44 (mean: 31.6). Their proficiency level was initial and advanced. It was tested with a written and oral test according to the Common European Framework of Reference for Languages (Council of Europe 2016). The second group, that functioned as a control group, consisted of 15 Spanish native speakers that had English as their L2 and Swedish as their L3 (7 female and 8 male). They had an age range at the time of testing of 22 to 42 years (mean: 27.5). Their Swedish level was tested, also according to the Common European Framework of References for languages. All participants had normal or corrected vision, and none of them was left handed. All participants provided informed consent in writing.

Table 2. Number, L1, L2 and L3 as well as Spanish proficiency level of the participants in the experiment
### 3.2. Experimental sentences

The sentences are based on the similarity of adjective agreement of L1 (Swedish) and L3 (Spanish) but lacking in L2 (English) and vice versa verb agreement, existing in L2 (English) but not in L1 (Swedish), as can be seen above in Table 1. On the basis of these traits a total of 48 sets were built on 80 verbs, 135 nouns and 45 adjectives. As shown in Table 1 each sentence set consisted of 5 conditions. The experimental sentences were evenly distributed across sets that were balanced with respect to the gender of the subject nouns of the AdjCon, AdjInc and PredInc conditions and the person, gender and number of the subject pronouns in the VerbCon and VerbInc conditions. Each condition consisted of either congruent (AdjCon and VerbCon) or incongruent (AdjInc, PredInc, and VerbInc) sentences. As the padiscussed earlier, the AdjInc condition contains adjective incongruencies that exist in Swedish (L1) but not in English (L2). The VerbInc condition, on the other hand, contains verb incongruences that exists in English (L2) but not in Swedish (L1). The AdjCon, AdjInc and PredInc conditions consisted of predicative constructions with a definite lexical subject, a copula verb, and an adjective. In order to avoid sentence wrap up effects, these sentences also contained a final conjuncted NP that also functioned as the base of predication (e.g., "The earth is round and the moon as well"). The VerbCon and VerbInc conditions consisted of prototypical transitive sentences with an initial pronominal subject NP, a lexical verb, and a definite lexical object NP. The incongruencies occur systematically with respect to the gender marking of the adjective in the AdjInc condition, and with respect to the number marking of the verb in the PredInc and VerbInc conditions. As illustrated in Table 1, the gender incongruency of the adjectives is presented at the fourth word in the AdjInc condition. The number incongruency of the verbs is presented at the third and the second word in the PredInc and VerbInc conditions, respectively.

All the sentences from each condition are found in Appendix 3. The sentences are based partially on the stimulus material used in Alemán & Bañón (2010) and Silva-Pereyra & Carreiras (2007).
3.3. Comprehension question

Each sentence presented during the experiment was subsequently followed by a yes/no question. Half of these comprehension questions were to be answered with a yes, and the other half with a no, and that this was evenly balanced across the sentences within a set. The interrogative sentences were context related with respect to the declarative sentences, based on synonyms and antonyms. The comprehension questions were used in order to be certain that the participants stayed attentive at the task at hand and were able to understand the corresponding critical sentences. ERP epochs corresponding to sentences for which the comprehension questions had been answered incorrectly were excluded for further analysis (see e.g. below Table 3). As shown in Table 3 the length of the questions were formed by 6 words in the conditions of AdjInc and AdjCon and 4 words in the conditions of VerbInc and VerbCon (see e.g. Appendix II).

Table 3. Examples of 5 different comprehension questions for the critical sentence (the strawberry is digestive and the carrot also)

<table>
<thead>
<tr>
<th>Yes</th>
<th>¿La</th>
<th>fresa</th>
<th>ayuda</th>
<th>a</th>
<th>la</th>
<th>digestión?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the-F.Sg</td>
<td>strawberry-F.SG</td>
<td>help</td>
<td>to</td>
<td>the-F.SG.</td>
<td>digestion?</td>
</tr>
<tr>
<td></td>
<td>‘Does the strawberry help to digest food?’</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No</th>
<th>¿La</th>
<th>fresa</th>
<th>es</th>
<th>desagradable?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the.F.SG.</td>
<td>strawberry</td>
<td>is.P3.SG</td>
<td>disgusting?</td>
</tr>
<tr>
<td></td>
<td>‘Is the strawberry disgusting?’</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yes1</th>
<th>¿La</th>
<th>zanahoria</th>
<th>ayuda</th>
<th>a</th>
<th>la</th>
<th>digestión?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the.F.SG</td>
<td>carrot-F.SG</td>
<td>help.INF</td>
<td>to</td>
<td>the.F.SG.</td>
<td>digestion?</td>
</tr>
<tr>
<td></td>
<td>‘Does the carrot help to digest food?’</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No1</th>
<th>¿La</th>
<th>piña</th>
<th>es</th>
<th>dulce?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The.F.SG</td>
<td>pineapple-F.SG</td>
<td>is.P3.SG</td>
<td>sweet?</td>
</tr>
<tr>
<td></td>
<td>‘Is the pineapple sweet?’</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yes2</th>
<th>¿La</th>
<th>fresa</th>
<th>no</th>
<th>es</th>
<th>ácida?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the.F.SG</td>
<td>strawberry</td>
<td>NEG</td>
<td>is.P3.SG.</td>
<td>acid?</td>
</tr>
<tr>
<td></td>
<td>‘Is the strawberry acid?’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No2</th>
<th>¿La</th>
<th>zanahoria</th>
<th>no</th>
<th>es</th>
<th>digestiva?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the.F.SG</td>
<td>carrot-F.SG</td>
<td>NEG</td>
<td>is.P3.SG.</td>
<td>digestive?</td>
</tr>
<tr>
<td></td>
<td>‘Isn’t the carrot digestive?’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4. Stimuli presentation

