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Studies of non-native language processing:
behavioural and neurophysiological evidence,
and the cognitive effects of non-balanced bilingualism

Mariana Vega Mendoza

Doctor of Philosophy in Psychology
The University of Edinburgh
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Declaration

I hereby declare that this thesis is of my own work, and that it contains no material previously submitted for the award of any other degree. The work reported in this thesis is my own, except where due acknowledgement is made in the text by proper use of quotes and references.

Mariana Vega Mendoza.
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Thesis Abstract

What are the effects of non-balanced bilingualism on cognitive performance? And how do proficient, non-native speakers acquire and use lexical, syntactic and semantic information during sentence processing? Whilst there is growing research on these topics, there is no firm consensus on how to answer these questions. In the literature on cognitive effects of bilingualism, this lack of consensus has even resulted in radically opposing views and a heated debate. In this thesis, I seek to provide a balanced treatment of the literature and to address the abovementioned questions by employing behavioral and neurophysiological paradigms. First, using a structural priming paradigm, I examine how proficient, non-native speakers of different native language backgrounds (Romance and Germanic) acquire lexically-specific syntactic restrictions of non-alternating verbs in English. Results from these experiments suggest that, although non-native speakers partially acquire lexically-specific syntactic restrictions, their knowledge is not native-like. Moreover, transfer from the first language does not seem to play a role in the acquisition of the relevant restrictions. Second, using Event-Related Potentials (ERPs) I examine whether proficient non-native Spanish-English speakers draw on different forms of semantic information such as relatedness and animacy incrementally during sentence comprehension. Results of these experiments suggest that, while relatedness facilitates processing (indexed by N400s) in both native and non-native speakers, effects of animacy are smaller in non-native speakers, relative to native speakers. Third, I employ a series of auditory attentional tasks and measures of lexical access and verbal fluency to assess cognitive functions in non-balanced bilinguals with
different levels of language proficiency. Results show a bilingual advantage in inhibitory control and a non-significant trend towards bilingual better performance in attentional switching, and the groups exhibit similar performance on verbal fluency. Results of all the studies are discussed in the context of the existing literature on cognitive performance in bilinguals and accounts of language processing in native and non-native speakers and suggestions for future research are provided.
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Chapter 1: Introduction and thesis overview

1.1 Introduction

No introduction to the topic of bilingualism could be written without providing, or at least attempting to provide, a definition of bilingualism. For a number of reasons, providing a precise characterisation of bilingualism is not an easy endeavour. For many years, it had been asserted that a bilingual individual was a person who acquired two (or more) languages simultaneously, early in life, and who was equally fluent in both of them or had “native-like control of two languages” (e.g., Bloomfield, 1933; as cited in Butler & Hakuta, 2004, p. 114). However, this classical definition has been contested and, indeed, early views of “perfect” bilingualism have attracted a great deal of criticism (e.g., Grosjean, 1989; Luk & Bialystok, 2013). Three aspects that can be taken into account to characterise different types of bilingualism are age of acquisition (AoA), proficiency, and language use. The three variables can dissociate: for instance, while it is possible that infants in some communities are exposed to a bilingual environment or grow up with simultaneous exposure to two languages (e.g., “crib bilingualism”: Kovacs & Mehler, 2009), their subsequent degree of bilingualism will be ultimately determined by factors such as the degree of proficiency achieved or use of each of the languages.

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1In this work, we will take into account these three factors to refer to balanced and non-balanced cases of bilingualism such that we will consider a “balanced” bilingual someone who acquired their languages early in life simultaneously, is equally proficient in both languages and has had a symmetrical use of the languages throughout their life. We will use the term “non-balanced bilingualism” to refer to individuals who did not acquire their languages early in life simultaneously, and/or are not equally proficient in both languages and/or have not had a symmetrical use of the languages throughout their life.
Many individuals learn languages later in life, and while they may achieve a high degree of proficiency, they may still have a dominant language and or be more proficient in one of their languages. Depending on the disparity between the dominance and proficiency of each of the bilingual’s two languages, they may fall into the spectrum of more ‘balanced’ or less ‘balanced’ (e.g., Butler & Hakuta, 2008). This picture becomes even more complicated when we consider people who have acquired more than two languages (henceforth referred to as multilinguals) and when other factors surrounding the bilingual experience are taken into account. Given the complex pattern of interactions between all these variables, in the present thesis, we consider bilingualism as a multidimensional phenomenon and treat it as a continuous, rather than a categorical variable (Luk & Bialystok, 2013).

Nowadays, in the field of second language acquisition and psycholinguistics, there seems to be more awareness of the need to define bilingualism from a multidimensional perspective. As we have seen, there does not seem to be a clear cut-off point or unified definition regarding who is a bilingual. Part of the challenge arises from the multiple factors that could be taken into account in order to define the concept, as we mentioned previously. Fortunately, our understanding of how the bilingual brain works has rapidly increased in the past decades through the study of the multiple factors surrounding the bilingual experience. In the present thesis, we will use the concept of bilingualism in the broad sense: someone who is able to communicate in two languages, as opposed to cases of “perfect”, balanced and simultaneous bilinguals who grew up and lived in a bilingual environment.
1.2 Different approaches to the study of bilingualism

To do justice to the multi-factorial nature of bilingualism, studies on bilingualism need to use different methodologies to examine how the bilingual’s languages are organised in the brain, how bilinguals process different types of linguistic information, and more recently, what the cognitive effects of the bilingual experience are. The study of bilingualism has been approached by different fields, ranging from linguistics, psycholinguistics, cognitive psychology, neuropsychology, and neuroscience. For instance, linguistic and psycholinguistic research have greatly contributed to the development of the most prominent linguistic theories on how linguistic representations are formed in bilinguals (e.g., Bates & MacWhinney, 1989; Clahsen & Felser, 2006). In addition, because different methods are more appropriate to address different questions in the study of bilingualism, each field of study has contributed to our understanding of bilingualism through different approaches. For instance, neuropsychological approaches have included patient and lesion studies, as in cases of bilingual aphasia, yielding insights into how languages are organised in the brain. Cognitive psychology and neuroscience have also led to fruitful research into the neural substrates of language organization in typical bilingual populations, as well as aiding our understanding of bilingual cognitive functioning beyond language functions (e.g., Abutalebi & Green, 2008).

The aim of the present dissertation is to offer a multidisciplinary, comprehensive approach to the study of bilingualism. Using different techniques, I explore non-native language processing at different levels: lexico-syntactic and semantic, as well as cognitive functioning in bilingualism.
In any area of science, progress in pursuing theoretical questions interacts with and depends on the technological advances that allow us to address them. Bilingualism is not an exception. In the area of bilingualism, for instance, through the development of behavioural paradigms such as priming we can study different levels of language processing. Neurophysiological techniques such as Event-Related Potentials have also shed light into real time aspects of language processing with millisecond temporal resolution. More recently the study of bilingualism by using behavioural and neuroimaging techniques has allowed us to explore effects of bilingualism in different cognitive domains extending to the non-linguistic domain (e.g., Abutalebi, et al., 2012).

In the following sections (1.2.1 – 1.2.4), I introduce earlier studies of bilingualism in each of the abovementioned areas. First, I present structural priming and its application in non-native lexical-syntactic processing; then, I introduce Event Related Potentials (ERPs) and its uses and applications to non-native semantic processing during sentence comprehension. I follow with a section on cognitive effects of bilingualism, with focus on unbalanced bilinguals. The final section discusses what the clinical literature tells us about the topic of bilingualism. More precisely, I focus on how patient studies have helped us understand the neural underpinnings and organisation of language processing. To conclude, I outline the general objectives of the present thesis.
1.2.1 Structural Priming (Chapter 2)

In every day communicative interactions, people frequently face situations in which they hear their interlocutor and tend to repeat a word or a structure that has previously been uttered. This phenomenon has been studied in psycholinguistics and has been called *structural priming*. Formal definitions of priming describe the phenomenon as the “speaker’s tendency to produce sentences with previously heard or produced syntactic structures” (Ferreira & Bock, 2006, p. 1, for reviews see Branigan, 2007; Pickering & Ferrerira, 2008). Structural priming has been studied in laboratory settings. For instance, Bock (1986) showed that the likelihood for participants to produce a sentence using a given syntactic construction increased when participants had been exposed to the same construction in a sentence-prime condition. More precisely, participants were more likely to produce a passive sentence after being exposed to a passive than after an active construction. Structural priming is not restricted to the spoken modality, it has also been observed in written production (Branigan, Pickering, & Cleland, 1999). Moreover, structural priming is a wide-spread phenomenon observed in children (Branigan, McLean, & Jones, 2005), language-interaction as in dialogue (Branigan, Pickering, & Cleland, 2000), patients with aphasia (Hartsuiker & Kolk, 1998), patients with amnesia (Ferreira, Bock, Wilson, & Cohen, 2008) and in cross-linguistic studies with bilingual populations (Hartsuiker, Pickering, & Veltkamp, 2004). In what follows, I will focus on the application of structural priming to the study of non-native (L2) language processing.

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2 Also known as syntactic priming or structural persistence
1.2.1.1 Structural priming in L2

One of the most important contributions of structural priming is that it has aided our understanding of how syntactic representations are mapped into the linguistic system in both native and non-native speakers. In this thesis, the employment of structural priming is primarily concerned with how non-native speakers might acquire lexical-syntactic representations for specific verb-constructions combinations that are shared and not shared between their languages, and whether their first language influences such representations.

The application of structural priming in bilingualism has shown that priming occurs across languages, for structures that are shared between languages. An example of shared constructions between two languages are passive and active constructions in both English and Spanish. Hartsuiker et al. (2004) showed that Spanish-English speakers were more likely to produce a passive sentence in English after hearing a passive in Spanish, than after Spanish active or intransitive sentences, thus suggesting that syntactic representations for these structures are shared between the two languages. On the other hand, an example of a construction that is not shared between languages, is the double-object dative alternation that occurs in English but is not exhibited in languages like Spanish. The following examples illustrate the English dative alternation. Some verbs, such as give, can be used in a Prepositional-Object (PO) construction such as The clown gives the banana to the sailor, or in a Double-Object construction (DO) such as in The clown gives the sailor the banana. These types of verbs, which can alternate between DO and PO in dative constructions, are thusly called alternating verbs. The dative alternation in English
has served to describe structural preferences in non-native speakers with different language backgrounds that allow and do not allow the dative alternation. For example, Flett, Branigan, & Pickering (2013) compared to a group of English native speakers two groups of L2 learners, namely Spanish-English and German-English to a group of English native speakers. German and English are languages that use both DO and PO constructions, whereas Spanish, lacking DO constructions, only share the PO construction with German and English. Results of this study showed that the first language (L1) did not influence processing of L2 in these two groups of bilinguals, thus suggesting that syntactic L2 processing is not influenced by L1 experience, at least in highly proficient bilinguals.

In addition to alternating verbs, English also has non-alternating verbs. These are verbs such as donate, which allow the PO construction, such as in The clown donates the book to the sailor, but not the DO construction, such as in *The clown donates the sailor the book. Although native speakers of English are aware of this distinction, under certain circumstances they can be primed to produce ungrammatical DO with non-alternating verbs after same-verb and same-construction primes, but not by well-formed primes (Ivanova, McLean, Pickering, Branigan, & Costa, 2012). An extension of the previous study that uses grammatical and ungrammatical constructions in non-native speakers of English, can be informative to the extent that non-native speakers have knowledge of these fine-grained lexically specific syntactic restrictions in their L2, and whether these could be accounted for by similar mechanisms as those proposed for native speakers.
Structural priming is thus a useful methodology that taps into lexical-syntactic aspects of sentence processing and can provide insights to the extent that non-native speakers map grammatical representations in their L2.

1.2.2 Sentence processing and Event-Related Potentials (ERPs) (Chapter 3)

Event-Related Potentials (ERPs) is a neurophysiological technique that allows us to observe the electrical activity of the scalp associated with a particular cognitive process, with millisecond temporal resolution. ERPs are obtained by averaging the electrical activity of the brain, the Electroencephalogram (EEG) recorded from the scalp. In order to interpret ERPs waveforms, it is necessary to identify the ERP components (Kutas & Dale, 1997). These are deflections in the electrical ERP waveforms that can have a positive or a negative polarity and that are temporally associated with the relevant stimulus. The nomenclature of ERP components reflects their polarity (i.e., positive [P] or negative [N]), and the time course at which they occur, in relation to the stimulus of interest (e.g., 200, 300, 400 ms). Besides their nomenclature, ERP components usually have a characteristic scalp distribution. The two principal language components are the N400 and the P600.

The N400 is a negative-going wave peaking at around 200-500 ms after stimulus onset, with a predominantly central-parietal scalp distribution (Luck, 2005). The first report of the N400 was by Kutas and Hillyard (1980) in which they presented sentences word-by-word that were either congruent control sentences (e.g.,
It was his first day at work) or that were grammatical but contained a semantically unexpected ending (e.g., *He spread the warm bread with socks*). Sentences ending with the semantically unexpected word elicited an N400, compared to control sentences, thus suggesting the N400 relationship with processing of semantic incongruence. Since then, our knowledge about the N400 has increased. For instance, a number of studies have shown that the N400 component is not limited to written language, but it has also been studied using spoken input. The N400 is sensitive to factors such as word frequency and repetition. In addition, attenuations of N400s elicited by semantic anomalies have been observed in semantically-related words (e.g., Kuperberg, Sitnikova, Caplan, & Holcomb, 2003) and by supporting sentence contexts (Nieuwland & Van Berkum, 2006). The functional interpretation of the N400 has also evolved and different proposals have been put forward. For instance, the N400 has been thought to reflect the degree of fit between a word in a semantic context, and cloze probability (Kutas & Hillyard, 1984), post-lexical integration (Brown & Hagoort, 1993), ease of accessing words from long term memory (Federmeier & Kutas, 1999) or the degree of semantic-feature expectation matching (for a review see Kuperberg, 2007; see also Kutas & Federmier, 2011).

The second language-related component that we will review in this section is the P600, a positive-going wave peaking at around 500-700 ms after onset of critical words. First described by Osterhout and Holcomb (1992), it was originally associated with syntactic processing. However, the P600 can also be elicited by syntactically correct sentences that contain semantic incongruity such as severely implausible or impossible propositions, thus being described as a ‘semantic P600’ (e.g., Kuperberg,
which in turn gave rise to different functional interpretations of this component including sentence reanalysis (for a review see Kuperberg, 2007; see also Friederici, Steinhauer, & Frisch, 1999), conflict monitoring (e.g., van de Meerendonk et al., 2009), and prediction mismatch (DeLong, Urbach, Groppe, & Kutas, 2011). The P600 component has sometimes been described as a delayed version of the P300, which is a component usually observed to domain-general unexpected events (Coulson, King, & Kutas, 1998). A recent account indeed proposes more than one functional interpretation of the P600 (Van Petten & Luka, 2012), with different topographic distributions, rather than describing it as a single component, associated with a single function.

Besides the P600, another component associated with syntactic processing is the Left Anterior Negativity (LAN; e.g., Friederici, 2002). Although it is not always observed (for a discussion see e.g., Tanner & Van Hell, 2014; Steinhauer & Drury, 2012) this component has been reported in phrase structure violations (e.g., Friederici, Pfeifer, & Hahne, 1993) and has been attributed to reflect a certain degree of automaticity in processing (Hahne & Friederici, 1999). Because of its temporal closeness with the N400 component described above, attempts to dissociate both the LAN and the N400 have been made. Münte, Heinze, and Mangun (1993) reported N400s to semantically incorrect words in word pairs, while syntactic violations elicited a LAN, with a different distribution over the scalp. Using sentences that were either semantically and syntactically congruent (control sentences), ‘functional shifts’ (i.e. semantically expected words used in the wrong syntactic category),
semantically unexpected or semantically and syntactically anomalous sentences, Thierry et al. (2008) explored semantic and syntactic evaluation indexed by the LAN-P600 and N400 components. The functional shifts elicited a LAN and a P600, while semantically unexpected words elicited only N400 effects. The authors thus suggested that processing of a violation such as the functional shift follows the same ERP pattern of processing of a syntactic violation, without affecting semantic integration.

Due to the rapid speed at which language comprehension unfolds, a technique such as ERPs seems to be an appropriate method to answer questions about the time-course of language processing. In contrast to hemodynamic measures such as functional magnetic resonance imaging (fMRI), that provide more precise spatial resolution, ERPs with its millisecond temporal resolution allows us to address questions about the different stages of incremental sentence processing. In the present thesis, I focus on non-native semantic processing, and in particular examine whether or not non-native speakers use different sources of semantic information in the same way as has been previously reported for native speakers.

At the word level, the study of semantic processing in the non-native language has yielded a number of studies and theoretical frameworks. At the sentence level, however, less is known about how non-native speakers use and employ different forms of semantic information in real time to comprehend sentences. Online techniques such as ERPs are useful to address this issue as it can be revealing about the time-course of use of semantic information during non-native sentence comprehension. In the following paragraphs, I will present a brief overview
of the application of ERPs to the study of sentence processing in non-native speakers.

The incremental nature of sentence comprehension requires rapid processing of syntactic and semantic information (e.g., Marslen-Wilson, 1973). A great focus in the literature on non-native sentence processing has been on syntactic processing. Among the questions studied in non-native sentence processing, one is about the extent to which non-native speakers processing strategies differ from native speakers, and evidence from various studies suggests that differences between natives and non-natives lie more at the grammatical and less so at the semantic level. Theories of second language processing have even suggested that grammatical processing in the second language is “shallower” and that non-native speakers rely more on semantic and pragmatic cues when processing information in the second languages (Clahsen & Felser, 2006). In the literature on sentence comprehension, less research has examined semantic processing during incremental sentence comprehension the non-native language.

The studies assessing semantic processing in sentences in non-native speakers have reported that non-native speakers process semantic information in much the same way as native speakers. For example, ERP studies have shown similar N400 patterns to detection of semantic incongruity in both groups, although with the effects being delayed in the L2 of non-native speakers compared to monolinguals (Ardal, Donald, Meuter, Muldrew, & Luce, 1990) or reduced in amplitude (Hahne, 2001). Other studies have found that factors such as age of acquisition (Weber-Fox & Neville, 1996), proficiency (Moreno & Kutas, 2005) modulate the amplitude of
the N400 during L2 semantic processing. These studies seem to suggest that the nature of differences between native and non-native speakers in use of semantic information seem to be of quantitative, rather than qualitative. A recent proposal by Kaan (2014) also suggests that non-native speakers do not qualitatively differ from native speakers especially in predictive processing mechanisms, but that differences previously observed between the groups could be accounted for by the same mechanisms that modulate individual differences in native speakers.

Against this background, it is still an open question whether or not non-native speakers, even at high levels of proficiency, make use of different sources of semantic information. Therefore, the ERP technique can help us investigate and uncover the extent to which non-native speakers use semantic information in real time and whether or not different sources of semantic information are employed in an incremental way.

1.2.3 Cognitive functioning in bilingualism (Chapter 4)

Bilingualism can have effects well beyond the language itself and the topic of cognitive functioning in bilingualism has been the focus of a wealth of studies over the past two decades. Several studies have suggested that bilingualism can exert significant effects on cognitive functions other than language functions themselves. As I will describe below, these effects can be advantageous or represent more of a cost in some domains. While bilinguals show a disadvantage compared to monolinguals in reaction time and accuracy in lexical retrieval tasks, for example, a
bilingual advantage has been frequently reported for tests of executive functions, such as attentional control. Recently, however, this topic has been the subject of an ongoing heated debate in the bilingual literature. In particular, new empirical studies reporting failures of replicability seem to be in conflict with previous research documenting differences between monolingual and bilingual cognitive functioning (e.g., Paap & Greenberg, 2013).

1.2.3.1 The “bilingual advantage”

One of the domains most widely studied in relation to cognitive effects of bilingualism is that of executive control (EC). EC is an umbrella term to refer to a set of general executive functions such as attention, inhibition, attentional switching, updating, monitoring and working memory. Given that the bilingual’s two languages seem to be simultaneously active when they are performing linguistic tasks (Thierry & Wu, 2007; Wu & Thierry, 2010), effective communication requires a skilful navigation though language inhibition and switching mechanisms between the bilingual’s two languages. Given the growing mobility of people across countries, understanding the effects of bilingualism on cognitive function is a highly relevant issue. This can be illustrated through cases of non-native speakers moving into the country where their second language is spoken. In this context, bilinguals are likely to be faced with situations that will require them to make use of executive control mechanisms such as inhibition of one language or switching between languages appropriately in order to communicate effectively.
In light of these EC demands posed by the bilingual experience, researchers have put forth and scientifically investigated the idea that the bilingual’s handling their two languages (e.g., inhibiting and switching) might extend to and even enhance non-linguistic EC processes. Further support to this hypothesis is found in a neurofunctional model of Inhibitory Control put forward by Abutalebi and Green (2008), in which the authors identified common brain areas that may sub serve both bilingual EC as well as general EC processes using functional magnetic resonance imaging (fMRI).

Behavioural evidence of the so-called bilingual advantage on non-linguistic cognitive domains is found on a number of studies comparing monolingual with bilingual children, showing that bilingual children outperformed monolinguals on non-verbal tasks requiring attentional control (Bialystok, 1999; Bialystok & Martin, 2004). Other studies have shown similar effects also in young adults (Costa, Hernandez, & Sebastian-Galles, 2008; Bialystok, Craik, & Luk, 2008), but more recently, the bilingual advantage hypothesis has been under attack, with its critics appealing to replicability failures as their main evidence (Paap & Greenberg, 2013).

Among the studies contesting the so-called bilingual advantage, researchers have claimed that variables beyond the monolingual or bilingual status, such as task-relevant and design issues or socioeconomic status (SES), are factors possibly driving differences between monolinguals and bilinguals. For instance, Morton and Harper (2007) evaluated the extent to which differences in cognitive performance between monolingual and bilingual children could be due to ethnic and socioeconomic factors. Results of their study showed that, whilst no differences
between mono- and bilinguals were observed in performance on the Simon task, children with higher socioeconomic status (SES) outperformed those with lower SES, regardless of the language group. Similarly, Antón, et al. (2014) did not find any differences in performance on a children-adapted version of the Attention Network Test (ANT) between mono- and early bilingual children matched in SES and IQ measures (see also Duñabeitia, et al., 2015; and Gathercole, et al., 2014). It has also been suggested that the bilingual advantage might be restricted to certain experimental conditions (Costa, Hernandez, Costa-Faidella, & Sebastian-Galles, 2009). Finally, other researchers have suggested the existence of a publication bias in the literature on the bilingual advantage, claiming that positive results are more likely to be published than null results (de Bruin, Treccani, Della Sala, 2015, but see Bialystok, Kroll, Green, MacWhinney, & Craik, 2015 for a response).

Given the large individual variability in bilingual populations, and the conflicting results that have been reported in the literature, several aspects around the bilingual experience should be considered in the study of the cognitive effects of bilingualism. Important variables to consider are the type of bilingualism under study (AoA, proficiency, language use, linguistic context), the nature of the task employed (e.g., visual vs. auditory) and the different components of EC that are being evaluated (e.g., inhibition, attentional switching, monitoring) and other social variables. Evidence shows that the type of bilingualism may exert differential effects on general EC functioning. For instance, a recent study by Bak, Vega-Mendoza, & Sorace (2014) showed that cognitive advantages of bilingualism not only extend to the auditory modality of EC, but also to bilinguals who learned their languages later
in life. In addition, these EC advantages varied depending on AoA, with early childhood bilingual showing a more prominent advantage on a task requiring attentional switching, and later bilinguals showing an advantage on inhibition. Other studies reported that the cognitive effects of bilingualism on EC are modulated by factors such as AoA (Tao, Marzecova, Taft, Asanowicz, & Wodnieka, 2011) and the number of languages spoken (e.g., Chertkow et al., 2010). Other factors such as socioeconomic status or cultural backgrounds could generate variability between the groups being compared beyond mono- or bilingualism. A way to overcome this issue is using within subjects designs that allow minimising between-group variability. For example, Wu and Thierry (2013) assessed the cost of conflict monitoring in early Welsh-English bilinguals who performed an adaptation of a flanker task with incidental words in a fully monolingual context (Welsh or English) and in a bilingual context (mixed English and Welsh), instead of target arrows. Results showed that the mixed language context enhanced performance in the non-verbal conflict resolution as measured by the incongruent trials of the flanker task and ERPs.

The above evidence shows that the bilingual advantage does not seem to be a generalized effect, and that the effects of bilingualism on EC domains seem to be modulated by different aspects associated with different types of bilingualism or due to social variables.
1.2.3.2 The “costs” of bilingualism

Finally, the bilingual experience does not seem to confer only advantages. A domain in which “costs” of bilingualism have been reported instead, is in the lexical domain. For instance, bilinguals experience more tip of the tongue states (ToTs) (Gollan & Acenas, 2004), slower reaction times in lexical tasks such as picture naming, lexical decision and lexical retrieval (Gollan, Montoya, Fennema-Notestine, & Morris, 2005; Gollan, Fennema-Notestine, Montoya, & Jernigan, 2007; Ivanova & Costa, 2008). Two proposals that can account for these findings are the Reduced Frequency Hypothesis (Pyers, Gollan, & Emmorey, 2009), which suggests that difficulties in lexical retrieval in bilingualism arise because relative to monolinguals, bilingual speakers use each of the languages less frequently. The temporal delay L2 hypothesis (Van Heuven & Dijkstra, 2010) proposes that instead, the activation of concepts is delayed in the L2 in relation to the L1, particularly at lower levels of proficiency in the language, thus explaining slowed down RT in the L2 in bilinguals.

In sum, although the study of cognitive effects of bilingualism over the past years has been fruitful, current debates in the literature, particularly in relation to the so-called bilingual advantage, call for a systematic evaluation of the robustness of the effects. This includes taking into account that while there may be differential effects of bilingualism on different components of EC and while bilingualism may confer an advantage in certain domains, it is also important to offer a broader image of the bilingual experience, exploring those aspects in which bilingualism may exert a cost. The importance of systematic studies of bilingualism and cognitive function should expand to different types of bilingualism that will allow contribute to the
generalizability of findings and more precise descriptions of the cognitive effects of bilingualism.

1.2.4 Patient studies: language in the brain and bilingualism

Neuropsychological and neurolinguistic studies on clinical populations have been informative of how and which brain regions govern and underpin language processing. Aphasia is an example of an acquired language disorder that has aided our understanding of the neurophysiological basis of language both in bilinguals and monolinguals. For example, patterns of aphasia in bilingual individuals range from aphasia in one language but not the other (i.e. selective aphasia), to patients acquiring the same type of aphasia in both languages (i.e. parallel aphasia), and to having different types of aphasia in the bilingual’s different languages (Paradis & Libben 1987). Likewise, the patterns of recovery observed in bilingual aphasia vary from recovery in one language but not the other (i.e. differential recovery) or recovery of one language followed by other language (i.e. successive recovery; Paradis, 1989). These asymmetries in patterns of communication deficits and recovery in cases of bilingual aphasia thus provide insights into how two (or more) languages interact in the bilingual brain.

Studies on bilingual aphasia have also shed light on the functional neural networks underlying executive control mechanisms. In the linguistic domain, cases of anomalous switching and anomalous mixing in bilingual aphasia are informative of the functional organization of language control mechanisms in bilingualism. For
instance, cases of pathological language mixing in bilingual aphasia have been observed in patients with lesions in the left temporo-parietal region (Fabbro, 1999) and of the left-caudate nucleus (Abutalebi, Miozzo, & Cappa, 2000), while pathological switching has been reported posterior to a lesion in the anterior cingulate gyrus (Fabbro, Skrap, & Aglioti, 2000), thus revealing the potential involvement of these brain areas in language mixing and switching mechanisms.

In monolingual speakers, cases of aphasia are helpful to understand language processes and their neural substrates. At the level of syntax, Saffran and Martin (1997) used a structural priming paradigm to test whether patients with aphasia who exhibited difficulties at the grammatical level for sentence production would be primed to produce sentences that varied on degree of syntactic complexity. The authors also studied whether any observed priming effects would persist beyond the experimental task. Similar to findings previously reported in typical populations (e.g., Bock, 1986) patients with aphasia in their study produced more passive sentences after passive primes than after active or neutral primes. In addition, passive primes elicited production of by-phrase locative sentences. In a different study, Hartsuiker and Kolk (1998) assessed performance of patients with Broca’s aphasia and healthy controls in three different tasks, namely, spontaneous speech, picture description and sentence production in a structural priming task. Unlike control participants, Broca’s aphasia patients did not produce any double-object dative sentences and only one patient produced passive sentences in spontaneous speech. In the priming experiment, patients were primed to produce both double-object datives and passive sentences to a larger extent than control participants. Taken together,
these studies reveal the partly abstract-nature of structural priming, and that abstract representations of syntactic rules are not absent in these patients. Importantly, these studies also suggest that structural priming might confer a facilitatory effect for patients to produce complex sentences that would otherwise be too difficult to produce spontaneously.

Much in a similar way as observed in studies of bilingualism in typical populations, factors such as limited cognitive resources (e.g. working memory) or speed of processing have been suggested to account for linguistic deficits in aphasia. Friederici and Kilborn (1989) used a cross-modal syntactic priming paradigm in which a group of patients with agrammatism (Broca’s aphasia) and an age-matched control group were asked to make lexical decisions to visually presented words in isolation (baseline) or to words presented in a sentence context that were preceded by an auditorily presented context. In addition, the inter-stimulus interval (ISI) between the preceding auditory sentence context and the visual target varied from 0 milliseconds to 200 milliseconds. Results of this study showed that while agrammatic patients were sensitive to grammatical information, their reaction times were slowed down for words in context in the short ISI (i.e. priming effect), but not in the long ISI condition. These results suggest that the nature of the deficit in these agrammatic patients is temporal rather than due to unavailability of grammatical information during parsing, and also it provides insights regarding the time-course at which some aspects of syntactic information is available. In contrast, Haarman and Kolk (1991) using also a lexical task with long and short stimulus intervals found a priming effect in patients with Broca’s aphasia at the long latency, but not at the
short latency, thus suggesting that processing of syntactic information in agrammatic patients is slowed down. More recently, Caplan, Michaud and Hufford (2015) experimentally compared different models proposed to account for the underlying deficits in syntactic processing in aphasia, leading to the conclusion that a combination of factors such as reduced processing resources as well as slowed down lexical and syntactic processing are likely to contribute to comprehension deficits in aphasia.

With regards to semantic processing, behavioural techniques have shown that patients with impaired comprehension and with localised brain lesions are able to make use of semantic information to aid sentence parsing. Prather, Zurif, Love and Brownell (1997) compared patterns of lexical priming exhibited by a patient with Wernicke’s aphasia to the patterns exhibited by a patient with Broca’s aphasia varying the time between stimulus intervals. Results of this study showed that the patient with Broca’s aphasia exhibited lexical priming only at long ISIs, while the patient with Wernicke’s aphasia, showed priming at the short ISIs, but this priming pattern was present also at what the authors considered abnormally long ISIs, thus suggesting differential use of semantic information in different patterns of aphasia.

Regarding the study of specific forms of semantic information, such as animacy, Hartsuiker and Kolk (1998) reported that patients with Broca’s aphasia made use of animacy information in a structural priming task. Similarly to healthy controls, the patients were more likely to produce active sentences when the sentence patient was inanimate. Regarding use of plausibility information, Caplan and Waters (2003) examined the degree of correspondence between performance offline and
online measures of sentence processing (plausibility judgments and auditory-moving windows tasks, respectively) in patients with distinct types of aphasia and in control participants. Compared to control participants, patients showed longer latencies in reaction times to make their plausibility judgements. In addition, differential patterns of performance were exhibited by the patients, such that Broca’s patients showed a correspondence between the on-line and off-line impaired performance, while patients with fluent aphasia showed difficulties in sentence complexity in the off-line measure. These studies reveal that processing of lexical-semantic information seems to be a characteristic impairment in cases of agrammatism, while disruptions at the syntax-semantic level affect more cases of Wernicke’s aphasia. In addition, these studies suggest that through the use of paradigms such as semantic priming, it is possible to activate semantic information as a means to facilitate comprehension.

Event-Related Potentials (ERPs) is a technique that has been used in cases of aphasia and research on this field has aided our understanding of the relationship between comprehension and integration of lexical information for instance, as indexed by N400 patterns. Studies in aphasia using ERPs have shown the relationship between degree of language comprehension and amplitude and onset of the N400 component. In a study with Broca’s and Wernicke’s aphasia, Swaab, Brown and Hagoort (1997) examined whether difficulties in spoken sentence comprehension in aphasia were due to disruptions in on-line lexical integration. Participants were presented with sentences in the auditory modality. The sentences ended with a semantically expected or unexpected word and aphasic patients were split into good and poor comprehenders. Results of this study showed that high
comprehenders showed N400 effects comparable to those of control healthy participants, while the patients with more robust comprehension deficits, the N400 effects was reduced and delayed (see also Hagoort, Brown, & Swaab, 1996; Kojima & Kaga, 2003).

Beyond the linguistic domain, Glosser and Goodglass (1990) examined executive control performance using non-linguistic tasks in patients with aphasia. Results of this study showed that patients with anterior lesions showed the lower performance in non-linguistic tasks of executive control. This study illustrates that EC performance was irrespective of the aphasia classification, but rather dependent on the lesion location and thus provided insights to the neural substrates of EC. Understanding failures in language control in aphasia, can thus be informative of the underlying mechanisms and functional organisation of language control in the brain, which in turn, is of high relevance to extant theories of language processing in bilingualism as well as useful to devise language rehabilitation plans.

1.3 The present thesis: aims and overview

The general aim of the present thesis is to provide a comprehensive approach to the study of bilingualism through the investigation of different stages of sentence processing in the non-native language, and of the cognitive effects of bilingualism particularly in unbalanced bilinguals. Through the use of different methodologies, I aim to answer the following questions:
In Chapter 2, in a series of structural priming experiments, I explore lexical-syntactic processing in highly proficient non-native speakers. In particular, I ask whether non-native speakers of English whose languages do not allow dative-DO are sensitive to the fine-grained lexically-specific syntactic restrictions of non-alternating verbs in English. I also assess the potential influence of the L1 on the L2. Results of the studies are discussed in terms of mechanisms that have been applied to adult native-speakers and in relation to theories of acquisition of the DO dative acquisition.

In Chapter 3, using ERPs, I ask whether non-native processing of semantic information occurs in the same rapid, incremental way that has previously been reported for native speakers, and explore the effects of task demands on sentence processing. In addition, I evaluate how task demands impact native and non-native sentence processing. Results of these studies are discussed in terms of proposals of incremental processing in native and non-native speakers.