The experimental sentences were divided into 5 blocks in a manner that ensured that conditions, grammatical properties of the sentences, as well as the question types (whether the question were to be answered with "yes" or "no") were evenly balanced across blocks. Sentences within a block were presented in a randomised fashion. The ordering of the blocks was counterbalanced across participants on the basis of a latin-square design. Each sentence was displayed one word at a time presented 400ms in the center of the screen followed by a pause of one 100ms until the next word. The corresponding comprehension question was presented after the sentence on the screen at the same time; the time was not limited to answer the questions, thus the sentence was presented until the participant pressed the answer button to continue.

3.5. Procedure

The study was performed in the phonetics laboratory at the Department of Linguistics at Stockholm University. All of the participants were informed about the procedure of the experiment. The participants were informed about the possibility to abort the experiment at any time. Before starting the experiment, the participants were asked to sign a formal consent and fill out a language level test of their L3 language (Spanish or Swedish see blow Appendix I.). They were seated on a comfortable chair in front of a monitor within a distance of one meter. Also they were asked not to blink while the sentences were presented word by word on the monitor, and only to blink during the question was presented. They were provided with a response box with two buttons marked with “Yes” or “No” to answer whether the comprehension question was correct or not. Each experimental session started with a practice trial consisting of 12 practice sentences. During the practice trial, participants received feedback about whether they had answered the question correctly. Each experimental session varied from 60 to 90 minutes depending on the language proficiency (L3) of the participant.

3.6. EEG recordings

The EEG was recorded from 128 electrodes on a high-impedance Hydrocel Sensor Net and analyzed using Net Station equipment (Electrical Geodesics, Inc.). The 128 electrodes detected the electrical brain responses of the participants and measured the signal strength during each presented word. The electrooculogram (EOG) was monitored with two electrodes positioned at the outer canthus of each eye, four positioned above the eyes and two below. The signal was amplified with a Net Amps 300 amplifier with a fixed sampling rate of 20,000 Hz and a low-pass filter at 4,000 Hz, but down sampled during recording to a user set sampling rate of 250 Hz.
Impedances of all electrodes were adjusted below 50 kΩ before the recording was started. The ground electrode was positioned in between CPz and Pz. Channels were referenced to Cz during recording, but re-referenced to the average of the left and right mastoids.

### 3.7. ERP data analysis

The software used for acquiring and preprocessing the data was Net Studio 4.2. First the data was band-pass filtered off-line using a 0.5- to 20-Hz filter. Bad channels were interpolated from the good channels, using spherical splines (Perrin, Pernier, Bertrand, Giard, & Echallier, 1987). Channels were defined as bad if the signal exceeded ±100 μV in more than 20% of the 4000 ms time windows during the periods during which the experimental stimuli were presented. Single-trial epochs that ranged from 200 ms before the onset of the critical words\(^1\) to 1000 ms after their onsets were extracted. The 200 ms before stimulus onset was used for baseline correction. Baseline correction involves subtracting the mean voltage of the baselines from the full EEG epochs in order to make epochs comparable. Epochs were defined as bad and excluded if they contained more than 15 bad channels in which the signal exceeded ±100 μV in the full epoch, if the signal exceeded ±100 μV in a 600 ms time window in any of the anterior or posterior EOG channels, or if the signal exceeded ±55 μV in a 500 ms time window in any of the EOG channels outside the canthus of each eye. All single trial epochs in which participants answered incorrectly were also defined as bad and excluded. Single-subject ERPs time locked to the critical words of each condition were then calculated on the basis of the remaining good epochs. Data from subjects with less than 15 epochs in any of the conditions were excluded from further analysis. This entailed that data from two of the L1 Swedish participants and one of the L1 Spanish participants were excluded.

### 3.8. Statistical analysis

The statistical analyses were conducted in the statistical software R (R Core Team 2014), using RStudio (RStudio Team 2015). T-tests were conducted in order to compare differences in mean amplitudes between congruent and an incongruent conditions (e.g. VerbCon vs. VerbInc) within a particular group of speakers (i.e. L3 or L1 speakers), and to compare differences between the speaker groups for a particular condition (e.g., the difference in the processing of adjective incongruencies between L3 and L1 speakers). These analyses were conducted in scalp regions consisting of groups of electrodes (see Figure 1 below). The analyzed regions correspond to Regions of Interest “ROIs”, identified in other studies such as e.g., Hahne & Friederici, (2001); Hagoort, (2003); Ye et al., (2006). Electrodes were grouped in the following four regions-of-interest (ROIs): Left Anterior (“LA”), consisting of electrodes

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\(^1\) The fourth word in the AdjCon and AdjInc conditions, the second in the VerbCon and VerbInc conditions and the third in the PredInc condition
34, 28, 35, T7, 41 and 36, Left Anterior Superior ("LAS"), consisting of electrodes C1, C3, F1, F3, F7, F3, FC1, FC3, FC5, 7, 12, 20 and 35, Left Posterior Inferior ("LIP") and Centro-Parietal ("CP"), consisting of electrodes 31, 55, 80, 54, 79, 61 and 78. These regions are illustrated in Figure 1 below.

Figure 1. Regions on scalp map

Paired t-tests were used to analyse statistically the significance of an effect in a certain region based on regions of interest as explained above in which the conditions AdjCon and AdjInc as well as VerbCon and VerbInc of each group (L1 Spanish speaker or L3 Spanish learner) were compared with each other. It was also tested statistically across groups within the same condition (e.g. Spanish AdjCon and Swedish AdjCon, Spanish VerbInc and Swedish VerbInc). This statistical analysis schema is illustrated below in Figure 2.
Due to the few participants of each group, either time windows were adjusted, or regions were narrowed down in a few cases. Nevertheless, the most relevant time windows into this study are the 300-500 ms time window (for the LAN), the 500-700 ms time window (for the P600), and the 200-400 ms time window (for the P300).

4. Results

In the following, I first report the behavioral results (Section 10.1) and in the subsequent section 10.2 I move on to the ERP results examined according to Table 4 illustrated below.

4.1. Behavioural data

This section reports the response accuracies in the comprehension question test of both groups and also in comparison with each other. The L1 Spanish speaker group had a higher mean response accuracy (M=0.93, SD=0.001) than the L3 Spanish speaker group (M=0.85,
SD=0.01) in the test. The average response difference between the speaker groups is very significant, \( t(25)=30, p < .0001 \).

As expected, the L1 Spanish speakers showed a higher response accuracy.

4.2. ERP Data

The ERP data illustrates the effects of the grammatical anomalies on language comprehension in the L3 learners in comparison to the L1 speakers. In the following, I start out by presenting results for each anomaly type and group as shown in Table 4 below, followed by differences and similarities between groups. It is assumed that the effects are engendered by the incongruencies in comparison to the congruent control conditions.

### Table 4. Analysed effects per group and anomaly type

<table>
<thead>
<tr>
<th>Group</th>
<th>Incongruence</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>Adjective</td>
<td>*INC.NEG P600 P300</td>
</tr>
<tr>
<td>L3</td>
<td>Adjective</td>
<td>INC.NEG P600 P300</td>
</tr>
<tr>
<td>L1-L3</td>
<td>Adjective</td>
<td>INC.NEG P600 P300</td>
</tr>
<tr>
<td>L1</td>
<td>Verb</td>
<td>INC.NEG P600 P300</td>
</tr>
<tr>
<td>L3</td>
<td>Verb</td>
<td>INC.NEG P600 P300</td>
</tr>
<tr>
<td>L1-L3</td>
<td>Verb</td>
<td>INC.NEG P600 P300</td>
</tr>
</tbody>
</table>

*INC.NEG - incongruence negativity.

#### 4.2.1. Adjective - L1-Spanish speakers

**Incongruence negativity**

The L1 Spanish speaker group showed a negative response to adjective incongruences (see Figure 13) in the 300-500ms time window that had a left-parietal distribution (LP). This effect is illustrated in Figure 5. The difference in amplitude between the AdjInc and AdjCon conditions was significant (paired t-test, \( t(13)=2.80, p<0.01 \)) showing a more prominent deflection on the incongruent condition.
P600
L1 Spanish speakers also showed a positive response to adjective incongruencies that had a centro-parietal distribution, illustrated in Figures 6. This effect is highly significant (paired t-test, \( t(13) = -3.13, p < 0.01 \) in the 500-700ms.

P300
For L1 speakers, adjective condition did not show a positive deflection in the expected time window of 200-400 ms. The statistical result showed \( t(13) = 1.0, p = 0.34 \) in the centro-parietal region. An example is of the P300 effect is shown below in Figure 7.
4.2.2. Adjective - L3 Spanish learners

Incongruence negativity

In contrast to the L1 Spanish speakers, L3 Spanish learners did not show a significant effect engendered by adjective incongruencies in the 300-500 ms time window ($t(18)=1.87, p=0.08$) in the centro-parietal region. An example of this effect under this conditions is illustrated in the Figure below 8 which shows that AdjCon engendered a more prominent negativity than AdjInc.