In Chapter 4, I assess the cognitive effects of bilingualism through the use of behavioural tests. I employ three auditory tasks tapping into different components of EC: sustained attention, inhibition and attentional switching. In order to provide a full picture of the bilingual effects of bilingualism, we also employ tasks in which the effects of bilingualism are thought to represent a “cost” rather than an advantage, through the use of tasks of lexical access (picture-name matching and verbal fluency). Results are discussed in light of current debates.
The thesis ends with a general summary in Chapter 5, and provides future directions for research in different domains of non-native language processing and cognitive effects of the bilingual experience in light of the present results.
Chapter 2: Lexically-specific syntactic restrictions in non-native speakers: Structural priming studies

2.1 Summary

Are non-native speakers of English able to master lexically-specific syntactic restrictions? And is mastery of the restrictions influenced by the first language? In a series of four structural-priming experiments, we addressed these questions using non-alternating verbs in English, such as *donate*, which allow the prepositional object (PO) construction, but not the DO construction, unlike alternating verbs, such as *give*, which allow both. In Experiments 1 and 2, highly-proficient L2-English speakers whose native language lacks the DO construction were primed to produce ungrammatical DO sentences from same-verb primes with non-alternating verbs, but not by well-formed primes with grammatical DO sentences (Exp. 1). Participants were also primed to produce ungrammatical DO sentences with non-alternating verbs by ungrammatical DO-primes with different non-alternating verbs (Exp. 2). In Experiments 3 and 4 we show that non-native speakers of English, whose first languages (Germanic) allow DO-constructions, exhibited similar priming patterns as the Romance speakers. These results suggest that non-native speakers of English partially acquired the subtle restrictions for non-alternating verbs, and that they did not appear to generalise knowledge about these restrictions from alternating verbs, however, their knowledge is not native-like. These results also tentatively suggest that the first language does not play a role in acquisition of such restrictions.
2.2 Introduction

Are non-native speakers of English able to master lexically-specific syntactic restrictions? And is acquisition of lexically-specific syntactic restrictions in the second language (L2) influenced by the native language (L1)? Answers to these questions may be informative in regards to how such restrictions are acquired and represented by both native speakers and L2-speakers.

The use of alternating and non-alternating verbs represents a type of lexically-specific syntactic restriction in English. An example of this is found in the verb give, since its use in dative sentences can alternate between prepositional object (PO) and double object (DO) constructions (i.e., alternating verbs) as in 1a. and 1b., respectively. Other types of verbs, such as donate, allow the PO but not the DO construction (2a. and 2b., respectively), and are therefore known as non-alternating verbs.

1a. The monk gives the book to the boy (alternating, PO)
1b. The monk gives the boy the book (alternating, DO)
2a. The monk donates the book to the boy (non-alternating, PO)
2b. *The monk donates the boy the book (non-alternating, DO)

While adult native speakers of English are typically able to master these fine-grained lexically-specific verb restrictions with ease, acquisition of these restrictions in language development is by no means a simple endeavour. Literature on how L1-English children acquire the relevant restrictions for PO and DO dative constructions suggests that they resort to morphophonological and semantic class properties
conveyed by the particular verb-constructions (Gropen, Pinker, Hollander, Goldberg, & Wilson, 1989; Pinker, 1984; for a discussion see Ambridge, Pine, Rowland, Freudenthal, & Chang, 2014).

Statistical-based accounts propose that lexically-specific syntactic restrictions are learned based on the difference between frequency of occurrence of a verb in the correct structure and in the incorrect construction (e.g., Ambridge, Pine, Rowland, & Young, 2008). Like L1-children, non-native speakers of English are likely faced with the same challenge: their structural choice of DO or PO based on lexically-specific syntactic restrictions may pose a challenge. This may be especially the case for L1-speakers of languages which do not have the DO alternation because they would not have the same frequency of exposure to the two alternatives.

The aim of the present study is to investigate whether or not highly proficient, non-native speakers of English have knowledge of these fine-grained lexically-specific verb restrictions, and one manner with which to accomplish this is by employing structural priming. Also known as syntactic priming, this phenomenon is represented by “the tendency to produce sentences with previously heard or produced syntactic structures” (Ferreira & Bock, 2006, p.1), either in spoken or written form. For instance, subjects are more likely to produce a PO such as A rock star sold some cocaine to an undercover agent, after another PO than after a DO sentence. Moreover, they also tend to produce a DO after having been exposed to a DO such as A rock star sold an undercover agent some cocaine (Bock, 1986).
The use of structural priming has aided our understanding of different stages of syntactic processing described in models of language production. For instance, the influential Levelt’s model of language production (1989) includes the following stages: the conceptualization stage, in which the preverbal message to be conveyed is determined, the formulating stage, in which lexical items are connected into sequences to convey the message (grammatical encoding). Then, the sound representations are planned in the phonological encoding so that the final production is realised through the appropriate articulatory mechanisms. Structural priming has thus served to illustrate stages that would correspond to the stages between mapping concepts into syntax, corresponding to the grammatical encoding stage in Levelt’s model.

An important feature of structural priming is that while it may occur in absence of lexical repetition, such repetition enhances it, thus suggesting that priming is in part abstract, in part lexical. The enhancement of the magnitude of priming with lexical repetition is known as lexical boost (Branigan et al., 2000) and has been observed in repetition of content words such as nouns (Cleland & Pickering, 2003) and verbs (e.g., Pickering & Branigan, 1998), but not for function words (e.g., Fox-Tree & Meijer, 1999). The specific type of lexical boost involving verb repetition has been referred to as verb boost.

Pickering and Branigan (1998) have offered an account to explain both the mechanisms underlying priming and how the structural priming effects are strengthened through lexical boost. The authors propose that lemmas are connected to different nodes such as a syntactic category node (e.g., verb), a feature node (e.g.,
inflectional morphology), and the compatible combinatorial nodes (e.g., NP, PP or NP, NP). When activated, lemmas pass activation to other lemmas that they are connected to through a process known as spreading activation. For instance, exposure to a sentence in a particular structural configuration such as the *The sailor gives the soldier the apple*, activates the lemma *(give)* and this activation spreads to the corresponding abstract combinatorial node (i.e., NP, NP). Within this model, priming is the result of the residual activation of the combinatorial node, and thus people are more likely to select a DO and produce the next sentence using this configuration. Moreover, when the verb in a subsequent sentence uses the same verb as in a previous sentence, the priming effect is even larger because it would be the result of the pre-activation of the lemma *(give)*, the strengthened link between the lemma node and combinatorial node, and the activation of the combinatorial node as well. When a verb is different on a subsequent sentence, the priming effect is smaller because it would be the result of residual activation of the combinatorial node only (Pickering & Branigan, 1998).

An alternative account to explain the underlying priming mechanisms is offered by a model of implicit learning (Chang, Dell, & Bock, 2006). This model poses that syntactic priming occurs through implicit learning of abstract syntactic rules. This means that processing of a message in a given syntactic structure, strengthens the processes underlying mapping message representations into sequences making them more accessible, and in turn, leading to election of constructions with similar structures. To account for enhancement of priming with lexical repetition, the model proposes that after having been exposed to a certain
prime, the repeated word in the priming acts as a cue to activate the prime sentence through explicit memory, thus making the speaker more likely to use the same structure in his/her target utterance (Chang et al., 2006).

The use of structural priming and the application of the abovementioned models in ungrammatical sentence production can also provide insights on the interplay between lexical and syntactic information. For instance, Ivanova, Pickering, McLean, Costa, & Branigan (2012) examined whether native speakers of English could be primed to produce ungrammatical DO sentences after brief exposure to similar structural exemplars. They formulated two accounts: The abstract structural persistence account, in which an abstract syntactic rule (i.e., the double object rule: VP → V NP NP) becomes available and thus readily usable after brief exposure to sentences in the same structural configuration. And the lexically-driven persistence account, in which people might map associations between verbs and a syntactic configuration on an item-by-item basis. They hypothesised the following: if processing of a sentence in a certain configuration (e.g., The waitress gives the soldier the apple) access the corresponding abstract rule, the rule will be applied to the target verb in production (e.g., donate), thus producing an ungrammatical DO. This rule is incompatible with a verb such as donate, but this incompatibility would be overridden by the abstract structural rule (abstract structural persistence). In this account the authors expected priming to occur from well-formed DO sentences, because it would be irrespective of lexical items. The second alternative, the lexically-driven persistence account, predicted that production of ungrammatical sentences would occur only after exposure to ungrammatical DO sentences with the
same verb. This would be because particular verb-construction combinations are formed on item-by-item basis. Unlike the abstract-persistence account, the lexically-driven persistence account did not predict production of ungrammatical DOs after well-formed sentences with DOs.

To test these hypotheses, the authors employed a structural priming paradigm using both grammatical and ungrammatical sentences in DO and PO structures. Their results showed that adult L1-English speakers were primed to produce ungrammatical DO sentences only after exposure to the same-verb ungrammatical DO prime as the target, but not by different-verb ungrammatical DO primes or by well-formed DO sentences with alternating verbs (for reference, see Table 1). Their findings led the authors to provide evidence in favour of a lexically-driven account whereby production of ungrammatical DO sentences requires exposure to the same ungrammatical verb-construction types (item-by-item basis).

Table 1. Priming results for experiments with same and different non-alternating target verbs from Ivanova et al. (2012)

<table>
<thead>
<tr>
<th>Group</th>
<th>Prime verb</th>
<th>Target verb</th>
<th>Prime construction</th>
<th>Priming effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>DO</td>
<td>PO</td>
</tr>
<tr>
<td>L1-English</td>
<td>Alternating, different</td>
<td>Non-alternating</td>
<td>.01</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Non-alternating, same</td>
<td>Non-alternating</td>
<td>.09</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Alternating (dummy), different</td>
<td>Alternating</td>
<td>.28</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Non-alternating, different</td>
<td>Non-alternating</td>
<td>.01</td>
<td>.01</td>
</tr>
</tbody>
</table>

The production of ungrammatical DOs under those particular conditions in Ivanova et al. (2012) was also explained in relation to Pickering and Branigan’s (1998) model as follows: processing of an ungrammatical DO sentence with non-
alternating verb (e.g., donate) may have established a weak link between the lemma (donate) and the DO combinatorial node. Repeated exposure to more ungrammatical DOs led to increased activation of such link, as was the combinatorial node, leading to production of ungrammatical DOs.

As we have seen, structural priming has provided an empirical basis to illustrate different stages of L1 syntactic processing. It thus seems to be a suitable methodology to study the interplay between lexical and syntactic information, and how this information may be represented and used in the L2. This thesis is concerned in particular with whether non-native speakers of English are able to acquire and master knowledge about the lexical-syntactic restriction of verbs. In addition, the potential priming patterns displayed by non-native speakers may be very well informative about the processes underlying acquisition of lexical restrictions. In what follows, we will present a series of accounts from the native-speaker literature that may serve to explain how non-native speakers may acquire these fine-grained restrictions. Then, we will discuss the potential role of the L1 in acquisition of L2 relevant restrictions before outlining our predictions.

2.2.1 Acquisition of lexical-specific restrictions of verbs in the L2: link to L1-English speakers accounts

As we saw in the previous section, literature on developmental acquisition of lexically-specific syntactic restrictions has explored the role of verb-semantics in the acquisition of such restrictions. In native speakers, it has been proposed that the DO
dative construction could be acquired through verb semantic classes (Gropen et al., 1989; Pinker, 1989). For instance, it has been proposed that verbs that allow the DO and PO alternation have semantic elements that convey the meaning of *causing to go and causing to have* (Ambridge et al., 2014, p. 219). A semantic-driven account for acquisition of restrictions by second language speakers seems plausible, given that it has been proposed than non-native speakers rely more on semantics than on grammatical information when they process their L2 (e.g., Clahsen & Felser, 2006). On the other hand, this alternative account may face some problems to account for acquisition of the relevant alternation by non-native speakers. This is because even among adult native speakers, different classes of verb-semantics elicit different degrees of acceptability in DO constructions (Gropen et al., 1989). In addition, in some cases, the verb-semantic class of alternating and non-alternating verbs may not be straightforwardly distinguishable: and even within the same class of alternating verbs, further rules need to apply in order to derive the right verb-construction combination. For instance the alternation in some alternating verbs may occur in some contexts, such as in *Pat gave Mike a kick*, but not in others, such as *Pat gave a kick to Mike* (Goldsmith, 1980, cited in Mazurkewich, 1984). Another example can be found in the alternating verb *send*, which in some contexts can be used in PO or DO constructions such as *Mary sent John the book* and *Mary sent the book to John*. But in *Mary sent a book to France* and *Mary sent France a book* (White, 2003), the alternation does not apply. The examples above show that the semantic class of

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3 Unless metonymy. For instance, *France* as institution (e.g., government).
the verb alone does not fully determine the distinctive usage of alternating and non-alternating verbs. For transfer verb classes, as in the example above, in order to produce a felicitous DO construction, additional rules would need to apply: the beneficiary (first [NP]) need to be the ‘prospective’ possessor of the second [NP] in the DO construction (Gropen et al., 1989). Thus, *Mary sent John a book is an acceptable sentence because John meets the prospective possessor and animacy criteria, while in *Mary sent France a book, France does not.*

In other cases, although verbs such as give and donate may have similar semantics, other factors such as morphophonology could serve to cue the usage of alternating and non-alternating verbs in the right verb-construction combination. For instance, the etymology of non-alternating verbs is largely Latinate, and in turn, they tend to be longer in number of syllables and with a stress in the second syllable (e.g., donate), while alternating verbs are usually monosyllabic (e.g., give) (Ambridge et al., 2014; Gropen et al., 1989).

The application of the verb semantics accounts could be useful to explain how non-native speakers acquire lexical-specific semantics restrictions of the verbs, particularly for speakers of languages who do not allow dative-DO alternation (e.g., Spanish), and therefore cannot rely on the L1 for acquisition of the restrictions.

Usage of lexico-semantic cues thus seems to be a potential candidate to explain how non-native speakers acquire the relevant restrictions of non-alternating verbs. Nonetheless, this fine-grained knowledge of this type of verb restriction may be particularly challenging for non-native speakers. In particular, this would be the
case if such restrictions were to be acquired mostly on implicit-basis. For this reason, we will look at statistical-learning based accounts that will be reviewed in this section.

Here, it has been proposed that L1-English speaking children may learn the DO-dative construction by keeping track of the occurrences of a verb and the occurrences of this verb in the DO-dative construction (Ambridge et al., 2014). In non-native speakers, knowledge of the relevant restrictions could thus be based on their exposure to correct/incorrect occurrences of the target verb-construction combination. This would depend on their experience with the language, and thus, perhaps cannot apply in early stages of language acquisition.

With regards to the morphophonological syllabic distinction that may be useful for native speakers to establish rules governing alternating and non-alternating verbs, it may not confer the same advantage for L1-Speakers of Romance languages. Speakers of Romance languages are most likely familiar with non-alternating verbs given the etymology of their own language, and thus it is perhaps not an outstanding feature of such verbs when seen in their L2 for it to derive a rule of its usage in a given construction. Thus, within the verb semantics framework, the use of lexico-semantic cues seems to provide a better approach to explain how non-natives speakers may acquire the relevant restrictions.

In light of the above, the present study aims to investigate whether and how non-native speakers may acquire lexical specific-syntactic restrictions of non-alternating verbs. Nevertheless, it is also possible that a combination of factors play a
role in acquisition of these restrictions in the L2. In order to test whether or not non-native speakers know the lexical restrictions in a similar fashion as adult native speakers, the present study turns toward two alternative accounts, namely the 
abstract structural persistence account and lexically-driven persistence account
(Ivanova et al., 2012),

In the present study we investigate whether highly-proficient non-native speakers of English are also able to master lexically-specific syntactic restrictions. As we have seen, native speakers of English can be primed to produce ungrammatical sentences implicitly after brief exposure to same-verb ungrammatical sentences. Exploring whether L2-speakers can also be primed to produce ungrammatical DO with non-alternating verbs is informative to the extent that the underlying processes of the acquisition (or lack thereof) of dative alternation by non-native speakers resemble those of native speakers. Moreover, we will also investigate whether mastery of such restrictions is modulated by transfer from the L1 (see the section below).

Aside from their linguistic relevance, as a whole, the implications of these findings can be applied to theories of second language acquisition and used in English as a Second Language teaching models for learners of English.
2.2.2 L2 structural preferences and role of L1

In non-native speakers, the similarity between the L1 and L2 may play a role in the acquisition of lexically specific syntactic restrictions. Cross-linguistic studies of structural priming have shown that bilinguals exhibit priming from one language to the other, consistent with accounts of bilingual processing that non-native speakers are likely to use shared syntactic representations when the grammars of the bilingual’s two languages are similar (e.g., Bernolet, Hartsuiker, & Pickering, 2007). For instance, both English and Spanish have similar structural configuration for passive (O-V-S) and active sentences (S-V-O). Employing a structural priming paradigm, Hartsuiker, Pickering and Veltkamp (2004) demonstrated that English-Spanish bilinguals are more likely to use a passive sentence in English after having seen the corresponding structural equivalent in Spanish. In turn, they are less likely to use a passive sentence in English after an active Spanish one. Other examples of syntactic constructions shared between languages are the PO and DO in English and German. Loebell and Bock (2003) showed that fluent German-English speakers were primed to produce a DO or a PO in German after having been exposed to the English equivalents, and vice versa. In sum, these studies show that bilinguals’ syntactic representations are shared to some extent between languages.

Conversely, some representations are not shared between languages. This is the case for the DO-dative sentences in Spanish and English. As previously mentioned, English allows both PO and DO in dative sentences, while Spanish only allows PO, therefore English and Spanish might share the PO but not the DO-dative construction. To explain how non-native speakers may acquire syntactic
representations for structures that are and are not shared between languages as in the cases described above, two accounts have been put forward (Flett et al., 2012). The language-specific account proposes that preferences in L2 should be affected only by experience with the L2. Meanwhile, the language non-specific account poses that L2 preferences should be affected by exposure to L1 and L2. Notably, the absence of a structure in one of the bilingual’s two languages has been shown to exert an influence on structural preferences for the L2.

Flett et al. (2013) examined the extent to which differences in the grammar of the bilingual’s two languages affected their structural choice in the L2. The authors assessed whether structural preferences in the L2 were modulated by participant’s L1 (language non-specific) or only by their experience with the L2 (language-specific). To this purpose, they analysed the participants’ structural choice of DO and PO in English by comparing highly proficient native speakers of English to native speakers of German and Spanish who had English as L2. Importantly, as noted above, English and German both allow DO and PO constructions, whereas Spanish only allows PO. Results of this study showed no robust group differences in the magnitude of the priming effect in English, and participants were syntactically primed, such that they were more likely to produce a DO after a DO prime, and a PO after a PO prime, than after intransitive primes in both cases. Importantly, the magnitude of the priming effect did not differ across the groups, irrespective of their language background. This study thus provides evidence in favour of a language specific account whereby non-native speakers build syntactic representations on the basis of exposure to the second language. In addition, these results provide evidence
that the bilingual’s first language does not influence their structural preferences in the L2.

2.2.3 The present study

In light of the abovementioned findings, the present study examines whether non-native speakers of English whose L1 lacks the DO construction are sensitive to the fine-grained lexically-specific syntactic restrictions for non-alternating verbs in English. To this purpose, we conducted two structural priming experiments using materials from Ivanova et al. (2012), in which we assessed production of ungrammatical DO sentences by native speakers of Romance languages, whose L1 lacks the DO. We tested whether production of ungrammatical DO would occur when the verbs in primes and targets were the same (Experiment 1) and when the verbs in primes and targets were different (Experiment 2). Additionally, we investigated whether production of ungrammatical DO constructions would be modulated by the L1 and thus conducted the same experiments in native speakers of Germanic languages, whose L1 exhibits the DO construction (Experiments 3 and 4).

Experiment 1: Structural priming from non-alternating primes to same non-alternating targets in speakers of Romance languages

The aim of this experiment was to examine whether production of ungrammatical DO sentences with non-alternating verbs would prime production of
DO constructions with the same non-alternating verbs in participants whose native languages do not allow DO constructions. Based on the evidence discussed above, we made the following predictions:

One possibility is that non-native speakers whose L1 lacks the double construction may generalize the use of verb-construction combinations with non-alternating verbs from alternating verbs. In such a case, they would show the same pattern of priming by alternating and non-alternating verbs. This pattern would show evidence for the abstract-persistence account, in which an abstract syntactic rule is activated and available after brief exposure to sentences in the same structural configuration. Importantly, such a pattern would suggest that non-native speakers fail to acquire non-alternating verbs’ subtle restrictions.

Alternatively, non-native speakers may have knowledge – at least to some extent – of the fine-grained restrictions for non-alternating verbs on an item-by-item basis, such that exposure to DO construction alone would not trigger subsequent DO production. In such case, non-native speakers would only produce an ungrammatical DO after exposure to the same-verb and construction type. This would suggest that they represent restrictions for non-alternating verbs in a similar fashion as native speakers (see Ivanova et al., 2012), and this would provide further support for the lexically-driven persistence account.
2.3 Method

2.3.1 Participants

Twenty-eight participants from the University of Edinburgh community took part in this experiment (15 women) and received monetary compensation. Participants were native speakers of Romance languages as follows: Spanish (N = 16), Romanian (N = 5), French (N = 3), Italian (N = 2) and Portuguese (N = 2); mean age was 25 years old (SD = 3.98). Three participants were replaced from the original sample due to having reported exposure to a non-Romance language from birth, one for having lived in an English speaking country in early childhood, and two due to having more than 8 incomplete answers. Language proficiency was assessed through a self-rating language questionnaire (Table 2).

<table>
<thead>
<tr>
<th>Group</th>
<th>Average self-rated English Proficiency scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spoken comprehension</td>
</tr>
<tr>
<td>Experiment 1</td>
<td>8.6 ( .9 )</td>
</tr>
<tr>
<td>Romance</td>
<td></td>
</tr>
<tr>
<td>Experiment 2</td>
<td>8.9 ( .8 )</td>
</tr>
<tr>
<td>Romance</td>
<td></td>
</tr>
<tr>
<td>Experiment 3</td>
<td>9.2 ( .8 )</td>
</tr>
<tr>
<td>Germanic</td>
<td></td>
</tr>
<tr>
<td>Experiment 4</td>
<td>9 ( .9 )</td>
</tr>
<tr>
<td>Germanic</td>
<td></td>
</tr>
</tbody>
</table>

Notes. Self-rating scores based on a scale from 1 (“very bad”) to 10 (“excellent”) on each language domain. Standard Deviations (SDs) are given in parentheses.
2.3.2 Materials

All the stimuli were taken from and thus identical to those used by Ivanova et al. (2012; See Appendix A for full set of stimuli). Each of the thirty-two experimental items consisted of a prime sentence, a picture describing the prime sentence for picture-sentence matching, and a target picture for participants to produce an oral description. All the stimuli and testing materials were presented in English.

Each of the 32 prime sentences described ditransitive actions. There were four prime conditions comprised from either an alternating verb (*brings, flings, gives, lends, mails, rents, passes, tosses*) or an non-alternating verb (*convey, deliver, describe, demonstrate, display, donate, return, reveal*) and in one of two prime constructions: prepositional object (PO) or double object (DO). Table 3 shows examples of each of the crossed four prime condition design (1-4) resulting from the combination of verb type (alternating, non-alternating) and construction type (DO, PO).

Table 3. Sample sentences and characteristics of prime and target sentences in Experiment 1

<table>
<thead>
<tr>
<th>Prime sample sentence</th>
<th>Primes</th>
<th>Verb type</th>
<th>Construction type</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) The chef <em>gives</em> the pirate the ball</td>
<td>Alternating, different</td>
<td>DO</td>
<td></td>
</tr>
<tr>
<td>(2) The chef <em>gives</em> the ball to the pirate</td>
<td>Alternating, different</td>
<td>PO</td>
<td></td>
</tr>
<tr>
<td>(3) *The chef <em>donates</em> the clown the banana</td>
<td>Non-alternating, same</td>
<td>DO</td>
<td></td>
</tr>
<tr>
<td>(4) The chef <em>donates</em> the banana to the clown</td>
<td>Non-alternating, same</td>
<td>PO</td>
<td></td>
</tr>
</tbody>
</table>

Notes: DO = Double Object, PO = Prepositional Object
There were 32 black and white cartoon pictures to be matched with the action described in the prime sentence. Half of the pictures required a *yes* answer, and half a *no* answer. Target verbs were all non-alternating verbs and verbs in the non-alternating prime verb condition were the same as the targets. The target verb was in the present tense and was printed in capital letters beneath each picture. There were 4 different target pictures for each of the 8 non-alternating target verbs.

In addition to the 32 experimental items, there were 96 monotransitive fillers in the same format of presentation as experimental items. One third of the fillers used verbs of Latin origin. These fillers were used because many non-alternating verbs tend to be of Latinate origin (Ivanova et al., 2012; Pinker, 1989). Half of the matching pictures matched the previously seen sentence, and half did not match.

With experimental and filler items, four lists were created, such that each list comprised 32 experimental items (eight items from each of the four prime sentences, Table 3, conditions (1)-(4)) and the 96 fillers. The order of presentation of items was randomized for each participant and no items were repeated within a list.

### 2.3.3 Procedure

Participants were given a sheet with written instructions, which were identical to those used by Ivanova et al. (2012) (for full instructions see Appendix B). Participants were then presented with the noun training task in which they saw drawings of the characters and two objects twice. The first time, the character’s or
the object’s name was written under the corresponding picture for participants to read out loud. They were asked to pay close attention, as they would be presented with the drawings a second time without their names. The second time they saw the pictures again without the corresponding names and were asked to name them. Four pictures at a time were presented on a single slide using Microsoft Office Power Point ®. Before beginning the experiment, participants were told they would be presented with a set of practice trials, which were of similar structure to those in the actual experiment.

Upon completion of practice trials, the experiment began. Each experimental trial consisted of a fixation point, which remained in the centre of the screen for 700 ms followed by the prime sentence. Then, the matching picture appeared and participants had to press one of two keys on the keyboard to indicate whether the picture matched the preceding sentence (“M” key) or did not match (“N” key). The matching picture disappeared after 3325 ms or immediately after a response was given if it happened before this time. Finally, the target picture remained on the screen for 8000 ms during which participants had to provide a description of the picture using the verb underneath the picture and the next trial began (Figure 1). Both matching and target pictures were surrounded by a coloured frame as a cue to remind participants which action they had to perform (i.e., green frame for matching picture; pink frame for picture description).

Presentation times were adapted from the original ones used in Ivanova et al. (2012), to a slightly slower rate in order to adapt to the population on this study. The original study presentation times were: fixation point (700 ms), prime sentence (1500
ms), matching picture (2500 ms), and target picture (5000 ms). The corresponding
times in the present study are: 700 ms, 4000 ms, 3325 ms and 8000 ms (see Figure
1). This was done to ensure sufficient time for reading and describing for the
bilingual groups in this study. Presentation time was adapted based on pilot data
collected from 2 participants who did not take part in any subsequent experiment
reported here.

Figure 1. Sample trial
The experiment was presented using DMDX software (Forster & Forster, 2003) and participants’ answers were recorded by the program. At the end of the experiment, participants filled a questionnaire which contained the 8 non-alternating target verbs along with 8 common alternating verbs (different from the primes), and asked participants to translate into their native language was also administered. Finally, a language background questionnaire (Appendix F) and debriefing questions about the experiment were used. The full experimental session lasted approximately 55 minutes. All participants gave informed consent at the beginning of the experimental session and the study was carried out with approval of the University of Edinburgh’s Psychology Ethics Committee.

2.3.4 Scoring and data analyses

Scoring procedures were followed as in Ivanova et al. (2012). All participants’ responses were transcribed and scored as PO or DO or Other based on their syntactic structure. An answer was scored as a PO if the structure of the sentence was agent, verb, theme, preposition to and the beneficiary. An answer was scored as a DO if the sentence began with the agent, followed by the verb, beneficiary and the noun phrase expressing the theme of the sentence. Any other answer that did not meet the aforementioned criteria was scored as Other. These included for instance, trials in which participants did not produce an answer, incomplete sentences, use of different verbs than those shown in the target picture, answers using PO phrases but with prepositions other than “to” (e.g., “at”), and
ungrammatical DO constructions in which the theme of the sentence immediately followed the verb and the theme was immediately followed by the beneficiary (e.g., “the pirate reveals the jug to the soldier”).

Our dependent variable, proportion of DOs, was the number of DO responses divided by the sum of PO and DO responses per condition. We compared participants’ structural choice using 2 x 2 within-subjects ANOVAs with the factors prime verb (alternating, non-alternating) and prime construction (PO, DO). Separate ANOVAs were performed using subjects (F1) and items (F2) as random factors. Where appropriate, interactions were followed up using simple effects. Analyses involving two conditions were analysed using related-samples t-tests. Data analyses were performed using SPSS V. 21®.

2.4 Results

A total of 896 responses were produced. Of these, 762 (85%) were scored as POs, 82 (9%) were scored as DOs, and 58 (6%) as Other. Proportions of DOs per condition are shown in Table 4. The priming effect was calculated as the difference between the proportion of DO responses after DO primes, and the proportion of DOs responses after PO primes.

<table>
<thead>
<tr>
<th>Prime verb</th>
<th>Target verb</th>
<th>Prime construction</th>
<th>Priming effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternating, different</td>
<td>Non-alternating</td>
<td>.08</td>
<td>.04</td>
</tr>
<tr>
<td>Non-alternating, same</td>
<td>Non-alternating</td>
<td>.23</td>
<td>.19</td>
</tr>
</tbody>
</table>

Notes. Proportions shown by subject, untransformed data.
Results from the 2 x 2 ANOVAs showed a main effect of prime verb \([F_1 (1, 27) = 6.97, p = .014, \eta^2_p = .205; F_2 (1,31) = 17.01, p < .001, \eta^2_p = .355]\) showing that more DOs were produced after non-alternating same verb primes (.14) than after alternating different verb primes (.06). There was a main effect of prime construction \([F_1 (1, 27) = 15.88, p < .001, \eta^2_p = .370; F_2 (1,31) = 66.09, p < .001, \eta^2_p = .681]\), such that more DO responses were produced after DO primes (.16) than after PO primes (.04). There was an interaction between prime verb and prime construction \([F_1 (1, 27) = 6.90, p = .014, \eta^2_p = .204; F_2 (1,31) = 15.68, p < .001, \eta^2_p = .336]\). Simple effects, pairwise comparisons indicated that there was a robust priming effect in the non-alternating prime verb condition \([F_1 (1, 27) = 13.79, p = .001, \eta^2_p = .338; F_2 (1,31) = 89.30, p < .001, \eta^2_p = .742]\), but the effect in the alternating prime verb condition did not reach significance \([F_1 (1, 27) = 2.61, p = .118, \eta^2_p = .008; F_2 (1,31) = 2.64, p = .114, \eta^2_p = .079]\).

### 2.5 Discussion of Experiment 1

In this experiment, participants whose L1 lacks DO construction were primed to produce ungrammatical DO sentences after non-alternating verbs. Importantly, they were more likely to produce an ungrammatical DO sentence after exposure to the same-verb and same-construction (i.e., a DO non-alternating prime), than after well-formed DOs with alternating verbs (i.e., no robust priming effects in the alternating priming verb condition). This pattern of results is consistent with two
possibilities. First, the priming effect by ungrammatical DOs with same verbs, in absence of a strong priming effect from alternating is consistent with a *lexically-driven persistence account* suggesting that non-native speakers did not generalize use of DO from alternating verbs, and thus, L2 speakers might have partially acquired the relevant restrictions for non-alternating verbs. These results are also compatible with a lexical boost effect (e.g., Pickering & Branigan, 1998) due to verb repetition between prime and target, which led to increased production of DOs in the non-alternating same-verb condition. In the following experiment, we explore this issue further using a condition that does not involve lexical repetition, but that nevertheless uses the same verb-type (non-alternating) between primes and targets.

**Experiment 2: Structural priming from non-alternating primes to different non-alternating targets in speakers of Romance languages**

Experiment 1 showed that L2-speakers of English whose languages lack the DO construction seem to have partially acquired the relevant lexical-syntactic restrictions associated with non-alternating verbs in English, under these experimental conditions, at least to some extent. Experiment 2 explores whether L2-speakers of English, whose native language lacks the DO, would generalize their knowledge of restrictions about non-alternating verbs across different non-alternating verbs and explores priming patterns in absence of verb repetition. Therefore, we tested whether L2 speakers would be primed to produce ungrammatical DO-
sentences with non-alternating verbs by ungrammatical primes with *different* non-alternating verbs.

Our hypotheses were as follows: If lexical boost was driving the priming effect observed in Experiment 1, any priming effect in this experiment should be reduced or absent. If a strong priming effect is observed in this experiment, we would provide another test of the *abstract structural persistence account*. This would be because repeated activation of an abstract rule (after non-alternating verbs) is sufficient for production of DO, participants should show a reliable, strong priming effect by different non-alternating verbs. This would be because exposure to the abstract rule DO even with ungrammatical DO different verbs would override lexical repetition effects and an item-by-item account.

Conversely, the *lexical persistence account* would not predict priming effects in this experiment, because the knowledge of the restriction for non-alternating verbs would only occur on an item-by-item basis (i.e., combination of specific verb + structural configuration).

A smaller priming effect than the effects observed by same-verb in the non-alternating verb condition (Exp. 1) could be suggestive that participants generalize their knowledge of the alternation restrictions across the different verbs of the same class (i.e., non-alternating), but not across all ditransitive verbs, thus reflecting a type of *verb class persistence*. 
2.6 Method

2.6.1 Participants

Twenty-eight participants from the University of Edinburgh community took part in this experiment (23 women) and received monetary compensation. Participants were native speakers of Romance languages as follows: Italian (N = 8), French (N = 7), Romanian (N = 6), Spanish (N = 6) and Catalan (N = 1); their mean age was 22 years old (SD = 3.84). One participant was replaced for being a native speaker of English, who learned Spanish in late childhood. Language proficiency was assessed through a self-rating language questionnaire (Table 2).

2.6.2 Materials

In Experiment 2 there were two prime type verbs (alternating, non-alternating). Alternating primes were the same used in Experiment 1. However, the alternating verb type condition was presented only in the DO form and the targets in the alternating verb condition were different alternating verbs (shows, hands, sends, chucks, offers, sells, throws, loans). This was done following the procedures of Ivanova et al. (2012) in order to increase exposure to DOs, and hence the overall likelihood of producing DOs. Because there is no PO construction for alternating verbs, this is considered a dummy condition and was not used to calculate priming effect. As in Experiment 1, the same non-alternating prime verbs were presented either in a DO and PO construction type and targets for the non-alternating verbs were also non-alternating verbs. Importantly, non-alternating verbs between prime
and target were different from each other. The conditions of Experiment 2 can be seen in Table 5.

Table 5. Sample sentences and characteristics of prime and target sentences in Experiment 2

<table>
<thead>
<tr>
<th>Prime sample sentence</th>
<th>Primes</th>
<th>Construction type</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) The artist <em>gives</em> the soldier the banana</td>
<td>Alternating, different (Dummy)</td>
<td>DO</td>
</tr>
<tr>
<td>(2) <em>The teacher donates</em> the waitress the hat</td>
<td>Non-alternating, different</td>
<td>DO</td>
</tr>
<tr>
<td>(3) The dancer <em>donates</em> the cake to the doctor</td>
<td>Non-alternating, different</td>
<td>PO</td>
</tr>
</tbody>
</table>

Notes: DO = Double Object, PO= Prepositional Object

2.6.3 Procedure

Procedure was the same as in Experiment 1.

2.6.4 Scoring and data analyses

Scoring was the same as in Experiment 1. For completeness, proportions of DOs in the Alternating (dummy) condition are reported, but analyses were carried out only in the non-alternating condition.
2.7 Results

A total of 896 responses were produced. Of these, 760 (85%) were scored as POs, 84 (9%) were scored as DOs, and 52 (6%) as Other. Proportions of DOs per condition are shown in Table 6.

Table 6. Experiment 2: Mean proportion of DOs per condition

<table>
<thead>
<tr>
<th>Prime verb</th>
<th>Target verb</th>
<th>Prime construction</th>
<th>Priming effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternating (Dummy), different</td>
<td>Alternating</td>
<td>.13</td>
<td>-</td>
</tr>
<tr>
<td>Non-alternating, different</td>
<td>Non-alternating</td>
<td>.09</td>
<td>.04</td>
</tr>
</tbody>
</table>

Notes. Proportions shown by subject, untransformed data.