Figure 8. The ERP response at electrode 78 of L3 Spanish learner comparing Adjective Congruent and Incongruent condition
**P600**

For the L3 speakers, a significant difference between the AdjCon and AdjInc conditions was detected in the 500-700 ms time window in the centro-parietal scalp distribution. This was statistically tested (paired t-test, t(13)=−2.35, p=0.038). The effect is illustrated in Figure 9.

![Figure 9. The ERP response at electrode 80 of L3 Spanish learner comparing Adjective Congruent and Incongruent condition](image)

**P300**

For L3 speakers, however, adjective incongruencies appear to engender an early positivity in the 200-400 ms time window with centro-parietal distribution (see Figure 10). A paired t-test on between-condition mean amplitudes in the 200-500 ms time window showed a statistically significant difference (paired t-test, t(13)=−2.98, p=0.01).

![Figure 10.](image)
4.2.3. Adjective - L1 Spanish speaker - L3 Spanish learners

Incongruence negativity

By comparing L1 and L3 groups to each other in the congruent and incongruent-adjective conditions, a statistically significant amplitude difference was detected in both cases. The unpaired test showed \( t(22)=4.36 \ p>0.001 \) in the 300-500ms time window in the centro-parietal region a very significant amplitude difference in L1 and L3 group. The L1 group showed a lower negative deflection on the congruent adjective condition in comparison with the L3 group, an example is illustrated below in Figure 11.

In respect to the incongruent condition the amplitude difference was statistically less significant than AdjCon. A Unpaired t-test was used to test the same region as for AdjCon (centro-parietal region) and time window 300-500 ms with the following result \( t(22)=2.08 \ p>0.05 \). As expected the deflection is stronger on L1 speakers, an example is shown below in Figure 12.

P300

For L3 learners, both the AdjCon and AdjInc conditions appear to engender an enhanced P300 wave in comparison to L1 speakers. Unpaired t-tests on mean amplitudes in the 200-400 ms time window in the centro-parietal region showed that this difference between L1 and L3 speakers is significant both in the adjective congruent \( t(22)=2.29, \ p > 0.05 \) and the adjective incongruent conditions \( t(22)=3.38, \ p< 0.01 \). The between group differences of congruent and incongruent adjective condition are illustrated in Figure 13 and 14 below.
4.2.4. Verb – L1 Spanish speakers

Incongruence negativity
Data from L1 Spanish speakers showed an effect of verb incongruencies in the centro-parietal (CP) region with a somewhat leftward distribution on the scalp. As illustrated in Figure 15, verb incongruencies engender a negative deflection peaking around 450 ms time window. A paired t-test between-condition (VerbInc vs. VerbCon) on mean amplitudes in the 300-500 ms time window of the centro-parietal region found a significant difference ($t(13) = 2.89$, $p < 0.01$). This effect, henceforth referred to as the incongruence negativity, is similar to the conventional N400 effect in terms of its scalp distribution. However, it’s somewhat leftward scalp distribution suggests that it is a LAN effect with a posterior distribution, which is the kind of effect that is expected.
The expected region to find a P600 effect engendered by verb incongruencies is the centro-parietal (CP) region. The expected region was tested statistically in the 500-700 ms time window, but no significant differences were found ($t(13)=0.88, p = 0.39$).

Additionally, due to the finding of the so-called P300 effect (see below) in the between group comparisons, this effect was also tested statistically for the verb condition. The centro-parietal region was also tested statistically in the 200-400 ms time window, but no significant amplitude differences were found ($t(12)=1.58, p = 0.14$). Both results are illustrated below in Figure 16.

![Figure 16. The ERP response at electrode 61 and 31 of L1 Spanish speakers comparing conditions Verb Congruent and Verb Incongruent conditions](image)

### 4.2.5. Verb-L3-Spanish learners

**Incongruence negativity**

For the L3 Spanish learners, the incongruence negativity effect was localized in the centro-parietal region, but showed a nonsignificant difference ($t(17)=1.13, p = 0.28$) in the 300-500 ms time window. The effect is shown below in Figure 17.
P600
For L3 learners, verb incongruencies appear to engender a late positivity effect with a left anterior scalp distribution, similar to the conventional P600. This effect was tested in the 500-700 ms time window in the left anterior (LA) region in which a significant effect was detected ($t(17)=2.90, p<0.01$). This effect is illustrated in the Figure 18 below.