The priming effect on Table 6 shows a significantly larger number of DOs produced following DO than following PO prime constructions in the non-alternating verb-condition by items, $t_2 (31) = 2.53, p = .017, r = .41$, and marginally significant by subjects, $t_1 (27) = 2.04, p = .051, r = .37$.

Further analyses excluding six participants who reported early use and/or exposure to English or other non-romance language in addition to their native language revealed a similar pattern of results, with the by-subject priming effect being marginally significant by subjects ($t_1 (21) = 2.04, p = .055$) and statistically significant by items ($t_2 (31) = 2.38, p = .024$).
2.8 Discussion of Experiment 2

In this study, we explored whether non-native speakers of Romance languages would generalize their knowledge of non-alternating verbs across the same class of verbs. Participants were primed to produce ungrammatical DO sentences after different non-alternating verbs, thus suggesting some generalization across non-alternating verbs, potentially compatible with a verb class persistence.

Experiment 3: Structural priming from non-alternating primes to same non-alternating targets in speakers of Germanic languages

Experiments 1 and 2 suggest that speakers of languages that lack the DO construction seem to have modest knowledge of the fine-grained lexically specific syntactic restrictions for non-alternating verbs in English. They did not generalize from well-formed DO primes, but were more likely to produce DOs from ungrammatical same-verb primes, and to a lesser degree from ungrammatical different-verb DO primes. One possibility to account for this ‘imperfect’ knowledge is that non-native speakers of English were L1-speakers of languages that do not allow dative-DO constructions, and therefore their knowledge about the relevant restrictions may be built on the basis of their experience with their L2 only. In order to test this further, we investigated whether mastery of lexically-specific syntactic restrictions in non-native speakers might be influenced by the L1. As mentioned in the introduction, Germanic languages allow DO constructions, similarly to English, thus syntactic representations for this construction could be shared between the L1
and the L2. Moreover, unlike L1-speakers of Romance languages, L1-Germanic
speakers have abstract representations for this structure, and therefore, any
differences in priming patterns might be informative to the extent that L1 may play a
role in acquisition of the relevant restrictions.

In order to test whether the L1 exerts an influence in processing of these
types of constructions, in terms of overall DO production, the language non-specific
account would predict overall more production of DOs as participants in this group
should be familiar with this construction based in their experience with L1 and L2.
On the other hand, the language specific account would predict a similar pattern of
overall proportions of DO and PO previously shown for Romance speakers. In
addition, any differences in overall rate of DO/PO production between L1-Germanic
speakers and those observed in L1-Romance speakers in Experiment 1 would be
suggestive of an influence from the L1 on non-native structural preferences.

2.9 Method

2.9.1 Participants

The Germanic group was composed of 28 native speakers of the following
Germanic languages: German (N = 13), Dutch (N = 6), Swedish (N = 5), Norwegian
(N = 2), and Danish (N = 2). Participants were from the University of Edinburgh
community (21 women, mean age 24 years old, SD = 3.02) and received monetary
compensation for their participation. Two participants were replaced, one for not
being native speaker of a Germanic language, and the second one for having reported
growing up with a non-Germanic language in addition to their native language.
Language proficiency was assessed through a self-rating language questionnaire (Table 2).

### 2.9.2 Materials, Procedure, Scoring and data analyses.

These were the same as in Experiment 1.

### 2.10 Results

Out of the 896 responses produced, 761 (85%) were scored as POs, 78 (9%) were scored as DOs, and 57 (6%) as Other. Proportions of DOs per condition are shown in Table 7.

**Table 7. Experiment 3: Mean proportion of DOs per condition**

<table>
<thead>
<tr>
<th>Prime verb</th>
<th>Target verb</th>
<th>Prime construction</th>
<th>Priming effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternating, different</td>
<td>Non-alternating</td>
<td>.07</td>
<td>.04</td>
</tr>
<tr>
<td>Non-alternating, same</td>
<td>Non-alternating</td>
<td>.23</td>
<td>.19</td>
</tr>
</tbody>
</table>

*Notes. Mean proportions shown by subject, untransformed data.*

The 2 x 2 ANOVAs showed a main effect of prime verb \([F_1 (1, 27) = 11.50, p = .002, \eta_p^2 = .299; F_2 (1,31) = 15.21, p < .001, \eta_p^2 = 329]\) indicating that more DOs were produced after non-alternating verb primes (subjects: .13; Items: .14) than after alternating verb primes (Subjects: .06; Items: .04). There was a main effect of prime
construction \[ F_1 (1, 27) = 12.65, p = .001, \eta^2_p = .319; F_2 (1,31) = 52.37, p < .001, \eta^2_p = .628 \], such that more DO responses were produced after DO primes (.15) than after PO primes (.04). An interaction between prime verb and prime construction \[ F_1 (1, 27) = 10.20, p = .004, \eta^2_p = .274; F_2 (1,31) = 19.4, p < .001, \eta^2_p = .384 \] followed up using simple effects indicated that there was a robust priming effect in the non-alternating prime verb condition \[ F_1 (1, 27) = 13.52, p = .001, \eta^2_p = .334; F_2 (1,31) = 48.30, p < .001, \eta^2_p = .609 \], but not in the alternating condition \[ F_1 (1, 27) = 2.99, p = .095, \eta^2_p = .100; F_2 (1,31) = 2.76, p = .107, \eta^2_p = .082 \].

Analyses excluding participants who reported early use and / or exposure to English or another non-Germanic language in childhood (N = 9) yielded the same pattern of results (all \( F_1 s > 5.44, ps < .033, F_2 s > 9.3, ps < .005 \). Simple effects: Alternating verb condition: \( F_1 (1,18) = 2.7, p = .120; F_2 (1,31) = 3.7, p = .062 \); Non-alternating verb condition: \( F_1 (1,18) = 8.1, p = .011; F_2 (1,31) = 28.9, p < .001 \).

### 2.11 Discussion of Experiment 3

In this experiment, we showed that non-native speakers of English, whose L1 allows DO construction, were primed to produce ungrammatical DO sentences after ungrammatical DO primes with the same verbs, but not by grammatical DO with alternating verbs. This pattern of results resembles the pattern of results found for L1-Romance in Experiment 1. This experiment provides insight into the potential influence of the L1 when processing L2. While a numerically larger overall
proportion of DOs was observed in this group, the priming patterns were similar to those previously reported for native speakers.

**Experiment 4: Structural priming from non-alternating primes to different non-alternating targets in speakers of Romance languages**

In Experiment 3, non-native speakers whose languages allow DO constructions were primed to produce ungrammatical sentences after same non-alternating verbs in the same structural configuration but not after well-formed DO primes. In order to provide another test of the potential influence of L1 in processing of ungrammatical sentences, we explored whether speakers of Germanic languages would generalize their use of DOs to other verbs of the same class.

If L1-Germanic speakers generalized across different verbs of the same class, in a similar fashion as the patterns previously shown for Romance speakers, this would provide more evidence in support of the *language specific account*, as knowledge of restrictions would be on the basis of experience with the L2 only. This account would predict that Germanic speakers would be primed to produce ungrammatical DO with non-alternating verbs by different non-alternating verbs in the same structural configuration (DO). Conversely, the *language non-specific account* would not predict priming, and the pattern exhibited by Germanic speakers should resemble the previous results for native speakers of English.
2.12 Method

2.12.1 Participants

Twenty-eight participants from the University of Edinburgh community took part in this experiment (18 women) and received monetary compensation. Three participants were replaced due to a technical problem (no audio recorded). One participant was excluded from analyses for having reported using a Romance language predominantly (over German) in early childhood. The remaining 27 Participants were native speakers of Germanic languages as follows: German (N = 19), Dutch (N = 4), Swedish (N = 2), Danish (N = 1) and Icelandic (N = 1), their mean age was 22.7 years old (SD = 2.77). Language proficiency was assessed through a self-rating language questionnaire (Table 2).

2.12.2 Materials, Procedure, Scoring and data analyses.

These were the same as in Experiment 2.

2.13 Results

Out of the 864 responses produced, 674 (78%) were scored as POs, 134 (16%) were scored as DOs, and 56 (6%) as Other. Proportions of DOs per condition are shown in Table 8.
Table 8. Experiment 4: Mean proportion of DOs per condition

<table>
<thead>
<tr>
<th>Prime verb</th>
<th>Target verb</th>
<th>Prime construction</th>
<th>Priming effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternating, different (Dummy)</td>
<td>Alternating</td>
<td>.25</td>
<td>-</td>
</tr>
<tr>
<td>Non-alternating, different</td>
<td>Non-alternating</td>
<td>.10</td>
<td>.06</td>
</tr>
</tbody>
</table>

*Notes. Proportions shown by subject, untransformed data.*

Table 8 shows the priming effect for the non-alternating verb prime. Although the rate of DO responses after DO prime constructions was slightly larger than after PO prime constructions, this difference was not statistically significant $(t_1(26) = 1.85, p = .075, r = .34; t_2(31) = 1.01, p = .318, r = .18)$.

Further analyses excluding 6 participants who reported early use and exposure to English or early exposure to a non-Germanic language reached significance by subjects, but not by items $(t_1(20) = 2.2, p = .038; t_2(31) = 1.3, p = .199)$.

2.14 Discussion Experiment 4

In this experiment, we showed that, although more DO constructions were produced after DO than after PO primes with different non-alternating verbs, these effects were not statistically reliable. These results provide no evidence that speakers of Germanic languages generalize across different non-alternating verbs. In addition, when considering results of Experiment 3 in light of lexical boost, this effect was reduced in this experiment.
2.15 Experiments 1-4 General Discussion

In a series of four structural priming experiments, we investigated whether non-native speakers of English have knowledge of lexically-specific syntactic restrictions of verbs, and whether the L1 may play a role in acquisition and use of these restrictions. In Experiments 1 and 2, participants were native speakers of languages that do not allow DO object constructions (Romance languages). They were primed to produce ungrammatical DO sentences with non-alternating verbs following DO primes with the same verbs, but not by primes with alternating verbs (Experiment 1). Moreover, in Experiment 2 we showed that L1-Romance speakers seem to generalize – to some extent – their knowledge about syntactic restrictions across other verbs of the same class (non-alternating). Experiment 3 replicated the same pattern of results observed in Experiment 1 in a group of L1-Germanic speakers whose L1 allows DO constructions. Experiment 4 showed that, although L1-Germanic speakers produced more ungrammatical DO sentences after different non-alternating verbs in DO constructions than after PO, this difference was not robust.

To discuss our results in the context of previous findings in native speakers, Table 9 presents a summary of the priming effects found for native speakers in Ivanova et al. (2012), as well as in the present study.
Table 9. Comparative proportion of DOs per condition in structural priming in all experiments

<table>
<thead>
<tr>
<th>Language group</th>
<th>Prime verb</th>
<th>Target verb</th>
<th>Prime construction</th>
<th>Priming effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>DO</td>
<td>PO</td>
</tr>
<tr>
<td>L1-English</td>
<td>Alternating, different</td>
<td>Non-alternating</td>
<td>.01</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Non-alternating, same</td>
<td>Non-alternating</td>
<td>.09</td>
<td>.00</td>
</tr>
<tr>
<td>L1-Romance</td>
<td>Alternating, different</td>
<td>Non-alternating</td>
<td>.08</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>Non-alternating, same</td>
<td>Non-alternating</td>
<td>.23</td>
<td>.04</td>
</tr>
<tr>
<td>L1-Germanic</td>
<td>Alternating, different</td>
<td>Non-alternating</td>
<td>.07</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>Non-alternating, same</td>
<td>Non-alternating</td>
<td>.23</td>
<td>.04</td>
</tr>
<tr>
<td>L1-English</td>
<td>Alternating (dummy), different</td>
<td>Alternating</td>
<td>.28</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Non-alternating, different</td>
<td>Non-alternating</td>
<td>.01</td>
<td>.01</td>
</tr>
<tr>
<td>L1-Romance</td>
<td>Alternating (dummy), different</td>
<td>Alternating</td>
<td>.13</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Non-alternating, different</td>
<td>Non-alternating</td>
<td>.09</td>
<td>.04</td>
</tr>
<tr>
<td>L1-Germanic</td>
<td>Alternating (dummy), different</td>
<td>Alternating</td>
<td>.25</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Non-alternating, different</td>
<td>Non-alternating</td>
<td>.10</td>
<td>.06</td>
</tr>
</tbody>
</table>

Notes: L1-English data taken from Ivanova et al. (2012) for reference purposes.

* p ≤ .05 by subjects and items

(*) p < .05 by items and p < .06 by subjects

^ p ≤ .075 by subjects and p > .1 by items

Table 9 shows priming effects in bold-font and statistical significance is indicated where appropriate. As it can be seen, in Ivanova et al. (2012) native speakers of English were primed to produce ungrammatical DO sentences after same verb non-alternating DO ungrammatical primes, but not after well-formed DO sentences, or by ungrammatical DO sentences with different verbs. These results provided support for the lexically-driven persistence account, whereby native speakers came to produce ungrammatical DO sentences only by the same verb-structure combination on an item-by-item basis. Their results were also accounted for by Pickering and Branigan’s (1998) model as follows: production of ungrammatical DO sentences by native speakers occurred because, after exposure to an ungrammatical verb-construction combination, a weak link between the lemma (the
non-alternating verb) and the DO structural node was established. Activation of this link was increased after repeated exposure to other exemplars with the same verb in the same construction, resulting in production of ungrammatical DOs with the same verb. In our study, while non-native speakers produced more DOs in general than the observed numbers in native speakers, similar patterns of priming by same-verb ungrammatical DO primes, and of different-verbs grammatical DO primes were observed for both non-native groups (Experiments 1 and 3).

Our results can also be accounted for by Pickering and Branigan’s (1998) model. Non-native speakers might have established a weak representation of a DO structural node, whose link was increasingly strengthened after repeated exposure. This effect was particularly enhanced in presence of verb repetition in Experiments 1 & 3 (cf. with Experiments 2 & 4). These results could be taken to suggest that activation of the DO alone was not enough to elicit production of ungrammatical DOs, as the abstract structural persistence account would predict, but rather, this seems to fit better with the lexically-driven persistence account, which also explains ungrammatical production in native speakers.

In addition, verb repetition seems to have played an important role. The larger priming effects observed with same verb in Experiments 1 and 3, considered alongside the results reported for native speakers suggest that non-native speakers were more influenced by verb repetition. Although there is evidence that verb repetition strengthens priming in a similar way within languages in bilinguals (Schoonbaert, Hartsuiker, & Pickering, 2007), our study shows a preliminary indication that verb repetition may exert a differential effect in the L2 when
processing ungrammatical sentences. A limitation of our study is that, in absence of a condition that allows us to determine a lexical boost baseline in grammatical verb-repetition exemplars, it is difficult to provide evidence for a differential effect of lexical boost in grammatical and ungrammatical L2 processing. This work is thus a call for more research trying to explore this possibility further.

With regards to production of ungrammatical DOs after different non-alternating verbs in non-native speakers (Experiments 2 & 4), the reduced priming effects in Romance speakers (cf. Experiment 1) and the marginal to absent priming effects in Germanic speakers suggest that non-native speakers generalized to some extent the DO rule across different verbs of the same class (non-alternating). This may suggest that non-native speakers have modest knowledge of the restrictions for non-alternating verbs, and this knowledge does not seem to be native-like. The reduction in priming size (cf. with Experiments 1 and 3) ties in with lexical boost.

Our study also provides indications that L1 did not seem to play a role in patterns of production of ungrammatical DOs. First, let us rule out a language non-specific account whereby structural preferences would be modulated by knowledge of L1 and L2. For Romance speakers, experience with DO in their L1 would be null, therefore they would be more likely to produce larger numbers of PO and almost no DOs. Our results indicate that this was not the case; in other words, although Romance speakers do not have DOs in their languages, this did not prevent them from producing DOs. Interestingly, their production of DOs resembled that of Germanic speakers. Therefore this pattern seems to be in line with the language specific account whereby non-native speakers build representations based on their
experience with L2, independently of the L1. This observation is also in line with previously reported findings by Flett et al. (2012) with grammatical sentences. In their study, non-native structural preferences for DO or PO did not differ regardless of language background (Romance, Germanic), also in line with the language specific account.

We will now discuss how the partial knowledge of restrictions for non-alternating verbs in English can be related to theories of DO-dative acquisition. As outlined in the introduction, verb-semantics and morphophonology alone, or in combination, seem to be unlikely to account for how non-native speakers acquire these restrictions. This is because the verb-semantics does not seem to provide straightforward cues when the meanings of alternating and non-alternating verbs overlap (e.g., give – donate).

Therefore, it seems that an answer to this question can be found in statistical-learning based accounts. These propose that the lexically-specific syntactic restrictions are learnt based on the difference between frequency of occurrence of a verb in the correct structure and in the incorrect construction (e.g., Ambridge et al., 2008). This proposal could also account for the fact that knowledge of the restrictions in non-native speakers was not native-like: they have had less experience with their L2, and therefore have less evidence to make the relevant probabilistic computations than native speakers acquiring this knowledge implicitly through a lifelong experience. A compatible account is also found in experience-based learning models whereby learning correct verb-constructions occurs through error-based learning (Chang, 2002). A model like this also highlights the important role of
concrete experience (Chang et al., 2006), as well as the nature of implicit learning in acquisition of the relevant restrictions (Chang, Dell, Bock, & Griffin, 2000). Further research needs to explore whether factors such as the extent of experience with the L2 may modulate knowledge and/or acquisition of the relevant restrictions.

In conclusion, our study suggests that highly proficient non-native speakers of English have modest knowledge of the relevant lexical-specific syntactic restrictions of non-alternating verbs. Our results also suggest that, most likely, L1 does not play a role in acquisition of these restrictions. A combination of factors such as lexically-driven verb repetition (boost) and probabilistic learning may explain non-native speakers’ use of these fine-grained restrictions.
Chapter 3: Native and non-native recruitment of semantic knowledge during online sentence comprehension: ERP evidence

3.1 Summary

Do proficient, non-native speakers recruit semantic information during online sentence comprehension in the same way as native speakers? Using ERPs, we examined how native and non-native speakers draw on different sources of semantic information during comprehension. Participants read passive sentences with plausible agents (e.g., The prescription for the mental disease was written by the psychiatrist) or with implausible agents that were either animate or inanimate and either semantically related or unrelated to the sentence (schizophrenic/guard/pill/fence). Non-native participants gave similar offline plausibility judgments as natives, and both groups showed facilitated semantic word retrieval (i.e., smaller N400s) for plausible words compared to implausible words, and of related nouns compared to unrelated nouns. However, whereas native speakers showed facilitated semantic retrieval for animate nouns compared to inanimate nouns, these effects were reduced in non-native speakers, compared to native speakers. Our results suggest that proficient non-native speakers have a reduced capacity to recruit animacy information in a fully incremental fashion.
3.2 Introduction

Do non-native speakers interpret utterances in the same way as native speakers? Most studies on non-native sentence processing have focused on whether non-native speakers apply the grammatical rules of a language in the same way as native speakers (e.g., Hahne & Friederici, 2001). Such studies often find that non-native speakers show impairments in their syntactic processing, as evidenced by reduced sensitivity to syntactically anomalous sentences (for reviews, see Frenck-Mestre, 2005; Kotz, 2009). However, while the incremental nature of native and non-native sentence comprehension requires rapid processing of both syntactic and semantic information (e.g., Marslen-Wilson, 1973), few studies have examined whether non-native comprehenders draw on semantic information in the same way as native comprehenders. The current study examines whether semantic processing in the non-native language proceeds in the same rapid and incremental way that it typically does in the native language.

We address this issue using Event-Related Potentials (ERPs) to examine how different forms of semantic knowledge interact during non-native sentence comprehension. In order to explore how non-native comprehenders draw on different sources of semantic information, we used the paradigm developed by Paczynski and Kuperberg (2012) (henceforth, P&K). P&K based their study on previous research showing that specific forms of semantic knowledge influence sentence processing, in particular verb animacy restrictions (knowledge of whether living/non-living agents can perform the action of a verb) and semantic relatedness (degree of semantic overlap between words). Our study examined whether non-native speakers use verb
animacy restrictions and semantic relatedness during online semantic processing in the same way as native speakers. Before outlining our experimental design and our predictions, we discuss relevant research on semantic aspects of native and non-native sentence comprehension.

3.2.1 Non-native sentence comprehension

Studies of non-native sentence comprehension have largely focused on people’s ability to apply grammatical rules in real time (e.g., Weber-Fox & Neville, 1996; Hahne & Friederici, 2001) and on the role therein of factors such as age of acquisition, proficiency and similarity between L1 and L2 syntax. Such studies usually show differences between native and non-native speakers in morphosyntactic processing. For example, non-native speakers show delayed and reduced ERP effects to gender and number violations (Guillon Dowens, Vergara, Barber, & Carreiras, 2010; White, Valenzuela, Kozlowska, McGregor, & Leung, 2004), and reduced ERP effects to subject-verb agreement violations (Chen, Shu, Liu, Zhao, & Li, 2007).

With regards to morphosyntactic processing and L2 ERP patterns, Steinhauer, White and Drury (2009) assessed the relationship between language proficiency and age of acquisition indexed by ERPs, particularly in late L2-speakers. A component that the authors studied as an index of the relationship between proficiency and syntactic processing was the LAN, since this component has been associated to automatic processing. Thus, at increasing levels of proficiency, L2-grammatical processing is expected to be more automatic, leading to the hypothesis that biphasic
LAN-P600 patterns to morpho-syntactic violations should be observed in higher proficient L2-Speakers. Therefore, according to the authors, ERP patterns of morphosyntactic processing in the L2 can be predicted as a function of L2-proficiency more than AoA.

Some theories of non-native processing account for these findings by proposing that late second language learners are unable to acquire abstract grammatical features (Hawkins & Chan, 1997) or that the ultimate attainment of the non-native grammar is incomplete (Schachter, 1990; Sorace, 1993). But alternative accounts are based on processing differences. Thus, Clahsen and Felser (2006) argued that even when non-native speakers have native-like knowledge of grammar, they do not use syntactic information in the same incremental, rule-based fashion as native speakers but rely more on semantic and pragmatic cues such as plausibility. In a different proposal, Kaan (2014) argued that native and non-native speakers have the same sentence processing mechanisms, and that differences between native and non-natives are due to the same factors that drive individual differences in native processing (e.g., frequency of information, task effects). As we will now discuss, most evidence on semantic processing suggests that proficient non-natives employ qualitatively similar processing strategies as natives, consistent with the proposal by Kaan (2014).

Self-paced reading results suggest that, although non-native speakers generally read more slowly, they employ similar strategies as native speakers (i.e., show similar patterns of initial analysis). For example, Jackson and Roberts (2010) reported similar self-paced reading patterns for advanced German-Dutch speakers
and for native Dutch speakers. Both groups read object-relative sentences and subject-relative sentences equally fast as long as the sentences had an animate subject, whereas both groups were slower in reading object-relative sentences than subject-relative sentences when the sentences had an inanimate subject. Roberts and Felser (2011) found that advanced Greek-English learners are influenced by plausibility/animacy information more strongly than native speakers when reading sentences with temporary subject/object ambiguities (e.g., *The inspector warned the boss/crimes would destroy very many lives*). The learners immediately slowed down at direct objects that did not match the semantic constraints of the preceding verb, whereas native controls only showed this plausibility effect at the subsequent verb (*would*). In a related study, Williams (2006, Exp. 1) found that native and non-native speakers made similar use of plausibility information to aid sentence re-analysis depending on task demands. When the task required plausibility judgments, non-native performance mirrored that of native performance, but when participants were only instructed to remember the sentences, the effects of plausibility were delayed for non-native participants. In sum, these self-paced reading studies suggest that non-natives use semantic information such as animacy very similarly to native speakers, but they seem to do so more slowly.

The results of several studies suggest that native and non-native speakers also show similar word-word semantic priming effects. Semantic priming is the relative facilitation of words that are semantically related to a preceding word compared to

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4 However, the native speakers read about twice as fast as the non-native speakers and it is possible that this difference underlay the delayed effect of plausibility in the native speakers (i.e., there was a spill-over effect; e.g., Trueswell, Tanenhaus, & Kello, 1993).
words that are unrelated (Neely, 1977). In ERP studies on word-word semantic priming, this facilitation is reflected by N400 amplitude, which indexes contextually facilitated retrieval of semantic information associated with words (Kutas & Federmeier, 2011), with lower amplitudes reflecting facilitated processing as compared to higher amplitudes. ERP studies on word-word semantic priming have reported similar N400 priming effects in native and non-native speakers (e.g., Kotz, 2001; Kotz & Elston-Güttler, 2004; see also Thierry & Wu, 2007) and in the languages of the bilinguals in within-subjects studies (Martin, Dering, Thomas, & Thierry, 2009; Wu & Thierry, 2010).

A number of ERP studies on non-native sentence comprehension have reported delayed latencies of the N400 component in non-natives (Ardal, Donald, Meuter, Muldrew, & Luce, 1990; Weber-Fox & Neville, 1996; Moreno & Kutas, 2005). In within-subject comparisons, studies have also shown asymmetries in processing between the bilinguals’ two languages (e.g., Martin, et al., 2009). Moreno and Kutas (2005) presented English and Spanish sentences that ended with semantically congruous or incongruous words to assess semantic processing in the dominant and in the non-dominant language. They showed that the N400 effect elicited by incongruous (relative to congruous) words peaked later in the bilinguals’ non-dominant language than in their dominant language, and that this delay increased with age of acquisition but decreased with proficiency. Other studies showed reduced N400 amplitudes in non-natives relative to natives (Hahne, 2001), and differences in topographic distributions between the groups (Hahne & Friederici, 2001; Proverbio, Cok, & Zani, 2002). Although these studies show that non-native
speakers are generally sensitive to semantic violations, as indexed by N400 effects, it is unclear what effects are due to proficiency and what effects reflect differences between native and non-native processing (for a review, see Frenck-Mestre, 2005).

To sum up, the evidence above suggests that non-natives use various types of semantic information (e.g., animacy, plausibility) during sentence processing. However, very few studies have directly compared how different forms of semantic information are used during native and non-native comprehension. A study of this issue could be informative about the extent to which different forms of semantic information are available within the same time-span during non-native semantic processing.

3.2.2 Native language semantic processing

We now consider ERP studies that examine the effects of animacy, semantic relatedness, or plausibility during sentence comprehension, as they are most relevant to our study. ERP evidence suggests that comprehenders generate expectations about general semantic features such as animacy. Such expectations are reflected in reduced N400 amplitude for words that meet the animacy requirements or preferences imposed by the preceding context (e.g., Nieuwland & Van Berkum, 2006; Nieuwland, Martin & Carreiras, 2013; Paczynski & Kuperberg, 2012). For example, sentence-initial animate nouns elicit smaller N400s than appropriately matched inanimate nouns (Weckerly & Kutas, 1999), a finding that is consistent with the preference for English sentences to start with animate entities. Similarly,
consistent with the preference for patient roles to be filled by inanimate entities rather than animate entities, Paczynski and Kuperberg (2011; Experiment 1) reported reduced N400s for inanimate patients (e.g., *At the homestead the farmer plowed the meadow...*) compared to equally plausible animate patients (e.g., *At the homestead the farmer penalized the labourer...*). Moreover, people may predict the animacy of upcoming words in Polish (Szewczyk & Schriefers, 2013). This latter study used discourse contexts that biased towards either an animate or an inanimate direct object noun in the story-final sentence. In the final sentence, pre-nominal adjectives (which in Polish are marked for animacy) that matched this animacy prediction elicited smaller N400s than adjectives that did not match the animacy prediction, irrespective of whether participants strongly expected a specific lexical item.

Sentence comprehension in native speakers is also facilitated by the semantic relatedness between an encountered word and its context. In ERP studies, implausible words that are related to words in the sentence context cause an attenuation in the N400 relative to unrelated implausible words. For instance, Federmeier and Kutas (1999) presented people with a context that was strongly compatible with a target word (e.g., *Eleanor offered to fix her visitor some coffee. Then she realized she didn’t have a clean...*) followed by the predicted word (*cup*), an implausible word that shared many semantic features with the predicted word (*bowl*), or an implausible word that shared few semantic features with the predicted word (*spoon*). Although both implausible words elicited a larger N400 effect relative to the predicted word, the N400 effect was reduced for the words that shared more features with the predicted word. Similarly, Metusalem et al. (2012, Experiment 1)
presented participants with passages such as *A huge blizzard ripped through town last night. My kids ended up getting the day off from school. They spent the whole day outside building a big...* which then continued with either a highly predicted word (*snowman*), an implausible word that was related to the described event (*jacket*), or an implausible word that was unrelated to the described event (*towel*). Again, results showed that event-related anomalous nouns elicited reduced N400s compared to unrelated anomalous nouns.

Most relevantly, P&K (2012) found semantic relatedness effects for animate words that met the animacy requirements of the preceding verb but not for inanimate words that did not meet the verb’s animacy requirements. Participants read passive sentences with critical words that rendered the sentences plausible or implausible (see Table 10). The implausible words were either animate or inanimate (and therefore compatible or incompatible, respectively, with the preceding verb), and either semantically related or unrelated to the sentence context. The authors found N400 attenuation for related words compared to unrelated words when they were animate (2 compared to 3) but not when inanimate (4 compared to 5). Based on these results, P&K argued that readers use animacy-selection restriction information of verbs to predict a constrained set of potential candidates that match the animacy requirements (i.e., predict animacy), and that relatedness facilitates further processing only if this animacy prediction is confirmed. P&K suggested that native speakers use animacy as an initial ‘filter’ on semantic interpretation of incoming words. P&K therefore argued for a functional distinction between violations of animacy selection restriction, and violations of real-world event/state knowledge,
during online sentence processing. Therefore, in the present study we aim to test this account in native speakers and compare it to non-native speakers.

Table 10. *Summary of the sentence types and sample sentence*\(^5\)

<table>
<thead>
<tr>
<th>Sentence Type</th>
<th>Description of critical word (CW)</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Control</td>
<td>Semantically related to the sentence context, meets expectations about the most likely agent to perform the action described by the verb (real-world knowledge), rendering the sentence plausible.</td>
<td>psychiatrist</td>
</tr>
<tr>
<td>Violation sentences:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Animate-Related</td>
<td>Semantically related, meets the animacy-selection restriction of the verb, but violates real-world knowledge expectations, thus rendering the sentence implausible.</td>
<td>schizophrenic</td>
</tr>
<tr>
<td>(3) Animate-Unrelated</td>
<td>Semantically unrelated, meets the animacy-selection restriction of the verb, but violates real-world knowledge expectations, thus rendering the sentence implausible.</td>
<td>guard</td>
</tr>
<tr>
<td>(4) Inanimate-Related</td>
<td>Semantically related, violates the animacy-selection restriction of the verb, thus rendering the sentence not only implausible but also impossible.</td>
<td>pill</td>
</tr>
<tr>
<td>(5) Inanimate-Unrelated</td>
<td>Semantically unrelated, violates the animacy-selection restriction of the verb, thus rendering the sentence not only implausible but also impossible.</td>
<td>fence</td>
</tr>
</tbody>
</table>

---

\(^5\) Table adapted from Paczynski and Kuperberg (2012)
In summary, native speakers process different forms of semantic information in an incremental and sometimes predictive fashion (Kutas & Federmeier, 2011). Animacy information appears to play an important role in incremental processing, as ERP results suggest that native comprehenders use verb selection restrictions to anticipate the animacy of upcoming arguments (P & K, 2012; Szewczyk & Schriefers, 2013). However, it is an open question whether or not animacy selection restrictions are indeed privileged, as suggested by P&K (see also Matsuki et al., 2011, for discussion). At face value, the P&K results appear inconsistent with the often-reported facilitation of semantically related words (e.g., Federmeier & Kutas, 1999; Metusalem et al., 2012). Even if a verb restricts the animacy of the upcoming noun, facilitation of semantically related concepts would still benefit incremental comprehension given that they are potentially relevant to the described event and because they might even occur later in the sentence. For example, the sentence “The prescription for the mental disease was written by the…” probably facilitates processing of animate nouns like ‘doctor’ or ‘psychiatrist’ but may also facilitate the inanimate noun ‘pill’ because prescriptions for mental diseases typically involve pills. Moreover, readers may use event-related knowledge to anticipate concepts beyond the immediately upcoming noun, also because relevant concepts are implicitly part of the described event (e.g., Ferretti & McRae, 2011; Metusalem et al., 2012) and could appear downstream (e.g., “The prescription for the mental disease was written by the psychiatrist. The pills were green”).

If animacy information is indeed privileged or prioritized, as argued by P&K, our study might provide evidence for a functional distinction between violations of
animacy selection restrictions and violations of real-world event-knowledge. But on a more interactive view on incremental semantic processing (e.g., Amsel, Delong, & Kutas, 2015; Federmeier & Kutas, 1999; Matsuki et al., 2011; Matusalem et al., 2012), our study should find facilitation of related words independently of animacy.

More importantly, the current study examines whether verb animacy selection restrictions and semantic relatedness have the same impact on non-native processing as they have on native processing. Self-paced reading and eye-tracking studies suggest that non-native speakers process semantic information in broadly the same way as native speakers, and make similar use of animacy information to disambiguate sentences. However, these studies also show that non-native speakers read more slowly overall than native speakers (e.g., Jackson & Roberts, 2010; Roberts & Felser, 2011). So when non-native speakers are not in control of the input rate, as is the case during spoken language comprehension or during serial visual presentation procedures typically used in ERP research, they may experience difficulty with building a message-level representation in an incremental and rapid fashion. Broadly consistent with this hypothesis, recent ERP work suggests that L2 comprehenders do not actively predict specific lexical items during sentence comprehension to the same extent as L1 comprehenders (Martin, Thierry, Kuipers, Boutonnet, Foucart, & Costa, 2013; Martin, et al., in press; but cf. Foucart, Martin, Moreno, & Costa 2014; for a review, see Kaan 2014). However, we do not know whether non-native speakers process animacy and assess plausibility in the same way that native speakers do.
3.2.3 Predictions for the current study

We adopted the experimental paradigm by P&K (2012), which allowed us to assess the interplay between animacy and semantic relatedness (see Table 10) during sentence comprehension. We tested a group of native speakers of Spanish who were proficient in English (see Methods for details) and a group of native English speakers. Importantly, plausibility judgments for the different conditions did not differ between non-native and native speakers. Our predictions focused on the N400 component elicited by the critical words in the five conditions.

According to a fully incremental hypothesis, comprehenders make use of all different sources of semantic information in a rapid and incremental fashion. If so, non-native speakers would show the same semantic facilitation effects as native speakers.

We will consider two alternative hypotheses, constituting different instantiations of a non-incremental non-native processing hypothesis. The most extreme alternative is that proficient non-native speakers do not show any online sensitivity to whether a sentence is plausible or not, in which case none of the above ERP effects would occur in non-native speakers, whereas all of them may occur in native speakers. Another alternative, a mildly incremental pattern, whereby quantitative differences but no qualitative differences between the groups are found (e.g., Kaan, 2014), predicts that message-level representations in non-native speakers are weaker than those of native speakers.
Although the focus of the present study is on the N400 component, we will also report the ERP effects in a later time window to examine possible post-N400 positive ERP (P600). Previous literature has proposed that P600 effects, traditionally associated with syntactic violations, can also be elicited by severely implausible or impossible propositions, thus being described as a ‘semantic P600’ (e.g., Kuperberg, 2007; van de Meerendonk et al., 2009). In the present study, all four violation conditions (2-5) are implausible, but the inanimate conditions can be considered genuinely impossible, given the animacy selection restrictions of the verb. If severe implausibility or impossibility triggers semantic P600s, as reported by P&K, we expect to observe such effects for the inanimate conditions irrespective of semantic relatedness. In addition, if non-native speakers use animacy selection restrictions in the same way as native speakers, such a pattern would hold for native and non-native speakers alike.