P300
As explained above, because of the detected amplitude difference in the adjective condition finding a so-called P300 effect, the verb condition has also been tested statistically. The tested area correspond to the centro-parietal region in the 200-400 ms time window, no significant amplitude difference was found ($t(17)=1.04, p = 0.32$), an example is shown below:
4.2.6. Verb - L1 Spanish speakers - L3 Spanish learners

Incongruence negativity

Figures 9 and 10 illustrates the difference in the incongruence negativity effect between the two groups of speakers in the verb incongruent condition. As indicated in Figure 9, this effect is somewhat strong for L1 speakers than L3 speakers. An unpaired t-test on the mean amplitudes in the 300-400 ms time window in the centro-parietal region showed that this difference is significant ($t(22)=1.75$, $p=0.09$). In contrast to this result the congruent verb condition did not show a statistically significant result within the same time window and region as the incongruent verb condition. The unpaired test on the mean amplitudes ($t(22)=1.02$, $p=0.31$) showed as mentioned a non-significant result. Finally, as illustrated in Figures 9 and 10, in the incongruent as well as the congruent condition, the incongruence negativity peaks around 500-550 ms for L3 speakers but around 400-450 ms for L1 speakers. Thus, the negative deflection peak is later for L3 than L1.
For L3 learners, verb incongruencies were tested because a significant difference was detected on the adjective condition. This effect was tested statistically in the 200-400 ms time window using an unpaired t-test on the mean amplitude of this region found a non-significant effect for the verb congruent and verb incongruent condition in the centro-parietal region. The unpaired t-test showed for the congruent verb the following result ($t(22)=0.823, p=0.41$) and for the incongruent adjective condition ($t(22)=1.00, p=0.07$). Both conditions are shown below in Figure 22 and 23.

Table 5 summarizes the effects that were detected when comparing conditions as well as speaker groups.
Table 5. Summary of effects differentiated on the basis of verb classes, groups and condition comparisons

**Incongruence Negativity**

<table>
<thead>
<tr>
<th>Word class</th>
<th>Group comparison</th>
<th>Condition comparison</th>
<th>Time window</th>
<th>t-value</th>
<th>p-value</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Verb</strong></td>
<td>L1-L1</td>
<td>Congruent-Incongruent</td>
<td>300:500</td>
<td>2.89</td>
<td>0.01**</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L3-L3</td>
<td>Congruent-Incongruent</td>
<td>300:500</td>
<td>1.13</td>
<td>0.28</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L1-L3</td>
<td>Congruent</td>
<td>300:500</td>
<td>1.02</td>
<td>0.31</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L1-L3</td>
<td>Incongruent</td>
<td>300:500</td>
<td>1.75</td>
<td>0.09</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L1-L1</td>
<td>Congruent-Incongruent</td>
<td>350:500</td>
<td>2.80</td>
<td>0.01**</td>
<td>LP</td>
</tr>
<tr>
<td></td>
<td>L3-L3</td>
<td>Congruent-Incongruent</td>
<td>300:500</td>
<td>1.87</td>
<td>0.08</td>
<td>CP</td>
</tr>
<tr>
<td><strong>ADJ.</strong></td>
<td>L1-L3</td>
<td>Congruent</td>
<td>300:500</td>
<td>4.36</td>
<td>0.0002***</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L1-L3</td>
<td>Incongruent</td>
<td>300:500</td>
<td>1.02</td>
<td>0.31</td>
<td>CP</td>
</tr>
</tbody>
</table>

**P600**

<table>
<thead>
<tr>
<th>Word class</th>
<th>Group comparison</th>
<th>Condition comparison</th>
<th>Time window</th>
<th>t-value</th>
<th>p-value</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VERB</strong></td>
<td>L1-L1</td>
<td>Congruent-Incongruent</td>
<td>500:700</td>
<td>0.88</td>
<td>0.39</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L3-L3</td>
<td>Congruent-Incongruent</td>
<td>500:700</td>
<td>2.90</td>
<td>0.01**</td>
<td>LA</td>
</tr>
<tr>
<td></td>
<td>L1-L3</td>
<td>Congruent</td>
<td>500:700</td>
<td>-0.49</td>
<td>0.62</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L1-L3</td>
<td>Incongruent</td>
<td>500:700</td>
<td>-0.92</td>
<td>0.36</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L1-L1</td>
<td>Congruent-Incongruent</td>
<td>500:700</td>
<td>-3.13</td>
<td>0.009**</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L3-L3</td>
<td>Congruent-Incongruent</td>
<td>500:700</td>
<td>-2.35</td>
<td>0.038*</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L1-L3</td>
<td>Congruent</td>
<td>500:700</td>
<td>0.95</td>
<td>0.3</td>
<td>CP</td>
</tr>
<tr>
<td></td>
<td>L1-L3</td>
<td>Incongruent</td>
<td>500:700</td>
<td>1.13</td>
<td>0.2</td>
<td>CP</td>
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**P300**

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P600

Verbs:

- L1-L1: Congruent-Incongruent, 500:700, t-value: 2.90, p-value: 0.01**, Region: LA
- L3-L3: Congruent-Incongruent, 500:700, t-value: 2.35, p-value: 0.038*, Region: CP

ADJ.

- L1-L3: Congruent, 500:700, t-value: 4.36, p-value: 0.0002***, Region: CP
- L1-L3: Incongruent, 300:500, t-value: 2.08, p-value: 0.04*, Region: CP
5. Discussion

This study aimed to compare differences in language processing in L1 and L3 Spanish speakers with respect to verb and adjective agreement incongruencies. The study aimed as well to assess how specific morphosyntactic features are transferred from L1 (Swedish) and L2 (English) to a L3 Spanish learner group. In this scope the purpose was to investigate whether L1 (Swedish) or in contrast L2 (English) influences L3 (Spanish) acquisition the most. Results showed evidence for a stronger transfer occurring from L2 (English) based on the finding of a P300 effect as a response to the processing of adjective conditions in the L3 learner group. The details of this argument are presented in the following.