Like P&K, we also computed ERPs for sentence-final words to find evidence for downstream processing consequences of semantic anomalies. We report those findings as supplementary materials in Appendix C.

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6 An example of this is found in syntactically correct sentences that are semantically anomalous (e.g. For breakfast, the eggs would only eat toast and jam; Kuperberg, 2007). This ‘semantic P600’ could be taken to reflect sentence re-evaluation or integration difficulty (Van Petten & Luka, 2012).
Experiment 1: Native and non-native processing of semantic information using a plausibility judgement metalinguistic task

3.3 Method

3.3.1 Participants

Fifty-three right-handed participants from the University of Edinburgh student community who had normal or corrected-to-normal vision were paid to take part. After excluding participants who had too many artifacts or who did not have enough trials with correct responses (see results section for information on rates of discarded trials), the final sample consisted of 20 native speakers of English (11 women) and 20 Spanish-English speakers (14 women). These participants rated themselves as highly proficient on 5-point scales from basic to proficient for expression, comprehension, reading, and writing (see Table 11).

Table 11. Demographic and language information about the participants

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean age</th>
<th>Mean self-rated proficiency (with SD in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Expression</td>
</tr>
<tr>
<td>Natives</td>
<td>25.2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(4.91)</td>
<td>(0)</td>
</tr>
<tr>
<td>Non-natives</td>
<td>27.0</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>(4.91)</td>
<td>(.73)</td>
</tr>
</tbody>
</table>

3.3.2 Materials

The stimuli consisted of English passive sentences. Each sentence was composed of an introductory context that introduced the sentential patient followed
by a verb requiring an animate agent noun (henceforth referred to as the *critical word* or CW), and two subsequent words. In the control condition (1), the CWs were animate agents that were plausible and semantically related to the preceding context. In the animate-related condition (2) the CWs were implausible, semantically related, animate agents. In the animate-unrelated condition (3), the CWs were implausible, semantically unrelated, animate agents. In the inanimate-related condition (4) the CWs were implausible, semantically related, inanimate agents. In the inanimate-unrelated condition (5), the CWs were implausible, semantically unrelated, inanimate agents. As the verb always required an animate agent, the inanimate conditions but not the animate conditions involved selection-restriction violations (Table 10).

We developed our stimuli from the 120 items from P&K together with 61 novel items. We adapted the original materials in the following ways. First, we rephrased some of the original sentences, changed both spelling and some words that are used only in American English to British English. Second, we followed the procedure used by P&K to calculate Latent Semantic Analysis Semantic Similarity Values (LSA-SSV) to quantify the relatedness between the CW and its preceding context (http://lsa.colorado.edu; Landauer, 1998; Landauer, Foltz, & Laham, 1998), but we imposed the further restriction that, for each item, neither of the unrelated conditions had a higher LSA-SSV value than either the control or the related conditions. Third, two words followed the critical noun. Fourth, we wrote sentences in which the implausible critical words could not be plausible in a metaphorical sense or could not form part of a plausible compound noun, and there was no sentence completion that would render the sentence plausible.
All sentences, truncated after the CW of each condition, were rated for plausibility by 6 native speakers of English and 6 Spanish native speakers, who were proficient in English who did not take part in the EEG study, using a 1-7 plausibility Likert scale. Participants were presented with all five CWs following each item and rated each CW for plausibility. To balance the number of plausible sentences containing animate and inanimate nouns, we also included 30 passive filler sentences with the same format, with three implausible animate CWs and two plausible inanimate CWs per sentence. The 1-7 scale for each CW contained a question mark as an additional option, which participants were asked to circle in case they did not know the CW. Each rating participant saw one of two different lists, which only differed in the order of appearance of the same items. Based on these plausibility pre-ratings, we either removed or rephrased (and then re-tested for plausibility) any sentence that contained words not understood by non-native speakers or sentences that did not match our plausibility expectations by either group, and thus selected a final set of 155 sentences (Table 12).

In the total set of items for the ERP experiment, 137 animate and 137 inanimate CWs appeared in two different violation conditions of different items (related in one item, unrelated in another item), but none of the CWs appeared in the same condition of different items. We used counterbalanced lists so that participants never saw more than ten CW in the violation conditions twice during the experiment, and control words were not repeated within a list. We added 90 plausible sentence fillers (adapted from P&K) using verbs that were compatible with either animate or inanimate agents. Sixty fillers had inanimate agents and thirty had animate agents.
Table 12. Characteristics of the experimental stimuli

<table>
<thead>
<tr>
<th>Sentence type</th>
<th>CW Length</th>
<th>CW Frequency</th>
<th>LSA-SSV</th>
<th>Plausibility ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>native</td>
</tr>
<tr>
<td>1. Control</td>
<td>7.52 (2.27)</td>
<td>0.88 (0.64)</td>
<td>0.23 (0.14)</td>
<td>6.7 (0.61)</td>
</tr>
<tr>
<td>2. Animate-Related</td>
<td>7.39 (1.96)</td>
<td>0.96 (0.63)</td>
<td>0.19 (0.12)</td>
<td>2.3 (1.06)</td>
</tr>
<tr>
<td>3. Animate-Unrelated</td>
<td>7.39 (1.96)</td>
<td>0.98 (0.62)</td>
<td>0.04 (0.03)</td>
<td>1.7 (0.78)</td>
</tr>
<tr>
<td>4. Inanimate-Related</td>
<td>6.83 (2.19)</td>
<td>0.96 (0.60)</td>
<td>0.19 (0.11)</td>
<td>1.3 (0.70)</td>
</tr>
<tr>
<td>5. Inanimate-Unrelated</td>
<td>6.80 (2.25)</td>
<td>0.98 (0.59)</td>
<td>0.04 (0.03)</td>
<td>1.0 (0.14)</td>
</tr>
</tbody>
</table>

Note. Mean values (Standard Deviations in Parentheses).
CW = Critical word
CW length = number of letters
CW Frequency given in log word frequency per million.
Pre-ratings plausibility scale: 1-7.

CWs in the control condition and the animate conditions did not differ in frequency (ts < 1.5, ps > .149) or word length (ts < .57, ps > .572). Likewise, the control condition and the inanimate conditions did not differ in CW frequency (ts < 1.5, ps > .153). Inanimate words were on average slightly shorter than the control and animate conditions (ts > 2.3, ps < .02). There were no differences in word frequency between the violation conditions (2-5) (ts < 1.5, ps > .133). With regards to LSA-SSVs values, there was a main effect of sentence type (F4,616 = 157.3, p < .001) such that all sentence violations had lower SSVs than the control condition (all ps < .003). The related conditions did not differ from each other in their LSA-SSVs, and likewise, the unrelated conditions did not differ from each other (ps > .994). A 2x2 ANOVA with animacy and relatedness as factors, revealed a main effect of relatedness (F1,616 = 480.9, p < .001), with significantly higher LSA values for related sentences than for unrelated ones. There was no main effect of animacy or interaction (ps > .588).
For the plausibility ratings analysis, we used a 2 x 5 mixed-ANOVA with language group as between-subject factor and sentence type as a within-subject factor. Regarding the effect of language group, there was a trend ($F_{1,308} = 2.8, p = .094$), such that native speakers rated the sentences as slightly more plausible overall than the non-native speakers. A main effect of sentence type ($F_{4,1232} = 3578.5, p < .001$) was followed up with pairwise comparisons and showed that sentences in the control condition were rated higher than all 4 violation conditions (all $ps < .001$). No sentence type by group interaction was observed ($F_{4,1232} = 1.8, p = .133$). A 3-way mixed ANOVA with animacy and relatedness as within subject factors, and language group as a between-subject factor, showed main effects of animacy and relatedness such that inanimate nouns were rated as more implausible than animate nouns ($F_{1,308} = 4959.5, p < .001$), and likewise, unrelated nouns as more implausible than related nouns ($F_{1,308} = 320, p < .001$). We followed up on a robust interaction between animacy and relatedness ($F_{4,1232} = 2549.0, p < .001$) with simple effects. This revealed that animate-related words were rated as more plausible than animate-unrelated words ($F_{1,308} = 4426.8, p < .001$), and inanimate-related words were rated as more plausible than inanimate-unrelated words ($F_{1,308} = 16.7, p < .001$), but that the difference was greatest for the animate nouns. Finally, a marginal main effect of group ($F_{1,308} = 3.2, p = .074$) suggested that natives overall provided slightly higher plausibility ratings than non-natives. A marginally significant group by relatedness interaction was found ($F_{1,308} = 320, p = .083$), which we did not resolve.

---

7 Parametric and non-parametric analyses for these pairwise comparisons yielded the same pattern of results.
3.3.3 Procedure

We constructed five lists, each containing one version of each item and 31 items per condition. The order of the 155 experimental sentences and 90 fillers was pseudorandomized to avoid repeating the same condition more than 2 times in successive trials, and with the additional constrain of not having more than 4 consecutive experimental items (using MIX; Van Casteren & Davis, 2006), while keeping a fixed trial order per list.

Participants were randomly assigned to one of the five lists. They sat in front of the computer monitor in a dimly lit room. Sentences were presented word-by-word in black font on a white-background screen and the experiment was run using E-Prime 2.0®. Each trial started with a fixation point on the center of the screen for the duration of 450 ms, followed by a 200 ms blank screen. Following the procedure of P&K, each word of the sentence was presented using Serial Visual Presentation (SVP) paradigm with 450/100 ms on/off intervals; followed by a 750 ms blank screen and then a question mark appeared on the center of the screen. At this point, participants indicated as quickly as possible whether the sentence read was plausible or implausible using one of two buttons on a control pad. The next trial started after participants had given their answer. The experiment began with 6 practice trials and was split into 6 equal-length blocks to allow for brief breaks if desired. The experiment lasted about 45 minutes, together with about 30 minutes of EEG preparation time. Before the EEG recording, participants completed a language background questionnaire.
3.3.4 Electroencephalogram (EEG) recording and data processing

The EEG was recorded at a sampling rate of 512 Hz using a BioSemi ActiveTwo system (http://www.biosemi.com) with 64 EEG electrodes in an international 10–20 electrode configuration, two additional mastoid electrodes and four EOG electrodes (left and right horizontal cantus, and above/below the right eye), referenced to the common mode sense (CMS; active electrode) and grounded to a passive electrode. The EEG was re-referenced to the average of the left and right mastoid electrode offline, filtered (0.05-20 Hz band-width filter plus 50 Hz notch filter).

Data was segmented into epochs that started 100 ms before word onset, and that lasted until 1100 ms after CW onset. All epochs were corrected for ocular artifacts (Gratton and Coles correction; Gratton, Coles, & Donchin, 1983) baseline-corrected and then automatically screened for artifacts (allowed amplitude: minimal = -75µV, maximal = 75µV) before being entered into condition-averages per participant.

Thirteen participants were excluded as follows: eight participants for having fewer than 16 (52%) correctly-responded trials in at least one of the conditions, five participants for having fewer than 16 remaining trials in at least one of the conditions due to excessive artifacts. For the remaining 40 participants, averaged ERPs were computed over artifact-free trials for CWs per condition (Control: $M = 25, SD = 3.2$; Animate-Related: $M = 23, SD = 3.2$; Animate-Unrelated: $M = 25, SD = 3.7$, Inanimate-Related: $M = 25, SD = 3.1$; and Inanimate-Unrelated: $M = 27, SD = 3.2$)
3.3.5 ERP Statistical analysis

We selected time windows for N400, P600, and sentence-final effects based on those reported in P&K. We compared average ERP amplitude within each window per condition and clustered groups of electrodes into Regions-of-Interest (ROIs). These ROIs were organised into four groups (see Nieuwland, 2014), comparable to the 4-column approach reported by P&K: Lateral (LAF/RAF, LLFC/RLFC, LLCP/RLCP, LPO/RPO), Medial (LMFC/RMFC, LMCP/RMCP), Midline (MAF/MFC/MCP/MPO), and additional crossline (LLC/LMC/RMC/RLC) (Figure 2). To simplify the presentation of our results, we only report analyses for the medial ROIs here. These medial ROIs are most important for observing the N400 and P600 components of interest, and correspond to the electrode regions where the effects observed by P&K were maximal. Similarly to P&K, we report two sets of analyses. The first set compares each violation condition directly to the control condition, through pairwise comparisons between each violation condition and the control condition using repeated measures Analyses of Variance (ANOVA) with sentence type as a 2-level factor (Sentence Type: control condition, violation condition) and the factors 2(Hemisphere: left, right) by 2(Anteriority: Frontal-Central, Central-Parietal) to test for scalp distribution effects.

The second set tests for interactions between animacy and relatedness in the four violation conditions, using 2 (Animacy: animate, inanimate) by 2 (Relatedness: related, unrelated) ANOVAs along with the same distribution factors as used in the first section. All analyses also included a between-subjects factor (Group: native, non-native). Where appropriate, Greenhouse–Geisser (Greenhouse & Geisser, 1959)
p-values were applied and original $F$ values are reported here. Only statistical results with $p < .1$ are reported. Sentence-final effects are reported in Appendix C.

*Figure 2.* Electrode configuration (black letters) and the Region of Interest clusters (white letters); medial ROIs used for analyses are shown in dark grey. The last one or two letters refer to the anterior/posterior dimension: AF = Anterior Frontal, FC = Frontocentral, C = Central, CP = Centroparietal, PO = Parieto-occipital. The first letter of 3-letter cluster-names and the first two letters of 4-letter cluster names refer to left-right dimension: L/R = Left/Right, LL/RL = Left/Right Lateral, LM/RM = Left/Right Medial (taken from Nieuwland, 2014).
3.4 Results

3.4.1 Behavioural results

3.4.1.1 Accuracy

The accuracy of the plausibility judgments of the two participant groups is shown in Table 13. There were no significant differences in plausibility judgments between the groups, as revealed by lack of a main effect of group ($F_{1,38} = .441, p = .511$) or a sentence by group interaction ($F_{4,152} = 2.2, p = .104$). There was an overall effect of sentence type ($F_{4,152} = 29.5, p < .001$). Post-hoc pairwise comparisons showed that animate-related sentences (2) were rated as less implausible than the remaining three violation conditions (3-5) (all $p$s < .001), whereas the inanimate-unrelated sentences (5) were rated as more implausible than the three other violation conditions (2-4) (all $p$s < .001). There were no differences in plausibility judgments between the animate-unrelated (3) and inanimate-related (4) conditions ($p = .318$).

Table 13. Plausibility judgments per group per condition from the ERP experiment

<table>
<thead>
<tr>
<th>Sentence Type</th>
<th>Natives</th>
<th>Non-natives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plausible</td>
<td>Im plausible</td>
</tr>
<tr>
<td>(1) Control</td>
<td>91 (5.5)</td>
<td>86 (11.3)</td>
</tr>
<tr>
<td>(2) Animate-Related</td>
<td>82 (9.7)</td>
<td>84 (8.9)</td>
</tr>
<tr>
<td>(3) Animate-Unrelated</td>
<td>90 (8.5)</td>
<td>92 (7.3)</td>
</tr>
<tr>
<td>(4) Inanimate-Related</td>
<td>94 (4.5)</td>
<td>91 (7.9)</td>
</tr>
<tr>
<td>(5) Inanimate-Unrelated</td>
<td>99 (1.8)</td>
<td>98 (4.0)</td>
</tr>
</tbody>
</table>

Note. Mean percentages of condition-congruent responses per groups and SD in parentheses.
3.4.1.2 Reaction Time analysis

Reaction times (RTs) on correct answers for each participant were analysed, after removing values that fell outside 2 standard deviations from the mean per participant per condition. Non-native speakers did not give significantly slower responses overall than natives (Table 14; main effect of group: $F_{1,38} = 0.8$, $p = .391$, sentence by group interaction: $F_{4,152} = 1.7$, $p = .182$). However, there was an overall effect of sentence type ($F_{4,152} = 16.5$, $p < .001$). Post-hoc pairwise comparisons showed that participants responded significantly slower to animate-related sentences (2) than to the remaining three violation conditions (3-5) (all ps < .002), and responses to the inanimate-unrelated sentences (5) were significantly faster than the other three violation conditions (2-4) (all ps < .008).

<table>
<thead>
<tr>
<th>Sentence type</th>
<th>Natives</th>
<th>Non-natives</th>
<th>Overall mean RT per condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Control</td>
<td>532 (186)</td>
<td>672 (365)</td>
<td>602 (294)</td>
</tr>
<tr>
<td>(2) Animate-Related</td>
<td>611 (284)</td>
<td>661 (362)</td>
<td>636 (322)</td>
</tr>
<tr>
<td>(3) Animate-Unrelated</td>
<td>512 (212)</td>
<td>519 (234)</td>
<td>516 (221)</td>
</tr>
<tr>
<td>(4) Inanimate-Related</td>
<td>478 (146)</td>
<td>494 (187)</td>
<td>486 (166)</td>
</tr>
<tr>
<td>(5) Inanimate-Unrelated</td>
<td>396 (109)</td>
<td>471 (169)</td>
<td>433 (145)</td>
</tr>
</tbody>
</table>

*Note: SD given in parentheses.*

In sum, non-natives reaction times showed the same patterns as native speakers, and consistently, animate-related words elicited the longest latencies of RTs, while responses to inanimate-related words were the fastest.
3.4.2 ERP Results

3.4.2.1 N400 Results

3.4.2.1.1 Pairwise (control vs. violation type) analyses.

The two groups of participants showed similar effects for all the pairwise comparisons as revealed by lack of group effects or interactions including the group factor (Table 16). Across all participants, N400s in the control condition were significantly smaller than the animate-unrelated, inanimate-related and inanimate unrelated words, and only marginally smaller than animate-related words (Table 15). For this violation type, however, the N400 effect depended on anteriority (revealed by a robust sentence type by anteriority interaction), reflecting robust N400 effects at posterior channels ($F_{1,39} = 5.6, p = .023$) but not at anterior channels ($F_{1,39} = 1.6, p = .217$).

Table 15. Pairwise ANOVAs contrasting each type of violation with the control condition at different time windows, across all participants.

<table>
<thead>
<tr>
<th>N400 (300-500 ms)</th>
<th>P600 (700-900 ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sent</td>
</tr>
<tr>
<td>(2)Animate-Related</td>
<td>3.52</td>
</tr>
<tr>
<td>(3)Animate-Unrelated</td>
<td>21.59***</td>
</tr>
<tr>
<td>(4)Inanimate-Related</td>
<td>49.58***</td>
</tr>
<tr>
<td>(5)Inanimate-Unrelated</td>
<td>52.90***</td>
</tr>
</tbody>
</table>

Notes. F values reported on this table. DF [1,32]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution.

A three-way interaction involving sentence type, anteriority and hemisphere was observed for inanimate-related words and inanimate-unrelated words. Follow-up tests at each quadrant separately showed that, although the N400 effects elicited by
these two violation types compared to the control condition were statistically significant at all quadrants ($F_s > 36.9, p_s < .001$), inanimate-related words and inanimate-unrelated words elicited the largest N400 effects at posterior ROIs (LMCP and RMCP).

Table 16. *Pairwise ANOVAs contrasting each type of violation with the control condition at different time windows, across all participants, showing group effects and interactions.*

<table>
<thead>
<tr>
<th></th>
<th>N400 (300-500 ms)</th>
<th>P600 (700-900 ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group</td>
<td>Sent x Group</td>
</tr>
<tr>
<td>(2) Animate-Related</td>
<td>0.06</td>
<td>0.37</td>
</tr>
<tr>
<td>(3) Animate-Unrelated</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>(4) Inanimate-Related</td>
<td>0.40</td>
<td>2.89^</td>
</tr>
<tr>
<td>(5) Inanimate-Unrelated</td>
<td>0.44</td>
<td>1.63</td>
</tr>
</tbody>
</table>

*Notes. F values reported on this table. DF [1,32]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution.

^$p \leq .1$

* $p \leq .05$

** $p \leq .01$

*** $p \leq .001$

3.4.2.1.2 Animacy by relatedness interaction analyses.

Animate nouns elicited smaller N400s than inanimates, and similarly, related words elicited smaller N400s than unrelated words, as indicated by robust main effects of animacy and relatedness (Table 17). There were no interactions involving both animacy and relatedness, except a 4-way animacy by relatedness by hemisphere by anteriority interaction. Follow up analyses of the animacy by relatedness
interaction confirmed main effects of both animacy ($F_s > 17.6, ps < .001$) and relatedness at all quadrants ($F_s > 7.1, ps < .011$) but no further robust animacy by relatedness interactions at any quadrant ($F_s < 3.2, ps > .080$).

Table 17. $2 \times 2$ ANOVAs at the medial column

<table>
<thead>
<tr>
<th></th>
<th>Main effect of Ani</th>
<th>Main effect of Rela</th>
<th>Ani x Rela</th>
<th>Ani x AP</th>
<th>Rela x AP</th>
<th>Ani x Hem x AP</th>
<th>Rela x Hem x AP</th>
<th>Ani x Rela x AP</th>
<th>Rela x Hem x AP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N400</strong></td>
<td>30.1***</td>
<td>9.3**</td>
<td>0.6</td>
<td>0.9</td>
<td>0.2</td>
<td>8.2**</td>
<td>5.7*</td>
<td>3.1^</td>
<td>5.3*</td>
</tr>
<tr>
<td><strong>P600</strong></td>
<td>0.2</td>
<td>3.5^</td>
<td>0.5</td>
<td>41.3***</td>
<td>40.6***</td>
<td>2.5</td>
<td>0.4</td>
<td>3.0^</td>
<td>7.82*</td>
</tr>
</tbody>
</table>


^ $p \leq .1$

* $p \leq .05$

** $p \leq .01$

*** $p \leq .001$

Differences between the groups in the N400 time window became apparent in the animacy by relatedness interaction tests and their topographic distribution, in a 4-way interaction between animacy, relatedness, anteriority and group (see Table 18). Visual inspection of the data indicated that the maximal effects were observed at posterior regions (Figures 3-4), therefore we followed up using stepwise analyses of animacy by relatedness by group at anterior and posterior regions separately. At anterior electrodes, in addition to main effects of animacy ($F_{1,38} = 28.5, p < .001$) and relatedness ($F_{1,38} = 8.6, p = .006$), we observed a robust animacy by group interaction ($F_{1,38} = 7.6, p = .009$). Simple effects comparisons indicated that for native speakers, animates elicited significantly smaller N400s ($M = 2.3 \mu V$) than inanimates ($M = -0.39 \mu V; F_{1,38} = 32.8, p < .001$), whereas for non-natives this difference was only marginal (Animates $M = 1.88 \mu V$; Inanimates $M = 1.03 \mu V; F_{1,38} = 3.3, p = .077$).
At posterior electrodes, similarly main effects of animacy \((F_{1,38} = 24.4, p < .001)\) and relatedness \((F_{1,38} = 8.4, p = .006)\), and an animacy by group interaction \((F_{1,38} = 7.3, p = .010)\) were found. Simple effects analyses showed that in the native group animates elicited significantly smaller N400s \((M = 1.99 \mu V)\) than inanimates \((M = -0.41 \mu V; F_{1,38} = 29.3, p < .001)\), while the difference between animates \((M = 1.73 \mu V)\) and inanimates \((M = 1.03 \mu V)\) was not significant for the non-native group \((F_{1,38} = 2.5, p = .122)\).

Table 18. 2 x 2 ANOVAs at the medial column showing group effects and interactions

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>Ani x Group</th>
<th>Rela x Group</th>
<th>Rela x</th>
<th>Hem x AP x Group</th>
<th>Ani x Rela x</th>
<th>Rela x Hem x AP x Group</th>
<th>Ani x Rela x AP x Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N400</strong></td>
<td>0.3</td>
<td>8.5**</td>
<td>0.1</td>
<td>0.7</td>
<td>2.0</td>
<td>4.3*</td>
<td>3.0^</td>
<td></td>
</tr>
<tr>
<td><strong>P600</strong></td>
<td>0.2</td>
<td>0.6</td>
<td>0.6</td>
<td>4.1*</td>
<td>5.8*</td>
<td>5.9*</td>
<td>8.5**</td>
<td></td>
</tr>
</tbody>
</table>


\(^{\wedge} p \leq .1\)
\(^{\star} p \leq .05\)
\(^{**} p \leq .01\)
\(^{***} p \leq .001\)
Figure 3. ERPs elicited by critical words in the native group
ERPs elicited by critical words (CWs)

Sentence Type:
The prescription for the mental disease was written by the...

- **psychiatrist**: Plausible-Animate (Control)
- **schizophrenic**: Animate-Related
- **guard**: Animate-Unrelated
- **pill**: Inanimate-Related
- **fence**: Inanimate-Unrelated

Non-native speakers

![Figure 4. ERPs elicited by critical words in the non-native group.](image)
3.4.2.2 Summary of N400 results

Our N400 results show that both natives and non-natives exhibited significantly smaller N400s to the control condition compared to the animate unrelated, animate-unrelated and inanimate-related conditions, particularly on posterior channels. The difference between the control condition and the animate-related violation was reliable at posterior channels only. No differences between the groups were observed in these pairwise comparisons.

In the 2 x 2 analyses, robust effects of animacy and relatedness in native speakers were observed as animate nouns elicited smaller N400s than inanimate nouns, and likewise, semantically related nouns elicited smaller N400s than unrelated nouns. Importantly, no interaction between animacy and semantic relatedness was found in this group. The non-native group, while sensitive to the relatedness manipulations, showed smaller effects of animacy. These results are consistent with a mildly incremental pattern whereby non-native speakers have a reduced ability to incrementally use verb selection restrictions to facilitate processing of animate words. These findings thus suggest that, consistent with previous studies using self-paced reading (e.g., Williams, 2006), non-native speakers were able to integrate semantic information, specifically about plausibility, to aid sentence processing. However, their reduced effects of animacy, compared to the effects of native speakers, suggests that animacy did not confer the same facilitatory effects as for native speakers. These findings are discussed in more detail in section 3.5.1.
**3.4.2.3 P600 Results**

**3.4.2.3.1 Pairwise (control vs. violation type) analyses**

Natives and non-natives showed similar patterns of sentence type for all violation sentences except for the animate-unrelated condition. With the groups together, a three-way sentence by hemisphere by anteriority interaction was observed for the animate-related and inanimate-unrelated sentences (Table 15). Animate-related words elicited robustly more positive ERPs in this time window than the control condition at the right anterior RMFC ROI only ($F_{1,39} = 10.0, p = .003$; all other ROIs: $Fs < 3.0, ps > .093$). Inanimate-unrelated words elicited robustly more positive ERPs than the control condition at the left and right posterior ROIs (LMCP: $F_{1,39} = 6.6, p = .014$; RMCP: $F_{1,39} = 4.7, p = .037$), and marginally more positive at the LMFC ROI ($F_{1,39} = 3.8, p = .057$; RMFC: $F_{1,39} = 1.4, p = .237$). A two-way sentence type by anteriority interaction for inanimate-related words indicated significantly more positive ERPs for inanimate-related than control words at posterior ($F_{1,39} = 5.3, p = .026$) but not at anterior ROIs ($F_{1,39} = 0.2, p = .670$).

The only group difference was observed in the topographic P600 distribution of the animate-unrelated words, in a four-way sentence by hemisphere by anteriority by group interaction (Table 16). We followed up step-wise for each group separately and a further three-way sentence by hemisphere by anteriority interaction for native speakers ($F_{1,19} = 10.0, p = .005$) did not show any further sentence effects at any of the quadrants ($Fs < .915, ps > .351$). For the non-native group, a two-way sentence by anteriority interaction ($F_{1,19} = 10.4, p = .004$) did not revealed further sentence effects at anterior or posterior channels ($Fs < .977, ps > .335$).
3.4.2.3.2 Animacy by relatedness interaction analyses

The native and non-native groups showed different patterns for animacy and relatedness and its topographic distribution as revealed by a 5-way animacy by relatedness by hemisphere by anteriority by group interaction (Table 18). In the follow up stepwise analyses, the native group showed a three-way animacy by relatedness by hemisphere interaction ($F_{1,19} = 6.7, p = .018$) but it did not yield any further interactions between animacy and relatedness at either hemisphere (Left: $F_{1,19} = 0.3, p = .582$; Right: $F_{1,19} = 3.1, p = .097$). This group also showed two significant 2-way interactions for animacy by anteriority ($F_{1,19} = 21.9, p < .001$) and relatedness by anteriority ($F_{1,19} = 26.6, p < .001$) from which only significantly smaller P600s to unrelated words ($M = 4.41 \mu V$) than related words ($M = 5.70 \mu V$) at anterior regions were observed ($F_{1,19} = 6.1, p = .023$). The non-native group showed a 4-way animacy by relatedness by hemisphere by anteriority interaction ($F_{1,19} = 13.1, p = .002$) which was followed up on each quadrant. Main effects of relatedness at both frontal ROIs ($Fs > 5.3, ps < .032$) reflected significantly smaller P600s to unrelated words relative to related nouns (LMFC: Related $M = 6.34 \mu V$, Unrelated $M = 4.90 \mu V$; RMFC: Related: $M = 6.65 \mu V$, Unrelated $M = 4.99 \mu V$). No further main effects of animacy or interactions were observed.

3.4.2.4 Summary of P600 results

In the pairwise comparisons, we observed that the animate-related condition and the two inanimate conditions elicited more positive ERPs than the control
condition, and this pattern was observed in both groups. In the animacy by relatedness interaction analyses, the two groups showed different effect distributions but no robust group differences occurred in the subsequent follow-up tests. The groups thus showed the same pattern of more positive ERPs for related words than unrelated words, and, in contrast to P&K, we did not observe P600 effects of animacy in either group.

### 3.5 Discussion of Experiment 1

The present study examined whether semantic processing in non-native speakers proceeds in the same incremental way that is typical for native speakers. To this purpose, we used event-related potentials to assess the extent to which non-native and native speakers use different types of semantic information during sentence comprehension. We employed a paradigm based on that used by Paczynski and Kuperberg (2012; P&K), in which participants read passive sentences with plausible agents or implausible agents. The implausible agents were created employing a crossed 2x2 design using either animate or inanimate nouns that were either semantically related or unrelated to the sentential context.

Crucially, we observed differences between the non-native speakers and native speakers in their online sensitivity, as revealed by the N400 patterns. Whereas both groups showed facilitated semantic lexical retrieval of the CW (smaller N400s) for plausible words compared to implausible words, and both groups showed
facilitated semantic word retrieval of related nouns compared to unrelated nouns, native speakers showed larger and robust facilitation effects for animate nouns compared to inanimate nouns, and this effect was reduced in non-native speakers.

In the post-N400 time window, both groups of participants showed enhanced positive ERPs (‘semantic P600 effects’) for animate-related words, inanimate-related words and inanimate-unrelated words relative to the control condition. In both groups, semantically related words elicited more positive ERPs than unrelated words.

Results from the post-sentence plausibility judgments during the ERP experiment showed that native and non-native speakers judged the four violation conditions as more implausible than the plausible control condition, in line with our off-line plausibility norming data. In this final set of participants used for the ERP analysis, no group differences were observed in response accuracy\(^8\) or in the RT analyses. Thus, our proficient non-native speakers did not differ from native speakers in their offline sensitivity to sentence plausibility.

Based on our N400 results, we conclude that our proficient, non-native speakers showed a reduced capacity to recruit semantic information during online sentence comprehension in the same incremental way as native speakers.

\(^8\) This conclusion applies to the participants that entered the final ERP analysis, but does not apply to the initial set of participants. The exclusion of participants based on their response accuracy (in order to keep enough trials per condition per participant) minimised group differences in accuracy. We excluded 8 non-native speakers but no native speakers from the analysis based on response accuracy.
Specifically, non-native speakers showed a reduced capacity to recruit animacy information, as available through verb selection constraints, in a fully incremental fashion. We will discuss these issues in more detail later on in the Discussion. However, because our results for native speakers deviated from the P&K results, and the native speaker results constitute the benchmark for our interpretation of the non-native results, we first dedicate a separate section of our discussion to the native speaker results, followed by our main discussion of the non-native results. We follow with a section on why our study may have yielded different results than P&K, and we end with a section on the post-N400 positive ERP results, which also did yield different patterns than P&K.

3.5.1 Discussion of N400 results

3.5.1.1 Native speakers elicit N400 effects of animacy and of relatedness

In addition to robust N400 effects for all violation conditions, native speakers showed robust effects of animacy and of relatedness, evidenced by smaller N400s elicited by animate nouns compared to inanimate nouns and by smaller N400s elicited by related nouns compared to unrelated nouns. We take this to reflect the facilitation of semantic word retrieval of the critical animate nouns and related nouns compared to inanimate nouns and unrelated nouns. These results are consistent with those of other studies that reported reduced N400s for words that match the sentence context in terms of animacy (e.g., Nieuwland & Van Berkum, 2006; Szewczyk &
Schriefers, 2013), or for words that are semantically related to the discourse context compared to unrelated words (e.g., Metusalem et al., 2012).

Our findings could be taken to result from coarse-grained semantic predictions, which activate certain semantic features of upcoming words to facilitate their processing (e.g., Kutas, DeLong, & Smith, 2011). Previous studies have reported ERP evidence for the pre-activation of animacy features (Szewczyk & Schriefers, 2013), as well as for the activation for semantic concepts that are related to the described event (e.g., Metusalem et al., 2012). In our study, animacy predictions may have been generated as a result of the verb’s selection restrictions and based on real-world event-knowledge. Upon reading a phrase such as “the prescription was written by the”, people may expect the next upcoming word to be animate. Activation of semantically related concepts could arise from event-knowledge, for example the activation of ‘pill’ due to knowledge about prescription medicine, even if this word constitutes an anomalous continuation at that point in the sentence.

However, while we consider this ‘broad semantic prediction’ account to be a plausible interpretation of our findings, we do not consider our results as clear-cut evidence for online semantic predictions. An alternative explanation is that the results reflect ease of integration (see Federmeier & Kutas, 1999, for discussion). Under an integration account, the facilitation of animate words and semantically related words, reflected in the reduced N400, occurs primarily because these words are more plausible sentence continuations. The pattern of N400 amplitude per condition (inanimate-unrelated > inanimate-related > animate-unrelated > animate-
related > plausible control) exactly follows the pattern of the plausibility judgments (see Tables 12 and 13), with larger N400s found for more implausible conditions. Based on these patterns, we cannot rule out that the results reflect integration-difficulty instead of semantic prediction effects. However, because many other studies have reported that the N400 is more sensitive to the expectation of semantic features than to sentential plausibility per se (e.g., Amsel, Delong, & Kutas, 2015; Federmeier & Kutas, 1999; Ito, Corley, Pickering, Martin, & Nieuwland, 2015; Metusalem et al., 2012), an interpretation in terms of semantic predictions is perhaps the stronger contender.

### 3.5.1.2 Non-native speakers elicit N400 effects of relatedness and reduced effects of animacy

Like native speakers, non-native speakers showed reduced N400s for the plausible control words compared to each of the violated words. This finding indicates that non-native speakers were also able to rapidly integrate semantic information about plausibility, a finding that is broadly consistent with previous self-paced reading studies (e.g., Roberts & Felser, 2011; Williams, 2006). While non-native speakers showed smaller N400s for related nouns compared to unrelated nouns, they showed reduced effects of animacy, suggesting that animacy information did not impact non-native processing in same fully incremental way as in native speakers. We will discuss the implications of these findings for theories on bilingual
sentence comprehension and for recent accounts on linguistic prediction in bilinguals.

Our results are partially compatible with accounts whereby non-native speakers, relative to native speakers, rely more on semantic than grammatical cues to guide sentence processing (e.g., Clahsen & Felser), and that they do not qualitatively differ from native speakers (Kaan, 2014). For instance, Clahsen and Felser’s (2006) theory poses that non-native speakers rely more on lexical-semantic cues than on syntactic cues during sentence processing. Although this account does not predict differential use of the type of semantic information guiding non-native processing, it seems fair to assume that non-native speakers should not exhibit difficulties using semantic information in an incremental manner. Our data is partially in line with this assumption. In the present study, while natives and non-native speakers showed similar N400 patterns of relatedness, animacy did not confer the same facilitatory effects seen in natives, thus suggesting a possible difficulty or ‘underuse’ of animacy cues.

Our findings could also be linked to predictive processing accounts. If the N400 results from the native speakers are taken to reflect expectations of semantic features, animate words may be easier to process than inanimate words because expectations generated through the verb’s selection restrictions are met. Likewise, N400 attenuations to related words, compared to unrelated words, would reflect pre-activation of semantically related concepts. Although the study of anticipatory mechanisms in non-native processing has recently received a good deal of attention, evidence of non-native predictive processing is still inconclusive. Hypotheses of
non-native predictive processing range from the proposal that non-native speakers have a reduced ability to make predictions during sentence processing (e.g., the ‘Reduced Ability to Generate Expectations’ or ‘RAGE’ hypothesis, Grüter, Rohde, & Schafer, 2014; but see also Hopp, 2015; Martin, et al., 2013), to the account posing that non-native speakers do not qualitatively differ from native speakers in predictive processing (Kaan, 2014). Our results seem to fit better with the latter account. The non-native N400 pattern of relatedness not being qualitatively different from native speakers is in line with Kaan’s account. However, in terms of predictive processing, differences between the groups in animacy patterns could suggest that non-native speakers’ expectations of coarse-grained animacy features were somewhat impaired or less detailed than those of native speakers. In other levels of sentence processing, such as lexical prediction, a factor that has been shown to influence (dis)similarities between the ERP patterns elicited by natives and non-natives is cloze probability, such that more unexpected words elicit larger N400s in natives but not in non-natives (Martin, et al., 2013). Future research could examine factors that influence semantic expectations as in the present study (e.g., verb-selection restrictions) in non-native sentence processing.

As outlined in the native section, an alternative explanation for N400 effects observed could also be taken to reflect ease of lexical integration. This process requires integration of a word into the context where it occurs (e.g., Brown & Hagoort, 2007). From this point of view, semantically related words should be easier and faster to integrate (i.e., reduced N400s) than unrelated words because of the better semantic fit or association within words in the sentential context. The
integration account is in line with the reduced N400 effects for related words and the absence of group differences in relatedness in this study. This is further supported by studies reporting the same N400 effects and reaction time patterns of semantic lexical priming in the native and non-native language (Kerkhofs, Dijkstra, Chwilla, & de Bruijn, 2006). Facilitation of related words compared to unrelated words in non-native speakers is also consistent with previous studies on lexical semantic priming (e.g., Kotz, 2001), and non-native ERP patterns of word-word in semantic priming are also similar to native speakers (e.g., Kotz & Elston-Güttler, 2004). In addition, words that are associated to the words in the event described in a sentence also facilitate processing (e.g., Metusalem et al., 2012). In this study, semantic relatedness was indexed through LSA, by averaging the degree of association between each of content words in the sentential context and the critical nouns. The combination of these factors may have resulted in a semantic priming-type effect, allowing non-native speakers to build message-level representations with more ease (or at a faster speed) than their use of information about animacy-verb selection restrictions.

Another factor that might have influenced the reduced effects of animacy in non-native speakers could be related to the speed of processing. As we have seen from the literature on self-pace reading, although non-native speakers use semantic information in a similar fashion as native speakers, they read in the non-native language more slowly (e.g., Jackson & Roberts, 2010). In the present study, participants were presented with sentences word-by-word at a fixed rate, and therefore an efficient and rapid incremental processing of animacy may have proven
more challenging. Non-native language processing is thought to impose higher
cognitive demands on working memory (e.g., Ardila, 2003). Even in native speakers,
working memory has been shown to affect sentence processing (e.g., Otten & van
For instance, Nakano et al. (2010) showed that working memory had a differential
effect in the way native speakers process animacy and real-world knowledge
information. Given that low working memory capacity affects processing of animacy
and event-knowledge in natives, and that non-native processing may impose higher
working memory demands, different availability of cognitive resources could explain
why non-natives did not immediately use animacy information in the same way as
native speakers did in the present study. Because in our study we do not have a direct
measure of working memory to test whether it affected the way processing of these
semantic features, we cannot provide evidence for this account. Further studies could
explore the extent to which cognitive resources (e.g., working memory) affect non-
native processing of specific forms of semantic information.

Future studies could also explore the possibility of potential transfer effects
from the first to second language in processing of animacy. For instance, by using
active sentences in cross-linguistic studies of participants whose first language does
and does not require grammatical marker of animacy. In this vein, although not
uniquely relevant to semantic processing, models of sentence processing have
already reported differential uses of cues on different languages. For instance, the
‘competition model’ (Bates & MacWhinney, 1989; MacWhinney, Bates, & Kliegl,
1984) proposes that speakers of different languages use different cues (grammatical,
semantic) differently to guide sentence processing. According to this model, the hierarchy of cues followed in English is ‘word order > agreement, animacy’, while speakers of Italian are guided by ‘agreement > animacy > word order’, and German speakers by ‘animacy > agreement > word order’ (MacWhinney et al., 1984, p. 142). In the present study, the first language of the non-native speaker group was Spanish, in which animacy is marked by the preposition ‘a’ in active sentences. Although in our study participants read passive sentences, which would not require the use of the grammatical marker of animacy in Spanish, it is possible that the conflict between the “cues” in the two languages have led to less detailed or reduced animacy expectations. Cross-language syntactic activation for rules not shared between languages has been previously reported in balanced English-Welsh bilinguals (Vaughan-Evans, Kuipers, Thierry, & Jones, 2014). In this ERP study, a mutation rule in Welsh, whereby the initial consonant of nouns changes depending on the grammatical context, was applied to the L2-English, a language that lacks this mutation rule, as shown by ERP patterns.

From the different alternatives considered above, our non-native results seem to fit better with an account whereby non-native speakers do not qualitatively differ from native speakers. While non-native speakers were able to build message-level representations, their reduced effects of animacy might suggest that animacy expectations were weaker than those generated by native speakers.
3.5.2 Comparison of native-speaker results in P&K and the current study

While we take our results for native speakers to be broadly consistent with those of previous studies on the recruitment of semantic knowledge during comprehension (Metusalem et al., 2012; Szewczyk & Schriefers, 2013), our results did not replicate the findings from P&K despite the fact that the exact same paradigm was used. In our study, we found reduced N400s for related words independently of animacy, and reduced N400s for animate words overall, whereas P&K found reduced N400s for related words when animate but not when inanimate, and no reduced N400s for animate words overall. There were also significant differences in the subsequent P600 component, which we discuss in a separate section. In order to understand why our study generated different results than P&K while using the same design, we first outline several methodological differences between the two studies.

We adapted the P&K stimuli and also created new stimuli in order to have a larger set of stimuli (see Methods section for details). P&K only used 120 experimental sentence contexts, and each participant saw each context in two different conditions throughout the experiment. Repetition of sentence context may have led participants to recognize sentence materials during the experiment, thereby inducing expectations or processing strategies. Moreover, participants read a total of 384 sentences, rending the experiment very long. In our study, participants saw each sentence context only once and each control critical word only once, to a total of 245 sentences. Although another adaptation to the original stimuli was to adjust the number of sentence final-words to 2 words, a process such as sentence wrap-up is
unlikely to have influenced the differences between the two studies, given that
although in a varied number of words, P&K also had sentence-final words following
cWs.

We cannot be certain about the precise reasons why we did not replicate the
P&K findings. However, it should be noted that one particular finding from the P&K
study, the absence of any immediate N400 or P600 effect for animate-related words
compared to the plausible control, is inconsistent with a large body of literature.
Implausible words elicit robust N400 effects or, under certain circumstances, robust
P600 effects instead (e.g., Nieuwland & Van Berkum, 2005; Van Herten, Chwilla, &
Kolk, 2006; for reviews, see Bornkessel-Schlesewsky & Schlesewsky, 2008;
Brouwer, Fitz, & Hoeks, 2012; Kuperberg, 2007). Therefore, the absence of any
immediate effect at all (until the sentence-final word) is inconsistent with previous
findings, and could be taken to suggest that their participants initially found animate-
related words unproblematic.

The P&K finding that relatedness did not impact the processing of animate
words also seems inconsistent with current literature on semantic pre-activation (e.g.,
Federmeier & Kutas, 1999; Ito et al., 2015; Metusalem et al., 2012). As we detailed
in our Introduction, facilitation of semantically related concepts probably occurs
despite verb animacy restrictions. Even if people anticipate the first upcoming word
to animate, the activation of event-related concepts would benefit animate or
inanimate concepts alike. Based on our N400 results, and the apparent absence of a
genuine functional distinction between violations of animacy selection restrictions
and violations of real-world event-knowledge, we thus conclude that animacy information is not privileged or prioritized, contra the claims by P&K.

3.5.3 P600 results in native and non-native speakers

Both groups showed more positive ERPs in the post-N400 time window for the animate-related condition and the two inanimate conditions compared to the control condition. The groups also showed the same pattern of more positive ERPs for related words than unrelated words. We did not observe P600 effects of animacy in either group.

Like our N400 results, our P600 results also do not replicate the P&K findings. In the P&K study, only inanimate words elicited a P600 effect compared to the control condition, and this effect was not influenced by relatedness. Based on their findings and previous reports (e.g., Paczynski & Kuperberg, 2011; Van de Meerendonk et al., 2009), P&K argued that their P600 effect reflected a ‘semantic P600’ effect, which can be triggered by a conflict between an expected representation and the detection of an incoherent proposition.

In our study, the P600 effect did not pattern with plausibility or impossibility. In fact, the least implausible condition elicited the largest P600 effects, particularly at frontal channels. However, our P600 effects do seem to pattern with task difficulty, (and P600s can also reflect sentence re-evaluation). Participants found it more difficult to establish that animate-related words were implausible, as was evident in response accuracy and response time measurements. This condition may be more
difficult precisely because these words are both animate and related to the context. Therefore, rather than reflecting the detection of propositional impossibility (P&K), we think that these P600 effects reflect the concomitant ERP effects of the task (i.e., decision-based effects). As a caveat, it is difficult to establish the precise relations between the task responses and the observed ERP effects, because the observed positive ERP effects may have overlapped with the generated N400 effects, and negative and positive potentials cancel each other out at the scalp surface.

The idea that task-behavior elicits positive ERP responses is not new. Kolk, Chwilla, van Herten, and Oor (2003) observed P600 effects to animacy violations when participants performed plausibility judgment but not when they only passively read the sentences. Similarly, in a follow-up study on the current study where participants did not perform plausibility judgments (see Chapter 3, Experiment 2), we did not observe post-N400 positive ERP effects. This suggests that such P600 effects may not reflect a process that occurs in naturalistic reading conditions but simply index the decision-processes and possibly response-preparation processes associated with plausibility judgments.

In conclusion, the present study aimed to investigate whether proficient, non-native speakers recruit semantic information during online sentence comprehension in the same way as native speakers do. Using an adaptation of a paradigm originally employed by Paczynski and Kuperberg (2012), participants read passive sentences in English, with plausible (control) and implausible agents using animate and inanimate words that were related and unrelated to the sentence context. Native and non-native speakers showed processing facilitation by semantic relatedness (i.e., smaller N400s).
and for plausible words compared to implausible words. Compared to native speakers, however, non-native speakers showed reduced effects of animacy. Among the reasons why animacy information may have been used differently between natives and non-natives, we discussed weaker or less elaborated non-native predictions and the potential transfer from the first to the second language when animacy features are different between the native and the non-native language and higher cognitive demands. In addition, the P600 in this study is taken to reflect task demand rather than patterns of plausibility or impossibility for both native and non-native speakers.

To conclude, the present study showed that non-native speakers process information about plausibility and semantic relatedness in a similar way as non-native speakers but they were less sensitive to animacy information than native speakers. A model whereby non-native semantic effects of plausibility and relatedness do not qualitatively differ from native processing can best fit our results.
Experiment 2: Native and non-native processing of semantic information without a plausibility judgement metalinguistic task

3.6 Summary

In this chapter, we investigate semantic comprehension in native and non-native speakers in absence of a meta-linguistic judgment task. More specifically, we ask whether non-native speakers use animacy and semantic relatedness information in the same way as native speakers when they are not explicitly evaluating sentence plausibility. The stimuli were identical to Chapter 3, Experiment 1, composed of control sentences with plausible agents (e.g., *The prescription for the mental disease was written by the psychiatrist*), or implausible agents that were either animate or inanimate and either semantically related or unrelated to the sentence (*schizophrenic/guard/pill/fence*). Results of the present study showed N400 effects of plausibility for the four-violation types, compared to the control condition in both groups. In addition, only native speakers showed smaller negative ERPs for animate nouns than for inanimate nouns that extended beyond the N400 time window. No effects of semantic relatedness or interactions between animacy and relatedness were found in either group. In the later time window (700-900 ms), only native speakers exhibited marginal extended-N400 effects of animacy and extended-N400s for related than unrelated words at one ROI. We discuss our results in terms of differences and similarities in processing of semantic information between native and non-native speakers, and address the influence of decision-based strategies on ERP components.
3.7 Introduction

How similar is sentence comprehension in native and non-native speakers? As we saw in Chapter 3, Experiment 1, most research on this topic focuses on whether native and non-native speakers differ in the way that they recruit syntactic knowledge during comprehension (e.g., Hopp, 2010; Kotz, Holcomb, & Osterhout, 2008; Rüschemeyer, Zysset, & Friederici, 2006). Most research shows that syntactic processing is relatively impaired in non-native speakers (for reviews see Kotz, 2001; Van Hell & Tokowicz, 2010). Researchers have attempted to explain these observations in terms of proficiency (Rossi, Gugler, Friederici, & Hahne, 2006), age of acquisition (e.g., Weber-Fox & Neville, 1996; Hernandez, Hofmann, & Kotz, 2007), or grammatical differences between the native and non-native language (Tokowicz & MacWhinney, 2005). It is unknown, however, whether and to what extent native and non-native speakers also differ in their recruitment of semantic knowledge during comprehension. In particular, little is known about whether non-native speakers use various sources of semantic knowledge in the same incremental manner that is typical of native speakers.

In Chapter 3, Experiment 1, we narrowed this gap by investigating whether proficient, non-native speakers recruit animacy and semantic relatedness information during online sentence comprehension in the same way as native speakers. We used a design based on Paczynski and Kuperberg (2012), wherein native and non-native speakers (English and Spanish-English speakers, respectively) read English passive sentences with plausible agents (e.g., The prescription for the mental disease was written by the psychiatrist) or with implausible agents that were either animate or
inanimate and either semantically related or unrelated to the sentence
\textit{(schizophrenic/guard/pill/fence)}, and evaluated each sentence on plausibility after it was presented. Both groups showed facilitated semantic word retrieval (i.e., smaller N400s) for plausible words compared to implausible words, and for related nouns compared to unrelated nouns. However, non-native speakers did not show the same degree of facilitated semantic retrieval for animate nouns compared to inanimate nouns as observed for the native speakers. This difference occurred despite the fact that non-native participants gave the same offline plausibility judgments as natives.

The current study follows up on these findings by investigating semantic comprehension in native and non-native speakers in absence of a meta-linguistic judgment task. More specifically, we ask whether non-native speakers use animacy and semantic relatedness information in the same way as native speakers when they are not explicitly evaluating sentence plausibility.

Explicit evaluation of sentences compared to other tasks, such as passive reading, has been shown to influence native and non-native speakers’ processing strategies differently, as we will discuss in the sections below. In the present study, we tested native and non-native speakers of English using the same sentence materials as in Chapter 3, Experiment 1, but the participants in the current study only responded to simple comprehension questions and did not judge sentence plausibility. Our rationale for this approach is two-fold: firstly, it allows us to establish the influence of task-demands on the incremental semantic processes that underlie native and non-native sentence comprehension. This is important, as the results of several studies suggest that native and non-native speakers respond in
different ways to task demands during language processing (for a recent review, see Kaan, 2014; see also Roberts, 2012) in particular with respect to predictive processing and use of syntactic information. With regards to use of semantic information during sentence processing, behavioral evidence shows that the task participants are required to do can influence participant’s strategies and use of semantic information in both native and non-native speakers. For instance, in the self-paced reading study by Williams (2006) native and non-native speakers showed comparable effects of plausibility during incremental semantic processing when the task required making on-line plausibility judgments. However, when using a memory task, the plausibility effects were delayed in non-natives, but remained only in native speakers with the higher memory performance. These results suggest that non-native’s semantic incremental processing seems to be more affected by the task at play than in native processing, and that individual differences (e.g., working memory) also affect incremental sentence processing.

Secondly, our approach furthers the understanding about the extent to which task demands may impact ERP components. Recent ERP research on language comprehension in native speakers has shown that task-demands can influence the observed patterns both in qualitative and quantitative ways (e.g., Nieuwland, 2014; Chwilla, Brown, & Hagoort, 1995; Kolk et al, 2003). In the following sections, we briefly review relevant research on semantic aspects of non-native sentence comprehension, discuss research on the role of task-demands on semantic processing in native and non-native speakers, and then outline our predictions for the current study.
3.7.1 Semantic aspects of non-native sentence comprehension: use of animacy information

Comparisons between native and non-native semantic processing generally suggest that, unlike syntactic processing, semantic processing in non-natives resembles that of native speakers, or differs only quantitatively (e.g., Kroll & Dussias, 2004). For example, as previously mentioned, results from a self-paced reading study showed that non-native speakers use animacy information to disambiguate sentences in much the same way as native speakers (e.g., Roberts & Felser, 2011). In another self-paced reading study, Jackson and Roberts (2010) used subject- and object-relative ambiguous sentences and compared patterns of sentence reanalysis between Dutch native speakers and German-Dutch speakers. Although non-native speakers displayed overall slower reading times, their reading patterns resembled those of native speakers: similar reading times for object-relative and subject-relative sentences with animate subjects, and slower reading times for object-relative than subject-relative sentences when the sentences had an inanimate subject. These findings suggest that non-native speakers made use of semantic information, particularly animacy to disambiguate sentences in a similar way as native speakers. Importantly, these studies show that in processing ambiguities, non-native speakers make use of semantic information incrementally, and their patterns can even resemble those of native speakers. These findings are in line with the proposals that non-native semantic processing may differ only quantitatively from native speakers (Roberts, 2012) and, particularly, that predictive processing does not qualitatively differ from native speakers (e.g., Kaan, 2014).
Our own previous findings (Chapter 3, Exp. 1) suggest that non-native speakers might use animacy information in a different way than native speakers, at least when processing syntactically unambiguous sentences. This was suggested by a group difference in the N400 component amplitude (Kutas & Hillyard, 1980), which indexes the extent to which retrieval of semantic information associated with a word is facilitated by the context in which it appears (Kutas & Federmeier, 2011). Whereas native speakers showed reduced N400s for anomalous unrelated words and inanimate words compared to anomalous related words and animate words, this reduction in N400s was smaller in non-native speakers, compared to the native group. In a direct comparison between native and non-native speakers in our study, similar facilitatory patterns by semantic relatedness (i.e., reduced N400s) were observed between the groups, as indicated by lack of by group interaction with relatedness.

The abovementioned findings are relevant to extant theories of bilingual sentence comprehension such as the recent Shallow Structure Hypothesis (SSH, Clahsen & Felser, 2006) and the competition model (MacWhinney et al., 1984). The SSH argues that because syntactic/structural representations are less robust or less detailed in non-natives than in natives, non-native speakers rely more strongly on semantic and pragmatic information (e.g., lexical-association and plausibility) than native speakers. In our own previous study, non-native speakers may have had relative difficulty understanding passive sentences, which could have led to a reduced ability to anticipate the animacy of the sentential subject. However, the fact that the non-native speakers did not show overall larger N400s is inconsistent with
such an explanation, as difficulty with passive sentences should have affected all sentence conditions (including the plausible control sentence). In this regard, our results are not easily accommodated by the SSH, which focuses primarily on explaining differences in native and non-native parsing strategies during ambiguity resolution. As we understand SSH, it does not lead to strong predictions about how non-native speakers use animacy information when comprehending unambiguous sentences.

Another model that could potentially account for our previous results is the influential Competition Model (MacWhinney et al., 1984; Bates & MacWhinney, 1989). This model predicts semantic processing differences between native and non-native speakers when the native and non-native languages weight the relevant semantic cues differently. English and Spanish deal differently with animacy information. Animacy information in English might be conveyed in pronouns (e.g., he/she vs. it) but unlike Spanish, English has no differential object marking (DOM) for animacy. In Spanish, animate direct objects are preceded by the marker ‘a’. Within the Competition Model, stronger reliance on explicit animacy marking in Spanish could lead to a reduced ability of Spanish-English bilinguals to use animacy information fully incrementally in English. Although the Competition Model does not explicitly incorporate predictive processing, Kaan (2014) suggested that the basic assumptions of this model could also apply to predictive processing, such that native and non-native speakers use the available cues differently to predict upcoming information. Moreover, Kaan argued that sentence comprehension mechanisms do not differ qualitatively between native and non-native speakers but that differences in
predictive processing can be accounted for by the same factors that govern individual differences in native speakers, such as frequency of occurrence. Within this framework, the reliability of animacy-marking as a cue to predict the animacy in one’s native language (e.g., Nieuwland et al., 2013; Szewczyk & Schriefers, 2013; Packzynski & Kuperberg, 2012) may lead to a reduced ability to predict upcoming animacy in another language that does not mark animacy.

The N400 patterns observed in Chapter 3, Exp. 1 suggest that native and non-native speakers might have differed in their recruitment of animacy information during sentence comprehension. In the subsequent positive ERP component (the P600), however, the groups did not differ. Related words elicited more positive ERPs than unrelated words in native and non-native speakers alike, no animacy effects were observed on this P600 component. Interestingly, the largest (most positive) P600s were elicited by animate-related words, which also happened to be the least implausible violation condition. Response time and accuracy measures suggested that this condition was most difficult, in that participants were slower and less accurate to decide that sentences in this condition were implausible. Thus, the observed P600 effects may have been related to task difficulty. In the following section, we discuss previous ERP studies on the role of task-demands during sentence processing, with particular focus on semantic processing.
3.7.2 ERP effects of task-demands during native and non-native semantic processing

In many ERP studies on language comprehension, participants are asked to perform a meta-linguistic judgment task such as judging sentence acceptability (for overviews of relevant work, see Bornkessel-Schlesewsky & Schlesewsky, 2008; Kuperberg, 2007; Roehm, Bornkessel-Schlesewsky, Rösler, & Schlesewsky, 2007; Sassenhagen, Schlesewsky, & Bornkessel-Schlesewsky, 2014). This approach has several benefits. It enables researchers to avoid analysis of sentences that are not interpreted in the intended way (e.g., sentences in an anomalous condition that are considered to be plausible). It also enables researchers to make a direct comparison between the online ERP effects and the ‘final interpretation’ of a sentence as reflected in an overt evaluation. Both of these benefits are of particular importance in bilingualism research. Task results can be used to match native and non-native participant groups on comprehension, so that online ERP effects cannot be attributed to general comprehension differences between groups.

The use of sentence acceptability judgment tasks also has some disadvantages, however. Asking participants to evaluate a sentence may alter how they understand the sentence in the first place. For example, participants may pay more attention to specific parts of information contained in a sentence, relative to when they are asked to understand the sentence without the task. In this respect, the task itself may introduce a potential confound and limit on the generalizability of the results. Consequently, ERP effects elicited by semantic or syntactic anomalies when participants perform a task may differ qualitatively and/or quantitatively from when
participants do not perform this task. A particular problem arises when decision-processes associated with the task elicit ERP effects with spatial and/or temporal overlap with the ERP effects elicited by the experimental manipulation.

To deal with these potential problems, some studies compare patterns of results obtained with the same stimuli but under different task conditions. These results suggest that the N400 and the P600 ERP component can be affected by the task that participants are performing. Regarding the N400 component, Chwilla et al. (1995) observed standard semantic word-priming N400 effects (i.e., smaller N400 for related prime-target word pairs than unrelated ones) when participants performed a meaning-based task (lexical decision) but not when performing a task about a superficial word form feature (upper/lowercase). A similar pattern of results was obtained by Marí-Beffa, Valdés, Cullen, Catena, and Houghton (2005), who compared effects of a semantic categorization task (living/non-living) with a letter search task (identify the letters A/E). These studies show that differences in meaning between words do not seem to facilitate processing if participants are asked to focus solely on superficial features of the words. Please note, however, that these studies suggesting strengthening of N400 when drawing attention to semantic properties (i.e., metalinguistic task) were compared against a condition drawing attention to low-level features of the words. In sentence comprehension, however, the effects of tasks on N400 may be different. For instance, in the present study, reading for comprehension instead of giving explicit judgments of correctness may not exert the same effect as the abovementioned ones.
A few ERP studies have examined the effects of task in sentence comprehension paradigms, and they have shown task effects impacting the P600 component elicited by semantic anomalies, such that it is attenuated or absent when no decisions of sentence acceptability are made. For instance, Kolk et al. (2003) showed a biphasic N400-P600 effect in Dutch sentences with selection restriction violations (e.g., *The tree that in the park played/stood...*) with an acceptability judgment task, but only N400 and absence of P600 when participants only read for comprehension. In a different study, Schacht, Sommer, Shmuilovich, Casado Matienz, and Martin-Loeches (2014) showed absence of P600s and only an anterior negativity to Spanish semantically-violated sentences (e.g., *El sentimiento peludo/profundo emociona; English: The hairy/deep feeling moves*) when using a word probe task, in contrast to a previously reported N400-P600 pattern on the same stimuli using acceptability judgements (Martin-Loeches, Nigbur, Casado, Hohlfeld, & Sommer, 2006). This pattern of results led the authors to conclude that the semantic processes associated with P600 effects are not automatic. These findings are in line with a functional interpretation of the P600 whereby later stages of processing are less automatic than earlier stages (Hahne & Friederici, 1999). Other interpretations of P600 effects have also been observed to be influenced by task demands. For instance, Kuperberg (2007) proposes that P600 effects triggered by sentence implausibility and selection restriction violations might reflect sentence reanalysis. This, can in turn be influenced by the requirement of a plausibility judgment task due to the potential executive demands increasing the processing conflict (Kuperberg, Choi, Cohn, Paczynski, & Jackendoff, 2010).
In a similar way, in our previous study, the task requiring establishing a judgment of plausibility may have promoted that participants used animacy information as a cue to determine plausibility. Previous studies have shown evidence that animacy is a preponderant feature that is used in incremental predictive processing (Paczynski & Kuperberg, 2012; Szewczyk & Schriefers, 2013), thus suggesting that participants may have likely used animacy information as the basis for their plausibility judgments. Task instructions have shown to exert differential effects on ERP components in previous studies (e.g., Nieuwland, 2014; Roehm et al., 2007; Sassenhagen et al., 2014) and they have suggested that processing strategies may vary depending on the task participants are asked to engage with, rather than solely by the stimulus of interest.

In sum, the studies above show that the effects exerted on the N400 by task demands in lexical tasks seem to be boosting of this component when the tasks draw attention to meaning. At the sentence level, the early component, N400 elicited in N400-P600 in semantic violations seems to be less affected by correctness tasks (i.e., early negativities remain with and without correctness task shown in the studies above) than the P600. This, however could indicate that the P600 effects observed in presence of a correctness task could be elicited by the task itself, as the P600s are absent when removing correctness tasks, and N400s remain.

However, determining the extent to which two different components are part of a common process, be it linguistic or decision-based elicited, might be difficult especially if the two components co-occur in time. This potential methodological caveat of ERP studies could lead to component overlap. This refers to instances in
which one of two opposite-polarity ERP components is large enough to mask the other one if they overlap in time (Hagoort, 2003; Chow & Phillips, 2013). Because of the temporal proximity and opposite polarity of the N400 and the P600 components, it is possible that reduced N400s may be due to the overlapping of a positive component (i.e., P600). This would be particularly the case when, for instance, detection of anomalies in sentence processing elicits multiple components simultaneously. In our previous study, the decision-based conflict arising from establishing a judgment of plausibility may have led to a positive component that overlapped with the N400. For instance, the least implausible condition elicited large P600s and smaller N400s.

If on the other hand, the P600 observed in our previous study were not decision-based effects, their functional interpretation does not seem to be accounted for easily by existing P600 accounts. One interpretation of P600s elicited by semantic anomalies has been linked to severe implausibility and impossibility (Kuperberg, 2007, Packzynski & Kuperberg, 2012). However, our previous results could not be due to impossibility, as we observed large P600 for animate-related nouns, a condition that is not impossible as it meets the selection restriction of the verb (cf. Packzynski & Kuperberg, 2012). The interpretation of a potential semantic P600 would therefore be better accounted for by processing difficulty. Recall that, in our previous study, participants found more difficult to decide that implausible, semantically related words that did not violate animacy restrictions of verbs were indeed implausible. This was reflected in their lower response accuracy for this condition and response time measurements for this condition. In other words, the
least implausible condition elicits large P600 precisely because is the most difficult
to judge as implausible. While its critical word matches animacy constrains, other
sources of information such as world-knowledge information should be accessed to
establish its implausibility, thus the P600 might have been a reflection of this
processing difficulty arising from other factors such as the decision-based demands
of giving a plausibility judgment.

3.7.3 The present study

This study aims to shed light into the extent that task demands might impact
processing strategies and use of semantic information during native and non-native
sentence reading. To this purpose, we will observe patterns of N400 and P600 in
absence of an explicit plausibility task. This study also aims at investigating whether
any potential task effects may affect native and non-native processing differently and
whether the effects observed in Exp. 1 would generalize to a different task setting.
To do so, we will compare ERP patterns of native and non-native speakers when the
demands imposed by a metalinguistic task of judgements of plausibility are removed
and participants only perform a task to monitor comprehension. An answer to this
could be informative to the extent to which differences in native and non-native
patterns may be due to the demands imposed by the task, rather than qualitative
differences in processing as recently suggested (Kaan, 2014).

We address these questions using the same stimuli as in Chapter 3, Exp. 1. In
the present study, participants only had to read sentences and answer occasional
comprehension questions, rather than giving plausibility judgments. In light of the abovementioned literature, we made the following predictions basing the expected outcome on the findings observed in our previous study (Chapter 3, Exp. 1):

*N400 Hypotheses:*

If N400s elicited by semantic violations are independent from the nature of the task participants are required to do, absence of explicit metalinguistic plausibility judgment task should not impact the N400 component. Thus, the N400 effects that would be expected for implausible words compared to plausible control words, as well as of animacy and relatedness in native speakers should remain.

*P600 Hypotheses:*

If absence of active judgements of plausibility removes additional difficulties posed by decision-based mechanisms, we do not predict to observe a late positivity effect when such a requirement is removed. In particular, the post-N400 positivities we observed for animate-related and both inanimate conditions in our previous study, would be attenuated or absent when participants do not make explicit judgements of plausibility. Importantly, absence of a late positive for the animate-related condition would suggest evidence in favor of a functional distinction of P600s of decision-based demands rather than sentence implausibility. In addition, removing additional decision-based constrains, any differences between the groups of participants would indicate differences in processing information, rather than decision-based strategies.
3.8 Method

3.8.1 Participants

Forty-one right handed students who had normal or normal to corrected vision took part in this study. Participants did not take part in the study described in Chapter 3, Exp. 1. The final sample\(^9\) consisted of 17 native speakers of English (12 women) and the noun-native group were 17 Spanish-English participants (11 women). Table 19 shows participants demographic and language background information. As in Chapter 3, Exp. 1, participants rated themselves as highly proficient on 5-point scales from basic to proficient for expression, comprehension, reading, and writing.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean age</th>
<th>Mean self-rated proficiency (with SD in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Expression</td>
</tr>
<tr>
<td>Natives</td>
<td>21.9</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(2.7)</td>
<td>(0)</td>
</tr>
<tr>
<td>Non-natives</td>
<td>25.6</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>(5.0)</td>
<td>(.7)</td>
</tr>
</tbody>
</table>

3.8.2 Materials and Procedure

The sentence stimuli and experimental procedures were identical to those in Chapter 3, Exp. 1, with the important exception of the task instruction. Instead of evaluating sentence plausibility, participants answered 80 yes/no comprehension questions. These questions were only added to ensure attention throughout the

\(^9\) This final sample was selected after removing participants who had too many artifacts (see results section, for details).
experiment, and probed knowledge about the sentences that was independent of sentence plausibility (e.g., On the lake, the boat race was won by the (1) rower, (2) sunbather, (3) sheriff, (4) paddle, (5) revolver…. Question: Was the race at the lake?) Of these questions, 50 were for experimental items and 30 for fillers, with an even distribution of yes/no correct answer. Each trial began immediately after participants pressed any key on the keypad upon seeing the fixation point at beginning of each sentence.

3.8.3 Electroencephalogram (EEG) recording and data processing

The EEG recording parameters and data processing procedures were identical to those in Chapter 3, Exp. 1. Based on the cut-off of 16 (52%) artifact-free CW epochs per condition, we excluded data from 6 participants due to excessive artifacts (3 natives and 3 non-natives), and data from 1 native-speaker due to incomplete data. For the remaining 34 participants, averaged ERPs were computed over artifact-free trials for CWs per condition. The average number of trials per condition on all participants in the final sample were as follows: Control: $M = 24, SD = 4.0$; Animate-Related: $M = 24, SD = 4.1$; Animate-Unrelated: $M = 24, SD = 4.2$, Inanimate-Related: $M = 24, SD = 4.4$; and Inanimate-Unrelated: $M = 25, SD = 3.6$. 
3.8.4 ERP Statistical analysis

Electrode-clustering and statistical analysis was identical to those reported in Chapter 3, Exp. 1. Analyses were performed in 3 time windows: 300-500 ms, 500-700 ms and 700-900 ms relative to onset of the critical word. Additional analyses at the 300-500 ms relative to onset of the sentence-final word are reported in Appendix D. In addition to the medial analyses reported in Chapter 3, Exp. 1 (LMFC/RMFC, LMCP/RMCP), we here also report of the lateral column ROIs (LAF/RAF, LLFC/RLFC, LLCP/RLCP, LPO/RPO) (See Figure 2). As in the previous experiment, the first section compares each violation condition directly to the control condition, through pairwise comparisons between each violation condition and the control condition using mixed Analyses of Variance (ANOVA) with sentence type as a 2-level factor (Sentence Type: control condition, violation condition) and the factors 2(Hemisphere: left, right) by 2(Anteriority: Frontal-Central, Central-Parietal) to test for scalp distribution effects at the medial column. The lateral column included the same factors as the medial column, but the anteriority levels were 4(Anterior-Frontal, Frontal-Central, Central-Parietal and Parieto-occipital).

The second section tests the effects of animacy and relatedness in the four violation conditions, according to a 2(Animacy: animate, inanimate) by 2(Relatedness: related, unrelated) design, using the same distribution factors as used in the first section. All analyses also included a between-subjects factor (Group: native, non-native). Where appropriate, Greenhouse–Geisser corrected $p$-values were used and original degrees of freedom are reported here. Only statistical results with $p < .1$ are reported. Interactions were followed up using simple effects analyses. We
resolved interactions only when the involved factors were not part of higher-order significant interactions.

3.9 Results

3.9.1 Behavioural results

Accuracy of the responses to the comprehension questions per group is shown in Table 2. Native speakers were marginally more accurate than non-natives on comprehension questions following the experimental items ($t = 1.8, p = .088$) and following the filler items ($t = 1.9, p = .061$).