On the other hand, the results showed lack of an incongruence negativity that indicates that L3 Spanish learners process Spanish differentially perhaps due to a lower level of language proficiency. The mean proficiency scores per group L1 is M=0.99 and L3 is M=0.85. These scores were measured during the experiment and are based on the correct responses of each participant.

In the following, the results of the study will be discussed with respect to each ERP effect.

5.1. Incongruence negativity

This effect has been detected in the present study as well as in Barber & Carreras (2014). They found both verb and adjective incongruencies to engender a LAN effect. In the present study, verb and adjective agreement processing showed a significant difference between congruent and incongruent conditions. For L1 the VerbInc condition engendered a negativity on the centro-parietal region, whereas AdjInc on the left anterior region. In accordance with Carreiras et al. (2014) mentioned above, the results of AdjInc can be related with a LAN effect (left anterior negativity) since it is produced in a larger region in the left anterior region. For the L3 speakers the VerbInc condition did not engendered a significant negativity. These results indicate that verb and adjective agreement are differently processed by L1 Spanish speakers and L3 Spanish learners. The group comparisons (L1 and L3) showed as well a significant difference during the processing of both verb and adjective incongruences in terms of a significantly more pronounced incongruence negativity for the L1 Spanish speaker in comparison to L3 Spanish learners. These results suggest that the response to the agreement errors were detected stronger by the L1 group which shows a higher neuronal response to this error in contrast to the L3 group. These results confirm therefore that the comprehension and processing of adjective and verb incongruencies was different between the groups.

5.2. P600

This effect was detected in response to verb incongruencies in the L3 group, but not in the L1 group. It was also detected in the adjective incongruency condition in both the L1 and L3
groups the L1 in the 500-700 ms time window in the centro-parietal region. These results differ slightly with most previous studies (Carreiras et al., 2014, among many others) in which the P600 effect is detected for verb incongruencies in L1 speakers. This alteration presumably is caused due to the small sample size of the L1 group.

On the other hand, as mentioned above a significant amplitude difference was detected in L1 and L3 for the adjective condition, which manifested a stronger neuronal response on the incongruent condition in comparison to the congruent condition. The elicitation of a P600 can be expected to be stronger in the L1 Spanish speakers as shown for the adjective condition, since previous studies (e.g. Barber & Carrerias, 2014) have found an absence of the P600 effect in low-proficiency L2 learners. The reaction to grammatical errors such as agreement errors as in the present study, connect the P600 effect. The observed difference between the L1 and the L3 groups might be as well an effect of reanalysis, since the incongruent condition showed a more prominent response than the congruent condition. Incongruency might lead L1 and L3 to analyse in a different manner than initially expected sentence causing the reanalysis of the presented sentence. (Osterhout & Holcomb 1992).

5.3. P300
The L1 group showed no incongruence-congruence difference in the time window of 200-400 ms, neither for the verb nor the adjective conditions. In contrast, L3 speakers manifested a significant difference in the P300 time window between the adjective incongruence and congruence conditions. Comparisons between the L1 and L3 groups found a significant difference for AdjCon and a very significant amplitude difference on the AdjInc during the time window of 200-400 ms. The positive deflection is more pronounced in the L3 speakers in comparison to the L1 group. The literature does examine the P300 effect in relation with grammatical agreement errors. Hence it is not possible to relate the findings of this study directly with other studies in the frame of agreement processing.

Consequently, the results of the present study are related with various studies that have shown that the P300 effect is related to automaticity and strategical language processing as for example in Rugg (1995). These results indicate that the processing for the L3 group of adjective agreements, is less automatically processed than verb agreement. The detection of this effect only identified on the adjective condition and considering that adjective agreement exist in their L1 language (Swedish) and on the basis of previous studies, I assume that in the L3 group, the morphosyntactic transfer to their L3-Spanish is mainly done from their L2 (English), since no P300 effect is detected on verb agreement processing.