<table>
<thead>
<tr>
<th></th>
<th>Natives</th>
<th>Non-natives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Items</td>
<td>96 (.0)</td>
<td>91 (.1)</td>
</tr>
<tr>
<td>Fillers</td>
<td>95 (.1)</td>
<td>90 (.1)</td>
</tr>
</tbody>
</table>

Note. Mean percentages of condition-congruent responses per groups and SD in parentheses.

3.9.2 ERP results

Visual inspection of the data indicates that the control condition elicited smaller N400s in the 300-500 ms time window than implausible conditions (see Figures 5-6). These N400 effects were widely distributed and visible at most channels. For most conditions, these N400 effects even extended into the later 700-900 ms analysis window, therefore we will assess N400 effects at the 300-500 ms time window, and extended-N400s at two later windows: 500-700 and 700-900 ms.
3.9.2.1 The 300 – 500 ms. time window

3.9.2.1.1 Pairwise (control vs. violation type) analysis

The control condition elicited smaller N400s than all the violation conditions at the medial column, and smaller N400s than almost all conditions at the lateral column (Table 21). The two groups showed similar effects for the majority of the pairwise comparisons, except for inanimate-related words, for which we found an interaction between sentence type, hemisphere and group at the medial and lateral columns (Table 21). Follow up analyses of this interaction indicated that for the native group, control words elicited smaller N400s than inanimate-related words at both columns ($F$s > 9.7, $p$s < .006), and sentence by hemisphere interactions ($F$s > 8.3, $p$s = .011) reflected robust N400 effects of this violation type over the right hemisphere at the lateral column (Right lateral: $F_{1,16} = 21.9, p < .001$; Left lateral: $F_{1,16} = 2.2, p = .154$) and at both hemispheres at the medial column (Right medial: $F_{1,16} = 16.4, p = .001$, Left medial: Left: $F_{1,16} = 5.6, p = .031$) (see Fig. 1). For non-native speakers, control words elicited smaller N400s than inanimate-related words at the lateral and medial columns ($F$s > 12.7, $p$s < .003), without sentence by hemisphere interactions.
Table 21. Pairwise ANOVAs contrasting each type of violation with the control condition at different time windows, across all participants showing group effects and interactions

<table>
<thead>
<tr>
<th></th>
<th>300-500 ms.</th>
<th>500-700 ms.</th>
<th>700-900 ms.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sent</td>
<td>Group</td>
<td>Sent x Group</td>
</tr>
<tr>
<td>A. Animate-Related</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>6.7^</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Lateral</td>
<td>2.9^</td>
<td>0.8</td>
<td>0.0</td>
</tr>
<tr>
<td>B. Animate-Unrelated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>11.5**</td>
<td>0.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Lateral</td>
<td>7.3^</td>
<td>0.0</td>
<td>2.7</td>
</tr>
<tr>
<td>C. Inanimate-Related</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>28.8***</td>
<td>2.2</td>
<td>5.2^</td>
</tr>
<tr>
<td>Lateral</td>
<td>21.9***</td>
<td>0.9</td>
<td>4.7^</td>
</tr>
<tr>
<td>D. Inanimate-Unrelated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>40.6***</td>
<td>1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Lateral</td>
<td>30.8***</td>
<td>0.6</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Notes. F values reported on this table. DF [1,32], DF for factors involving AP for the lateral column [3,96]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution

^p ≤ .1
^p ≤ .05
* p ≤ .01
*** p ≤ .001
ERPs elicited by critical words (CWs)

Sentence Type:
The prescription for the mental disease was written by the...

- *psychiatrist*
- *schizophrenic*
- *guard*
- *pill*
- *fence*

Native speakers

![Graph and ERP waveforms with labels: Animate-Related, Animate-Unrelated, Inanimate-Related, Inanimate-Unrelated.](image)

Figure 5. ERPs elicited by critical words in native speakers.
Figure 6. ERPs elicited by critical words in non-native speakers
3.9.2.1.2 Animacy by relatedness interaction analysis

Differences between native and non-native speakers were observed in a 4-way animacy by relatedness by hemisphere by group interaction at the lateral column (Table 22). In the native speaker group, follow up analyses showed smaller N400s for animate than inanimate nouns ($F_{1,16} = 10.0, p = .006$), and a further 3-way animacy by relatedness by hemisphere interaction ($F_{1,16} = 6.5, p = .021$), which was followed up by hemisphere. This yielded further effects of animacy over the right hemisphere ($F_{1,16} = 15.5, p = .001$) and marginally over the left hemisphere ($F_{1,16} = 4.3, p = .054$) but no effects of relatedness or animacy by relatedness interactions on either hemisphere were found. In the non-native group, animate nouns elicited marginally smaller N400s than inanimate nouns ($F_{1,16} = 3.7, p = .072$), but no further effects of relatedness or interactions were found.

Table 22. 2 x 2 ANOVAs showing group effects and interactions.

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>Ani x Group</th>
<th>Rela x Group</th>
<th>Rela x AP x Group</th>
<th>Ani x Rela x Hem x Group</th>
<th>Ani x Hem x AP x Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300-500 ms.</td>
<td>0.4</td>
<td>1.5</td>
<td>1.7</td>
<td>0.3</td>
<td>0.6</td>
<td>2.8</td>
</tr>
<tr>
<td>500-700 ms.</td>
<td>1.2</td>
<td>1.8</td>
<td>1.2</td>
<td>0.9</td>
<td>0.4</td>
<td>3.2^</td>
</tr>
<tr>
<td>700-900 ms.</td>
<td>0.7</td>
<td>1.5</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
<td>4.7^</td>
</tr>
<tr>
<td><strong>Lateral</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300-500 ms.</td>
<td>0.2</td>
<td>1.0</td>
<td>0.9</td>
<td>2.0</td>
<td>4.3^</td>
<td>2.5^</td>
</tr>
<tr>
<td>500-700 ms.</td>
<td>1.4</td>
<td>1.5</td>
<td>0.6</td>
<td>3.1^</td>
<td>5.7^</td>
<td>1.6</td>
</tr>
<tr>
<td>700-900 ms.</td>
<td>0.6</td>
<td>1.0</td>
<td>0.3</td>
<td>3.6^</td>
<td>7.8^</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Notes. F values reported on this table. DF [1,32], DF for factors involving AP lateral column [3,96]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution. Ani: Animacy. Rela: Relatedness. ^$p \leq .1$

* $p \leq .05$

** $p \leq .01$

*** $p \leq .001$
With the groups together, animate nouns elicited smaller N400s than inanimates at the medial and lateral columns (Table 23). A 4-way interaction between animacy, relatedness, hemisphere and anteriority at the lateral column was followed up step-wise using animacy by relatedness analyses at each lateral quadrant. These analyses only confirmed reduced N400s for animates compared to inanimates at all right lateral ROIs (RAF, RLFC, RLCP, RPO: \( F_s > 10.5, p < .003 \)) and at the left LAF and LPO ROIs (\( F_s > 4.3, p < .046 \)). In addition, related words elicited smaller N400s than unrelated words at the RPO ROI only (\( F_{1,33} = 4.4, p = .045 \), all other lateral ROIs: \( F_s < 3.5, p > .070 \)). We did not find further animacy by relatedness interactions at any lateral ROI (\( F_s < 2.9, p > .096 \)).

### Table 23. 2 x 2 ANOVAs at the medial and lateral columns.

<table>
<thead>
<tr>
<th></th>
<th>Main effect</th>
<th>Main effect x</th>
<th>Main effect x x</th>
<th>Main effect x x x</th>
<th>Main effect x x x x</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ani</td>
<td>Rela</td>
<td>Ani</td>
<td>Rela</td>
<td>Ani x Rela</td>
</tr>
<tr>
<td>Medial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300-500 ms.</td>
<td>10.0**</td>
<td>2.8</td>
<td>0.9</td>
<td>0.5</td>
<td>3.9^</td>
</tr>
<tr>
<td>500-700 ms.</td>
<td>5.3*</td>
<td>2.2</td>
<td>0.0</td>
<td>1.4</td>
<td>2.0</td>
</tr>
<tr>
<td>700-900 ms.</td>
<td>2.7</td>
<td>0.9</td>
<td>0.0</td>
<td>0.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Lateral</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300-500 ms.</td>
<td>13.2**</td>
<td>2.5</td>
<td>0.4</td>
<td>4.9^</td>
<td>4.3^</td>
</tr>
<tr>
<td>500-700 ms.</td>
<td>7.4**</td>
<td>2.4</td>
<td>0.1</td>
<td>7.1^</td>
<td>0.1</td>
</tr>
<tr>
<td>700-900 ms.</td>
<td>2.1</td>
<td>1.2</td>
<td>0.0</td>
<td>6.0^</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Notes. \( F \) values reported on this table. DF [1,32], DF for factors involving AP for lateral column [3,96], Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution. Ani: Animacy. Rela: Relatedness.

\(^* p \leq .1 \)

\(^{**} p \leq .05 \)

\(^*** p \leq .01 \)

\(^{***} p \leq .001 \)
3.9.2.2 Summary of the 300-500 ms. results

Results at this time window showed that natives and non-natives exhibited significantly smaller N400s to the control condition compared to the animate-related, animate-unrelated, inanimate-related and inanimate-unrelated conditions.

In the animacy by relatedness analyses, animate nouns elicited smaller N400s than inanimate nouns, especially at the right hemisphere in native speakers, but no effects of relatedness or animacy by relatedness were obtained. In non-native speakers, the effects of animacy were only marginal, and no robust effects of relatedness or interactions were found.

3.9.2.3 The 500 – 700 ms. time window

3.9.2.3.1 Pairwise (control vs. violation type) analysis

Control words elicited significantly smaller extended-N400s than the animate-unrelated, inanimate-related and inanimate-unrelated conditions at the medial column, while at the lateral column, extended-N400s for control words were smaller than both inanimate conditions (Table 21). Group differences were found only at the lateral column in a 3-way sentence by hemisphere by group interaction for animate-unrelated words, and a 3-way sentence by anteriority by group interaction for inanimate-unrelated words that we followed up by group. The animate-unrelated words did not yield further sentence effects or interactions for native speakers ($F$s < 1.8, $p$s > .194). For this violation type, control words elicited smaller extended-N400s in the non-native group ($F_{1,16} = 5.1, p = .039$) and a
sentence by hemisphere interaction but it was marginal \((F_{1,16} = 3.4, p = .082)\). For inanimate-unrelated words, follow-up analyses in native speakers showed marginally smaller extended-N400s for control words than this violation type \((F_{1,16} = 3.5, p = .079)\) without further sentence by anteriority interaction. The non-native group showed smaller extended-N400s for control words than inanimate-unrelated words \((F_{1,16} = 9.3, p = .008)\) and a sentence by anteriority interaction \((F_{3,48} = 4.0, p = .031)\), indicating that the effects were distributed at the LFC, LCP and PO ROIs \((F_s > 5.8, ps < .028; AF\ ROI: F <1)\).

3.9.2.3.2 Animacy by relatedness interaction analysis

Animacy by relatedness interaction analysis shows that differences between the groups arose in a 4-way animacy by relatedness by hemisphere by group interaction at the lateral column (Table 22). In the follow up analyses, for native speakers in addition to smaller extended-N400s for animate than inanimate nouns \((F_{1,16} = 7.3, p = .016)\), a 3-way animacy by relatedness by hemisphere interaction \((F_{1,16} = 5.7, p = .029)\) was found. Follow up on each hemisphere revealed smaller extended-N400s for animate than inanimate nouns at the right hemisphere \((F_{1,16} = 13.1, p = .002)\), but not at the left hemisphere \((F_{1,16} = 2.9, p = .108)\) without further effects of relatedness or interaction between animacy by relatedness. The non-native group only showed a marginal animacy by hemisphere interaction \((F_{1,16} = 3.5, p = .081)\).
With the groups together, animate nouns elicited significantly smaller extended-N400s than inanimate nouns at both the medial and the lateral columns (Table 23). A 4-way animacy by relatedness by hemisphere by anteriority interaction at the lateral column was followed up step-wise using animacy by relatedness analyses on each lateral quadrant. These analyses showed that animate nouns elicited smaller extended-N400s than inanimate nouns at all right-hemisphere lateral quadrants ($F$s $> 6.4$, $p$s $< .017$). In addition, related words elicited smaller extended-N400s than unrelated words at the LLFC quadrant only ($F_{1,33} = 6.2$, $p = .018$). No other main effects or interactions were observed at any lateral quadrant.

3.9.2.4 Summary of the 500-700 ms. results

Both groups showed similar smaller extended-N400s for control words than inanimate-related words, as revealed by lack of by group interaction. Group differences were observed in the two unrelated conditions. Native speakers did not show effects of animate-unrelated words and only marginal effects for inanimate-unrelated words. The non-native group, however, showed statistically significant smaller extended-N400s for control words than both animate-unrelated and inanimate-unrelated words, with a mid-posterior distribution for the latter.

In the animacy by relatedness interaction analyses, native speakers showed smaller extended N400s for animate than inanimate words, with a right-hemisphere distribution mainly, while non-native speakers did not show robust extended-N400
effects of animacy. None of the groups showed effects of relatedness or animacy by relatedness interactions.

### 3.9.2.5 The 700-900 ms. time window

#### 3.9.2.5.1 Pairwise (control vs. violation type) analysis

The related conditions did not elicit robust N400s. Differences between the groups arose in the two unrelated conditions in 3-way sentence by anteriority by group interactions at the lateral column (Table 21). However, follow up analyses did not show further sentence effects or interactions in the native group for either animate-unrelated or inanimate-unrelated words. \( F_s < 1.8, p_s > .178 \). For animate-unrelated words, non-native speakers showed a 2-way sentence by anteriority interaction \( F_{3,48} = 5.6, p = .009 \) that did not yield any further effects \( F_s < 2.4, p_s > .144 \). This group did not show effects or interaction for inanimate-unrelated nouns \( F_s < 2.2, p_s > .123 \).

#### 3.9.2.5.2 Animacy by relatedness interaction analysis

Differences between the groups arose in interactions between animacy and relatedness and their topographic distribution. At the medial column, we found a 4-way animacy by hemisphere by anteriority by group interaction (Table 22). Follow up analyses on each group showed that for native speakers, animate nouns elicited marginally smaller extended-N400s than inanimate nouns \( F_{1,16} = 4.0, p = .064 \) but
no effects or relatedness or interactions were found. The non-native group only showed an animacy by anteriority interaction \( (F_{1,16} = 4.9, p = .042) \) that did not yield any further effects of animacy at anterior or posterior medial ROIs \( (Fs < 1) \). In addition, we found a 4-way animacy by relatedness by hemisphere by group interaction also at the medial column (Table 22). Follow-up analyses showed a 3-way animacy by relatedness by hemisphere interaction for native speakers \( (F_{1,16} = 5.6, p = .031) \), which was followed up stepwise using animacy by relatedness analyses on each hemisphere. This showed smaller extended-N400s for animate than inanimate nouns at the right hemisphere only \( (F_{1,16} = 6.4, p = .022) \) without further effects of animacy, relatedness or interactions. The non-native group did not show any effects or interactions \( (Fs < 2.7, ps > .120) \). Finally, an interaction between relatedness, anteriority and group was observed at the lateral column (Table 22). For native speakers this showed an additional relatedness by anteriority interaction \( (F_{3,48} = 5.0, p = .015) \) such that related words elicited smaller extended-N400s at the frontal AF ROI \( (F_{1,16} = 5.5, p = .032) \), marginally so at the LFC ROI \( (F_{1,16} = 3.4, p = .069) \) but not at posterior lateral ROIs \( (Fs < 1) \). For non-native speakers, no further effects or interaction were observed \( (Fs < 1) \).

With the groups together, a 4-way animacy by relatedness by hemisphere by anteriority interaction at the lateral column (Table 23) was followed up using animacy by relatedness analyses at each quadrant. These follow up analyses showed smaller extended-N400s for animates than inanimates at the right frontal ROIs (RAF: \( F_{1,33} = 4.2, p = .049 \), RLFC: \( F_{1,33} = 4.2, p = .049 \)) and marginally so at the RLCP ROI \( (F_{1,33} = 3.2, p = .082) \). In addition, extended-N400s for related words were
smaller than unrelated words at the LLFC ROI \((F_{1,33} = 4.9, p = .034)\), and marginally at the RLFC ROI \((F_{1,33} = 3.2, p = .084)\). No other effects or animacy by relatedness were found.

### 3.9.2.6 Summary of the 700-900 ms. results

In the pairwise comparisons, no robust sentence effects were observed. The interaction analyses showed that for the native speaker group, animates elicited reliable smaller extended-N400s on the right hemisphere and related words smaller extended-N400s at anterior channels, and smaller extended-N400s for related than unrelated words at a left-frontal ROI. No interaction between animacy and relatedness was observed in this group. The non-native groups did not show robust effects of animacy, relatedness or interaction between the two.

### 3.10 Discussion of Experiment 2

The present study aimed to examine use of semantic information in native and non-native processing when participants are not performing a meta-linguistic task of sentence plausibility. To this purpose, we used ERPs to examine the influence of animacy and semantic relatedness in native and non-native speakers of English while participants read English-passive sentences for comprehension. The stimuli were identical to those used in Chapter 3, Exp. 1, which were composed of control sentences with plausible agents (e.g., *The prescription for the mental disease was*
written by the psychiatrist), or implausible agents that were either animate or inanimate and either semantically related or unrelated to the sentence *(schizophrenic/guard/pill/fence)*.

Compared to control words, our results showed N400 effects of plausibility for the four-violation types in both groups. At the 500-700 ms time window, both groups showed extended-N400s for the two animate conditions, and only non-natives showed extended-N400s for the two unrelated conditions. In addition, native speakers showed smaller negative ERPs for animate nouns than for inanimate nouns in the first two time windows, while these effects were not robust in non-natives. No effects of semantic relatedness or interactions between animacy and relatedness were found on either group in the first two time windows. At the later time window, only native speakers exhibited marginal extended-N400 effects of animacy and extended-N400s for related than unrelated words at one ROI.

These results partially support our N400 hypothesis. This hypothesis predicted that when decision-based demands are not required, N400 effects elicited by implausible relative to plausible sentences, and by inanimates compared to animates, and related compared to unrelated would be attenuated or absent. While we observed N400s effects of plausibility in native and non-native speakers, only native speakers showed facilitation of animate nouns compared to inanimate nouns. No effects of semantic relatedness were observed. These results suggest that animacy information seems to occur independently of decision-based judgments during incremental processing in that it does not depend on drawing attention to semantic features. Our results also suggest that semantic relatedness did not impact
incremental processing at early stages of comprehension in absence of explicit sentence evaluation. With regards to the non-native speaker group, while sensitive to general implausibility, the lack of strong effects of animacy or relatedness suggests that they did not use different sources of semantic information incrementally.

The abovementioned negative-going effects extended beyond the typical N400 time window, leading to a sustained negativity and absence of positive post-N400 effect. In relation to our previous study, in the previous experiment we observed P600 effects for animate-related words and both inanimate-conditions and this was similar for both native and non-native speakers. In addition, the P600s in Exp. 1 seemed to have inversely patterned with sentence plausibility, such that the least implausible condition (i.e., animate-related) elicited the largest P600 when participants gave explicit judgments of plausibility. The lack of post-N400 positive effects when participants did not perform explicit judgments of plausibility in the present study provides evidence that the P600 component previously observed most likely reflected a task-related decision mechanism.

In light of these results, we will now discuss differences in ERP patterns between native and non-native speakers in the present study. Then, we will provide a discussion on the present results and task effects in relation to the findings reported in Chapter 3, Exp. 1.
3.10.1 Semantic processing in native and non-native speakers

In this study, we have shown that while non-native speakers are sensitive to general implausibility like native speakers, they do not appear to use other sources of semantic information such as animacy in the same incremental fashion as native speakers. These findings cannot be accounted for by theories of second language processing suggesting that non-native speakers rely more on semantic and pragmatic cues when processing their second language (e.g., Clahsen & Felser, 2006), at least not with regards to processing of animacy information specifically. At a first glance, our results might not seem to be in line with behavioural evidence suggesting that non-native speakers make use of animacy information in a similar fashion as native speakers (e.g., Jackson & Roberts, 2010; Roberts & Felser, 2011), but, importantly, these studies have looked at syntactically ambiguous sentences. While it is possible that non-native speakers rely on semantic information for structural disambiguation similarly to native speakers, our study suggests that in unambiguous sentences non-native speakers have a reduced ability to use animacy information incrementally.

A model that could potentially account for these results is the Competition Model (MacWhinney & Bates, 1989; MacWhinney, 1987), which predicts semantic processing differences between native and non-native speakers when the native and non-native languages weigh the relevant semantic cues differently. In addition, it has been noted that cue patterns from the native language could impact second language processing (Liu, Bates, & MacWhinney, 1992; Li & MacWhinney, 2007). A proposed extension of the competition model by Kaan poses that native and non-native speakers might use the available cues differently to predict upcoming
information. Importantly, this extension of the model also poses that non-native processing does not differ qualitatively between native and non-native speakers, but that differences in predictive processing can be accounted for by the same factors that govern individual differences in native speakers (Kaan, 2014). As noted in the introduction, marking of animacy differs between Spanish and English, and participants in our study were native speakers of Spanish. A potential transfer effect from the first into the second language, might have led to a reduced ability of Spanish-English bilinguals to use animacy information fully incrementally in English. Future research could explore whether other types of semantic violations (in absence of syntactic violations), and with different languages, for instance between languages that share the same cue hierarchy, might lead to non-native use of animacy information incrementally (see Vaughan-Evans, et al., 2014). This would provide evidence for or against quantitative differences in use of semantic information between native and non-native speakers.

An interesting difference that was observed between the groups in the present study is that non-native speakers showed extended-N400 effects for animate and inanimate unrelated words, relative to control words in the later 500-700 ms time window, while for native speakers this difference was absent for the former and marginal for the latter, at the same time window. Critical words in the control condition were the most strongly related to the sentence context (indexed by its LSA-SSV value (.23), see Table 12), and perhaps the gap between the unrelated conditions, whose value was the lowest, compared to the control condition was large enough to elicit a type of semantic priming effect that was prolonged in the non-
native group. This shows that relatedness might facilitate incremental processing in non-natives, under certain circumstances, for instance when the difference in relatedness is strong enough to elicit an effect.

Taken alongside our previous study, non-native speakers were sensitive to sentence implausibility as reflected by their N400 effects compared to plausible sentences in both studies. In our previous study, non-native speakers showed reduced effects of animacy compared to natives, but the effects of relatedness did not differ between the groups (as revealed by lack of by group interactions). These results suggest that non-native semantic processing might be affected by other factors that impact predictive processing (see Kaan, 2014). Therefore, our study does not show evidence that non-native speakers fundamentally differ from native speakers in semantic processing, but, rather, that their processing strategies seem to be affected by factors that influence predictive processing.

3.10.2 Influence of decision-based task demands on sentence processing

Our study showed that in absence of explicit judgments of plausibility, native speakers showed effects of plausibility as well as effects of animacy. However, no N400s effects of relatedness were observed. In addition, non-native speakers, did not show robust N400 effects of animacy or relatedness. To assess the potential task effects on the present study, let us describe our previous results, in which participants made explicit judgments of plausibility (Chapter 3, Exp. 1). In that study, besides
plausibility effects in both groups, native speakers showed N400 effects of animacy and of relatedness. Relative to natives, non-native speakers showed reduced effects of animacy and their effects of relatedness did not differ from native speakers. As we can see, in absence of explicit plausibility judgments, N400 effects of animacy remained for the native speaker group but no effects of relatedness were present for either group. This could mean that the decision-based demands imposed by the task force participants to draw onto different sources of semantic information in order to give a judgement. For instance, in order to decide that The prescription for the mental disease was written by the schizophrenic is implausible, because the selection-restriction of the verb is met, one needs to consult other sources of information such as world-knowledge which may in turn activate semantic networks of related words, leading to facilitation by semantic relatedness as well. However, when participants are not required to make explicit evaluation of the sentence, a coarse-grained semantic violation such as The prescription for the mental disease was written by the pill would violate the potential expectancy generation for animacy but in absence of an explicit response of plausibility, it is possible that no activation of related concepts would then occur. In such case, this would mean that the N400 effects elicited by animacy selection restrictions are insensitive to decision-based demands, and perhaps they occur through more automatic predictive mechanisms.

Task-decision demands seemed to have impacted both natives and no-natives. The absence of effects of both animacy and relatedness in non-natives in the present study was not surprising, since this group had already shown weaker effects than those of natives in our previous study. This is in line with Williams’ (2006) study in
which non-native speakers’ effects of plausibility during incremental semantic processing were delayed when participants performed a memory task compared to when they performed online-plausibility judgments. In his study, these effects remained only in native speakers with the higher memory performance. Therefore, when there is no ‘forced’ response, predictive mechanisms of both native and non-native speakers might be reduced, and this reduction would be more evident in non-natives since their “baseline” was already lower than natives when they had to give a plausibility judgment in our previous study.

The absence of N400 effects of semantic relatedness could be linked to studies of lexical priming, which have reported priming effects, indexed by N400s, when participants perform a metalinguistic task (e.g., lexical or semantic categorization), but these effects are absent when participant’s attention is drawn to lower features of the words (e.g., Chwilla et al., 1995; Mari-Beffa et al., 2005). Although our study employed sentences, rather than word-pairs (see Martin et al., 2009), and the contrastive condition was reading for comprehension, it could be that the relatedness effects observed in presence of the task were caused by a type of lexical priming. As such, when participants do not perform a metalinguistic task, facilitated retrieval does not occur.

With regards to the later component, in the present study, we did not find a post-N400 positivity, but, rather, N400s were extended into late time windows, thus yielding a sustained negativity. Compared to our previous study, in which we found post-N400 positivities for animate-related and both inanimate conditions, these results may suggest that the P600 previously observed could have been elicited by
the task itself. More evidence of this is that the P600 found in our previous study did not pattern with the impossibility of the sentences (cf. P & K, 2012).

Our results are in line with previous studies showing that ERP patterns can be affected by task demands and specifically, absence of P600s effects in semantic violations in absence of a decision-based correctness task (Schacht et al., 2014; Kolk et al., 2003). Importantly, it seems that the absence of P600 effects in those studies and in the present one seems to occur when a biphasic N400-P600 was otherwise elicited with a decision-based task. For instance, in the study by Kolk et al. (2003), as we had seen, selection restriction violations (*The tree that in the park played/stood*) elicited a biphasic N400-P600 with judgment task, and only an N400 when reading for comprehension, whereas in a different condition semantic anomalies of role reversed sentences (*The poachers who hunted the fox...*/The fox that hunted the poachers...*) elicited a P600 with and without explicit sentence evaluation task (Kolk et al., 2003). This indicates that some types of semantic violations that elicit a P600 do not elicit N400 (i.e., “semantic P600”) (e.g., Kim & Osterhout, 2005; Kuperberg, Sitnikova, Caplan, & Holcomb, 2003; for a proposal on the functional distinction of monophasic vs. biphasic effects see Bornkessel-Schlesewsky & Schlesewsky, 2008). The present study sheds light into the interpretation of the post-N400 positivity observed in our previous study, indicating that the previously observed P600 was most likely a result of decision-based task demands, rather than reflecting a semantic P600. This provides more support for the claim that the observed P600 in our previous study was related to decision-based responses. Both of our studies suggest that the large P600 (and reduced N400) elicited by the least implausible condition
(animate-related) in our previous study could be explained by means of component overlap.

In sum, the present study has shown that the task participants are required to do during sentence processing impacts processing strategies, and in turn the elicited components. Finally, there seems to be a differential effect of task between native and non-natives, with the largest attenuations of effects observed in non-native speakers when they are not performing a metalinguistic task in their second language.
Chapter 4: The cognitive effects of bilingualism

4.1 Summary

We present a study examining cognitive functions in late non-balanced bilinguals with different levels of second language proficiency. We examined in two experiments a total of 66 mono-, bi- and multilingual university students. We assessed different aspects of attention (sustained, selective and attentional switching), verbal fluency and a picture-word association task. Bilinguals and multilinguals exhibited a trend of slower reaction times than monolinguals on the picture-word association task. In contrast, bilinguals and multilinguals outperformed monolinguals on a test of selective attention. In addition, we observed a non-significant trend towards better performance for bi- and multilinguals compared to monolinguals in the attentional switching task. No differences between the groups were found in letter fluency. We conclude that overall, non-balanced bilinguals experience similar cognitive effects as their early-acquisition, balanced counterparts. However, different cognitive effects may appear at different stages of adult second language acquisition.

* This study grew from a 4th year project at the University of Edinburgh by Holly West. In addition, data from this study constituted part of the publication: Vega-Mendoza, M., West, H., Sorace, A., & Bak, T. H. (2015). The impact of late, non-balanced bilingualism on cognitive performance. Cognition, 137, 40-46.
4.2 Introduction

4.2.1 The Cognitive Effects of Bilingualism

Substantial evidence suggests that bilingualism can influence cognitive functions (Costa & Sebastián-Gallés, 2014). In the linguistic domain, bilinguals show a disadvantage compared to monolinguals in reaction time and accuracy in lexical access tasks such as picture naming (Gollan, Montoya, Fennema-Notestine, & Morris, 2005; Gollan, Fennema-Notestine, Montoya, & Jernigan, 2007; Ivanova & Costa, 2008) attributed to either parallel activation of words from different languages and the necessity to inhibit competing non-target items (Green, 1998) or to a reduced-frequency of use of each of the bilingual’s language (Gollan, Montoya, Cera, & Sandoval, 2008; Gollan et al., 2011). The disadvantage in lexical retrieval does not seem to be exclusive to early bilinguals who have had a life-time of exposure to bilingualism. Even a short immersion in a second language (L2) environment can have a detrimental effect on lexical access in the native tongue (Linck, Kroll, & Sunderman 2009).

In contrast, a bilingual advantage has been frequently reported for tests of executive functions, such as attentional control (e.g., Bialystok & Majumder, 1998; Bialystok 1999), inhibition (Bialystok & Martin, 2004) and switching (cf. Hernández, Martin, Barceló, & Costa, 2013). These differences continue across the lifespan (Bialystok, Craik, Klein, Viswanathan, & 2004; Bak, Nissan, Allerhand, & Deary, 2014) and might contribute to a later onset of dementia in bilinguals (Alladi et al., 2013; Bialystok, Craik, & Freedman, 2007; Bak & Alladi, 2014). It has been hypothesised that these effects come from higher demands posed on executive
control through inhibition and switching between languages associated with bilingualism (Green, 1998).

In some tasks, such as verbal fluency (VF), bilingual performance has shown both advantages and costs. With respect to category fluency, some studies have reported that bilinguals produce significantly fewer words than monolinguals (Rosselli et al., 2000; Gollan, Montoya, & Werner, 2002; Portocarrero, Burright, & Donovick, 2007), while other studies reported that bilinguals outperformed monolinguals in the *animals* category (Obler, Albert, & Lozowick, 1986). Other authors have also reported no influence of bilingualism on category fluency (Bialystok, Craik, & Luk, 2008). A similar pattern of conflicting results exists in letter fluency (Roselli et al., 2000; Bialystok et al., 2008). Within languages, it has been reported that monolinguals produce more words in category fluency than in letter fluency (e.g., Bialystok et al., 2008) whereas bilinguals might show the opposite pattern in both languages (Snodgrass & Tsivkin, 1995).

While current debates often focus on the specific nature of the tasks employed (e.g., Bak, Vega-Mendoza, & Sorace, 2014; Costa et al., 2009; Hernandez et al., 2013), less attention has been paid to the characteristics of the bilingual speakers and their bilingualism. Previous research has shown the importance of taking into account individual variability to rule out potential confounds in between-groups comparisons (Wu & Thierry, 2013). In addition, most research has been devoted to “classical” bilingualism: a simultaneous or early consecutive childhood acquisition and balanced, native-like command of two or more languages. It remains unclear to what extent bilingualism effects can also be detected in individuals who
acquire their second language in late childhood or adulthood without reaching native-like proficiency. Studies of late-acquisition bilingualism produced so far conflicting results. Luk et al. (2011) found a bilingual advantage only in early-acquisition bilinguals, while other studies found it in early as well as late-acquisition bilinguals (Bak et al., 2014a; Bak et al., 2014b; Tao et al., 2011; Pelham & Abrams, 2014).

Also regarding the importance of the number of languages involved, previous studies came to conflicting results. Some found a beneficial effect only in multi- but not in bilinguals (Chertkow et al., 2010) or reported a correlation between the number of languages and cognitive performance (Kavé, Eyal, Shorek, Cohen-Mansfield, 2008). Others found only a weak effect of multilingualism (Bak et al., 2014) or no effect at all (Alladi et al., 2014).

Against this background, our study set out to examine non-balanced bilinguals who acquired their second language in late childhood/early adulthood. For cognitive assessment, we selected three types of tests, in which we predict differential effects of bilingualism:

*The Picture Name Verification Task (PNVT)* measures accuracy and speed with which a picture-name combination is judged to be correct or not. On the basis of previous literature (e.g., Gollan et al., 2005; Gollan, 2007; Ivanova & Costa, 2008), we expect bilinguals (and particularly multilinguals) to have longer reaction times than monolinguals.
The Test of Everyday Attention (TEA; Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994), measures sustained attention (Elevator Task), divided attention (Elevator Task with Distraction) and attentional switching (Elevator Task with Switching). Based on previous literature (e.g., Bak et al., 2014; Bialystok et al., 2004) we expect a better performance from bilingual/multilingual subjects. Given the conflicting evidence so far (see Freedman et al., 2014 for a summary) possible differences between bi- and multilinguals remain to be determined.

Verbal fluency: Given the conflicting results in the literature, differences in verbal fluency between the groups remain to be determined. Between the languages of bi-and multi-linguals, however, we expect a larger production in English than in Spanish, given the non-balanced bilingualism.

4.3 Method

4.3.1 Participants

Sixty-six University of Edinburgh students (mostly in their 4th year) took part in this experiment. All were native English speakers. Demographic information is presented in Table 24.
The Monolingual participants (N=18) did not speak any language other than English beyond basic level. The Bilingual participants (N=16) had Spanish as their second language (L2) and no knowledge of other languages. The Multilingual participants (N=17) knew at least one more language in addition to English and Spanish, but their knowledge of Spanish, as indicated in the language questionnaire (Appendix F), was better/comparable to that of other foreign language(s). Among the additional languages known by multilinguals, ten participants reported Romance languages only, while seven participants reported non-Romance languages as well (e.g., German, Swedish, Arabic, Thai, Russian). Fourteen participants were excluded because Spanish was not their main L2, one because of incomplete data. Age and gender differences were not significant (chi-square and t-tests all \( ps > .05 \)) (Table 24).

4.3.2 Tasks

4.3.2.1 Picture Name Verification Task (PNVT)

The PNVT measures accuracy and speed with which a picture-name combination is judged to be correct or not and provides, therefore, an objective
measure of L2 proficiency. The stimuli were 42 pictures depicting clothing, furniture and body parts with corresponding written names in English and Spanish respectively. None of the words were cognates. There was no difference in the number of graphemes between English ($M = 5.36$) and Spanish ($M = 5.57$) words ($t(41) = -1.013, p > .05$). Colour pictures of the objects were displayed on a white background for 350 ms before the word appeared next to the image. Both picture and word remained on the screen until the participant responded. The presentation order was randomised. The task was produced and administered using E-prime 2.