According to the L2 Status factor theory presented in Section 2.3., transfer from L2 to L3 is more common than transfer from L1 to L3, because L2 and L3 are similar in terms of being acquired at a later stage in life, and therefore to a greater extent it is stored in declarative memory. The L2 is therefore making the L1 less accessible during the processing of an L3. In the present study, L3 learners are therefore more attentive to the adjective agreement that exist in their L1 but not in their L2 (i.e., adjective incongruencies) and this is reflected in the
enhanced P300 wave. L2-English acts like a filter to L1-Swedish, making it less accessible, thereby making it less automatically accessed, which is reflected by the P300 effect. This might be caused by the fact of the L3 learners being more attentive to the adjective incongruencies due to the L2 status. Current research suggests that the P300 reflects updating of working memory (Donchin & Coles 1988) produced by context updating. Language processing requires working memory capacity in order to keep continuously information of the sentence in the memory. It has been shown in different studies that the increased difficulty of a task in which strategic information processing was required, showed an increased P300 effect, since higher activity on working memory was necessary. In the present study the sentence similarity and the vastly structured task of the experiment might cause a “strategic information processing” (Donchin & Coles 1988). According to this study the P300 effect was engendered by stimuli that was originally unexpected but through repetition became expected. Finally, the results also stand in line with Ullman’s theory (2001) regarding the difference between declarative and procedural memory. The results of this study indicate a transfer difference between L1 and L2 to L3. In line with Ullman (2001), the filtering of L1 by L2 happens because L2 and L3 has the same status in terms of degree of entrenchment since both are stored in declarative memory to a greater extent, whereas L1 is stored in procedural memory.

6. Conclusions

In this study it has been shown how to use ERP methodology for research in third language acquisition, which is an emerging research field nowadays. The present study has confirmed that language is processed differently in native like speakers and L3 learners. Therefore, the most significant finding of this study is the P300 effect that was significantly more prominent in L3 learners than in L1 Spanish speakers but also demonstrated a higher amplitude in the condition of adjective agreements. This shed new light on L3 acquisition, stating that L2 acts like a filter making L1 inaccessible, standing in line with the L2 Status Factor. The findings of this study show, for the first time, the relation between third language acquisition and the P300 effect as a conclusion for a presumable transfer sign of L2 to L3. This is likely caused due to the cognitive similarity between L2 and L3 in contrast with L1 and L3, since L1 is part of the procedural memory and L2 and L3 are on the contrary part of the declarative memory. As explained in the Background Section, the L3 learners are more aware of the L2 grammatical features than of L1. This is shown in the present study through the P300 effect engendering a stronger neuronal response on L3 speakers first language feature the adjective condition (Swedish), indicating a less automatic language process.

Further research is needed with a higher amount of participants and a clear division between L3 language proficiency in order to get more certain results.
References


Appendix

I. Proficiency test

I.a. Spanish Test

Sample Language Usage Items

Select the correct choice to fill the blank space in the sentence:

1. Los hombres ______ afeitan cuando tienen barba.
   a. le
   b. lo
   c. me
   d. se

2. Cuando llegamos allí, nos dijeron que Roberto ya ______ .
   a. ha salido
   b. salga
   c. había salido
   d. saliera

3. ¿A usted ______ bien su nuevo secretario?
   a. te cae
   b. me cae
   c. se cae
   d. le cae

Sample Cloze Item
1. X: Necesito saber por qué no vino a la fiesta Ramón.
   Y: ______.
   a. Va a traer cerveza, ¿no?
   b. Es hora de preguntárselo.
   c. Me la pidió esta mañana.
   d. ¿No sabe qué hora es?

2. X: ¿Le llevaraste tu coche al mecánico?
   Y: ______.
   a. No, se me olvidó
   b. Sí, te lo hago esta tarde
   c. No, lo vas a arreglar pronto
   d. Sí, es del mecánico
I. Instructions: Select the best answer.

1. Robert ___________ på fabriken idag.
   o A - arbeta
   o B - arbetar
   o C - arbetat
   o D - arbetar

2. Vem är ___________. Marja eller Monika?
   o A - längre än
   o B - lång
   o C - längst
   o D - längst än

3. Filmen var ___________ boken.
   o A - så bra som
   o B - lika bra som
   o C - bra som
   o D - bra lika

4. Jag tycker om att läsa, titta på TV och ____________.
   o A - går på bio
   o B - jag går på bio
   o C - går jag på bio
   o D - gå på bio

II. Instructions: Select the underlined word or phrase that is incorrect.

1. Jag ska ___________ att få fem röda äppler.
   o A - be
   o B - få
   o C - röda
   o D - äppler

2. De ___________ turister som kommer till Sverige säger att allting är så ____________.
   o A - mest
   o B - turister
   o C - som
   o D - dyrt

3. Vet du ___________ det är mycket kallt ut idag?
   o A - om
   o B - mycket
   o C - kallt
   o D - ut

III. Instructions: Select the best answer.

1. De flesta stockholmare ___________ lägenhet.
   o A - hyr
   o B - bor
   o C - lever
   o D - tillhör

2. Jag har ont i ___________, så jag inte skriva.
   o A - halsen
   o B - handleden
   o C - vristen
   o D - ankeln

3. Många invandrare ___________ att svenskarna är reserverade.
   o A - tycker
   o B - tänker
   o C - avser
   o D - verkar

Instructions: Read the Swedish text and select the best answers for the questions.

Nina bor på Söder i Stockholm. Det är svårt att parkera i stan, så det är lättast att åka buss eller tunnelbana när man ska hälsa på henne. Nina brukar alltid rekommendera att man tar tunnelbanan eftersom tägen går oftare än bussarna. Ta vilket

1. På vilken gata bor Nina?
   - A - TCentralen
   - B - Högbergsgatan
   - C - Slussen
   - D - Götgatan

2. Varför rekommenderar Nina alltid tunnelbanan?
   - A - Tågen går oftare än bussarna.
   - B - Bussarna går oftare än tågen.
   - C - Hon bor vid TCentralen.
   - D - Hon bor långt från TCentralen.

---

### II. Experimental Sentences

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38
¿El consumo ha crecido?
¿Ha aumentado el consumo?
¿La casa y el jardín son minúsculos?
¿Sólo la cochera es grande?
¿La casa es grande?
¿Ha besado a alguien?
¿Es el otoño oscuro como el invierno?
¿Es el otoño claro?
¿El invierno es muy claro?
¿Es el otoño oscuro como el invierno?
¿Es el otoño claro?
¿No se ha solucionado el problema?
¿Se ha solucionado el problema?
¿Ha querido el papel?
¿El no quemó el papel?
¿Lo quemó nada?
¿La falda no es femenina?
¿Son las blusas son femeninas?
¿Tanto falda como blusa son femeninas?
¿La falda es azulada y la blusa también?
¿Es azul a la blusa?
¿Es el otoño claro?
¿Es el otoño oscuro como el invierno?
¿Es el otoño claro?
¿Es el otoño oscuro como el invierno?
¿Sólo la cochera es grande?
¿La casa y el jardín son minúsculos?
¿La casa es grande?
¿Son largos los arroyos y meandros?

¿Es el arroyo corto?

¿Es el meandro corto?

¿Ella mira la televisión?

¿Escucha ella la música?

¿Es amplia la cocina?

¿Es amplia la entrada?

¿Son amplias la entrada y la cocina?

¿El borra la libreta?

¿Borro el cuadernillo?

¿Es muy moderno el colegio?

¿El liceo no es moderno?

¿El colegio no es moderno?

¿Busca una foto?

¿Busca un libro?

¿Es fea la isla?

¿Es horrible la bahía?

¿La isla y la bahía son bonitas?

¿Presentó un cuadro?

¿Lo presentó fue un cuadro?

¿El verano no es seco?

¿El invierno es seco?

¿El verano no es húmedo como el invierno?

¿Modifica la imagen?

¿Cambia la imagen?

¿La casa es sombría?

¿La bodega es sombría?

¿La bodega tiene mucha luz?

¿Busca la libreta?

¿Busca una foto?

¿El pasillo es amplio?

¿El baño es amplio?

¿El pasillo es pequeño?

¿Subrayó el cuaderno?

¿Subrayó la pizarra?

¿Es rojo el dormitorio?

¿El baño es rosado?

¿El dormitorio tiene el mismo color que el baño?

¿No se celebra el cumpleaños?

¿Se celebra el santo?

¿La colina no es grandiosa?

¿La moñtana no es tan grandiosa como la colina?

¿Tanto moñtana como colina son grandiosas?
¿El artículo es anónimo?
¿El libro tiene un autor conocido?
¿No hay errores?
¿Nadie corrige los errores?
¿La zanahoria no es digestiva?
¿La fresa ayuda a la digestión?
¿Se necesita el dato?
¿El terremoto es catastrófico?
¿El maremoto es tan catastrófico como el maremoto?
¿El maremoto es catastrófico?
¿El terremoto es catastrófico?
¿Se necesita un coche?
¿Se necesita el dato?
¿La zanahoria ayuda a la digestión?
¿La fresa ayuda a la digestión?
¿La zanahoria no es digestiva?
¿Nadie corrije los errores?
¿No hay errores?
¿El libro tiene un autor conocido?
¿El artículo es anónimo?
¿La biblioteca es formativa?

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¿La biblioteca es formativa?
La biblioteca es formativo y la escuela también ¿La escuela es formativa?

La biblioteca eres formativa y la escuela también ¿La escuela no es formativa?

Tú escribes una carta ¿Dibujo una carta?

Tú escribo una carta ¿Escribo en la pizarra?

El espejo es precioso y el mosaico también ¿El mosaico es feo?

El espejo es preciosa y el mosaico también ¿El espejo es bonito?

El espejo soy precioso y el mosaico también ¿El mosaico es bonito?

Él encuentra la nota ¿Encontró la casa?

Él encuentro la nota ¿Encontró el coche?

La cafetera es metálica y la tetera también ¿La cafetería es de metal?

La cafetera eres metálica y la tetera también ¿La cafetera es de plástico?

El diccionario es didáctica y el glosario también ¿El glosario no es didáctico?

El diccionario es didáctico y el glosario también ¿El diccionario no es didáctico?

Tú invades el país ¿El país ha sufrido una invasión?

Tú invado el país ¿Alguien ha invadido el país?

La ventana es amarilla y la escalera también ¿La escalera y ventana son amarillas?

La ventana es amarillo y la escalera también ¿Es roja la ventana?

La ventana eres amarilla y la escalera también ¿Es azul la ventana?

Él olvida el horario ¿Él no se acuerda del horario?

Él olvda el horario ¿No recuerda el horario?