### 4.3.2.2 Test of Everyday Attention (TEA)

The TEA (Robertson et al., 1994) is a well-established clinical assessment tool, recently applied to measure executive functions in bilinguals (Bak et al., 2014). We selected three subtests, examining different aspects of attention: Elevator Task (ET), Elevator Task with Distraction (ETD) and Elevator Task with Switching (ETS). ET assesses sustained attention: prompted by recording, participants count seven strings of tones, presented at irregular intervals. ETD measures selective attention asking participants to count low tones while ignoring high-pitch ones over ten trials. ETS requires switching: participants have to use high and low pitch tones as cues for the direction (upwards and downwards, respectively) in which to count ten strings of tones. All tasks were presented through loudspeakers.
4.3.2.3 Verbal Fluency (VF)

The VF tasks consisted of letter and category fluency. Participants were asked to produce as many words as possible within 60 seconds, beginning with the letter F, M and P (letter fluency) or belonging to the category of animals, foods and degree courses (category fluency) (Rosselli et al., 2000; Gollan et al., 2002; Gasquioine, Croyle, Cavazos-Gonzalez, & Sandoval, 2007; Roberts & LeDorze, 1997).

4.3.2.4 Language Questionnaire

Participants completed a language questionnaire (Appendix F), rating their command of each language in expression, comprehension, reading and writing on a 5-point scale (basic/weak/moderate/advanced/fluent). Total proficiency score was calculated by adding proficiency levels in all domains. The questionnaire was completed after all other tasks.

4.3.3 Statistical Analysis

Analyses of Variance (ANOVAs) and independent and related t-tests (as appropriate) were performed to compare mean differences between and within groups. Correlational analyses were conducted using Pearson’s correlation coefficients. Analyses of variables not meeting the assumption of normality were
conducted using non-parametric tests. All analyses were performed using SPPS for Windows v.19.

4.4 Results

4.4.1 PNVT

There were no significant differences in accuracy to English words between the three groups ($H(2) = .82, p = .664$). The bilingual and multilingual groups were significantly less accurate for Spanish than for English words (bilinguals: $z = -2.067, p = .039$; multilinguals: $z = -2.217, p = .027$), with no difference between bilinguals and multilinguals ($p = .380$) (Table 25).

<table>
<thead>
<tr>
<th>Table 25. Summary of mean group performance on the PNVT and TEA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monolinguals</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td><strong>Accuracy L1</strong></td>
</tr>
<tr>
<td><strong>RT L1</strong></td>
</tr>
<tr>
<td><strong>Accuracy L2</strong></td>
</tr>
<tr>
<td><strong>RT L2</strong></td>
</tr>
<tr>
<td><strong>ET</strong></td>
</tr>
<tr>
<td><strong>ETD</strong></td>
</tr>
<tr>
<td><strong>ETS</strong></td>
</tr>
</tbody>
</table>

*Notes:* Accuracy and performance in ET, ETD and ETS are expressed in percentages. SD given in parentheses. Reaction Time (RT) given in milliseconds. Significant differences ($p < .05$) are reported on this table as follows:

a: ≠ monolinguals, b: ≠ bilinguals, c: ≠ multilinguals
Prior to the RT analysis, RTs of more than 2 Standard Deviations (SDs) above or below the individual’s mean were excluded and RTs for inaccurate responses were also excluded. There was a significant effect of language group on RTs to English words ($H(2) = 12.15, p = .002$). Overall, the reaction times were fastest in the monolingual, slightly slower in the bilingual and slower still in the multilingual group. Pairwise comparisons with adjusted $p$-values showed that monolinguals were significantly slower than multilinguals ($p = .002$) with no differences between mono- and bilinguals ($p = .182$) or bilinguals and multilinguals ($p = .382$). However, a Jonckheere-Terpstra test showed a significant ascending trend in the Median RTs of the groups in this order: monolinguals, bilinguals and multilinguals ($J = 639.00, z = 3.56, p < .001, r = .499$) (see Figure 7).

**Figure 7.** (a) Linear trend (median RT in ms) and (b) RT distributions in PNVT in English
Both bilinguals (z = -3.46, p = .001) and multilinguals (z = -2.77, p = .006) were significantly slower to respond to Spanish than to English words, with no difference between bilinguals and multilinguals (p = .309).

### 4.4.1.1 PNVT in relation to L2 Proficiency

There was a significant positive correlation between self-rated proficiency in Spanish and accuracy to Spanish words in bilingual and multilingual groups, $r_s = .722$, $p$ (2-tailed) < .001.

### 4.4.2 TEA

Prior to analysis, raw scores of the TEA tasks were transformed into percentages. Ninety-four percent of participants performed at ceiling on ET. The few who made an error were monolinguals, but due to the small number of errors the difference failed to reach significance ($H(2) = 5.73$, $p = .057$). A significant group effect was found on ETD ($H(2) = 9.13$, $p = .010$). Pairwise adjusted $p$-values comparisons showed that both bilinguals and multilinguals scored higher than monolinguals ($p = .020$ and $p = .041$, respectively), with no difference between them ($p > .05$). On ETS, there was a trend towards a better performance in bi- and multilinguals, but it did not reach significance ($H(2) = 5.51$, $p = .064$).
4.4.3 Verbal Fluency

No significant differences were found between the three letters or the three categories across groups (all ps > .312) (Table 26). More words were produced in category than in letter fluency: monolinguals: $t(17) = 7.343, p < .001$; bilinguals: $t(15) = 5.486, p < .001$, and multilinguals: $t(16) = 9.037, p < .001$, with no differences between the groups in overall score of category or letter fluency ($ps > .291$).

For the bi- and multilingual groups the verbal fluency tasks in Spanish showed the same pattern as in English: more words were produced on category than on letter fluency by both bilinguals ($t(15) = 3.92, p = .001$), and multilinguals ($t(16) = 3.82, p = .001$). There was a significant difference between English and Spanish letter ($t(15) = 11.19, p < .001$) and category fluency ($t(15) = 9.34, p < .001$) for bilinguals, and also for multilinguals ($t(16) = 8.67, p < .001$ and $t(16) = 9.93, p < .001$, respectively), with greater productivity in English than in Spanish. There was no significant difference in performance on both Spanish fluency tasks between bilinguals and multilinguals ($ps > .429$).
### Table 26. Summary of mean group performance on VF

<table>
<thead>
<tr>
<th>Category</th>
<th>Monolinguals</th>
<th>Bilinguals</th>
<th>Multilinguals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>English</td>
<td>English</td>
<td>Spanish</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spanish</td>
<td>English</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>17.78</td>
<td>17.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.47)</td>
<td>(4.55)</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>16.39</td>
<td>17.44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.90)</td>
<td>(4.86)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>15.50</td>
<td>17.31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.20)</td>
<td>(4.30)</td>
</tr>
<tr>
<td></td>
<td>Letter Total</td>
<td>49.67</td>
<td>52.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(11.09)</td>
<td>(11.93)</td>
</tr>
<tr>
<td></td>
<td>Animal Total</td>
<td>72.72</td>
<td>69.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(12.20)</td>
<td>(15.63)</td>
</tr>
<tr>
<td></td>
<td>Food Total</td>
<td>25.72</td>
<td>23.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.22)</td>
<td>(6.70)</td>
</tr>
<tr>
<td></td>
<td>Degrees Total</td>
<td>21.44</td>
<td>19.44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.70)</td>
<td>(4.52)</td>
</tr>
<tr>
<td></td>
<td>Category Total</td>
<td>72.72</td>
<td>69.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(12.20)</td>
<td>(15.63)</td>
</tr>
</tbody>
</table>

**Notes:** For each verbal fluency task, the number of correct words per minute is reported. SD given in parentheses. Significant differences ($p < .05$) are reported on this table as follows: a: ≠ monolinguals, b: ≠ bilinguals, c: ≠ multilinguals.
4.5 Discussion

In this study, we assessed cognitive functioning, in particular executive function and verbal fluency in monolinguals and unbalanced bi- and multilinguals. Results from this study suggest that unbalanced bi/multilinguals performed better than monolinguals on one of the attentional tasks (ETD), showed a trend towards a better performance on another (ETS) and no differences on VF.

Our results suggest that late non-balanced bilinguals experience similar cognitive costs and benefits as their early-acquisition balanced counterparts. A bilingual advantage was observed on ETD, measuring selective attention and, therefore, inhibition of irrelevant stimuli: a task previously reported to be particularly sensitive to late-acquisition bilingualism (Bak et al., 2014). In addition, there was no additional benefit of multilingualism over bilingualism. If the reason for a bilingual advantage on this task lies in the constant necessity of suppressing the irrelevant language (e.g., Green, 1998), knowing two languages is likely to lead to a ceiling effect, with no further benefit of additional languages. The results on ETS showed a trend towards bilingual and multilingual better performance than monolinguals, which failed to reach statistical significance. ETS is a complex task requiring two different processes: inhibition and switching.

In VF, bi- and multilingual participants did not differ from monolinguals. This finding suggests that the monolingual participants in our study were comparable in their general cognitive capacity to the bilingual ones. In contrast to previous results (e.g., Roselli, et al., 2000), late bilingualism/multilingualism had no effect
(neither positive, nor negative) on VF tasks in the native language. Within the bilingual and multilingual groups, it was not surprising that both groups performed better in their L1, given their unbalanced bilingualism.

To overcome potential limitations, when designing our study we made a particular effort to minimise potential confounding variables by keeping the sample as homogenous as possible. All participants were students with the same native tongue (English); and the L2 was Spanish.

While in some current debates attempts have been made to reduce the effects of bilingualism to a simple difference on a single task (Paap & Greenberg, 2013), our study emphasises the complex and multidimensional nature of this phenomenon (Luk & Bialystok, 2013). We suggest that the potential effects of bilingualism on cognition can be positive (e.g., selective attention) as well as negative (e.g., increased speed of lexical access). Some may occur early in the acquisition of L2 or even at modest levels of proficiency. More research is needed to explore these differences in more detail. So far, it seems that the cognitive effects of learning L2 in adulthood are not radically different from those of learning one in childhood: a result of considerable interest and relevance to millions of adult L2 learners worldwide.
CHAPTER 5: Summary and Conclusions

5.1 Summary of results and further directions

The general aim of the present thesis was to provide a comprehensive approach to the study of bilingualism through the use of different methodologies. I addressed different theoretical questions concerning the lexico-syntactic and semantic stages of language processing. In addition, I assessed the cognitive effects of bilingualism.

As we pointed out in the introductory chapter of the present thesis, understanding the multidimensional and complex phenomenon of bilingualism requires the use of different methodologies. Moreover, a dialogue between different areas of study can help us tackle the various research questions that research on bilingualism has raised, allowing us to approach the complex phenomenon of bilingualism from different angles. In the present thesis, I have strived to use a variety of methodologies to further our understanding of non-native sentence processing, as well as the cognitive effects of bilingualism.
5.1.1 Chapter 2: Structural priming and lexically-syntactic restrictions of verbs

In Chapter 2, in a series of structural priming experiments, I investigated whether non-native speakers of English whose languages do not allow double object (DO) dative constructions are sensitive to fine-grained lexically-specific syntactic restrictions of non-alternating verbs in English. In particular, in Experiments 1 and 2, I examined whether participants would be primed to produce ungrammatical DO sentences with non-alternating verbs, after grammatical (alternating verbs) and ungrammatical (non-alternating verbs) primes with same verbs as the target (Experiment 1) and different verbs as the target (Experiment 2). Results of Experiment 1 showed that participants whose first languages do not allow DO-dative constructions, produced ungrammatical DO sentences in English with non-alternating verbs, but more so after exposure to ungrammatical-DOs with same non-alternating verbs, than after well-formed DOs with alternating verbs. In Experiment 2, participants produced ungrammatical DOs after different non-alternating verbs, although the priming effect in this experiment was numerically smaller than in Experiment 1, in which a verb boost effect (e.g., Pickering & Branigan, 1998) likely increased the magnitude of the priming effect. Thus, these results suggest firstly, that participants have partially acquired the restrictions for non-alternating verbs from alternating verbs, and their knowledge is not native-like (cf. results of native speakers in Ivanova et al., 2012). Secondly, participants seemed to have generalized their knowledge of restrictions across same-class verbs (e.g., return – donate), but to some extent. Participants in Experiments 1 and 2 were native speakers of languages
that lack the dative DO-construction. From a perspective of frequency-based theories of language acquisition, these results would indicate that knowledge of lexical restrictions of non-alternating verbs might be acquired on the basis of the difference in the frequency of occurrence of the correct (PO) and incorrect (DO) alternatives. Non-native speakers in this group have had less exposure to English, and thus less evidence for the relevant difference than native speakers.

In Experiments 1 and 2, due to the nature of their first language, non-native speakers’ knowledge of the restrictions could be attributed to their experience (or lack thereof) with their second language, English. Therefore, I then asked whether acquisition of the restrictions might be influenced by the first language. To this purpose, I carried out Experiments 1 and 2 in groups of native speakers of Germanic languages (Experiments 3 and 4), whose languages allow dative DO-constructions. Results of the two experiments, largely patterned those of native speakers of Romance languages, thus suggesting that most likely, L1 does not play a role in acquisition of these specific type restrictions, in line with a language specific account.

Studying how highly proficient speakers of a second language acquire fine-grained lexically-specific syntactic restrictions in their second language further our understanding of the factors that can influence mastery of these restrictions. This is of great relevance not only to psycholinguistic models of sentence processing, but also to second language teaching models. If acquisition of such restrictions occurs on the basis of frequency of exposure, future research could examine the relationship between mastery of restrictions and factors such as age of acquisition of the L2,
levels of proficiency and use of the second language. An increasing body of research on acquisition of restrictions by monolingual English speaking children has offered different paradigms which could be also be employed in studies with second language learners. Comparisons between learners and children could also be informative about the extent that implicit learning modulates acquisition of such restrictions, which could in turn, be implemented in second language teaching. Finally, systematic analyses at different levels of proficiency could help elucidate whether the L1 would impact acquisition of the restrictions, for languages that share this structure in English, to the same extent as the results we showed in highly proficient bilinguals.

5.1.2 Chapter 3: ERPs and semantic processing

Moving from the lexical-syntactic level of processing into semantic processing, in Chapter 3, Experiment 1, using ERPs I asked whether non-native speakers use semantic information in the same rapid, incremental way that has been typically reported for native speakers. Results of this experiment showed that both natives and non-natives gave similar off-line plausibility judgments and likewise, both groups showed facilitated semantic lexical retrieval for control words compared to violation conditions, and for related nouns compared to unrelated nouns (i.e., smaller N400s). However, the effects of animacy were smaller in non-native speakers, relative to native speakers. These results are suggestive of a potentially reduced capacity in non-natives to recruit animacy information incrementally during
sentence processing. A follow up of this study, in which participants did not give explicit judgments of plausibility showed N400 effects of all violation conditions (compared to control words). In addition, we did not observe post-N400 positivities in this study, but rather extended N400 effects. Only native speakers showed reduced N400s for animate than inanimate nouns at the N400 window. No robust effects of relatedness were found for either group.

Taken alongside the results of Chapter 3, Exp. 1, this study shows that while non-native speakers are sensitive to sentence implausibility in a similar way as native speakers, their use of animacy information in incremental sentence processing is reduced, compared to that of native speakers. Chapter 3, Exp. 2 also shed light into the extent that task demands influence sentence comprehension. The finding that extended negativities and absence of post-N400 positivity were found (cf. Chapter 3, Exp. 1) provides more evidence that individual differences, such as decision-based factors influence sentence processing, and in turn, its associated ERP components. A question that remains to be addressed is the investigation of non-native semantic processing in bilinguals whose languages vary in their ‘cue’ weighting of semantic features (e.g., MacWhinney et al., 1984), for instance Spanish-English as in this study, compared to Italian-English, or German-English speakers.

Results of these studies raise theoretical questions that future research ought to address in order to further our understanding of various sources of semantic information in non-native sentence processing. For instance, incremental sentence processing in non-native speakers has largely been studied with regards to syntactic processing, but to a lesser extent in semantic L2-sentence processing. In addition, a
venue that has been underexplored is evaluating more closely the factors that might influence individual differences (e.g., task demands), which in turn might drive differences between L1 and L2 processing patterns. Future research could address the various factors that have been proposed to influence sentence processing, in particular predictive processing (for a review see Kaan, 2014), in order to draw firm conclusions with regards to quantitative rather than qualitatively differences between native and non-native language processing.

5.1.3 Chapter 4: Cognitive effects of bilingualism

As we saw in the introductory chapter, bilingualism can have effects well beyond the language domain itself. Therefore, in Chapter 4, using behavioural tasks, I addressed the effects of bilingualism in different cognitive domains, in which previous studies have reported “advantages” and “costs” of bilingualism. To this purpose, I examined three aspects of executive control, namely sustained attention, inhibition and attentional switching using auditory tasks, and I also employed lexical access tasks. Results of this study showed that in the task of sustained attention, all groups performed at ceiling. In addition, while both bilinguals and multilinguals outperformed monolinguals in a task requiring inhibition, the bilingual groups showed a trend towards better performance over monolinguals in attentional switching that did not reach statistical significance. On a picture-word matching task, a linear trend analysis suggested that reaction times increased with number of languages. Finally, the groups did not differ in tasks of letter and category fluency.
Results of this study have important practical implications. With the growing mobility of individuals around the world there comes an increasing need to communicate in different languages. This research is informative about the effects of bilingualism not only in ‘balanced’ but also in ‘non-balanced’ bilinguals and allows us to understand the bilingual experience beyond the linguistic domain. Recent lines of research in the field of bilingualism have shed light into important aspects of the bilingual experience that go beyond the linguistic domain. For instance, studies suggesting that bilingualism may contribute to delay the onset of dementia (Alladi et al., 2013; Bialystok et al, 2007; Bak & Alladi, 2014), that reasoning in the foreign language results in reduced cognitive biases in decision making (Costa, Foucart, Arnon, Aparici, & Apesteguia, 2014) and even that bilinguals are more likely to engage in risk-taking behaviour while gambling when receiving feedback in the first language (Gao, Zika, Rogers, & Thierry, 2015). These studies illustrate that the complex nature of the phenomenon of bilingualism manifests in other cognitive domains, which offer a potentially fruitful venue for a growing body of research.

The practical applications of the study of bilingualism also bear on fields such as neurolinguistics or neuropsychology. The study of language processing in bilingualism can have a direct impact on devising correct plans for language rehabilitation in cases of bilingual and monolingual aphasia. For example, models such as part-whole learning used, among other domains, in second language acquisition (SLA), have been applied to devise a modality of treatment for patients with aphasia (Milman, Vega-Mendoza, Clendenen, 2014).
The necessity of well-controlled, replicable and robust findings is imperative, given the conflicting results that have recently arisen in the field. Future research needs to provide objective assessments of the bilingual experience. Providing solid and reliable evidence of the different effects of bilingualism is key if we wish to promote bilingualism and helpful if we intend to rescue endangered languages wherever possible, as it has been reported that there are approximately 3000 languages at risk of being lost (“Endangered Languages,” 2015).
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Appendices
Appendix A: Experimental items Chapter 2

Experimental items used in Chapter 2 (Taken from Ivanova et al., 2012). The prime sentences in the Prepositional Object (PO) condition are before the slash and in the Double Object (DO) condition, after the slash. The prime verbs from the four experiments are given in brackets in the following order: alternating verb in Experiments 1 and 3/non-alternating verb in Experiments 1 and 3/non-alternating verb in Experiments 2 and 4. The non-alternating target verbs from the four experiments are given in brackets. The target picture is described in the order agent, verb, beneficiary, theme (e.g., DANCER GIVE SOLDIER APPLE is designed to elicit the descriptions the dancer gives the apple to the soldier and the dancer gives the soldier the apple)\textsuperscript{10}.

1. the burglar (rents/reveals/donates) the apple to the swimmer/the swimmer the apple/COWBOY (REVEAL) CLOWN BOOK.
2. the dancer (rents/reveals/donates) the cake to the doctor/the doctor the cake/PIRATE (REVEAL) SOLDIER JUG.
3. the teacher (rents/reveals/donates) the hat to the waitress/the waitress the cake/CHEF (REVEAL) BOXER GUN.
4. the nun (rents/reveals/donates) the ball to the sailor/the sailor the ball/WAITRESS (REVEAL) PIRATE BANANA.
5. the monk (lends/describes/conveys) the ball to the cowboy/the cowboy the ball/ARTIST (DESCRIBE) WAITRESS CAKE.
6. the pirate (lends/describes/conveys) the hat to the clown/the clown the hat/NUN (DESCRIBE) BURGLAR BANANA.
7. the policeman (lends/describes/conveys) the apple to the sailor/the sailor the apple/PRISONER (DESCRIBE) DOCTOR JUG.

\textsuperscript{10} Description of the list of items adapted from Ivanova et al. (2012)
8. the chef (lends/describes/conveys) the cup to the soldier/the soldier the
cup/DANCER (DESCRIBE) BOXER BOOK.
9. the artist (brings/demonstrates/returns) the hat to the nun/the nun the hat/CHEF
(DEMONSTRATE) COWBOY BANANA.
10. the policeman (brings/demonstrates/returns) the book to the doctor/the doctor the
book/MONK (DEMONSTRATE) PIRATE GUN.
11. the waitress (brings/demonstrates/returns) the jug to the swimmer/the swimmer
the jug/TEACHER (DEMONSTRATE) DANCER CUP.
12. the prisoner (brings/demonstrates/returns) the apple to the boxer/the boxer the
apple/BURGLAR (DEMONSTRATE) SOLDIER CAKE.
13. the artist (gives/displays/delivers) the banana to the soldier/the soldier the
banana/PRISONER (DISPLAY) SAILOR CAKE.
14. the cowboy (gives/displays/delivers) the gun to the burglar/the burglar the
gun/TEACHER (DISPLAY) DOCTOR APPLE.
15. the chef (gives/displays/delivers) the ball to the pirate/the pirate the
ball/POLICEMAN (DISPLAY) SWIMMER HAT.
16. the nun (gives/displays/delivers) the jug to the dancer/the dancer the
jug/WAITRESS (DISPLAY) CLOWN CUP.
17. the prisoner (flings/conveys/reveals) the cake to the clown/the clown the
cake/POLICEMAN (CONVEY) WAITRESS GUN.
18. the artist (flings/conveys/reveals) the jug to the cowboy/ the cowboy the
jug/BURGLAR (CONVEY) SAILOR CUP.
19. the monk (flings/conveys/reveals) the hat to the soldier/ the soldier the hat/CHEF
(CONVEY) NUN APPLE.
20. the teacher (flings/conveys/reveals) the banana to the swimmer/the swimmer the
banana/DANCER (CONVEY) PIRATE BOOK.
21. the policeman (tosses/returns/demonstrates) the banana to the dancer/the dancer
the banana/ARTIST (RETURN) DOCTOR HAT.
22. the chef (tosses/returns/demonstrates) the jug to the burglar/the burglar the
jug/COWBOY (RETURN) NUN CAKE.
23. the waitress (tosses/returns/demonstrates) the book to the monk/the monk the book/PRISONER (RETURN) SWIMMER BALL.
24. the pirate (tosses/returns/demonstrates) the cup to the boxer/the boxer the cup/TEACHER (RETURN) CLOWN GUN.
25. the nun (passes/donates/displays) the gun to the pirate/the pirate the gun/COWBOY (DONATE) WAITRESS JUG.
26. the artist (passes/donates/displays) the cake to the swimmer/the swimmer the cake/DANCER (DONATE) SOLDIER APPLE.
27. the monk (passes/donates/displays) the ball to the boxer/the boxer the ball/POLICEMAN (DONATE) DOCTOR CUP.
28. the chef (passes/donates/displays) the banana to the clown/the clown the banana/TEACHER (DONATE) SAILOR BOOK.
29. the cowboy (mails/delivers/describes) the gun to the sailor/the sailor the gun/BURGLAR (DELIVER) BOXER HAT.
30. the policeman (mails/delivers/describes) the gun to the soldier/the soldier the gun/PRISONER (DELIVER) DANCER JUG.
31. the chef (mails/delivers/describes) the cup to the clown/the clown the cup/NUN (DELIVER) DOCTOR BANANA.
32. the teacher (mails/delivers/describes) the apple to the waitress/the waitress the apple/PIRATE (DELIVER) SWIMMER CAKE.
APPENDIX B: Instructions Experiments 1-4 Chapter 2

Welcome and thanks for taking part! 😊

In this experiment, you will have two separate alternating tasks:
  a) match pictures (determine whether a picture matches a written description); and
  b) describe pictures.

- If you have to match a picture:
  Some text will appear on the screen in front of you. Please read it carefully. After the text goes away from the screen, a picture will appear in its place. Press the M key on the keyboard if the text was an accurate description of the picture, and the N key if it was not. Respond as soon as you can.

  Remember:
  M – YES
  N – NO

- If you have to describe a picture:
  A picture will appear on the screen in front of you. You have to produce an oral description of this picture. Under the picture you will see a written word. You have to describe the picture using this word, and it is very important that you use it in the exact form, in which it is written.

  Example: You see a waitress and burglar, with the word “KICKS” written below. Your description would be: “The waitress kicks the burglar”.

  You will have 8 seconds to produce your description. Please make sure that you describe the picture in this time.

In order to help you keep track of what task you have to perform for each picture, there are differently coloured rectangles surrounding the pictures:
LIGHT GREEN – MATCH PICTURE
PINK – DESCRIBE PICTURE

Please do not say anything else apart from the picture descriptions once we have started the experiment.

We will now begin by a short practice session. If you have any questions, please ask them now.
APPENDIX C: Supplementary analyses, tables and figures for Chapter 3, Experiment 1

ERPs on Sentence-final words (Chapter 3, Exp. 1)

Animacy by relatedness interaction analyses

Both groups showed similar N400 patterns for the sentence-final words as revealed by lack of by group interactions. With both groups alike, a 4-way animacy by relatedness by hemisphere by anteriority interaction was followed up on each quadrant separately. This revealed reduced N400s for animate than inanimate nouns at the posterior ROIs as indicated by main effects of animacy ($F$s > 5.4, $p$s < .026), and no main effects of relatedness nor further animacy by relatedness interactions at any of the four ROIs.
Figure 8. ERPs elicited by sentence final words per group (Chapter 3, Exp. 1)
Table 27. Pairwise ANOVAs contrasting each type of violation with the control condition at different time windows, at all columns, across all participants.

<table>
<thead>
<tr>
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<th>N400 (300-500 ms)</th>
<th>P600 (700-900 ms)</th>
<th>Sentence Final (300-500 ms)</th>
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<td>Sent x AP</td>
<td>Sent x Hem</td>
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<td></td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td></td>
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<td>1.65</td>
<td>4.05^</td>
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<td>6.14**</td>
<td>-</td>
</tr>
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<td>-</td>
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<td>5.69**</td>
<td>7.27***</td>
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Notes. F values reported on this table. DF [1,32], DF for factors involving AP for midline and lateral ROIs [3,96]. DF for analyses involving hemisphere for crossline ROI [3,96]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution

^p ≤ .1, *p ≤ .05, **p ≤ .01, ***p ≤ .001
Table 28. Pairwise ANOVAs contrasting each type of violation with the control condition at different time windows, and sentence final words, at all columns, showing group effects and interactions

<table>
<thead>
<tr>
<th></th>
<th>N400 (300-500 ms)</th>
<th>P600 (700-900 ms)</th>
<th>Sentence Final (300-500 ms)</th>
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<td>Group</td>
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<td>Group</td>
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<td></td>
<td>Sent x Hem x Group</td>
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<td></td>
</tr>
<tr>
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Notes. *F* values reported on this table. DF [1,32], DF for factors involving AP for midline and lateral ROIs [3,96], DF for analyses involving hemisphere for crossline ROI [3,96]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution.  
^* p ≤ .1,  ^* p ≤ .05,  ^** p ≤ .01,  ^*** p ≤ .001
Table 29. 2 x 2 ANOVAs at all columns, all time windows and sentence final words, showing group effects and interactions

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>Ani x Group</th>
<th>Rela x Group</th>
<th>Rela x Hem x Group</th>
<th>Ani x Rela x Group</th>
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<th>Ani x Rela x Hem x AP x Group</th>
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<tr>
<td>N400</td>
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<td>8.5''</td>
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<td>0.7</td>
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<td>1.4</td>
<td>4.1'</td>
<td>5.8'</td>
<td>5.9'</td>
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<td>2.1</td>
<td>0.9</td>
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<td>0.9</td>
<td>2.0</td>
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<td>0.1</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>P600</td>
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<td>0.5</td>
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<td>-</td>
<td>3.3'</td>
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<td>-</td>
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<td>0.1</td>
<td>-</td>
<td>0.0</td>
<td>4.7''</td>
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<tr>
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<tr>
<td>P600</td>
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<td>0.7</td>
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<td>-</td>
<td>-</td>
<td>3.6^</td>
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^ p ≤ .1, † p ≤ .05, ‡ p ≤ .01, §§ p ≤ .001
Table 30. 2 x 2 ANOVAs at all columns, all time windows and sentence final words.

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<th>Main effect of Rela</th>
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<th>Ani x Rela Hem</th>
<th>Rela x AP</th>
<th>Rela x Hem</th>
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<th>Ani x Rela x Hem</th>
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<th>Rela x Hem x Hem</th>
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<td>0.9</td>
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<td>0.4</td>
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<td>0.9</td>
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<td>41.3***</td>
<td>40.6***</td>
<td>2.0</td>
<td>0.8</td>
<td>2.5</td>
<td>0.4</td>
<td>0.0</td>
<td>3.0^ 7.82*</td>
</tr>
<tr>
<td>Medial Sentence Final</td>
<td>2.5</td>
<td>0.4</td>
<td>0.6</td>
<td>10.2**</td>
<td>1.4</td>
<td>0.0</td>
<td>1.6</td>
<td>2.3</td>
<td>1.2</td>
<td>0.1</td>
<td>3.6^ 4.7*</td>
</tr>
<tr>
<td>Midline N400</td>
<td>26.2***</td>
<td>7.7**</td>
<td>0.2</td>
<td>4.6*</td>
<td>0.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>Midline P600</td>
<td>0.1</td>
<td>5.2*</td>
<td>0.1</td>
<td>37.1***</td>
<td>28.7***</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.8</td>
<td>-</td>
</tr>
<tr>
<td>Midline Sentence Final</td>
<td>2.1</td>
<td>0.3</td>
<td>0.2</td>
<td>3.8*</td>
<td>4.8*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.7</td>
<td>-</td>
</tr>
<tr>
<td>Lateral N400</td>
<td>21.8***</td>
<td>7.9**</td>
<td>0.0</td>
<td>6.1***</td>
<td>0.8</td>
<td>1.1</td>
<td>1.1</td>
<td>1.5</td>
<td>0.2</td>
<td>0.2</td>
<td>3.5^ 2.8*</td>
</tr>
<tr>
<td>Lateral P600</td>
<td>0.2</td>
<td>4.2*</td>
<td>0.1</td>
<td>35.1***</td>
<td>36.2***</td>
<td>1.2</td>
<td>2.4</td>
<td>1.1</td>
<td>0.6</td>
<td>0.5</td>
<td>1.2 1.1</td>
</tr>
<tr>
<td>Lateral Sentence Final</td>
<td>0.4</td>
<td>0.7</td>
<td>1.5</td>
<td>3.1^</td>
<td>0.2</td>
<td>0.2</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
<td>1.3</td>
<td>1.3 2.5^</td>
</tr>
<tr>
<td>Crossline N400</td>
<td>24.5***</td>
<td>8.1**</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
<td>4.0*</td>
<td>4.1*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.9</td>
</tr>
<tr>
<td>Crossline P600</td>
<td>0.0</td>
<td>3.4^</td>
<td>1.1</td>
<td>-</td>
<td>-</td>
<td>1.6</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.7</td>
</tr>
<tr>
<td>Crossline Sentence Final</td>
<td>2.4</td>
<td>0.1</td>
<td>0.7</td>
<td>-</td>
<td>-</td>
<td>2.9^</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Notes. F values reported on this table. DF [1,32], DF for factors involving AP for midline and lateral ROIs [3,96], DF for analyses involving hemisphere for crossline ROI [3,96]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution. Ani: Animacy. Rela: Relatedness. ^p ≤ .1, *p ≤ .05, **p ≤ .01, ***p ≤ .001
APPENDIX D: Supplementary analyses, tables and figures for Chapter 3, Experiment 2

ERPs on Sentence-final words (300-500 ms.) (Chapter 3, Exp. 2)

Animacy by relatedness interaction analysis

Both groups showed similar N400 patterns for the sentence-final words as revealed by lack of by group interactions or main effects of group (Table 3). With the groups together, a 3-way relatedness by hemisphere by anteriority interaction showed that related nouns elicited significantly smaller N400s than unrelated nouns at posterior channels (RLCP: $F_{1,33} = 4.8, p = .035$, RPO: $F_{1,33} = 5.8, p = .021$, all other lateral ROIs: $F_s < 1.3, ps > .280$) (Table 32).
Figure 9. ERPs elicited by sentence final words per group (Chapter 3, Exp. 2).
Table 31. *Pairwise ANOVAs contrasting each type of violation with the control condition at different time windows, at all columns, across all participants for sentence final words*

<table>
<thead>
<tr>
<th>Sentence Final (300-500 ms.)</th>
<th>Sent</th>
<th>Sent x AP</th>
<th>Sent x Hem</th>
<th>Sent x Hem x AP</th>
<th>Group</th>
<th>Sent x Hem x AP x Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Animate-Related</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>1.3</td>
<td>1.7</td>
<td>1.3</td>
<td>1.1</td>
<td>0.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Lateral</td>
<td>0.7</td>
<td>0.8</td>
<td>0.4</td>
<td>4.3**</td>
<td>0.2</td>
<td>2.5^</td>
</tr>
<tr>
<td>(3) Animate-Unrelated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>0.7</td>
<td>0.3</td>
<td>2.1</td>
<td>3.5^</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Lateral</td>
<td>1.2</td>
<td>0.2</td>
<td>1.1</td>
<td>0.4</td>
<td>0.5</td>
<td>2.3^</td>
</tr>
<tr>
<td>(4) Inanimate-Related</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>3.3^</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Lateral</td>
<td>2.8</td>
<td>0.4</td>
<td>0.0</td>
<td>1.2</td>
<td>1.2</td>
<td>0.4</td>
</tr>
<tr>
<td>(5) Inanimate-Unrelated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>6.1**</td>
<td>0.6</td>
<td>0.0</td>
<td>0.2</td>
<td>0.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Lateral</td>
<td>4.8*</td>
<td>0.3</td>
<td>0.0</td>
<td>0.3</td>
<td>1.2</td>
<td>4.9**</td>
</tr>
</tbody>
</table>

*Notes. F values reported on this table. DF [1,32], DF for factors involving AP for lateral column [3,96]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution.

^ p ≤ .1
* p ≤ .05
** p ≤ .01
*** p ≤ .001
### Table 32. 2 x 2 ANOVAs at medial and lateral columns for sentence final words.

<table>
<thead>
<tr>
<th></th>
<th>Main effect of Ani</th>
<th>Main effect of Rela</th>
<th>Ani x Rela</th>
<th>Ani x AP</th>
<th>Rela x AP</th>
<th>Ani x Hem</th>
<th>Rela x Hem</th>
<th>Ani x Hem x AP</th>
<th>Rela x Hem x AP</th>
<th>Ani x Rela x AP</th>
<th>Ani x Rela x Hem x AP</th>
<th>Ani x Rela x Hem x AP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sentence Final (300-500 ms)</td>
<td>1.8</td>
<td>0.2</td>
<td>0.8</td>
<td>3.4^</td>
<td>1.2</td>
<td>3.7^</td>
<td>0.3</td>
<td>3.7^</td>
<td>0.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Lateral</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sentence Final (300-500 ms)</td>
<td>1.7</td>
<td>1.1</td>
<td>0.2</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.1</td>
<td>0.4</td>
<td>5.7**</td>
<td>0.5</td>
<td>0.0</td>
<td>2.3^</td>
</tr>
</tbody>
</table>


^p ≤ .1, *p ≤ .05, **p ≤ .01, ***p ≤ .001

### Table 33. 2 x 2 ANOVAs at medial and lateral columns for sentence final words showing group effects and interactions.

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>Ani x Group</th>
<th>Rela x Group</th>
<th>Ani x Rela x Group</th>
<th>Rela x Hem x Group</th>
<th>Ani x Hem x AP x Group</th>
<th>Ani x Rela x Hem x Group</th>
<th>Ani x Rela x Hem x Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sentence Final (300-500 ms)</td>
<td>0.7</td>
<td>1.7</td>
<td>0.4</td>
<td>0.0</td>
<td>0.4</td>
<td>0.1</td>
<td>1.8</td>
<td>0.0</td>
</tr>
<tr>
<td>Lateral</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sentence Final (300-500 ms)</td>
<td>0.8</td>
<td>1.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.9</td>
<td>0.9</td>
<td>1.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>


^p ≤ .1, *p ≤ .05, **p ≤ .01, ***p ≤ .001
Table 34. Pairwise ANOVAs contrasting each type of violation with the control condition at different time windows, at all columns, across all participants showing group effects and interactions.

<table>
<thead>
<tr>
<th></th>
<th>300-500 ms.</th>
<th>500-700 ms.</th>
<th>700-900 ms.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sent x Group</td>
<td>Sent x Hem x Group</td>
<td>Sent x Group</td>
</tr>
<tr>
<td>(2)Animate-Related</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>6.7*</td>
<td>1.6</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midline</td>
<td>4.3*</td>
<td>2.4</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td>2.9^</td>
<td>0.8</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crossline</td>
<td>5.3^</td>
<td>1.3</td>
<td>0.0</td>
</tr>
<tr>
<td>(3)Animate-Unrelated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>11.5**</td>
<td>0.0</td>
<td>3.7^</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midline</td>
<td>8.4**</td>
<td>0.4</td>
<td>5.4^</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td>7.3^</td>
<td>0.0</td>
<td>2.2</td>
</tr>
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<td>3.6^</td>
</tr>
<tr>
<td>(4)Inanimate-Related</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>28.8***</td>
<td>2.2</td>
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<td></td>
</tr>
<tr>
<td>Midline</td>
<td>27.3***</td>
<td>3.2^</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
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<td></td>
</tr>
<tr>
<td>Crossline</td>
<td>28.3***</td>
<td>2.2</td>
<td>0.6</td>
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<tr>
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<td>40.6***</td>
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<td></td>
</tr>
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</tr>
<tr>
<td>Lateral</td>
<td>30.8***</td>
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<tr>
<td>Crossline</td>
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<td>1.0</td>
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</tr>
</tbody>
</table>

Notes. F values reported on this table. DF [1,32], DF for factors involving AP for midline and lateral ROIs [3,96], DF for analyses involving hemisphere for crossline ROI [3,96]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution \(^*p \leq .1\), \(^*p \leq .05\), \(^**p \leq .01\), \(^***p \leq .001\).
Table 35. Pairwise ANOVAs contrasting each type of violation with the control condition at different time windows, at all columns, across all participants showing group effects and interactions for sentence final words.

Sentence Final (300-500 ms.)

<table>
<thead>
<tr>
<th></th>
<th>Sent</th>
<th>Sent x AP</th>
<th>Sent x Hem</th>
<th>Sent x Hem x AP</th>
<th>Group</th>
<th>Sent x Hem x AP x Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2)Animate-Related</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>1.3</td>
<td>1.7</td>
<td>1.3</td>
<td>1.1</td>
<td>0.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Midline</td>
<td>1.4</td>
<td>1.2</td>
<td>-</td>
<td>-</td>
<td>0.0</td>
<td>-</td>
</tr>
<tr>
<td>Lateral</td>
<td>0.7</td>
<td>0.8</td>
<td>0.4</td>
<td>4.3**</td>
<td>0.2</td>
<td>2.5^</td>
</tr>
<tr>
<td>Crossline</td>
<td>2.6</td>
<td>-</td>
<td>0.3</td>
<td>-</td>
<td>0.1</td>
<td>-</td>
</tr>
<tr>
<td>(3)Animate-Unrelated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>0.7</td>
<td>0.3</td>
<td>2.1</td>
<td>3.5^</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Midline</td>
<td>0.8</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>0.7</td>
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<tr>
<td>Lateral</td>
<td>1.2</td>
<td>0.2</td>
<td>1.1</td>
<td>0.4</td>
<td>0.5</td>
<td>2.3^</td>
</tr>
<tr>
<td>Crossline</td>
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<td>-</td>
<td>0.4</td>
<td>-</td>
<td>0.2</td>
<td>-</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
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<td>3.3^</td>
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<td>0.1</td>
<td>0.0</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Midline</td>
<td>2.7</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
<td>0.9</td>
<td>-</td>
</tr>
<tr>
<td>Lateral</td>
<td>2.8</td>
<td>0.4</td>
<td>0.0</td>
<td>1.2</td>
<td>1.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Crossline</td>
<td>2.7</td>
<td>-</td>
<td>0.1</td>
<td>-</td>
<td>1.1</td>
<td>-</td>
</tr>
<tr>
<td>(5)Inanimate-Unrelated</td>
<td></td>
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</tr>
<tr>
<td>Medial</td>
<td>6.1*</td>
<td></td>
<td>0.6</td>
<td>0.0</td>
<td>0.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Midline</td>
<td>4.8*</td>
<td></td>
<td>0.1</td>
<td>-</td>
<td>1.3</td>
<td>-</td>
</tr>
<tr>
<td>Lateral</td>
<td>4.8*</td>
<td></td>
<td>0.3</td>
<td>0.0</td>
<td>0.3</td>
<td>1.2</td>
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<tr>
<td>Crossline</td>
<td>5.6*</td>
<td></td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Notes. F values reported on this table. DF [1,32], DF for factors involving AP for midline and lateral ROIs [3,96], DF for analyses involving hemisphere for crossline ROI [3,96]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution

^ p ≤ .1, * p ≤ .05, ** p ≤ .01, *** p ≤ .001
Table 36. Pairwise ANOVAs contrasting each type of violation with the control condition at different time windows, at all columns

<table>
<thead>
<tr>
<th></th>
<th>300-500 ms.</th>
<th>500-700 ms.</th>
<th>700-900 ms.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300-500 ms</td>
<td>500-700 ms</td>
<td>700-900 ms</td>
</tr>
<tr>
<td></td>
<td>Sent x AP</td>
<td>Sent x Hem</td>
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<tr>
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<td>3.2^</td>
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<td>(5) Inanimate-Unrelated</td>
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<tr>
<td>Lateral</td>
<td>1.3</td>
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</tr>
<tr>
<td>Crossline</td>
<td>-</td>
<td>4.5**</td>
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</tbody>
</table>

Notes. F values reported on this table. DF [1,32], DF for factors involving AP for midline and lateral ROIs [3,96]. DF for analyses involving hemisphere for crossline ROI [3,96]. Sent: Sentence Type. AP: Anterior-Posterior distribution. Hem: Hemisphere distribution

^ p ≤ .1, * p ≤ .05, ** p ≤ .01, *** p ≤ .001
Table 37. By group 2 x 2 ANOVAs at different time windows at all columns.

<table>
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<tr>
<th></th>
<th>Main effect of Ani</th>
<th>Main effect of Rela</th>
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<th>Ani x AP</th>
<th>Rela x AP</th>
<th>Ani x Hem</th>
<th>Rela x Hem</th>
<th>Ani x Hem x AP</th>
<th>Rela x Hem x AP</th>
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<td>by 2 x 2 ANOVAs at different time windows</td>
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<td>1.7</td>
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<tr>
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<tr>
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<tr>
<td>700-900 ms.</td>
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<td>0.0</td>
<td>2.4</td>
<td>2.7^</td>
<td>-</td>
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<td>Lateral</td>
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<td>1.3</td>
<td>2.7^</td>
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<td>0.3</td>
<td>0.6</td>
<td>0.2</td>
<td>4.7**</td>
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<tr>
<td>Crossline</td>
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<td>300-500 ms.</td>
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<td>500-700 ms.</td>
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</tbody>
</table>


^ p ≤ .1, * p ≤ .05, ** p ≤ .01, *** p ≤ .001
APPENDIX E: Experimental items in Chapters 3 and 4.

Below the sentences, critical words are presented in the following order: (1) plausible control sentences / (2) animate-related / (3) animate-unrelated / (4) inanimate-related / (5) inanimate-unrelated.

1. The halftime show at the football match was organised by the cheerleader/striker/alcoholic/goalpost/rum
2. During the solo music performance the strings were plucked by the harpist/trumpeter/workman/violin/sculpture
3. At the restaurant all the meals were cooked by the chef/diner/aboriginal/plate/arrow
4. The scientific research was funded by the sponsor/volunteer/traveller/microscope/suitcase
5. Tenants were upset when housing prices were raised by the proprietor/occupant/actress/property/script
6. After crying and waking up his parents the baby was breast-fed by his mummy/brother/coach/carry-cot/stadium
7. At the baseball game, a ball was thrown by the pitcher/catcher/suspect/scoreboard/passport
8. The cure for the disease was discovered by the doctor/patient/guest/medication/stamp
9. At the theatre the programs were given out by the usher/audience/controller/ticket/turbine
10. At the wedding ceremony the ring was brought by the groom/reverend/diabetic/veil/aspirin
11. At the club the cocktails are served by the barmaid/drunkard/queen/tonic/dirt
12. The rules of the game show were explained by the host/contestant/undertaker/prize/tomb
13. The next bus stop was announced by the coachman/user/drunkard/bell/tonic
14. The child's dirty nappy was changed by his mum/toddler/captive/powder/cannon
15. At the ballet, the music was played by the orchestra/dancer/hypochondriac/tutu/medicine
16. In ancient Egypt the people were governed by the Pharaoh/slave/baby/pyramid/mess
17. The patient's aches and pains were examined by the physician/hypochondriac/candidate/medicine/microphone
18. The rope was thrown by the cowboy/Indian/graduate/saddle/diploma
19. The murder witness was cross-questioned by the detective/convict/freshman/blood/chalk
20. The violent demonstration was policed by the policeman/hooligan/cleaner/banner/turkey
21. The cult's prophecies were established by the prophet/admirer/wrestler/candle/trampoline
22. While eating dinner with her parents, the woman was proposed to by her boyfriend/father/pupil/diamond/pencil
23. The studio recorded an album with music sung by the vocalist/producer/merchant/keyboard/tear-gas
24. The aeroplane was flown by the pilot/controller/nurse/turbine/anaesthesia
25. The first lectures in college were given by the lecturer/freshman/gangster/chalk/shotgun
26. The car's new features were marketed by the saleswoman/client/concierge/engine/fuse
27. The husband got involved in an affair after having been seduced by his mistress/wife/contestant/divorce/prize
28. At UK pubs every drink is poured by the barman/alcoholic/architect/rum/crane
29. At the hotel, luggage is delivered by the porter/traveller/patient/suitcase/medication
30. The clever boy was able to win the contest helped by his mate/opponent/buyer/challenge/cutlery
31. Thanks to the union talks, improved benefits were received by the employee/boss/model/list/dress
32. In the fairy-tale, the princess was rescued by the prince/witch/intern/crown/artery
33. The chaos in the classroom was initiated by a preschooler/schoolmaster/beginner/blackboard/belt
34. Every day the rich Duke's soiled underwear was scrubbed by the maid/queen/principal/dirt/earlobe
35. The pianist played his music while the bass was strummed by the guitarist/drummer/diner/drum/plate
36. During the exam, unacceptable cheating behaviour was exhibited by the student/professor/admirer/chair/candle
37. Everyone sat around the campfire to hear a tale told by the storyteller/listener/viewer/log/camera
38. At the pharmacy three bottles of insulin were sold by the pharmacist/diabetic/striker/aspirin/goalpost
39. At the school, punishments for being late in class were given by the headmistress/child/accomplice/desk/handcuff
40. After the meal was over the waitress was tipped by the customer/cook/speaker/penny/television
41. At the wedding the couple was married by the pastor/bride/watcher/ring/commercial
42. The car was given a parking ticket by the
traffic-warden/delinquent/explorer/brake/ocean
43. The film was recorded by the
director/actress/assassin/script/rifle
44. During the basketball game hot dogs were sold by the
vendor/spectator/schoolmaster/mustard/blackboard
45. The man who stole the money was prosecuted by the
lawyer/witness/receptionist/confession/headlight
46. At the roller coaster in the amusement park, customers are counted by the
personnel/rider/journalist/track/print
47. The skin operation was performed by the
dermatologist/nurse/parent/anaesthesia/whistle
48. At the track, the horse was raced by the
jockey/gambler/applicant/harness/curriculum
49. The burglars were caught and arrested by the
cop/accomplice/pianist/handcuff/metronome
50. The castle was attacked by the
enemy/protector/shopper/protection/toffee
51. In the court case that attracted lots of media, the man was sentenced by the
judge/reporter/granny/verdict/extinguisher
52. Everyone watched while the man was mugged by the
attacker/bystander/technician/wallet/telescope
53. At the sausage stand lots of food was bought by the
eater/seller/villain/onion/tower
54. The decision to cancel the television show was made by the
executive/watcher/widow/commercial/coffin
55. In the courtroom the killer was set free by the
jury/murderer/violinist/bullet/flute
56. All possessions in the will were left by the
decayed/survivor/reporter/grave/verdict
57. In an act of generosity a large sum was donated by the
millionaire/recipient/sunbather/checkbook/paddle
58. The novel was written by the
author/reader/builder/page/lawn-mower
59. The holiday cruise ship was sailed by the
captain/tourist/president/anchor/constitution
60. At the church the baptism was conducted by the
minister/infant/passenger/basin/deck
61. Before the island was discovered, it was inhabited by the
native/explorer/assistant/ocean/tooth
62. The ship was navigated by the
sailor/passenger/toddler/deck/powder
63. The bank's vault had been robbed by the
burglar/watchman/psychologist/jewellery/tape-measure
64. The advanced karate class was taught by the
master/beginner/culprit/belt/fingerprint
65. Every day the school facilities were cleaned by the janitor/kid/amateur/soap/boot
66. Every morning at 6am the newspaper was delivered by the newsboy/journalist/lookout/print/aerosol
67. The president was interviewed on television by the correspondent/viewer/gambler/camera/harness
68. At the children's football game, a goal was scored by the player/parent/delinquent/whistle/brake
69. When there was a fire in the home everyone was carried out by the fireman/granny/examiner/extinguisher/textbook
70. During art lessons at kindergarten lots of messy pictures were created by the youngster/teacher/waiter/table/parking-meter
71. During a speech, the political rally was bombed by the terrorist/candidate/bride/microphone/ring
72. Data from the drug trial was analysed by the scientist/participant/engineer/injection/brick
73. The advanced mountain climbing lesson was given by the mountaineer/amateur/grocer/boot/shellfish
74. The couple was afraid that their missing baby girl would be found by a stranger/newborn/spectator/bib/mustard
75. Before the funeral of the old man the grave was dug by the digger/widow/dean/coffin/catalogue
76. Because of the recent threats the mayor was escorted by the bodyguard/assassin/sculptor/rifle/frame
77. Because the car was parked illegally a ticket was issued by the attendant/driver/trainee/windscreen/statement
78. When the bottle leaked the milk was mopped up by the mother/baby/apprentice/mess/sewing-machine
79. At the estate sale, prices are announced by the auctioneer/bidder/rider/furniture/track
80. Because of his ears, the student was targeted by the bully/principal/holiday-maker/earlobe/photograph
81. A big crowd had gathered to watch as the rocket was launched by the astronaut/onlooker/caller/planet/receiver
82. The soup company for homeless people was funded by the entrepreneur/beggar/plumber/bowl/keyhole
83. During the election, the presidential candidate was voted for by his supporter/rival/kid/ballot/soap
84. Despite the high security in the castle, the crown was stolen by the thief/king/winner/throne/golf-ball
85. During the kidnapping, freedom was requested by the hostage/kidnapper/fan/extortion/bicycle
86. The town was defended with guns by the army/invader/bookworm/weapon/paperback
87. At the sweet shop six pounds of candy was sold by the shopkeeper/shopper/centurion/toffee/sword
88. The hole through the prison wall was drilled by the fugitive/guard/bachelor/fence/bouquet
89. All the information for the test was memorised by the scholar/examiner/tourist/textbook/anchor
90. Each month the rent was paid by the tenant/landlord/composer/lease/costume
91. At the football match the winning goal was scored by the defender/referee/witch/crossbar/crown
92. At night the jail was locked by the warden/prisoner/character/gate/magazine
93. During the concert the symphony was conducted by the maestro/violinist/reverend/flute/veil
94. The phone call was redirected by the operator/caller/bidder/receiver/furniture
95. During the athletic tournament, the runner was overtaken by his competitor/coach/watchman/stadium/jewellery
96. Because of the recall everything was refunded by the manufacturer/consumer/cook/package/penny
97. At the construction site all of the dirtiest work was done by the worker/engineer/producer/brick/keyboard
98. Invitations to the dinner party were posted by the hostess/guest/victim/stamp/treasure
99. At the airport, the luggage is searched by the official/suspect/boss/passport/list
100. In the Texan town the bank was robbed by the outlaw/sheriff/participant/revolver/injection
101. The employment interviews were administered by the committee/applicant/servant/curriculum/tray
102. An interesting story was written by the writer/character/escort/magazine/wine
103. The taxi was driven by the cabdriver/pedestrian/dancer/wheel/tutu
104. At the golf game, a hole-in-one was scored by the golfer/umpire/landlord/cart/lease
105. At the pet hospital, dogs were cured by the vet/owner/soldier/ambulance/uniform
106. At the post office, letters are collected and delivered by the postman/cashier/maniac/mailbox/couch
107. At the garage, the car maintenance is performed by the mechanic/receptionist/beggar/headlight/bowl
108. At the hospital the complex heart surgery was performed by the surgeon/intern/slave/artery/pyramid
109. Upon arriving at the restaurant, the car was parked by the chauffeur/waiter/cameraman/parking-meter/monitor
110. The circus performance was directed by the presenter/juggler/nun/trapeze/oratory
111. To keep visitors safe, the national park was patrolled by the ranger/camper/repairer/sunlight/radiator
112. At the library, the books are organised on the shelves by the librarian/dean/king/catalogue/throne
113. At the bank, credit card requests are authorised by the manager/teller/restorer/receipt/spade
114. Fish in the aquarium were studied by the biologist/swimmer/musician/seaweed/spotlight
115. At the exhibition, all the pictures were taken by the photographer/sculptor/protector/frame/protection
116. At the graduation reception, the dinner was provided by the caterer/graduate/prisoner/diploma/gate
117. When the Italian diplomat gave a speech, the translation was performed by the interpreter/speaker/driver/television/windscreen
118. The prescription for the mental disorder was written by the psychiatrist/schizophrenic/guard/pill/fence
119. The bank robbery was prevented by the hero/gangster/server/shotgun/spoon
120. The attacks on the ships were led by the pirate/captive/trumpeter/cannon/violin
121. At the opera concert in the theatre, the musical pieces were sung by the tenor/composer/visitor/costume/cage
122. Because his parents work all day, the baby was attended by the nanny/dad/consumer/dummy/package
123. The dental restoration was performed by the dentist/assistant/Indian/tooth/saddle
124. At the Olympics, the bars competition was won by the gymnast/wrestler/cardinal/trampoline/crucifix
125. To lose weight, the woman's meal plan was prescribed by the dietician/psychologist/hooligan/tape-measure/banner
126. The psychotherapy session was delivered by the counsellor/manic/teacher/couch/table
127. In the circus, the lions were tamed by the trainer/ballerina/chemist/tightrope/manuscript
128. At the salon, the clients get their hair cut by the stylist/manicurist/pedestrian/hairbrush/wheel
129. At the museum, a tour and descriptions of the paintings were given by the guide/workman/kidnapper/sculpture/extortion
130. The safari excursion to Africa was led by the adventurer/holiday-maker/juggler/photograph/trapeze
131. The corrupt tax fraud was discovered by the accountant/charlatan/dad/calculator/dummy
132. After the electricity outage, the apartment was checked by the electrician/concierge/observer/fuse/wreckage
133. After being locked, the door was repaired by the repairman/plumber/reader/keyhole/page
134. In the theatre production, the villain was played by the actor/musician/recipient/spotlight/checkbook
135. The suit was adjusted by the tailor/apprentice/shepherd/sewing-machine/ice-pick
136. At the farmers market, fresh fish is sold by the fisherman/grocer/survivor/shellfish/grave
137. The Tour de France was won by the cyclist/fan/bystander/bicycle/wallet
138. The book signing was attended by the famous novelist/bookworm/camper/paperback/sunlight
139. The mountain summit was conquered by the climber/shepherd/audience/ice-pick/ticket
140. The school walls were ruined with graffiti drawn by the vandal/lookout/client/aerosol/engine
141. On the lake, the boat race was won by the rower/sunbather/sheriff/paddle/revolver
142. The bush in the garden was trimmed by the gardener/builder/opponent/lawn-mower/challenge
143. At the observatory, a new star was discovered by the astronomer/technician/criminal/telescope/bench
144. The card trick on the TV show was performed by the magician/cameraman/newborn/monitor/bib
145. During Christmas dinner, gifts for the family were bought by the grandma/cleaner/invader/turkey/weapon
146. At the wedding in the church, the service was performed by the cleric/bachelor/listener/bouquet/log
147. The destruction of the building was performed by the wrecker/architect/catcher/crane/scoreboard
148. At the monastery, a prayer was said by the monk/nun/owner/oratory/ambulance
149. The Vatican has been ruled by the pope/cardinal/swimmer/crucifix/seaweed
150. During the protests, the shops were attacked by the agitator/merchant/child/tear-gas/desk
151. At the restaurant, the plates are washed by the washer/server/charlatan/spoon/calculator
152. The roman empire defences were attacked by the barbarian/centurion/seller/sword/onion
153. The stolen new car was raced through town by the robber/repairer/schizophrenic/radiator/pill
154. The Nobel prize in literature was won by the poet/chemist/murderer/manuscript/bullet
155. During the excavation, an ancient artefact was discovered by the archaeologist/restorer/user/spade/bell
### Appendix F: Language questionnaires

#### I. General Information

<table>
<thead>
<tr>
<th>Participant ID:</th>
<th>Age:</th>
<th>Sex:</th>
<th>Place of birth:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current city of residence (time in years/months):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other places of residence (time lived in each in years/months):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education (in years):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profession:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Father’s place of birth:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s place of birth:</td>
<td></td>
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</tr>
</tbody>
</table>

#### II. Language Information

**A.**

1. Please list all languages you speak and have ever studied (even if it was only for a few months). Please start with the one you know best, and finish with the one you know worst.

   1. ________________________________
   2. ________________________________
   3. ________________________________
   4. ________________________________
   5. ________________________________

2. What is the language you normally use to speak to your:
   father:___________ mother: ___________ sibling(s): ____________ partner: ___________

3. In a day, how often (in %) do/ did you speak:

   **NOW**
   - English:_______ Other (specify which): _______ Other (specify which):___________
   - Other (specify which):_________

   **WHEN YOU WERE 2-10 YEARS OLD**
   - English:_______ Other (specify which): _______ Other (specify which):___________
   - Other (specify which):_________

4. At what age were you first exposed to ________? (please fill in with your best language) ________

   At what age did you start speaking ______________? ______________

   How did you learn __________? (please circle one) At home/ At school/ After arriving in the country where people speak this language/ other (explain)______________

   At what age were you first exposed to English? ____________

   At what age did you start speaking English? ____________

   How did you learn English? (please circle one) At home/ At school/ After arriving in the country where people speak this language/ other (explain)______________

   At what age were you first exposed to _________? (please fill in with another language you know, if any)__________

   At what age did you start speaking _______________? ________________

   How did you learn ___________? (please circle one) At home/ At school/ After arriving in the country where people speak this language/ other (explain)______________

   At what age were you first exposed to _________? (please fill in with another language you know, if any)__________

   At what age did you start speaking _______________? ________________

   How did you learn ___________? (please circle one) At home/ At school/ After arriving in the country where people speak this language/ other (explain)______________
At what age were you first exposed to _________? (please fill in with another language you know, if any) _________

At what age did you start speaking ______________? ________________

How did you learn __________? (please circle one) At home/At school/After arriving in the country where people speak this language/other (explain)_______________

B.

Please circle the option which best represents how good you are in each language, for each skill (where it says “other” please specify which language it is). You will have to do this on a scale of 1 to 10, where 1 means “very bad”, and 10 means “excellent”.

What is your SPEAKING (FLUENCY) level in each of these languages?

English 1 2 3 4 5 6 7 8 9 10
Other:_______ 1 2 3 4 5 6 7 8 9 10
Other:_______ 1 2 3 4 5 6 7 8 9 10
Other:_______ 1 2 3 4 5 6 7 8 9 10

What is your SPEAKING (PRONUNCIATION) level in each of these languages?

English 1 2 3 4 5 6 7 8 9 10
Other:_______ 1 2 3 4 5 6 7 8 9 10
Other:_______ 1 2 3 4 5 6 7 8 9 10
Other:_______ 1 2 3 4 5 6 7 8 9 10

What is your WRITING level in each of these languages?

English 1 2 3 4 5 6 7 8 9 10
Other:_______ 1 2 3 4 5 6 7 8 9 10
Other:_______ 1 2 3 4 5 6 7 8 9 10
Other:_______ 1 2 3 4 5 6 7 8 9 10
PART I: GENERAL DEMOGRAPHIC INFORMATION

Age....................................................................Gender........................................Handedness..............
Profession/Subject studied........................................................................................................................................
Current level of study or highest level achieved......................................................................................................
At what age did you start school? At .......... yrs old
Have you lived in other places in which other languages are spoken?................................................
If so, where and for how long?.............................................................................................................................
Place of birth:.........................................................................................................................................................

PART II: LANGUAGES SPOKEN

1. ...........................................................................................................................................................
2. ...........................................................................................................................................................
3. ...........................................................................................................................................................
4. ...........................................................................................................................................................
5. ...........................................................................................................................................................

PART III: PARENTS' MOTHER TONGUES:

What is your father’s mother tongue? Does your father speak any other languages? Please specify
What is your mother’s mother tongue? Does your mother speak any other languages? Please specify
If you have a child, which is their first language? Does your child speak any other languages? Please specify

LANGUAGE 1:

LANGUAGE HISTORY – ACQUISITION OF LANGUAGE

1. First contact with the language: since birth/at ___ yrs of age
2. Choose the most appropriate option: - I hear the language spoken but I don’t speak it □
   - I both hear and speak the language □
3. If you were schooled in this language, at what age did you learn to write it? ____ yrs old
4. Environment in which you used the language in childhood: Frequency of use (choose one):

<table>
<thead>
<tr>
<th>Family</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother</td>
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<td>Father</td>
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<tr>
<td>Grandparents</td>
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<tr>
<td>Siblings</td>
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<tr>
<td>Other relatives</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Official</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schooling</td>
<td></td>
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<tr>
<td>Teachers</td>
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<tr>
<td>Classmates</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Immediate Environment</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friends</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Neighbours</td>
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</tbody>
</table>

LANGUAGE USE

1. Do you continue to use the language? Yes □ No □ (If no, when did you stop using it? ___ yrs old)
If yes, how often do you use it in each one of the following contexts (choose one):

<table>
<thead>
<tr>
<th>Family</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner</td>
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<td></td>
</tr>
<tr>
<td>Siblings/Nephews/Nieces</td>
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<td></td>
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<tr>
<td>Children</td>
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<tr>
<td>Other relatives</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Official</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colleagues</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Shopping</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Radio/TV</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Books/magazines</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Immediate environment</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friends</td>
<td>Neighbours</td>
<td>Church/society</td>
<td>Do you use different languages with the same person?</td>
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</tbody>
</table>

**COMMAND OF THE LANGUAGE**

Evaluate your command of the language in each of the following categories:

<table>
<thead>
<tr>
<th>Basic</th>
<th>Weak</th>
<th>Moderate</th>
<th>Advanced</th>
<th>Fluent</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Expression</th>
<th>Comprehension</th>
<th>Reading</th>
<th>Writing</th>
</tr>
</thead>
</table>

**LANGUAGE HISTORY – ACQUISITION OF LANGUAGE**

1. First contact with the language: since birth/at ___ yrs of age
2. Choose the most appropriate option:
   - I hear the language spoken but I don’t speak it □
   - I both hear and speak the language □
3. If you were schooled in this language, at what age did you learn to write it? ____ yrs old
4. Environment in which you used the language in childhood: Frequency of use (choose one):

<table>
<thead>
<tr>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
</table>

**Family**
- Mother
- Father
- Grandparents
- Siblings
- Other relatives

**Official**
- Schooling
- Teachers
- Classmates

**Immediate Environment**
- Friends
- Neighbours

**LANGUAGE USE**

1. Do you continue to use the language? Yes □  No □ (If no, when did you stop using it? ____ yrs old)

If yes, how often do you use it in each one of the following contexts (choose one):

<table>
<thead>
<tr>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
</table>

**Family**
- Partner
- Siblings/Nephews/Nieces
- Children
- Other relatives

**Official**
- Colleagues
- Shopping
- Radio/TV
- Books/magazines

**Immediate Environment**
- Friends
- Neighbours
- Church/society

Do you use different languages with the same person?

**COMMAND OF THE LANGUAGE**

Evaluate your command of the language in each of the following categories:

<table>
<thead>
<tr>
<th>Basic</th>
<th>Weak</th>
<th>Moderate</th>
<th>Advanced</th>
<th>Fluent</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Expression</th>
<th>Comprehension</th>
<th>Reading</th>
</tr>
</thead>
</table>
**LANGUAGE HISTORY – ACQUISITION OF LANGUAGE**

1. First contact with the language: since birth/at __ yrs of age

2. Choose the most appropriate option:
   - I hear the language spoken but I don’t speak it □
   - I both hear and speak the language □

3. If you were schooled in this language, at what age did you learn to write it? __ yrs old

4. Environment in which you used the language in childhood: Frequency of use (choose one):

<table>
<thead>
<tr>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
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<tr>
<td>Mother</td>
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<td>Father</td>
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<td>Grandparents</td>
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<td>Siblings</td>
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<td>Other relatives</td>
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<td>Teachers</td>
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<td>Classmates</td>
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<td>Immediate Environment</td>
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<td>Friends</td>
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<td>Neighbours</td>
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</tr>
</tbody>
</table>

**LANGUAGE USE**

1. Do you continue to use the language? Yes □ No □ (If no, when did you stop using it? __ yrs old)

If yes, how often do you use it in each one of the following contexts (choose one):

<table>
<thead>
<tr>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
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<td></td>
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</tr>
<tr>
<td>Partner</td>
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<td></td>
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<tr>
<td>Siblings/Nephews/Nieces</td>
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<tr>
<td>Children</td>
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<td>Other relatives</td>
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<tr>
<td>Official</td>
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<tr>
<td>Colleagues</td>
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<td>Friends</td>
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<td>Neighbours</td>
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<tr>
<td>Church/society</td>
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</tbody>
</table>

Do you use different languages with the same person?

**COMMAND OF THE LANGUAGE**

Evaluate your command of the language in each of the following categories:

<table>
<thead>
<tr>
<th>Basic</th>
<th>Weak</th>
<th>Moderate</th>
<th>Advanced</th>
<th>Fluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression</td>
<td></td>
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</tr>
<tr>
<td>Comprehension</td>
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</tr>
<tr>
<td>Reading</td>
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</tr>
<tr>
<td>Writing</td>
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</tbody>
</table>

**LANGUAGE HISTORY – ACQUISITION OF LANGUAGE**

1. First contact with the language: since birth/at __ yrs of age

2. Choose the most appropriate option:
   - I hear the language spoken but I don’t speak it □
   - I both hear and speak the language □

3. If you were schooled in this language, at what age did you learn to write it? __ yrs old

4. Environment in which you used the language in childhood: Frequency of use (choose one):
<table>
<thead>
<tr>
<th>FAMILY</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Father</td>
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<tr>
<td>Grandparents</td>
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<tr>
<td>Siblings</td>
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<tr>
<td>Other relatives</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>OFFICIAL</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
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</thead>
<tbody>
<tr>
<td>Schooling</td>
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<tr>
<td>Teachers</td>
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</tr>
<tr>
<td>Classmates</td>
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</table>

<table>
<thead>
<tr>
<th>IMMEDIATE ENVIRONMENT</th>
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<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friends</td>
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</tr>
<tr>
<td>Neighbours</td>
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</tr>
</tbody>
</table>

**LANGUAGE USE**
1. Do you continue to use the language? Yes [ ] No [ ] (If no, when did you stop using it? ___ yrs old)

If yes, how often do you use it in each one of the following contexts (choose one):

<table>
<thead>
<tr>
<th>FAMILY</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
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<tbody>
<tr>
<td>Partner</td>
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<td>Siblings/Nephews/Nieces</td>
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<td>Children</td>
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<tr>
<td>Other relatives</td>
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<table>
<thead>
<tr>
<th>OFFICIAL</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colleagues</td>
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<td>Shopping</td>
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<td>Books/magazines</td>
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</table>

**COMMAND OF THE LANGUAGE**
Evaluate your command of the language in each of the following categories:

<table>
<thead>
<tr>
<th>Category</th>
<th>Basic</th>
<th>Weak</th>
<th>Moderate</th>
<th>Advanced</th>
<th>Fluent</th>
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</thead>
<tbody>
<tr>
<td>Expression</td>
<td></td>
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<tr>
<td>Comprehension</td>
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<tr>
<td>Writing</td>
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</table>

**LANGUAGE HISTORY – ACQUISITION OF LANGUAGE**
1. First contact with the language: since birth/at ___ yrs of age
2. Choose the most appropriate option: - I hear the language spoken but I don’t speak it [ ]
   - I both hear and speak the language [ ]
3. If you were schooled in this language, at what age did you learn to write it? ___ yrs old
4. Environment in which you used the language in childhood: Frequency of use (choose one):

<table>
<thead>
<tr>
<th>FAMILY</th>
<th>Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
<th>Not applicable</th>
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</thead>
<tbody>
<tr>
<td>Mother</td>
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<tr>
<td>Father</td>
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<td>Grandparents</td>
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<tr>
<td>Siblings</td>
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<tr>
<td>Other relatives</td>
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<tbody>
<tr>
<td>Schooling</td>
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<tr>
<td>Teachers</td>
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<tr>
<td>Classmates</td>
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</tbody>
</table>
Schooling
Teachers
Classmates
Immediate Environment
Friends
Neighbours

**LANGUAGE USE**

1. Do you continue to use the language? Yes ☐ No ☐ (If no, when did you stop using it? ___ yrs old)

If yes, how often do you use it in each one of the following contexts (choose one)

<table>
<thead>
<tr>
<th></th>
<th>Always</th>
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</thead>
<tbody>
<tr>
<td><strong>Family</strong></td>
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<tr>
<td>Partner</td>
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**Immediate environment**

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<tbody>
<tr>
<td>Friends</td>
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<td>Church/society</td>
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Do you use different languages with the same person?

**COMMAND OF THE LANGUAGE**

Evaluate your command of the language in each of the following categories:

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Appendix G: Conference presentations and publications from thesis material

Chapter 2:


Chapter 3:

Chapter 4: