**Inhibitory Control and First Language Flexibility in Second Language Learning
A Neurocognitive Study**

BY

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THESIS

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ALF

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List of Abbreviations

ACH	Adaptive Control Hypothesis
AX-CPT	Automated Continuous Performance Task
BIA+	Bilingual Interactive Activation Model
DELE	Diploma del Español com Lengua Extranjera (Spanish Proficiency Task)
DP	Determiner Phrase
EEG	Electroencephalogram
EIT	Elicited Imitation Task
ERP	Event-related potentials
fMRI	Functional magnetic resonance
HEOG	Horizontal electro-oculogram electrodes
IC	Inhibitory control
IIR	Infinite impulse response
IQ	Intelligence quotient
kΩ	Kiloohms
L1	First language
L2	Second language
ms	Milliseconds
N2	N200 ERP component
OSpan	Operation-Span Task
ROI	Region of interest
RSpan	Reading-Span Task
RT	Reaction Time
SLA	Second language acquisition as a field of research
SymSpan	Symmetry-Span Task
VEOG	Vertical electro-oculogram electrodes
VF	Verbal fluency
WM	Working memory
μV	Microvolts

Summary

This dissertation study investigates the relationship between individual internal factors and successful adult second language (L2) learning by analyzing the role that individual differences in inhibitory control (IC) abilities and first language (L1) grammatical flexibility, two factors that have been posited to be important for proficient bilingualism, may play for adult L2 learning. This study aims to provide a multi-dimensional account on the role of these two factors and their relationship with successful adult L2 learning by providing both behavioral and neurocognitive evidence, as an attempt to better understand the factors that may help explain the high degree of variability in adult L2 learning outcomes.

Accordingly, the present study addresses the claims that suggests inhibitory control abilities and L1 flexibility lead to increased adult L2 learning. First, this study addresses this issue by directly measuring inhibitory control with multiple behavioral cognitive measures and by measuring L1 flexibility at the grammatical level using an event-related potential (ERP) paradigm. Second, this study aims to probe further into the posited role of these constructs by investigating the distinctive roles that inhibitory control and L1 grammatical flexibility may play in adult L2 learning among intermediate adult L2 learners with different types of L2 learning experience. Finally, the study aims to investigate to what extent inhibitory control abilities and L1 flexibility predict adult L2 learning success.

The results suggest that both inhibitory control abilities, specifically reactive inhibitory control, and L1 grammatical flexibility helped account for the variability found in L2 proficiency among our adult L2 learners of Spanish, and thus, may be added to the

list of existing individual factors that have been posited to be related to successful adult L2 learning.

This study is the first, to the author's knowledge, to specifically advance our understanding of the role of inhibitory control and L1 grammatical flexibility in adult L2 learning by using both behavioral and neurocognitive measures. Thus, importantly, the results of this study contribute to the existing body of knowledge on individual difference factors related to adult L2 development and provide critical new insight into the underlying cognitive and brain mechanisms that may contribute to successful adult L2 learning. Additionally, the results of this study, using both theories and methods from cognitive psychology, bilingualism, and adult L2 learning have the potential to inform research in these fields by expanding previous literature about the ways in which the adult brain is able to accommodate and regulate the presence of a new language and the functional role that inhibitory control and L1 flexibility may play both in adult L2 learning and for the *becoming bilingual* experience as a whole.

Chapter 1. Background

1.1 Introduction

In today's world, many adults find themselves in a situation in which it is beneficial or even necessary to learn a second language (L2). Yet, we can argue that L2 learning is possibly one of the most challenging and complex tasks for the adult mind. As a matter of fact, adult L2 learners often struggle when learning an L2, resulting in a great deal of variability in their learning outcomes, with some learners reaching favorable milestones in their language learning experience while some other learners do not. Given the great deal of variability in learning success across adult L2 learners, researchers in the field of second language acquisition (SLA), for over five decades now, have been interested in investigating the different characteristics that lead to successful adult L2 learning (e.g., Gardner & Lambert, 1965; Carroll, 1981; Segalowitz, 1997; Dornyei & Skehan, 2003). Despite the large number of SLA studies that have shed light on our understanding how adult L2 learning takes place and the different conditions that may enhance it, explaining the varying success in adult L2 learning is still an open question.

1.2 Statement of the Problem

One way in which SLA researchers have attempted to provide answers as to why some adults succeed when learning an L2 while others struggle has been to identify the role that internal factors, i.e., factors that are directly related to the learner, play in successful adult L2 development using both behavioral and neurocognitive methods. A variety of individual factors or individual differences have been proposed and explored empirically (see Dörnyei, 2006, for review) with the goal of identifying the ways in which they contribute to adult L2 learning. Among the characteristics that have been identified, we find individual differences related to three different sets of factors, (a) biological, such as age or sex (e.g., MacIntyre, Baker, Clément, & Donovan, 2002; DeKeyser, 2012), (b) cognitive, such as language aptitude, intelligence, attention or working memory (e.g., Harley & Hart, 1997; Kormos, 2000; Tagarelli, Borges-Mota, & Rebuschat, 2011) and (c) affective, such as personality, learning styles or motivation (e.g., Gardner, 1996; Van der Walt & Dreyer, 1997; Carson & Longhini, 2002). In particular, research that focuses on investigating the role that individual differences in cognitive abilities play in L2 learning has proven to be especially useful in accounting for some of the large variability found among adults learning an L2. Findings from this area of research have provided critical new insight into identifying the underlying cognitive and brain mechanisms that may contribute to adult L2 learning. Also, they have contributed to investigate the ways in which individual differences in cognitive abilities may interact with different learning contexts, instructional practices, or processing conditions to facilitate or hinder adult L2 learning (e.g., Morgan-Short, Faretta-Stutenberg, Brill-Schuetz, Carpenter, & Wong, 2014; Issa, Morgan-Short, Villegas, & Raney, 2015; Faretta-Stutenberg & Morgan-Short, 2018).

In addition to the abovementioned set of individual cognitive factors that have been found to play a role in adult L2 learning, researchers in SLA have recently begun to examine inhibitory control and first language (L1) flexibility as cognitive factors that may potentially facilitate adult L2 learning. This interest has emerged, in part, due to a hypothesis that suggests that learners with better inhibitory control abilities and more "flexible" L1 systems may be better at learning an L2 (Bice & Kroll, 2015). This hypothesis is driven by psycholinguistic research with bilinguals that revealed that both of their languages seem to be always active in the bilingual mind (e.g., Abutalebi & Green, 2008; Bartolotti & Marian, 2012; Kroll, Dussias, Bogulski, & Kroff, 2012; Poarch & van Hell, 2012), yet bilinguals are able to maintain functional separation between their two languages (i.e., they are able use either one or the other language as desired). The ability for bilinguals to functionally manage the constant co-activation seems to (a) be at least partially resolved by inhibitory control mechanisms (e.g., Green, 1998; Dijkstra & Van Heuven, 2002; Sunderman & Kroll, 2006; Misra, Guo, Bobb, & Kroll, 2012), and (b) result in an interaction between the languages at the lexical, phonological, and syntactic levels in which effects of one language are seen in the processing and, sometimes, use of the other language (e.g., Thierry & Wu, 2007; Dussias & Sagarra, 2007; Sanoudaki & Thierry, 2014; Chang, 2013; Luque, Mizyed, & Morgan-Short, 2018, Cabrelli, Luque, & Finestrat-Martinez, 2019). Although these effects have been examined extensively in early bilinguals, their posited role in adult L2 learning, i.e., emerging adult bilingualism, is relatively new and is only beginning to be addressed by empirical research.

1.2.1 Inhibitory Control

One cognitive factor that has received special attention in bilingualism research, but has only started to be explored empirically in adult L2 learners, is inhibitory control. The interest in inhibitory control has been motivated by the increasing number of studies with bilinguals that have found a relationship between inhibitory control mechanisms and bilingualism, suggesting that inhibitory control may be one of the underlying mechanisms that allow the mind and brain of bilinguals to accommodate the presence of two languages (Green, 1998; Green & Abutalebi, 2013). These studies have found evidence that suggests that, even in monolingual contexts, bilinguals have their languages active at all times (e.g., Hernandez, Li, & MacWhinney, 2005; Sunderman & Kroll, 2006; Thierry & Wu, 2007; Hatzidaki, Branigan, & Pickering, 2011; Wu, Cristino, Leek, & Thierry, 2013; Jacobs, Fricke, & Kroll, 2016). The constant co-activation of bilinguals' languages has been shown to generate cross-linguistic competition. The resulting cross-linguistic competition requires bilinguals to learn to correctly select the language they intend to use while having, at the same time, to manage the competition and interference derived from having their other language active at all times. Among the mechanisms involved in helping bilinguals manage their languages, inhibitory control has been posited to play a central role in helping bilinguals to functionally manage their languages (Green, 1998; Green & Abutalebi, 2013). With regard to adult L2 learning, only a few studies to date have investigated the role that inhibitory control abilities play in successful adult L2 development with some indicating a relationship (Levy, McVeigh, Marful, & Anderson, 2007; Linck, Kroll, & Sunderman, 2009; Bartolotti, Marian, Schroeder, & Shook, 2011; Kapa & Colombo, 2014; Grant, Fang, & Li, 2015; Darcy, Mora, & Daidone, 2016) while some others do not (Linck & Weiss, 2015; Stone & Pili-Moss, 2015). Considering the relevance of the findings that suggest that inhibitory control plays a functional role in bilingualism, we need to identify to what extent inhibitory control abilities are related to successful adult L2 learning, i.e., emerging bilingualism. Thus, one of the primary goals of this dissertation is to investigate the relationship between inhibitory control ability and adult L2 learning.

1.2.2 First Language Flexibility

As the field of bilingualism and SLA continued to investigate the way in which bilinguals and L2 learners are able to functionally manage their languages, studies of bilingual language processing have provided evidence that sheds light onto how each language may be affected by the cross-linguistic interference that results from juggling two languages in one mind (e.g., Dussias & Sagarra, 2007; Sanoudaki & Thierry, 2014; Sanoudaki & Thierry, 2015; Luque, Mizyed, & Morgan-Short, 2018).

These studies have revealed that bilingualism holds implications for the ways in which bilinguals and L2 learners process their languages. Particularly, empirical evidence has been found that indicates that the constant interaction between bilinguals' languages may result in bidirectional influences between the languages of bilinguals (Cook, 2003), where, in addition to L1 influences on the L2, we may find L2 influences on L1 that may change the way in which bilinguals process their L1. In that vein, a recent hypothesis has suggested that changes to the L1 may constitute a key step of proficient bilingualism and thus, has posited that learners who may be more flexible and thus, better able to tolerate changes to the L1, may be those who become more successful L2 learners (Bice & Kroll, 2015; Kroll, Bogulski, & McClain, 2012). An emerging strand of research has started to investigate whether being more flexible in your L1 and, thus, more tolerant to the underlying changes that the L1 may undergo as a function of being bilingual, can also be evidenced during adult L2 learning. Recent behavioral and neurocognitive studies have found evidence of L1 changes to the lexicon and phonology during adult L2 learning. These studies have provided some preliminary evidence of L1 change at both the lexical and phonological level (Baus, Costa, & Carreiras, 2013; Bice & Kroll, 2015; Chang, 2012; Kartushina, Frauenfelder, & Golestani, 2016, Cabrelli, Luque, & Finestrat-Martinez, 2019). However, no study, to our knowledge, has investigated whether evidence of L1 change can also be found during L1 grammatical processing and whether adult L2 learners who seem to be better able to tolerate those changes, i.e., those with a more flexible L1 system, may be those who show higher proficiency in an L2. In addition, further investigation into the interplay among inhibitory control abilities and L1 flexibility may allow us to better understand the implications that L1 flexibility may have for adult L2 development. Addressing these open questions is the second general aim of this dissertation.

1.3 Open Questions and Present Study

These open questions lead to the dissertation study's aim to examine whether being able to control and tolerate changes to one's L1, specifically during grammatical processing, may be among the characteristics of successful adult L2 learning.

Accordingly, this doctoral dissertation study addresses claims that suggest that inhibitory control abilities and L1 (grammatical) flexibility lead to increased adult L2 learning. First, this study addresses this issue by directly measuring inhibitory control with multiple behavioral cognitive measures and by measuring L1 grammatical flexibility using an event-related potential (ERP) paradigm. Second, this study aims to probe further into the posited role of these constructs by investigating the distinctive roles that inhibitory control and L1 flexibility may play among a range of intermediate adult L2 learners. Finally, the study aims to investigate to what extent inhibitory control abilities and L1 flexibility predict adult L2 learning success. The present study will be the first, to our knowledge, to specifically advance the field's understanding of the role of inhibitory control and L1 grammatical flexibility in adult L2 learning. More generally, the present study is expected to, at least partially, account for variation among L2 learners, and to provide new insight into the underlying cognitive and brain mechanisms that may contribute to successful adult L2 learning. Overall, the current dissertation study aims to experimentally address theoretical questions about adult L2 learning as informed by methodological approaches and theoretical perspectives from cognitive psychology, bilingualism, and L2 research.

Chapter 2. Review of Literature

2.1. Introduction

The present study encompasses questions of interest that aim to investigate the role that inhibitory control and L1 flexibility, two cognitive factors which have been posited to play a key role in bilingualism, have for successful adult L2 learning. Due to the interdisciplinary nature of this study, this chapter provides a review of relevant literature for the proposed study as informed by theories and methods from cognitive psychology, bilingualism, and adult L2 learning.

First, Section 2.2 provides an overview of theoretical questions as well as a review of empirical research related to the role of inhibitory control in bilingualism and adult L2 learning. Next, Section 2.3 offers a tentative definition of L1 flexibility as well as a review of empirical research related to the role of L1 flexibility in bilingualism and adult L2 learning. Finally, section 2.4 provides a description of the motivation and research questions for examination in the present study to elucidate the role that inhibitory control and L1 flexibility may play in adult L2 learning.

2.2 Inhibitory Control

In the last 20 years, a growing body of research has been dedicated to investigating how the mind and brain accommodate the presence of two languages. A key finding in bilingualism research suggests that, even in monolingual contexts, both languages are always active while bilinguals read, write, listen, plan to speak and/or speak in one of their languages, regardless of the requirement to use one language alone, as revealed by a substantial amount of evidence gathered by both behavioral and neurocognitive studies (e.g., Poarch & van Hell, 2012; Dijkstra, 2005; Wu & Thierry, 2010; Jacobs et al., 2016; Marian & Spivey, 2003; see Costa, La Heij, & Navarrete, 2006 for alternative view). These studies have shown that the constant parallel activation of the bilinguals' two languages generates cross-linguistic competition. Nonetheless, we observe that bilinguals are able to maintain functional separation between their languages. In other words, they are able to select the language they want to use and even switch between their languages with relatively high accuracy. This observation suggests that bilingual language processing requires bilinguals to learn to correctly select the language they intend to use while having to, at the same time, resolve the resulting cross-linguistic interference derived from their other language being active at all times (e.g., Linck, Hoshino, & Kroll, 2008; Abutalebi & Green, 2008; see Kroll et al., 2012, for a recent review).

One domain-general cognitive mechanism that has been proposed to aid in the resolution of this cross-linguistic competition and interference for bilinguals is inhibitory control (e.g., Green, 1998; Green & Abutalebi, 2013; Kroll, 2008). Below I more specifically review the phenomena of inhibitory control in bilingualism and lay out the argument about why inhibitory control capacity should be considered as an individual difference worth investigating in adult L2 learning. First, I provide a definition of inhibitory control and describe models that attempt to explain its role in bilingualism. Second, I briefly review evidence that suggests that inhibitory control is an important element of bilingual language processing and use. Finally, I argue as to why inhibitory control abilities may play a functional role in adult L2 learning.

2.2.1 Inhibitory Control: Definition and Models

The context for examining inhibitory control within the area of bilingualism and L2 learning research has been determined by a growing interest in understanding the way in which bilinguals are able to juggle two languages in one mind. As previously mentioned, a large number of psycholinguistic studies have hypothesized that the parallel activation of the bilinguals' languages generates cross-linguistic competition which needs to be resolved for bilinguals to be able to functionally use their languages. One of the mechanisms hypothesized to be involved in bilingual language selection is inhibitory control (e.g., Green, 1998; Dijkstra & Van Heuven, 2002; Abutalebi & Green, 2008). Inhibitory control refers to the ability to suppress information or responses that are prepotent, automatic, and/or irrelevant for the successful completion of a given task (Miyake & Friedman, 2000; Miyake & Friedman, 2012). In regard to language, it has been posited to play a role in aiding the management and regulation of the competition between the bilinguals' languages as well as in selecting the language that is being intended for use by the bilingual brain (e.g., Bialystok, 2009; Bialystok & Craik, 2010; Costa & Sebastián-Gallés, 2014).

Theories in cognitive psychology have identified inhibitory control, along with interference control, working memory updating, and set shifting, as core executive functions (EFs) (e.g., Barkley, 2012; see Diamond, 2013, for recent review). EFs have been defined as "high-level cognitive processes that, through their influence on lower-level processes, enable individuals to regulate their thoughts and actions during goal-directed behavior" (Diamond, 2013, p. 137) and have been shown to display a general pattern of shared but distinct functions (Miyake & Friedman, 2000).

A series of theoretical models have attempted to conceptualize how bilingual language selection and control takes place and suggested that bilinguals' ability to functionally manage and use their languages may be directly linked to inhibitory control.

The most prominent hypothesis, the Inhibitory Control (IC) Model (Green, 1998), poses that a domain-general control mechanism in the bilingual brain is responsible for aiding the resolution of the cross-linguistic competition and interference by suppressing irrelevant language representation, such as words from the language that the speaker does not intend to use (i.e., non-target language), in order to allow for the representations of the language in use (i.e., target language) to reach the necessary level of activation required for language selection to take place.

Similarly, the Bilingual Interactive Activation (BIA+) model of word recognition (Dijkstra & Van Heuven, 2002) proposes that bilingual language selection is an interactive process that requires both activation and control of lexical entries. More specifically, the BIA+ proposes that as lexical representations of the target language become activated, that activation is spread through language nodes that use non-linguistic contextual cues, i.e., task demands, goals of the speaker, etc., to inhibit the activation of the lexical representations from the non-target language.

Both the IC and BIA+ models propose that the amount of control that needs to be exerted for bilingual language selection to occur is of a reactive nature. In other words, they posit that individuals utilize inhibitory control in response to the degree of activation of the competing representations from the non-target language. These two models implicitly suggest that bilingual language selection and control is an interactive process, involving the ability to coordinate top-down and bottom-up processes that extend beyond the ability to inhibit non-target language representations.

In that regard, recent psycholinguistic studies investigating how bilingual language selection and control take place have provided evidence that supports the idea that language control extends beyond an individual's global inhibitory capacity (e.g., Costa, Hernández, Costa-Faidella, & Sebastián-Gallés, 2009; Morales, Gómez-Ariza, & Bajo, 2013; Morales, Yudes, Gómez-Ariza, & Bajo, 2015). Findings from these studies have driven researchers to suggest the need to dissociate different aspects of inhibitory control, such as proactive and reactive inhibition, in order to investigate how different executive processes dynamically interact during bilingual language processing and use. In the same vein, Green and Abutalebi (2013) have proposed a revised version of the IC model, the Adaptive Control Hypothesis (ACH), which attempts to incorporate other factors within the inhibitory-account perspective of bilingual language selection that may better capture the complexity of the bilingual experience. The ACH posits that bilingual language control may not just be exerted based on individuals' needs to achieve a specific goal, i.e., the inhibition of non-target language representations. Instead, Green and Abutalebi (2013) argue that bilingual language control may not only be reactive but may also be adaptive to meet the ever-changing demands placed by the very diverse interactional contexts in which bilinguals often find themselves. Thus, the ACH poses that bilingual language control also involves the ability to coordinate a different set of processes, such as goal maintenance and conflict monitoring, in addition to reactive inhibitory mechanisms to achieve proficient language performance.

Accordingly, the present study addresses these theoretical considerations given that multiple measures of inhibitory control were incorporated in order to dissociate different aspects of inhibitory control, such as conflict monitoring and proactive and reactive inhibition. The incorporation of multiple tasks allows us to investigate (a) the relationship between global inhibitory control ability (i.e., reactive control) and adult L2 learning, as well as (b) how different inhibitory control processes (i.e., proactive, reactive, and conflict monitoring) interact and adapt during adult L2 processing among adult L2 learners at the intermediate level.

2.2.2 Inhibitory Control: Evidence of Its Role in Bilingualism

Initial evidence supporting the inhibitory control account in bilinguals comes from behavioral studies that employed language-switching tasks on the lexical level (see Abutalebi & Green, 2008, for review). One of the earliest studies to test this hypothesis was conducted by Meuter and Allport (1999). In their seminal study, Meuter and Allport (1999) asked bilinguals to name aloud a series of digits using their two languages in an unpredictable manner. During the task, participants were presented with a set of trials and were asked to respond using their L1 for a consecutive number of trials (non-switch trials) followed by a set of trials where participants had to respond using their L2 (switch trials) with the order counterbalanced across participants. Results showed that bilinguals took longer to perform the switch trials compared to the non-switch trials. The most interesting finding was revealed when comparing the time it took for bilinguals to switch (i.e. switch-cost) from their L1 to their L2 relative to the time it took for them to switch from their L2 to their L1. Analyses showed a greater switching cost when the switch was made from their L2 to their L1 than the reverse, revealing that it was more costly for bilinguals to switch from L2 to their L1 than from their L1 to their L2. The asymmetry found was taken as evidence of inhibition by hypothesizing that naming in the L2 required bilinguals to engage inhibitory control more in order to manage the resulting cross-linguistic competition from a dominant and stronger lexical representation in their L1. Therefore, additional time would be required, as revealed by the difference in switch costs, to overcome the effects from having the corresponding L1 lexical and phonological representation inhibited in the bilinguals' strong L1 (see also Van Heuven, Dijkstra, & Grainger, 1998; Wodniecka, Bobb, Kroll, & Green, 2005; Costa & Santesteban, 2004; Costa et al., 2006).

Additional behavioral evidence for the role of inhibition in bilingual language processing has been found for semantics, grammar, and speech planning (e.g., Hoshino & Thierry, 2012; Morales, Paolieri, & Bajo, 2011; Misra et al., 2012; Wu & Thierry, 2017). At the semantic level, Hoshino and Thierry (2012) found electrophysiological evidence of inhibition of semantic representations from the non-target language when bilinguals were asked to process homographs in one of their languages that were related in meaning to the bilinguals' other language. At the grammatical level, in a picture-naming task, Morales et al. (2011), found evidence of inhibition when grammatical gender was a source of competition between the bilinguals' two languages. Finally, for speech planning, Misra et al. (2012), found electrophysiological evidence of inhibition in a blocked switching task when bilinguals were asked to make a switch from naming pictures in their L2 to naming them in their L1.

An additional indication of the role of inhibitory control in bilingualism comes from studies reporting that bilinguals often tend to outperform monolinguals in non-verbal tasks that require the use of inhibition (e.g., Bialystok & Martin, 2004; Ryan, Bialystok, Craik, & Logan, 2004) although results have been mixed (e.g., Costa et al., 2009; Paap & Greenberg, 2013, Wu & Thierry, 2013; Duñabeitia & Carreiras, 2015). In a study comparing monolingual and bilingual children performance on the dimensional change card sort task (DCSST, Frye, Zelazo, & Palfai, 1995), a task that requires participants to inhibit attention to a mental representation and ignore misleading cues so that a new representation can be constructed, Bialystok and Martin (2004) found that bilinguals exhibited significantly better inhibitory control skills in the DCCST than monolinguals. Similarly, Ryan et al. (2004), in a study that required younger and older monolinguals and bilinguals to perform a task where they needed to inhibit specific information, such as the misleading position of target items or irrelevant information, found a bilingual advantage when comparing performance between bilinguals and monolinguals. Overall, these studies suggest that the lifelong experience of learning to manage two languages in one mind, requiring the constant practice of having to inhibit the language not in use, may hold implications for cognition more generally extending beyond the language domain, resulting for example in more efficient inhibitory control abilities and a more enhanced executive function network for bilinguals (e.g., Bialystok, Klein, Craik, & Viswanathan, 2004; Bialystok & Craik, 2010; see Bialystok, 2009, for review).

These findings converge well with a growing body of neurocognitive research with bilinguals that has provided evidence that brain regions associated with inhibition and other cognitive control mechanisms, such as the left dorsolateral pre-frontal cortex (DLPC), the left anterior cingulate cortex (ACC) and the caudate nucleus (CN), have shown increased activation during bilingual language processing (see Abutalebi & Green, 2016, for review). These results are consistent with the hypothesis that juggling two languages in one mind engages domain-general executive functions, such as inhibitory control, to correctly select the language that bilinguals intend to use while suppressing the non-target language representations from their other language (see Abutalebi, 2008, for review).

In sum, the available empirical evidence suggests that bilinguals seem to engage inhibitory control, among other executive functions, to manage the competition between their languages. Also, it indicates that the life-long experience of using language control mechanisms while juggling two languages in one mind has consequences for the mind and the brain of bilinguals. Such consequences may reflect a reorganization of brain networks resulting in the enhancement of domain-general cognitive control functions outside of the language-domain for bilinguals, thus impacting the brain mechanisms that support the languages of bilinguals, and ultimately reshaping the ways in which bilinguals are able to negotiate competition more generally (e.g., Bialystok, Craik, & Luk, 2012; Kroll, Bobb, & Hoshino, 2014). Considering the relevance of the findings that suggest that inhibitory control plays a functional role in bilingualism, we need to identify to what extent inhibitory control abilities are related to successful adult L2 learning, i.e., emerging bilingualism, as well as the ways in which it impacts the ability for adult L2 learners to become more bilingual-like during the L2 learning experience.

2.2.3 Inhibitory Control: Its Role in Successful Adult L2 Learning.

Drawing from the relevance of the findings that suggests that inhibitory control plays a functional role in bilingualism, studies in the field of L2 learning have recently started to investigate how inhibitory control abilities contribute to adult L2 learning. Emerging evidence for a role of inhibitory control in adult L2 learning has been found at the lexical, phonological, and grammatical level, as evidenced by both behavioral and neurocognitive studies (for the lexical: Linck et al., 2009; Bartolotti et al., 2011; Grant et al., 2015; for the phonological: Levy et al., 2007; Darcy et al., 2016; for the grammatical: Kapa & Colombo, 2014). However, contradictory results have been found indicating no relationship between inhibitory control abilities and adult L2 learning (Linck & Weiss, 2015; Stone & Pili-Moss, 2015).

Among the studies that have found a relationship between inhibitory control abilities and adult L2 learning outcomes, we find three main patterns of interesting findings. First, similar to bilinguals, empirical evidence suggests that the L1 seems to be inhibited during L2 use. Effects of inhibition have been found in the L1 when looking at adult L2 learners' L1 performance on behavioral tasks after L2 use. For example, using a picture-naming task adapted to a retrieval practice paradigm, Levy et al. (2009) asked adult L2 learners of Spanish whose L1 was English to repeatedly name target items in each one of their languages. The amount of trials that participants had to spend naming target items in each language was critically manipulated in order to investigate whether naming an item in the participants' L2 would result in the inhibition of the corresponding representation in the participants' L1. Results showed that naming target items in Spanish 10 times in a row significantly decreased the generation of English target items, suggesting that increased use of an L2 required participants to inhibit the phonological representations of the target items in their L1, making them less accessible and thus, harder to retrieve.

Linck et al. (2009) conducted an experiment where they examined performance on a verbal fluency task between L2 learners who were immersed in the L2 during a semester abroad with learners who had L2 classroom experience only. Participants were told that they would be presented with a category (e.g., fruits) and had to produce as many examples of that category as they could within 30 seconds (e.g., “apple, pear, banana, etc.”). Participants performed the verbal fluency task in both their L1 and their L2. Results indicated that immersed participants were able to produce significantly more examples in the L2 than the classroom learners. Interestingly, the immersed learners produced significantly fewer examples in their L1 than the classroom learners. These results provide further evidence for inhibition of the L1 during L2 use. Additionally, their results show that access to the L1 may be differentially attenuated depending on the context of learning (immersion *vs* classroom learning), with the L1 being less accessible during immersion but the L2 more available. Taken together, these findings may partially shed some light on why studying abroad, where learners are put in an environment where they are asked to continuously exercise their ability to control their languages, has been evidenced to result in greater language learning gains than classroom-only learning (e.g., Sanz, 2014; Grey, Cox, Serafini, & Sanz, 2015).

Additional evidence of a role for inhibition during L2 processing comes from a longitudinal study using functional neuroimaging (fMRI). In their study, Grant et al. (2015) investigated whether L2 lexical processing would reveal increased activation of brain regions associated with cognitive control, including inhibitory control, as compared to L1 lexical processing among early L2 learners. Participants completed a lexical decision task while their brain activity was being recorded and were asked to identify both language-ambiguous words (e.g., Spanish–English homographs such as *pie*, which means foot in Spanish but cake in English) and language-unambiguous words (e.g., clearly English or clearly Spanish). Results revealed significantly increased activation in cognitive control areas when adult L2 learners were asked to resolve cross-linguistic interference from competing language ambiguous representations. In sum, these results suggest that adult L2 learning, like proficient bilingualism, requires domain-general control mechanisms, such as inhibitory control, to manage the consequences of having to juggle two languages in one mind.

Second, studies suggest that the engagement of inhibitory control may be adaptive, as hypothesized by the ACH model (Green & Abutalebi, 2013), and may differ based on L2 proficiency, as revealed by a significant interaction between inhibition and language dominance where the least fluent L2 learners showed a significantly larger L1-inhibition effect relative to the more fluent L2 learners (Levy et al., 2009). Similarly, changes in neural activity in brain regions related to cognitive control were found as adult learners achieved higher proficiency in an L2, revealing that gains in L2 proficiency may be related to participants' ability to manage competition across their languages, at least at the lexical level (Grant et al., 2015). These results suggest that the role that inhibitory control plays during L2 learning may differ as proficiency increases, which may also be related to learners becoming more skilled at regulating the influence of their L1 on their developing L2.

Third, studies have found an association between stronger inhibitory control abilities and L2 learning outcomes. Evidence of a relationship between inhibitory control abilities and adult L2 learning has been found for L2 word learning (Bartolotti et al., 2011), for L2 phonological learning (Darcy et al., 2016), and also for L2 grammar learning (Kapa & Colombo, 2014). For L2 word learning, Bartolotti et al. (2011) asked participants to learn words from two novel languages that were based on International Morse Code. Interference between the two languages was manipulated by introducing two highly conflicting cues that competed to define word boundaries differently across languages. Participants' inhibitory control abilities were assessed via a Simon task, a widely used behavioral task to assess inhibition. Results indicated that when interference was high during L2 word learning, participants with stronger inhibitory control abilities performed significantly better than participants with poorer inhibitory control abilities. Researchers interpreted the effect by claiming that stronger inhibitory control abilities allowed participants to better selectively attend to the set of cues that were key for word segmentation in the high-interference condition, suggesting that stronger inhibitory control skills may not also contribute to better L2 word learning overall, but that, importantly, they can also contribute to word segmentation ability, both key abilities in L2 learning.

For L2 phonological learning, Darcy et al. (2016) asked L2 learners of Spanish to complete a speeded ABX categorization task and a delayed sentence repetition task to assess L2 phonological processing in both perception and production. Additionally, they used a retrieval-induced inhibition task to measure learners' inhibitory control abilities. Results indicated a relationship between L2 learners' ability for segmental perception and consonant production and inhibitory control abilities. Along with the finding of a relationship between L2 word and L2 grammar learning and inhibitory control, these results suggest that inhibitory control abilities may also play a role in L2 phonological acquisition, where inhibitory control abilities may aid L2 learners with the processing of phonologically relevant acoustic information in the L2 input, which would ultimately lead to the development of more accurate phonological representations in their L2.

Finally, for L2 grammar learning, Kapa and Colombo (2014) had participants learn an artificial language to examine whether executive function abilities would predict how easily a second language can be acquired. Participants were exposed to a simplified version of the artificial language via an implicit training task, i.e., grammar rules were never explicitly taught. The artificial language consisted of 12 nouns and 4 verbs presented via a picture book and a series of training videos that were created for the study. From the combination of nouns and verbs, 528 different sentences were created in the artificial language. Participants' ability to learn the small artificial language system was measured by using six tests of receptive and expressive knowledge, including a grammaticality judgment task to assess L2 grammatical learning. Inhibitory control abilities were assessed using the Attentional Network Task (ANT; Fan et al., 2002), a task used to assess inhibitory control abilities among other executive functions. Results found a relationship between inhibitory control skills and learners' performance on a grammaticality judgment task. The researchers concluded that the relationship between inhibitory control and L2 learning that was found in the study may have be related to the participants' ability to inhibit their L1 during L2 grammar learning, suggesting that individuals who may be able to better inhibit access to their L1 during L2 learning may be better equipped to ultimately become more successful L2 learners.

The results from these studies suggest that the additional cognitive demands of incorporating a new language into an already established linguistic system might be less challenging to those individuals who have stronger inhibitory control abilities. In that vein, based on the available evidence one would predict that one's ability to better regulate the influence from a strong L1 grammar during L2 learning may yield benefits to learning the grammar of an

L2.

However, despite the empirical evidence that suggests a posited role of inhibitory control in adult L2 learning, other studies have found no relationship. In a correlational study, Linck & Weiss (2015) found the opposite effect. Twenty-five beginner university students learning Spanish as an L2 were asked to complete the Diploma of Spanish as a Foreign Language Test (e.g., DELE, Montrul, 2005), to assess L2 grammatical competence, and a Simon task (Simon & Rudell, 1967), as a measure of inhibitory control. Results revealed no relationship between inhibitory control abilities and L2 grammatical proficiency, as assessed by the grammar portion of the DELE, for adults learning an L2 in a classroom context. Additionally, and contrary to Kapa and Colombo (2014)'s findings, Stone and Pili-Moss (2015) found no relationship between inhibitory control abilities and participants' ability to learn an artificial language. In their study, native speakers of English were trained in an artificial language named Brocanto2 (developed by Morgan-Short, Steinhauer, Sanz, & Ullman, 2012), which is composed of rules that are common to Romance languages, such as Spanish. Participants received explicit training, i.e., grammar rules were explicitly taught, of Brocanto2 grammar via a computer board game that contained six comprehension and six production modules of language practice. After the practice modules were completed, participants were asked to complete a GJT as a measure of L2 grammatical development. Inhibitory control abilities were assessed via a Flanker task (Eriksen & Eriksen, 1974), a task typically used to assess inhibitory control abilities. Results showed a relationship between performance on the Flanker task and GJT scores, thus suggesting no relationship between inhibitory control abilities and the early stages of L2 grammatical development under explicit learning conditions.

Even if results are mixed, the available evidence is relatively new and there still remain open questions to be answered. Also, the overwhelming findings in bilingualism that suggest a role for inhibitory control in bilingualism motivate the need to continue studying this relationship. Thus, advancing this line of research in the field of SLA may positively shed light on the different underlying cognitive mechanisms that are involved in adult L2 learning. Studies to date have not yet explored the role of inhibitory control abilities across a wide range of intermediate adult learners with different L2 learning experience. A possible justification for the null effects found in Linck and Weiss (2015) and Stone and Pili-Moss (2015) studies could be partially explained by the fact that their participants were at very early stages of L2 learning, and thus, inhibitory control effects may not have emerged because learners may have not had enough experience controlling their two languages and/or may be still relying heavily in their L1 knowledge while using their L2. Given that inhibitory control has been linked to L2 learning, but the relationship between L2 learners' inhibitory control ability and L2 development at the intermediate stages of L2 learning and for different L2 learning experiences is still largely unknown, the primary research question of the proposed project is well suited to address the existing gap. This project should provide some insight into this question given that data will be collected across intermediate adult L2 learners as well as from monolinguals and bilinguals.

Also, recently it has been argued that the Flanker and the Simon task, the tasks used by Linck and Weiss (2015) and Stone and Pili-Moss (2015) to assess inhibitory control in their respective studies, may have low task reliability, and thus, using them as the only assessment of inhibitory control may not provide the best measure of one's overall inhibitory control ability (Paap & Greenberg, 2013). In that regard, there is a growing consensus that suggests that due to the complexity of the *becoming* bilingual experience, multiple inhibitory control tasks should be utilized to assess both the unique and diverse nature of inhibition in order to explore in what ways and at what stages inhibitory control may play a role during adult L2 learning (e.g., Miyake & Friedman, 2012; Morales et al., 2013). The proposed dissertation will address this methodological consideration given that I propose to incorporate multiple measures of inhibitory control and will collect data from adult L2 learners with different L2 proficiency and L2 experience.

Beyond looking at whether inhibitory control is associated with adult L2 learning, we also want to consider whether a phenomenon that is at least partially related to inhibitory control may also be related to adult L2 development. This phenomenon is L1 flexibility, and it has recently been hypothesized to play a role in successful adult L2 learning (Bice & Kroll, 2015). In the following section, I more specifically lay out the argument as to why L1 flexibility should be considered as an individual difference in adult L2 learning. First, I provide a tentative definition of L1 flexibility. Second, I briefly review evidence that suggests that L1 flexibility is an important element to bilingual language processing. Finally, I argue as to why L1 flexibility may play a functional role in adult L2 learning.

2.3. L1 Flexibility

As the field of bilingualism and L2 research have continued to investigate the way in which bilinguals and L2 learners are able to manage two languages in a single mind, studies of language processing with bilinguals have provided evidence that sheds light onto how each language may be affected by the cross-linguistic interference that results from having to manage both of their languages (e.g., Hernandez et al., 2005; Wu et al., 2013).

These studies revealed that the consequences of bilingualism extend beyond the parallel activation of the bilinguals' two languages and the reported cognitive advantages of enhanced inhibitory control, among other executive functions. Interestingly, they also suggest that bilingualism has consequences for the way in which bilinguals and L2 learners process their languages. Particularly, empirical evidence has been found that suggests that the constant interaction between bilinguals' languages may result in bidirectional influences between the languages of bilinguals (Cook, 2003). Bidirectional influences have been found where not only the L1[1] influences the L2, as it has been shown throughout the extensive literature on L1 transfer (e.g., Sabourin, Stowe, & de Haan, 2006; Treffers-Daller & Sakel, 2012; Montrul & Ionin, 2010), but also where the L2 influences the L1, and, thus, may change the way in which bilinguals process their L1, possibly making it more flexible, as a function of accommodating the L2 into their existing language system.

2.3.1 L1 Flexibility: Definition

A formal definition of L1 flexibility has not yet been proposed. Nonetheless, researchers that have found evidence of L1 flexibility due to L2 influence have attempted to explain the nature of those changes. Among the ways researchers have attempted to characterize what L1 flexibility entails, we find L1 flexibility tentatively defined as (a) an acquired regulation skill, (b) a strategy to admit the L2 into the existing language system, (c) a consequence of having to regulate the L1 to enable proficient performance of the L2, (d) as indication that the learning and active use of two languages creates dynamics that change the language system as a whole, and (e) as an expected consequence of the interactive nature of having two languages housed in a single brain (e.g., Kroll et al., 2012; Bice & Kroll, 2015; van Hell & Dijkstra, 2002; Kroll et al., 2014; Kroll & Bialystok, 2013).

[1]Throughout the dissertation, we will use L1 to refer to the native or most dominant language and L2 to refer to the weakest or least dominant language.

2.3.2. L1 Flexibility: Evidence of Its Role in Bilingualism

As demonstrated by research in bilingualism, changes to the L1 seem to be a natural consequence of managing two languages in one mind. In that vein, a recent hypothesis has suggested that changes to the L1 may constitute a key step of proficient bilingualism, and, thus, has posited that learners who may be more flexible and better able to tolerate changes to the L1 may be those who become more successful L2 learners (Bice & Kroll, 2015; Kroll et al., 2012).

An emerging strand of research has started to investigate whether being more flexible in your L1 and, thus, more tolerant to the underlying changes that the L1 may undergo as one becomes bilingual, can also be evidenced during adult L2 learning. Recent behavioral studies have found evidence of L1 changes to the lexicon and phonology during adult L2 learning (e.g., Van Assche, Duyck, Hartsuiker, & Diependaele, 2009; van Hell & Dijkstra, 2002).

Empirical evidence suggesting changes to the L1 in bilinguals due to L2 influence have been found for all levels of representation, suggesting that differences in language dominance, use, and exposure may lead to changes in the linguistic system of bilinguals. For example, at the lexical level, effects of the L2 during L1 word use have been found when looking at bilinguals' performance on lexical decision and sentence processing tasks in their L1 that contained cognates. Results from those studies showed that L2 word knowledge affected L1 word performance, where cognates were processed significantly slower than non-cognates. For example, van Hell and Dijkstra (2002) showed that highly proficient Dutch-English-French trillinguals' performance on a L1 (Dutch) lexical decision task that contained cognates as well as non-cognates was influenced by the knowledge of the L2, evidenced by the finding that reaction time (RT) in the lexical decision task was significantly slower for cognates than non-cognates. Similarly, in a later study van Assche et al. (2009) asked Dutch-English bilinguals to read sentences in Dutch, some of them containing cognates, while their eye movements were being recorded. Results indicated faster reading times for cognates than non-cognates, suggesting that L2 knowledge affected L1 reading.

Indication of L2-to-L1 influence has also been found at the phonological level for bilinguals (e.g., De Leeuw, Schmid, & Mennen, 2010; Chang, 2013; Mora & Nadeu, 2012, Cabrelli, Luque, & Finestrat-Martinez, 2019). For example, in a study with German-English bilinguals, De Leeuw et al. (2010) found evidence of systematic phonetic changes, known as phonetic drift, as L1 speech was being perceived as L2-accented speech due to the influence of L2 phonological knowledge during L1 production. Relatedly, Chang (2013) in a study with L1 English/L2 Korean bilinguals found evidence of L1 sounds drifting towards similar L2 sounds after just six weeks in the L2 environment. Additionally, Mora and Nadeu (2012) found that early Catalan-Spanish bilinguals that had extensive L2 experience were less accurate and significantly slower when asked to discriminate L1 sound categories. Additionally, highly experienced bilinguals exhibited a more L2-like acoustic target production for specific L1 sounds, such as the Catalan /ɛ/, particularly in cognate words. Finally, Cabrelli, Luque, and Finestrat-Martinez (2019), in a study with late Brazilian Portuguese-English bilinguals found evidence of L2 phonotactic influence in L1 perception as a function of L2 learning experience. Specifically, participants in their study showed differences in the way they perceived the L1's phonotactic structure, specifically in regard to the perception of illusory vowels in Brazilian Portuguese, when compared to monolingual speakers. These results are consistent with the view that extensive experience with an L2 has consequences for the L1, also at the phonological level.

Finally, at the grammatical level, studies have revealed effects of L2 grammatical knowledge during L1 grammatical use, where bilinguals seemed to prefer syntactic properties shared by both languages to syntactic properties that were L1 specific when performing tasks that asked them to switch between their languages (Kootstra, van Hell, & Dijkstra, 2010; Hatzidaki et al., 2011; Purmohammad, 2015). For example, Koostra et al. (2010) showed that Dutch-English late bilinguals preferred using a word order shared by both languages rather than a word order specific to the language at the start of the sentence when asked to switch between their L1 and L2 while describing pictures. Similarly, Hatzidaki et al. (2011) found that highly proficient English-Greek bilinguals' production of subject-verb agreement in one language was influenced by the syntactic properties of the subject of the other language when they had to switch languages between the subject and the verb. Finally, in a language-switching picture-naming task, Purmohammad (2015) provided evidence that highly proficient Persian-English bilinguals' production of noun phrase word order in one language was influenced by the syntax of the noun phrase word order of the other language when participants were required to switch between their languages.

Additional supporting evidence of L1 flexibility comes from studies investigating bilingual language processing using more fine-grained methods, such as eye-tracking or ERPs, where changes to L1 processing have been identified and interpreted as indicators of L2 to L1 influence (e.g., Dussias & Sagarra, 2007; Vaughan-Evans, Kuiper, Thierry, & Jones, 2014; Sanoudaki & Thierry, 2014; Sanoudaki & Thierry, 2015) . For example, Dussias and Sagarra (2007) in a study using eye-tracking, found evidence of L2-to-L1 influence as Spanish-English bilinguals were asked to read complex sentences in their L1 and resolve syntactic ambiguities. Results from their studies revealed that bilinguals who had been immersed in the L2 environment for a long time, adopted a parsing strategy in their L1 that was L2-like. Results from their study suggest that the L1 changes, becoming more flexible, in response to increased L2 use. In another study, Vaughan-Evans and colleagues (2014) provided some initial neurocognitive evidence of L2 to L1 influence and change during grammatical processing in a study using event-related potentials (ERPs) with highly proficient Welsh-English bilinguals. In their study, they found that Welsh-English bilinguals unconsciously applied Welsh-specific morphosyntactic rules while reading in English. Similarly, in another study, Sanoudaki and Thierry (2014, 2015) provided additional neurocognitive evidence of L2 to L1 influence/change during grammatical processing in an ERP study with Welsh-English bilinguals that revealed that the way bilinguals processed one of their languages was being influenced by the knowledge of the co-activated grammar of their other language.

These changes have been hypothesized to occur as a function of accommodating the L2 into their existing language system. Also, it has been posited that constant cross-language interactions, along with the need for bilinguals to regulate the L1 via inhibitory control processes to enable proficient performance in the L2, may help to partially explain the source of the changes that occur to the L1 as a consequence of increased L2 use (Kroll & Bialystok, 2013). Because the linguistic system of bilinguals has been posited to be dynamic and interactive, it is reasonable to expect that changes to their seemingly stable L1 can be found as evidence of the intrinsic plasticity of the bilinguals' language system, as well as an expected consequence of the interactive nature of the languages at play as part of the bilingual experience.

The aforementioned findings have very important implications for the way in which we conceive language processing and organization for bilinguals and L2 learners, particularly when taking into account the available evidence that suggests that the active use of two languages in a single mind may hold specific implications for the languages of bilinguals, for example causing them to converge (e.g., Ameel, Storms, Malt, & Sloman, 2005; Green, Crinion, & Price, 2006), resulting in changes to both languages that make the bilinguals' two languages more similar to each other and less like the languages of monolingual speakers. Evidence of bilingual language convergence and L1 change reinforces the idea posited by Grosjean (1989) that a bilingual is not two monolinguals in one, and thus, suggests that monolingual-like processing and performance should not constitute the ultimate goal for L2 learning. Instead, bilingual-like processing and performance should be considered as the model to understand the underlying mechanisms that allow L2 learners to become more bilingual-like, including but not limited to changes to their seemingly stable L1 that may or may not be revealed behaviorally.

2.3.3 L1 Flexibility: Its Role in Successful Adult L2 Learning

As shown by research in bilingualism, changes to the L1 seem to be a natural consequence of managing two languages in one mind. In that vein, a recent hypothesis has suggested that changes to the L1 may constitute a key step of proficient bilingualism and thus, has posited that learners who may be more flexible and thus, better able to tolerate changes to the L1, may be those who become more successful L2 learners (Bice & Kroll, 2015; Kroll et al., 2012).

An emerging line of research has started to investigate whether evidence of L1 flexibility can be also evidence during adult L2 learning (e.g., Baus et al., 2013; Chang, 2012; Kartushina et al., 2016). Recent studies have found behavioral evidence of L1 change at the lexical and phonological levels during adult L2 learning. At the lexical level, Baus et al. (2013) found that naming latencies for low-frequency L1 words were considerably slower just after 4 months of L2 immersion. Similarly, these researchers found slower naming latencies at the end than at the beginning of the immersion period but only for both low frequency items and non-cognate words. These results have been attributed to the less frequent use of the L1, and thus the more attenuated activity of the L1 due to the constant need of exerting inhibition of the L1, during L2 immersion (see also Linck, Kroll, & Sunderman, 2009). At the phonological level, Chang (2012) found L1 speech sound production changes in the form of drifts toward the phonetic properties of the L2 after six weeks of L2 classes in the L2 environment. Similarly, Kartushina et al (2016) showed L1 production changes after only 1 hour of articulatory training with nonnative sounds. Results from these studies indicate that even brief experience with the L2 may lead the L1 to become at least more flexible both at the lexical and phonological level.

These results converge well with evidence from a recent neurocognitive study using ERPs that investigated changes to the processing of L1 words during adult L2 learning. In their study, Bice and Kroll (2015) showed that L1 word processing was affected by L2 word knowledge from the very early stages of learning, as differences were found when processing cognate words versus non-cognates, and that the effect seemed to increase at higher levels of proficiency. Interestingly, Bice and Kroll (2015) found individual variability in the degree of the L1 change during word processing. Specifically, when looking at the degree of L1 change among their participants, Bice and Kroll (2015) found that learners who showed more change during L1 processing, in other words, those who had a more flexible L1, exhibited greater proficiency in their L2. Additionally, a positive relationship was found between the magnitude of the effect and the inhibitory control abilities of the L2 learners, suggesting a relationship between one's ability to critically regulate the influence of the L1 during L2 learning using inhibitory control processes, L1 changes and L2 proficiency.

Similarly, other studies have found that both effects of the L2 on L1 production as well as the degree of L1 change can vary greatly across speakers (e.g., De Leeuw, Mennen, & Scobbie, 2012; Major, 1992). Such variability seems to be related in part to the inhibitory control abilities of the L2 learners as well as the robustness of L1 category representations. For example, Lev-Ari and Peperkamp (2013) found a relationship between the amount of L1 drift and inhibitory control abilities among L2 learners, with individuals with lower inhibitory control showing greater L1 drift than individuals with higher inhibitory control, suggesting that inhibitory control abilities may help modulate changes to the L1. Also, Kartushina et al. (2016) found a relationship between individual differences in the production of L1 speech sounds and the amount of drift that these sounds underwent after brief training with non-native sounds. Results revealed that L2 to L1 influence was greater for individuals who were more variable in their L1 production before training. These results suggest that speakers with more robust, and thus, less flexible, L1 category representations may be less susceptible to L2-to-L1 influences and may experience greater difficulty during L2 learning.

These studies have provided some preliminary evidence of L1 flexibility at both the lexical and phonological level. However, no study, to our knowledge, has investigated whether evidence of L1 flexibility can also be found during L1 grammatical processing, and whether adult L2 learners who seem to be better able to tolerate those changes, i.e., those with a more flexible L1 system, may be those who show higher proficiency in an L2 (Bice & Kroll, 2015). In addition, further investigation into the role that inhibitory control abilities may have in adult L2 learning, as well as its relationship with L1 flexibility, may allow us to better understand the implications that being better able to tolerate changes to one's L1 grammar may have for adult L2 learning.

2.4 Motivation and Research Questions for Study

These abovementioned open questions lead to the study's aim to investigate whether being able to control the influence of the L1 during L2 learning as well as well as to tolerate changes to one's L1, specifically during grammatical processing, may be among the factors related to successful adult L2 learning. Therefore, the current study addresses claims that suggest that inhibitory control abilities and L1 (grammatical) flexibility may be related to increased proficiency for adult L2 learners. First, this study addresses this issue by directly measuring inhibitory control with multiple behavioral cognitive measures and by measuring L1 grammatical flexibility using an event-related potential (ERP) paradigm. Second, this study aims to probe further into the posited role of these constructs by investigating the distinctive roles that inhibitory control and L1 flexibility may play among a range of intermediate adult L2 learners. Finally, the study aims to investigate to what extent inhibitory control abilities and L1 flexibility predict adult L2 learning success.

The present study will be the first, to our knowledge, to specifically advance the field's understanding of the role of inhibitory control and L1 grammatical flexibility in adult L2 learning. More generally, the present study is expected to, at least partially, account for variation among L2 learners at the intermediate, and to provide new insight into the underlying cognitive and brain mechanisms that may contribute to successful adult L2 learning. Overall, the current dissertation study aims to experimentally address theoretical questions about adult L2 learning as informed by methodological approaches and theoretical perspectives from cognitive psychology, bilingualism, and L2 research.

2.4.1. Research Questions

Given the study's goal of investigating whether individual differences in inhibitory control abilities and L1 flexibility may contribute to L2 development among adult intermediate learners of Spanish, the following specific research questions are addressed:

Research Question 1 (RQ1): Do we find evidence of a relationship between inhibitory control and linguistic ability in an L2?

Research Question 2 (RQ2): Do we find evidence of L1 change/flexibility during grammatical processing for adult L2 learners?

Research Question 3 (RQ3): Do we find evidence of a relationship between the degree of L1 flexibility and linguistic ability in an L2?

Research Question 4 (RQ4): Do inhibitory control abilities and degree of L1 flexibility predict L2 learning outcomes?

Chapter 3. Research Methods and Design

3.1 Introduction

This chapter provides a detailed description of the research methods and design of the study. Section 3.2 provides an overall description of the research design. Section 3.3 describes the participants. Section 3.4 describes the target structure of interest to investigate flexibility during L1 grammatical processing. Section 3.5 provides detailed information about the materials and procedures related to control variables (i.e., language experience and use, intelligence, working memory, and language switching), predictor variables (behavioral measures of inhibitory control and electrophysiological measures of L1 flexibility), and dependent variables (L2 proficiency). Section 3.6 provides an explanation of the statistical analyses that were performed to address the research questions.

3.2 Overall Research Design

The present study investigates the role that inhibitory control abilities and L1 grammatical flexibility play during adult L2 learning using both behavioral and neurocognitive methods. The experimental design consists of one group of adult L2 intermediate learners of Spanish. Additionally, an English monolingual and a Spanish-English early bilingual group serve as control groups to investigate whether higher L2 proficiency and greater L2 experience within the group of intermediate Spanish learners result in more bilingual-like and less monolingual-like processing of the grammar of their L1. We examined these questions by (a) assessing L2 proficiency with multiple measures in adult learners of Spanish with varying levels of L2 experience, (b) measuring learners' domain-general inhibitory control ability, (c) measuring to what extent their L2 knowledge affects their L1 grammatical processing using an electrophysiological paradigm, and finally, (d) examining to what extent inhibitory control abilities and L1 grammar flexibility predict adult L2 learning success.

The study was divided in two experimental sessions lasting approximately three hours each that on average occurred three days from each other. Task order was randomized across participants for both sessions. The experimental design of the study is summarized graphically in the figure below (see Figure 1).

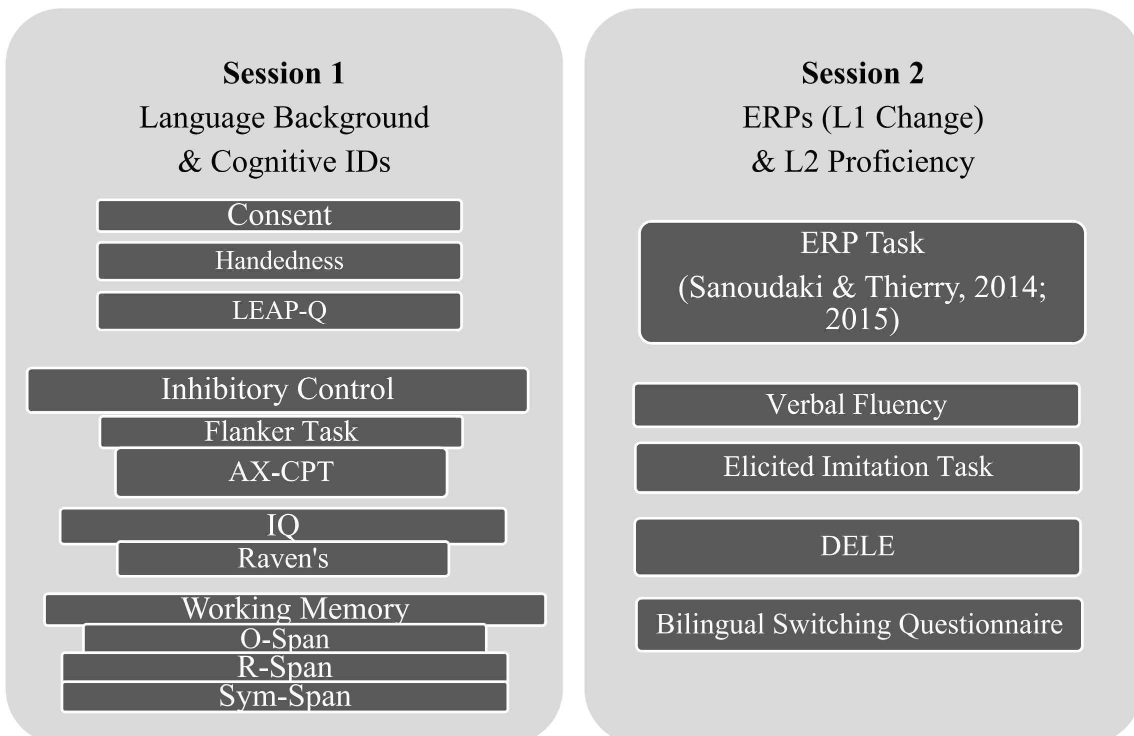

Figure 1. Overview of study design

3.3 Participants

Twenty-one adult L2 intermediate learners of Spanish (*N*= 14 females) participated in this study. All participants were speakers of American English, between the ages of 18 and 35, right-handed as assessed by the abridged version of the Edinburgh Handedness Inventory (Oldfield, 1971) with normal or corrected-to-normal vision and/or hearing, and with no reported history of drug or alcohol dependence or psychiatric, neurological, or learning disorders. The experimental participants were adult L2 learners who have first been exposed to Spanish after the age of 14 and in classroom environments. The reason behind choosing 14 years of age or older as the threshold age of first L2 exposure to is related to 14 years of age being the *common* age for students to start high school in the United States.

We chose to investigate the study's research questions among intermediate learners because previous research has suggested that they may be expected to show an effect as a group, as Bice & Kroll (2015) showed evidence of L1 flexibility during lexical processing for adult L2 learning at the intermediate level, at the same time, I expected to find a significant amount of variability within the group as I recruited learners that represent a broad spectrum of intermediate learners. The minimum requirement for intermediate learners was that they had completed the basic Spanish language program and were enrolled in 200 or 300 level courses at the time of testing. Also, no study abroad experience was required to participate in the study, although participants completed a language history background questionnaire to gather exhaustive data about their overall L2 experience. (see Table I).

Table I

L2 Group: Participant characteristics

	L2 Learners *M* (*SD*)
Age (years)	20.76 (2.09)
Years of Education	15.76 (2.08)
Age first exposed to L1	0 (0)
L1 Self-Rated[a] Reading Proficiency	10 (0)
L1 Self- Rated[a] Writing Proficiency	9.55 (.56)
L1 Self- Rated[a] Speaking Proficiency	10 (0)
Age first exposed to L2	14 (.78)
L2 Self- Rated[a] Reading Proficiency	7 (1.03)
L2 Self- Rated[a] Writing Proficiency	6.34 (1.21)
L2 Self- Rated[a] Speaking Proficiency	6.50 (.95)
WM-Composite Score[b]	-0.01 (0.52)
WM-OSpan[c]	17.81 (6.74)
WM-RSpan[d]	16.71 (8.08)
WM-SymSpan[e]	8.21 (5.27)
IQ[f]	9.57 (3.7)
Language Switching (Daily)[g]	2.48 (.88)
% of Daily L2 Use	30% (2.78)

Note.
[a.] Reported on a scale from 1 = no proficiency to 10 = native-like proficiency
[b,] (Average of z-scores from each of the three tasks, which are standardized scores that rely on group mean and SD).
[c, d & e.] Maximum score on OSpan & RSpan = 75; SymSpan = 42 (following absolute scoring protocol)
[f .] Shortened Raven's Task = Maximum score 18
[g] BSWQ = Reported on a scale from 1 = never to 5 =always

In order to examine the relationship between L1 flexibility and adult L2 learning from a multilingual continuum perspective, i.e., whether having higher L2 proficiency makes adult L2 learners' processing of grammar in their L1 look more bilingual-like and, thus, less monolingual-like, two additional control groups of 15 participants each were included: (a) an English monolingual group, and (b) a Spanish-English early bilingual group Bilingual participants had been exposed to both Spanish and English before the age of eight, which was the age by which bilinguals in S&T (2014; 2015) had been exposed to their two languages. Bilingual participants in the current study reported that they were fluent in both Spanish and English (see Table II), as did bilinguals in S&T for Welsh and English. Monolingual participants only reported being fluent in English and reported minimal study of second languages, including Spanish.

All participants provided written informed consent to participate in the study and received either monetary compensation (all the participants from the L2 and bilingual groups) or course credit (all the participants in the monolingual group) for their time.

Table II

Control groups: Participant characteristics

	Bilinguals *M* (*SD*)	Monolinguals *M* (*SD*)
Age (years)	20 (1.35)	19.5 (0.86)
Age first exposed to L1	0 (0)	0 (0)
L1 Self- Rated[a] Reading	9.3 (.98)	10 (0)
L1 Self- Rated[a] Writing	8.9 (.63)	10 (0)
L1 Self- Rated[a] Speaking	9.5 (.73)	10 (0)
Age first exposed to L2	3.6 (2.43)	12.78 (2.91)
L2 Self- Rated[a] Reading	9.3 (.58)	3.14 (3.4)
L2 Self- Rated[a] Writing	9.2 (1.01)	3.3 (.93)
L2 Self- Rated[a] Speaking	9.8 (.81)	3.2 (2.51)

Note. [a]Reported on a scale from 1 = *no proficiency* to 10 = *native-like proficiency*.

3.4 Target Structure

The target structure we used to investigate L1 grammar flexibility is adjective-noun word order. The rationale behind using this grammatical structure in the study was based on the cross-linguistic variation in the adjective-noun word order between English, i.e., the L1 of our proposed experimental participants, and Spanish, i.e., the L2 of our proposed experimental participants. The canonical word order in the determiner phrase (DP) for English is adjective-first (i.e., The blue$_{adjective}$ house$_{noun}$ was on the left), whereas in Spanish it is noun-first[2] (i.e., La casa$_{noun}$ azul$_{adjective}$ estaba a la izquierda). Hence, this cross-linguistic syntactic variation between English and Spanish allowed us to investigate whether the increasing experience with noun-first DP order in L2 Spanish has an effect on processing L1 English adjective-first DP order.

3.5 Materials and Procedure

3.5.1 Control Variables

Individual difference measures of language history (LEAP-Q, Marian, Blumenfeld, & Kaushanskaya, 2007) and cognitive abilities, specifically those that may be related to inhibitory control and language change, such as IQ (APM; Winfred & David, 1994), working memory (OSpan, RSpan, SymSpan, Oswald, McAbee, Redick, & Hambrick, 2015), and language switching tendencies (BSW, Rodriguez-Fornells, Kramer, Lorenzo-Seva, Festman, & Münte, 2012), were collected in the study in order to control for any intervening effects these variables may have on the relationship between the predictor variables and the dependent variables. These measures are described below.

3.5.1.1 Language Experience

Language Experience and Proficiency Questionnaire (LEAP-Q). The LEAP-Q (Marian et al., 2007) was used in the study to assess the language experience of our participants. The LEAP-Q is a validated and widely used tool designed to provide a comprehensive account of an individual's language history for descriptive purposes. The domains assessed by the LEAP-Q include acquisition history, contexts of acquisition, present

[2] Some exceptions to the rule may be found in literary prose, where categorical adjectives may be placed before nouns. In such cases, pre-nominal adjectives conserve their original attributive meaning, (i.e., *green/verde*) but they been moved to a pre-nominal focalized position (Taboada, 2010) to fulfill a specific interpretive effect.

language use, language preference, accent ratings as well as proficiency ratings, across the four domains of language use: speaking, understanding, reading, and writing. The questionnaire has a total of 16 items including nine general questions and seven language-specific questions. The questionnaire took approximately 15 minutes to complete for speakers of two languages. (See Appendix A; Language Experience and Proficiency Questionnaire.)

3.5.1.2 Intelligence

Shortened Raven Advanced Standard Progressive Matrices Test. In order to control for any effects of general intelligence (IQ) on various measures, IQ was measured with the Shortened Raven's Advanced Progressive Matrices Test (APM; Winfred & David, 1994). The Raven is a measure of abstract reasoning. The version of the Raven's that we used in this study was computer administered and consists of 36 individual items presented in three segments of 12 items each. Within each segment, the items were presented in ascending order of difficulty (i.e., the easiest item was presented first, and the hardest item was presented last). Each item consisted of a matrix of geometric patterns with the bottom-right pattern missing. Participants were asked to select, among either six or eight alternatives, the one that correctly completes the overall series of patterns that have been presented. Each matrix item was presented separately on the screen along with the response alternatives. Participants were asked to use the mouse to select the response from the ones presented that they thought would complete the pattern. Participants were allotted 5 minutes to complete each segment. Participants received two practice problems before starting with the experimental trials. Overall, the task took approximately 15 minutes to complete. IQ was computed as each participant's total number of correctly solved problems. (See Figure 2)

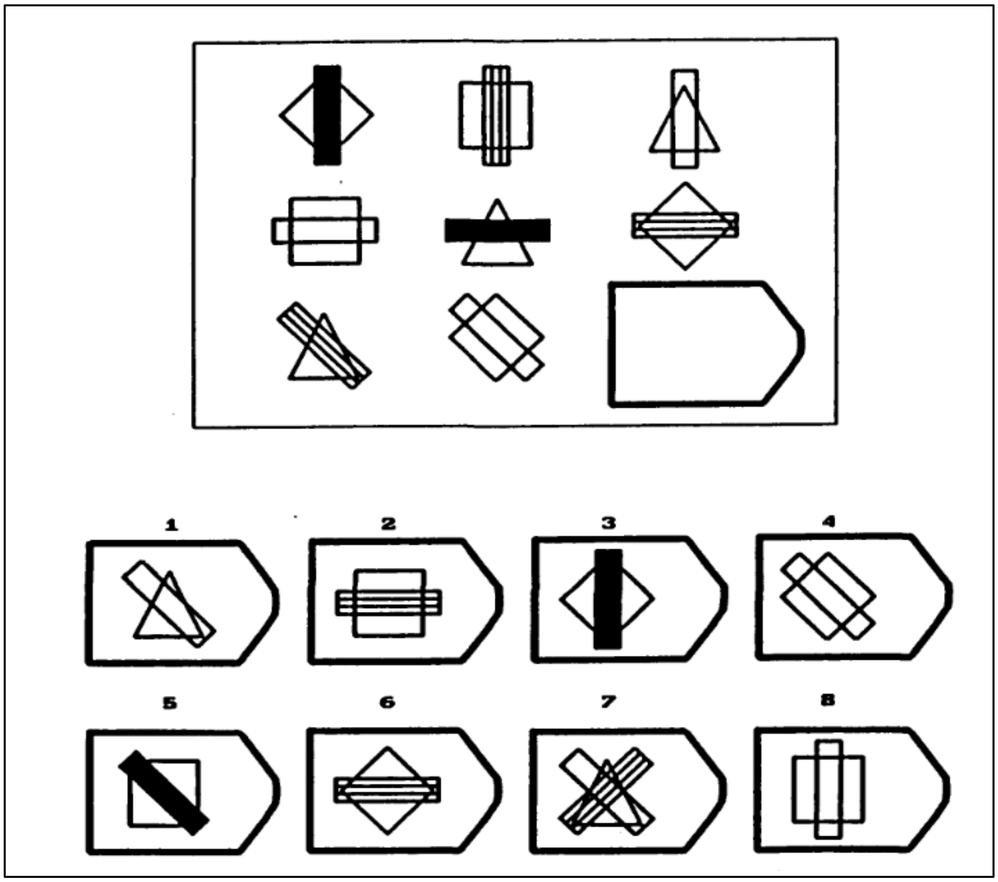

Figure 2. Example Trial of Raven's Task. Adapted from "Development of a Short form for the Raven Advanced Progressive Matrices Test", by A. Winfred and D. David, 1994, *Journal of Educational and Psychological Measurement*, *52*(2), p. 397. Copyright © 1994 by SAGE Publications.

3.5.1.3 Working Memory

Working memory (WM) is one of the cognitive variables that has been posited to play a role during adult L2 learning (see Linck, Osthus, Koeth, & Bunting, 2014, for review). Also, working memory and inhibitory control are hypothesized to co-occur and support one another and rarely is one needed but not the other (Diamond, 2013). Thus, in order to independently examine the role of inhibitory control, we controlled for WM using scores from three shortened versions of established WM capacity tasks (following Oswald et al., 2015) namely the operation span task (OSpan), the reading span task (RSpan), and the symmetry span task (SymSpan). Each one of these tasks was designed to tap into both the processing and storage components of WM (Baddeley, 2012) by specifically asking participants to (a) make judgments about a given series of items and (b) to recall a specific list of given series of elements (See Figure 3 for an overview of the WM tasks).

O-Span Task. In this task, participants were presented with simple math problems and were asked to verify whether the solution provided is correct or incorrect (e.g., "Is (1+5)/2 = 3?"). Approximately half of the equations presented were correct. After each match problem, participants were presented with a letter from the alphabet (e.g., "L") and were asked to store it in memory for recall at the end of each set. Set sizes ranged from 3–7 trials, including both letters and math problems, with three administrations for each set size (i.e., 75 total operation-storage pairs).

R-Span Task. In this task, participants were presented with a set of sentences of approximately 10–15 words in length and were asked to determine whether the sentences presented make sense, i.e., they describe situations that are likely to occur on a daily basis (e.g., John was asked to sit on a chair) or not (e.g., John was asked to sit on a cloud).

Approximately half of the sentences presented were sensical/nonsensical. After each letter, participants were presented with a letter from the alphabet (e.g., “L”) and were asked to store it in memory for recall at the end of each set. Set sizes ranged from 3–7 trials, including both letters and math problems, with three administrations for each set size (i.e., 75 total operation-storage pairs).

Sym-Span Task. In this task, participants were presented with 8x8 matrices of black and white squares and were asked to judge if the matrices were symmetrical with respect to the vertical axis or not. Approximately, half of the matrices presented were symmetrical. After each matrix, participants were asked to recall the location of a red square position inside a 4x4 matrix. Set sizes ranged from 2–5, with three administrations for each set size (i.e., 42 total symmetry-storage pairs).

Following Oswald (2015), participants received two overall scores for each combination of span task and set size. Participants’ absolute scores were the number of trials in which the participant recalled all elements in the correct order without error, and participants’ partial-credit scores incorporated error by adding up the proportions of correctly recalled elements in each trial. In order to ensure assessment of overall WM ability rather than attentional control alone, participants ‘absolute’ scores (Overall Score), which takes into account recalled sets with correct responses on both processing and recall portions were the ones included in the analyses. Given the disparity between maximum score between the OSpan/RSpan – 75, and SymSpan – 42), following Faretta-Stutenbeg (2014) the overall OSpan, RSpan, and SymSpan scores were converted into z-scores, (i.e., [Participant Score – Group Average Score) / Group Standard Deviation]) and then then averaged together in order to calculate a composite WM ability score for each participant.

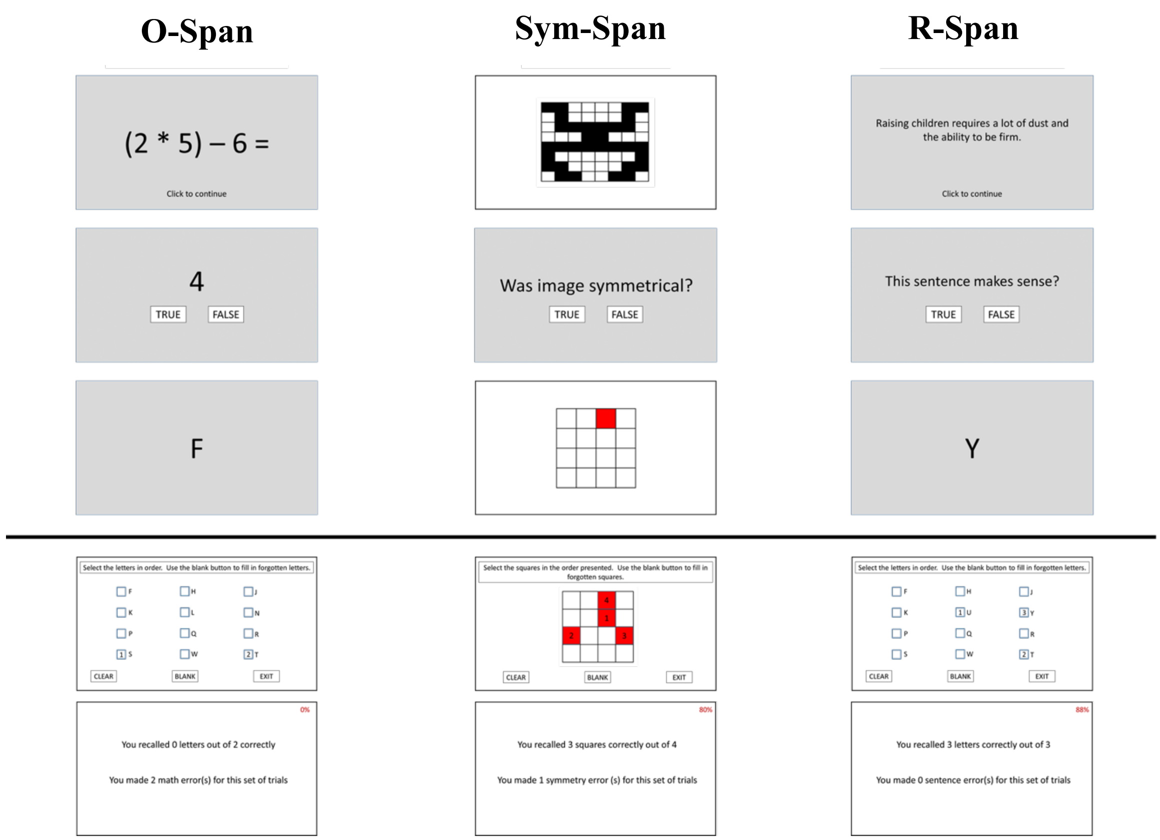

Figure 3. Overview of experimental trials for working memory tasks. For each task, the first three slides show one processing-storage sequence and the last two slides show the recall and feedback screens at the end of each trial. Task provided by R. Engle Laboratory; Unsworth, Heitz, Schrock & Engle, 2005.

3.5.1.4 Language-switching

Previous literature has found a relationship between language switching behavior, i.e., whether an individual is used to switching between their languages regularly or not, and differences in the way in which bilinguals utilize inhibitory control (e.g., Prior & Gollan, 2011; Bialystok, 2009). Thus, language switching tendencies were assessed in the proposed study by asking participants to complete a bilingual switching questionnaire to gather information about their daily language-switching behavior (following Rodriguez-Fornells et al., 2012).

Bilingual switching questionnaire (BSWQ). The BSWQ allows experimenters to evaluate the degree to which a specific behavior characterizes an individual's language switching habits. The BSQW uses a five- point scale (1–5) to quantify the frequency of the behavior described: never (1), rarely (2), occasionally (3), frequently (4), or always (5), with larger values on the index indicating more frequent switching behavior. (See Appendix B; Bilingual Switching Questionnaire).

3.5.2 Predictor Variables

The present study aims to explore the relationship between inhibitory control abilities and L1 change in adult L2 development; as such, these variables were examined as predictors of performance in the behavioral measures of adult L2 development. In this section, the measures of inhibitory control ability and L1 flexibility are described.

3.5.2.1 Inhibitory Control

Inhibitory control (IC) abilities was assessed via two widely used tasks, that include the presence of competing or conflicting information that must be ignored (i.e., inhibited) in order to successfully perform the task. The two tasks will be a Flanker Task (Flanker; Erisken & Erisken, 1974) and the Automated Continuous Performance Task (AX-CPT; following Morales et al., 2013). Two different tasks were used in order to facilitate a valid and diverse measurement of IC ability (Miyake & Friedman, 2012). As suggested by the ACH (Green & Abutalebi, 2013) it is necessary to take into consideration that the ability to coordinate other control mechanisms, apart from reactive inhibition may play a distinctive role in achieving efficient language selection. By incorporating these two tasks in the study, we were able to examine the relationship between global IC ability and two sub-components of IC ability that have been posited to play a role in bilingualism, such as proactive control (i.e., conflict monitoring) and reactive control (i.e., inhibition). Below, the materials and procedures for each task are summarized. The materials and procedures for each task are described in detail below and an overview of these tasks is provided in Figures 4 and 5.

Flanker Task. In this study, we assessed global inhibitory control abilities by having participants complete a Flanker task (Flanker; Erisken & Erisken, 1974) In this task, participants were presented with a series of arrows pointing to the left or the right and were asked to indicate as quickly and as accurately as possible whether the central arrow (the target item) points to the left or right by pressing the left-side mouse button when the target arrow points to the left, or the right-slide mouse button when the target arrow points to the right. In this task, the target arrow was always presented alongside 4 flanker stimuli following either one of the 3 following conditions: (a) arrows pointing in the same direction as the target arrow (i.e., congruent trials), (b) arrows pointing in the opposite direction of the target arrow (i.e., incongruent trials) or (c) surrounded by flanking lines without arrowheads (i.e., neutral trials).

The task procedure was as follows: (a) a fixation cross appeared on the center of the screen and remained there during the whole trial, (b) a cue (an asterisk) was presented for 100 ms, (c) a fixation cross appeared for 400 ms after the cue (d) the target arrow and the flankers were presented simultaneously for 1700 ms or until participant's response, (e) the target and flankers disappeared after a response was made and the next trial began. Accuracy and reaction time (RT) were recorded. Global IC ability was assessed via the Flanker effect (RT difference between incongruent and congruent trials).

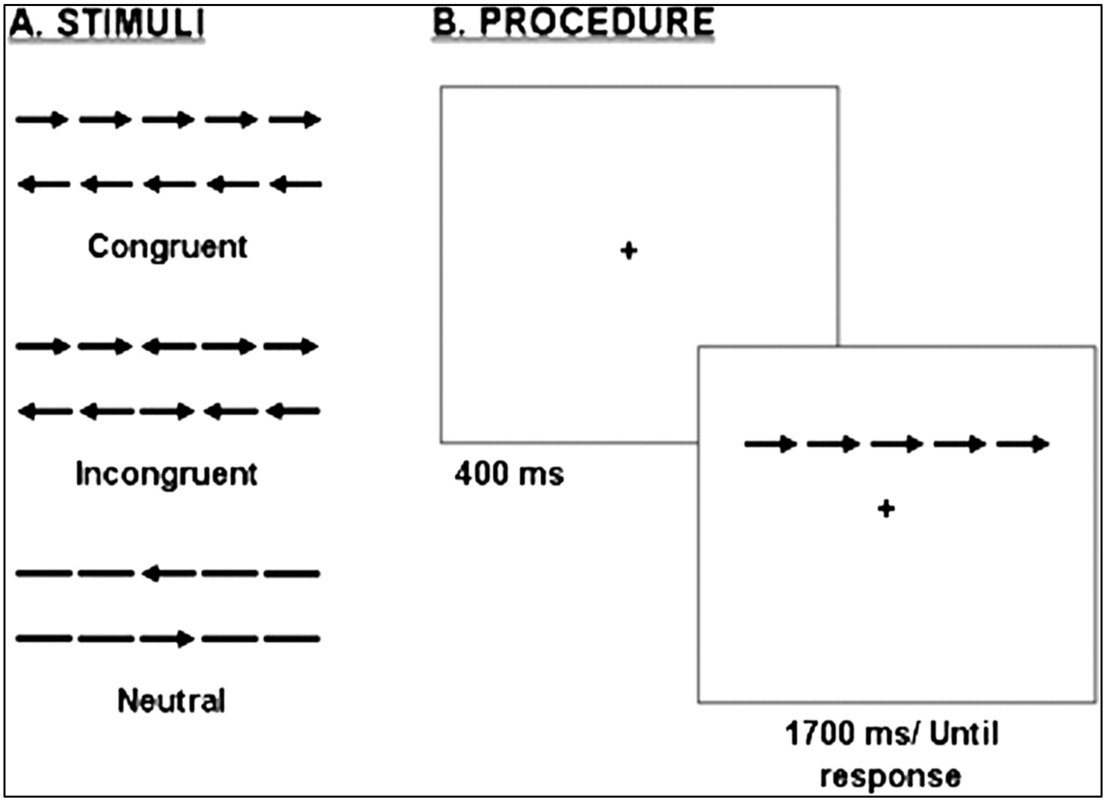

Figure 4. Example trials of Flanker task. Adapted from “Bilingualism Tunes the Anterior Cingular Cortex in Conflict Monitoring”, by J. Abutalebi, P. A. Della Rosa, D. W. Green, M. Hernandez, P. Scifo, R. Keim, S. F. Cappa, and A. Costa, 2011, *Cerebral Cortex*, *22(9)*, p. 3. Copyright © 2011 by Oxford University Press.

Automated Continuous Performance Task (AX-CPT). The current study aimed to assess the coordination of two sub-components of IC ability, reactive and proactive control, that are relatively independent but mutually complementary, and that have been posited to interplay to achieve efficient language selection in bilinguals (Morales et al., 2013; Morales et al., 2015) by using the AX-CPT (following Morales et al., 2013). The AX-CPT has been previously used to differentiate proactive and reactive control mechanisms in bilinguals as it allows for the recreation of conditions under which it is possible to anticipate a highly probable event from those conditions where processes that are already engaged must be inhibited in reaction to a presented stimulus. Proactive control is hypothesized to be an early attentional mechanism that helps select and maintain task goals. More specifically, proactive control is hypothesized to anticipate upcoming events and manage interference by selecting the most relevant and/or appropriate candidate before competition occurs. Alternatively, reactive control is hypothesized to be responsible for detecting and solving potential interference in a conflicting context. In the version of the AX-CPT that we incorporated in the current study, participants were presented with pair of letters and were asked to respond to specific cue and probe combinations, namely press "yes" when the letter X is preceded by the letter A and press "No" for all other sequences (AY, BX and/or BY)[3]. Target "AX" trials appeared 70% of the time whereas non-target trials "AY, BX, and/or BY" appeared only 10% of the time. Following Morales et al., (2013), proactive and reactive control was assessed by comparing performance on the different types of trials,

[3] AY trials consist of an A prime followed by any letter than it's not an X. BX trials consists of a letter prime that could by any letter, but A followed by an X letter probe. BY trials are control trials where neither the prime nor the probe overlap with the experimental trials.

specifically, reactive inhibitory control was the measure of number of errors in AY trials and proactive inhibitory control was the measure of number of errors in BX trials. Optimal performance in the task would mean that participants keep the number of errors to a minimum for both proactive and reactive control trials (See Figure 5).

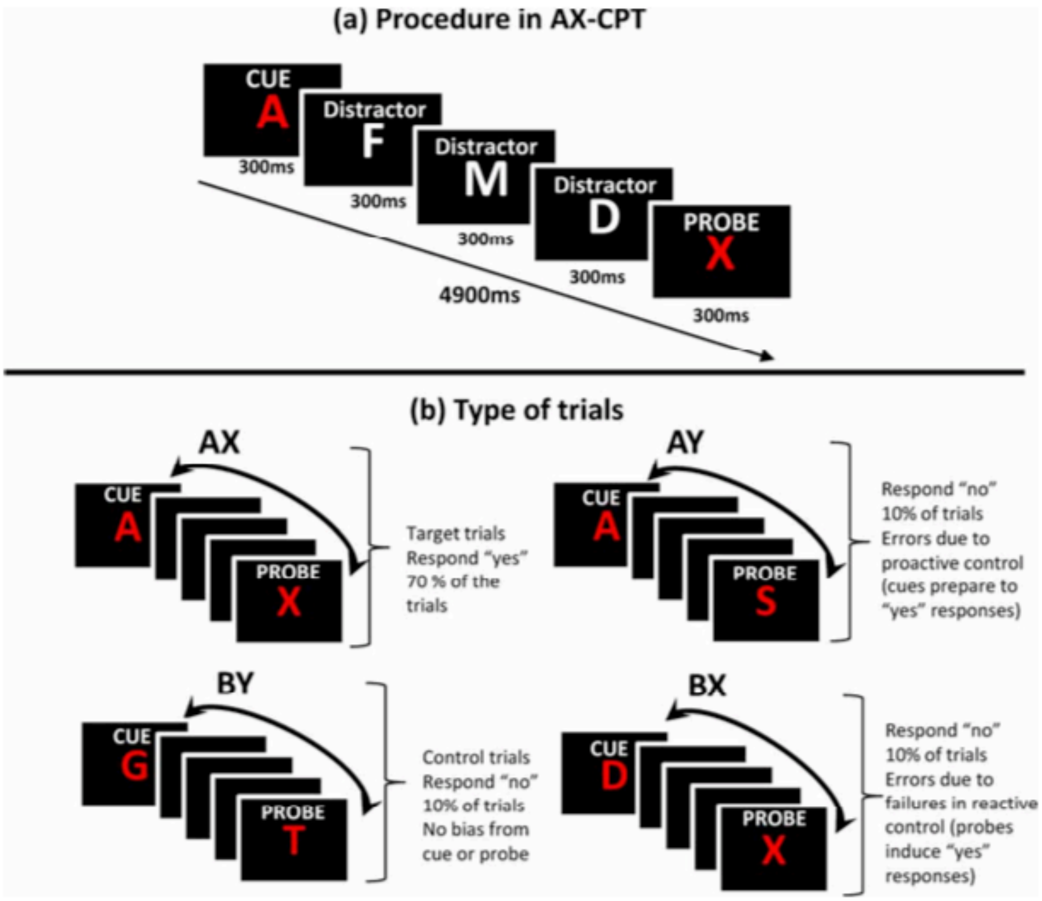

Figure 5. Example trials for the AX-CPT task. Adapted from "Dual Mechanisms of Cognitive Control in Bilinguals and Monolingual", by J. Morales, J. Gómez-Ariza, J., and M.T., 2013, *Journal of Cognitive Psychology*, *25*:5, p. 5. Copyright © 2013 by Taylor & Francis.

3.5.2.2 L1 Flexibility

Flexibility in L1 grammatical processing was assessed with a picture sentence-relatedness Go/No-Go task adopted from Sanoudaki and Thierry (henceforth, S&T) (2014, 2015), an ERP study that provided some initial evidence of neurocognitive changes during grammatical processing in bilinguals, with processing in one of their languages being influenced by the grammar of their other language.

Picture sentence-relatedness Go/No-Go ERP task. *Stimuli.* All of the stimuli used in the current study were adopted directly from S&T (2014, 2015). A total of 48 colored pictures had been generated by S&T from line drawings of six objects (book, phone, car, pen, box, shirt) and eight colors (red, blue, yellow, green, pink, white, brown, black). For each picture (e.g., red box), ten sentences were generated that included a noun phrase that described the picture and a verbal phrase that described the location of the picture on the screen (e.g., *The red box was on the right.*). Eight of the ten sentences for each picture included a noun phrase that contained both an adjective and a noun, with half of the adjectives and half of the nouns matching the picture. Additionally, half of the noun phrases were presented in the grammatical word order for English (e.g., adjective-first), and half of the noun phrases were presented in the ungrammatical English word order (e.g., noun-first). Note that the ungrammatical noun-first order in English would be grammatical in Spanish. Thus, for each picture, there were eight sentences with different iterations of noun phrases, half of which had a matching noun, half of which had a matching adjective, half of which had an adjective-first English-like word order, and half of which had a noun-first Spanish-like word order (e.g., *red box, box red, blue box, box blue, red pen, pen red, blue pen, pen blue)*. Additionally, two filler sentences for each picture included a noun phrase where only a matching or mismatching noun was presented so that participants did not to expect to see an adjective upon seeing a noun in the first position (e.g., *box, pen*). Overall, the stimuli consisted of 480 trial sentences with ten sentences for each of the 48 pictures, in a fully balanced two-by-two-by-two design as explained above.

Task Procedure. Following S &T (2014; 2015), each of the 480 trials began with a picture being presented on either the right or the left side of the screen for 200 ms (e.g., red box). After a 500 ms interval, the stimuli sentence, as described above, was presented using rapid serial visual presentation with individual words or phrases being displayed in the center of the screen for 200 ms each (e.g., *The / red / book / was on / the right.*). The inter-stimulus interval between words in the noun phrase was 800 ms to allow for ERP measurement during noun phrase presentation, and the inter-stimulus interval between the final two segments of the sentence was 500 ms. Finally, a "Correct/Incorrect?" prompt was displayed for 2000 ms where participants were expected to respond. The 480 trials were presented in 6 blocks with 80 trials each, and the trial order was randomized for each participant.

Participants were instructed to decide whether the information in the sentence about the position of the picture is correct or not, and they had to respond by clicking the "Yes" mouse button if the position information was correct and the "No" mouse button if the position information was incorrect. The response side on the mouse for the "Yes" and "No" responses was counterbalanced between participants.

Importantly, as in S&T (2014; 2015), the experimental ERP task is a Go/No-Go task. Thus, participants were instructed to respond ('Go') only if the sentence contains an adjective or a noun (or both) that matched the picture that had been presented (e.g., red box). Otherwise, participants were instructed not to respond ('No-Go') to the sentence. Given the word order manipulation (i.e., adjective-first or noun-first) and the picture matching manipulation (i.e., match or mismatch), there were four conditions, exactly as in S&T, based on the first word of the noun phrase: adjective-first match (e.g., *red box, red car*), adjective-first mismatch (e.g., *blue box, blue car*), noun-first match (e.g., *box red, car red*), and noun-first mismatch (e.g., *box blue , car blue*). The matching conditions were considered to be ‘Go’ trials as participants could make their decision to respond when the first word was presented because the first word matched the picture. The mismatching conditions were considered to be ‘No-Go’ trials because the first word did not match the picture and, thus, participants would need to either (a) inhibit their response decision until the second word was presented if they expected a second word (for English monolinguals and L2 learners of Spanish when the adjective was presented first as they would expect a subsequent noun, because nouns follow adjectives in English, and for bilinguals and possibly more advanced L2 learners of Spanish when the noun was presented first, the hypothesis is that they may expect a subsequent adjective, because adjectives can follow nouns in Spanish), or (b) decide not to respond if they did not expect a second word (for monolinguals when a noun presented first as they would not expect a subsequent adjective, because adjectives do not follow nouns in English). Regardless of when participants made their response decision, at the end of each sentence, participants were expected to respond to all ‘Go’ sentences with a matching noun or adjective as either the first or second word matches the picture, but participants were expected to not respond to ‘No-Go’ sentences with neither a matching noun nor a matching adjective.

ERP Data Acquisition. Before the start of EEG data acquisition, participants completed practice trials following the experimental design described above and were required to reach at least 70% response accuracy on 15 practice trials, which were different than trials presented during the experimental task. Practice trials were repeated for a maximum of two times to ensure

that the participant understands the procedures of the task. All participants needed to reach the accuracy threshold for practice in order to proceed with the experimental task. As participants completed the experimental task, continuous EEG was recorded. For 17 participants from the experimental L2 group, the EEG data was recorded from a 32 sintered Ag/AgCl electrodes on an Easycap (BrainProducts GmbH, Gilching, Germany) placed according to the extended 10-20 international system (Jasper, 1958) as subjects performed the task silently. Eye movements and blinks were monitored by placing two vertical electro-oculogram (VEOG) electrodes above and below the right eye and, and one horizontal (HEOG) electrodes on the outer canthus of the right eye. EEG was recorded relative to FCz and later re-referenced offline to the average of the mastoid channels. Impedances were maintained below 5 Ω for all channels.
The EEG signal was amplified using a BrainAmp MR Plus amplifier (BrainProducts GmbH). Continuous analog-to-digital conversion of the EEG and stimulus trigger codes were performed at a sampling rate of 512 Hz.

Instead, for the control monolingual and bilingual groups and for the first 4 participants[4] from the experimental group, the EEG data was recorded in DC mode using asalabTM 4.7.9 (ANT Neuro) software from a waveguard™touch cap (ANT Neuro) comprised of 32 Ag/AgC1 electrodes placed according to the extended 10–20 international system (Jasper, 1958). Impedances for each electrode were reduced to below 10 kΩ (kiloohms) with the great majority of impedances being reduced to below 5 kΩ. Eye movements and blinks were monitored by placing two vertical electro-oculogram (VEOG) electrodes above and below the left eye, and two horizontal (HEOG) electrodes on the outer canthi of each eye. EEG was recorded relative to FCz

[4] The switch between systems was made due to unexpected technical issues with the ANT Neuro equipment.

and later re-referenced offline to the average of the mastoid channels. The EEG signal was amplified by using an AMP-TRG40AB Refa-8 amplifier with a gain of 22-bit (ANT Neuro). Similarly, to the L2 group, continuous analog-to-digital conversion of the EEG and stimulus trigger codes were performed at a sampling rate of 512 Hz.

EEG Data Processing. Data processing and analysis were completed using MatLab (MathWorks®) with the EEGlab and ERPlab plug-in (Delorme & Makeig, 2004; López-Calderon & Luck, 2014). Following S&T (2014, 2015), epochs were extracted starting at 100 ms before and extending to 1000 ms after the onset of the critical target item, which were either the adjective in adjective-first noun phrases or the noun in noun-first noun phrases. Epochs were baseline corrected based on the 100 ms pre-stimulus time window and then filtered using an IIR (infinite impulse response) Butterworth filter with a high pass of .10 Hz and a low pass of 30.0 Hz. Trials containing excessive muscle artifact and eye blinks were rejected using step-like artifact detection on all EEG and EOG channels using 50µV threshold with a 100 ms moving window applied every 50 ms over the entire 1100 ms epoch. Next, epochs were averaged together for each participant by condition. All trials were included in the participant averages regardless of accuracy. Finally, individual averages were averaged together by condition to obtain group averages.

ERP Analyses. As in S&T and Luque et al, (2018), L1 flexibility was assessed by examining the response elicited in the 260-360 ms time window, known as the N200 (N2) component, for a fronto-central region of interest (ROI) as participants processed the first element of the noun-phrase (adjective-first or noun-first). The N2 component, hypothesized to be a marker of response inhibition, was used to measure the inhibition associated with the No-Go trials in comparison to the Go trials in the experimental task. This time window and region of interest was justified in S&T (2014, 2015) as typical for the topography reported previously for the N2 component. In regard to the ROI, S&T (2014, 2015) included FC1, FC2, FCZ and FZ as the ROI. Nonetheless, the electrode caps available in the laboratory where the study took place did not have the FCZ electrode, thus, the ROI was adjusted slightly and included the following electrodes: FC1, FC2, FZ and CZ. (See Appendix C for electrode cap layouts). Rejection rates for each group by session and condition are provided in Table III. Following previous research, all remaining trials, regardless of behavioral responses, were included in the main analyses.

Table III

EEG Artifact Rejection Rates by Group

Condition	Group		
	Monolinguals	L2 Learners	Bilinguals
Article-First Go	3.31%	4.56%	3.09%
Article-First No/Go	4.30%	3.56%	3.95%
Noun-First Go	2.65%	2.86%	2.12%
Noun-First No/Go	3.61%	2.77%	3.23%
Total Experimental Trials	3.55%	3.86%	2.95%

Note. Values represent percentage of rejected trials for each experimental condition.

3.5.3 Dependent Variable

The current study included three measures of L2 development: the Diploma of Spanish as a Foreign Language test (Montrul, 2005), a verbal fluency task (adapted from Sanoudaki & Thierry, 2015) in both English and Spanish, and an elicited imitation task in Spanish (Ortega, 2000). Below, the materials and procedures of each task are summarized.

3.5.3.1 L2 Proficiency

Diploma of Spanish as a Foreign Language (DELE). In addition to providing self-ratings of their Spanish skills in the areas of speaking, understanding, reading and writing via the LEAP-Q, participants in the study completed a modified version of the Diploma of Spanish as a Foreign Language (DELE), a standardized, objective proficiency measure (Montrul, 2005). The test included a cloze portion, in which participants filled in missing words in a text (20 items), and a multiple-choice version that required participants to select the most appropriate word to complete a sentence from a list of four options (30 items). (See Appendix D; DELE Proficiency Task for All test items and Scoring Procedure).

Verbal fluency task. Participants in the study completed a category fluency task (adapted from Sanoudaki & Thierry, 2015) as a relative proficiency measure where they were asked to produce as many words as they could in 30 seconds from four different categories (i.e., animals, professions, fruits). Participants completed this task in both English and Spanish. Language order and task versions were counterbalanced across participants. The total number of words produced was calculated for each category for each participant. Repetitions/variations of the same word and proper names of people/places were excluded from data analysis. Finally, participant responses were averaged separately for each different category.

Elicited imitation task. Participants in the study completed an EIT (Ortega et al., 2002) as an additional measure of L2 spoken proficiency. Participants were asked to listen to sentences in Spanish, which were presented one at a time, and to repeat each sentence out loud as closely as possible after hearing a beep that sounds after each sentence. Participants' responses to the EIT were digitally recorded. Following Ortega et al. (2002), the digital recordings were transcribed by two independent raters and then rated following a scoring protocol, which resulted in an overall interrater reliability of 90%, where participants' responses were rated from 1-4 in depending on how accurately (1-not accurately to 4 very accurately) each response represented the content from the original sentence participants were asked to repeat back aloud. (See Appendix E; Elicited Imitation Task for Stimuli and Scoring Procedure).

3.6 Statistical Analyses

For Research Question 1 (*Is there a relationship between inhibitory control and linguistic ability in an L2?*) Correlational analyses were performed between L2 ability, calculated as a composite score[5] on standard deviation above the group mean, across the three measures of L2 proficiency, and both measures of IC, performing this analysis allowed to investigate the relationship between IC abilities and adult L2 development across intermediate learners with different levels of L2 proficiency and experience.

For Research Question 2 (*Do we find evidence of L1 flexibility during grammatical processing?*), mean ERP amplitudes elicited by the first element of the noun phrase across the ERP region of interest, i.e., N200-time-window, were entered into a three-way repeated measures ANOVAs with the within-subject factors of congruence (match/mismatch)[6] and

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[5] Z-score calculations were performed, such that the average and standard deviation used in the z-score calculation [(Participant Score – Average Score) / Standard Deviation] reflects the values for each group, rather than the entire participant pool.

[6] As a reminder, a match trial is a trial where the 'Go' decision could be made based on the first element of the noun phrase matching the color and/or object name of the picture that was previously presented. On the contrary, a mismatch trial is a trial when the decision would be 'No-Go' based on the first element of the noun phrase not matching the color and/or object name of the picture that was previously presented. Even though the sentence itself could be a 'Go' sentence after processing the second element of the noun

speech-part (adjective-first/noun-first) and the between-subject factor group. This allowed to examine whether evidence of L1 flexibility can also be found during L1 grammatical processing, and whether adult L2 learners who seem to be better able to tolerate those changes, i.e., those with a more flexible L1 system, may be those who show higher proficiency in an L2.

Research Question 3. (*Is there a relationship between the degree of L1 change and linguistic ability in an L2?)* Correlational analyses were performed between the L2 ability composite score and the measure of L1 flexibility (each L2 learner's N200 effect for the noun-first condition). This allowed to investigate whether L1 grammatical processing becomes more bilingual-like and less monolingual-like as adult L2 learners achieve higher levels of proficiency and have a more diverse L2 experience.

Research Question 4. (*Do inhibitory control abilities and degree of L1 flexibility predict L2 learning outcomes?)* Regression analyses were performed with IC and L1 flexibility as predictor measures and L2 linguistic ability as the outcome measure. Additionally, we used working memory (calculated as a composite score on standard deviation above the group mean), IQ, and language-switching tendency scores as control measures. This allowed us to further investigate the interplay between IC control abilities and L1 flexibility and their predictive role in successful adult L2 learning.

phrase presented, our analyses will only be performed based on the brain response elicited to the first word of the noun phrase (i.e., adjective-first or noun-first).

Chapter 4. Results

4.1 Introduction

This chapter presents the results of the linguistic, cognitive, and electrophysiological measures that were collected in this study in order to investigate the role of inhibitory control and L1 flexibility in adult L2 learning. Section 4.2 presents an overall description of individual-level behavioral performance on the linguistic and inhibitory control tasks for the L2 group, followed by statistical analyses of relationships between individual differences in inhibitory control abilities and L2 proficiency aimed at answering research question 1. Section 4.3 presents an overall description of processing performance on the electrophysiological task for the monolingual, L2, and bilingual groups, followed by statistical analyses of group-level processing patterns for the control (adjective-first) and experimental (noun-first) target structures chosen to assess L1 flexibility during grammatical processing aimed at answering research question 2. Next, individual-level processing signatures for the experimental noun-first condition, which served as the measure of degree of L1 flexibility, are explored and statistical analysis of relationships between individual differences in L1 flexibility and L2 proficiency within the L2 group are provided aimed at answering research question 3. Finally, Section 4..4 presents an overall summary of behavioral performance for both the predictor (behavioral measures of inhibitory control and electrophysiological measures of L1 flexibility) and control variables (i.e., language experience and use, intelligence, working memory, and language switching) for the L2 group, followed by regression analyses aimed at addressing research question 4.

4.2 Inhibitory Control and L2 Learning

Participants completed three behavioral measures to assess L2 proficiency, a verbal fluency task, an elicited imitation task, and an overall proficiency task as described in detail in Chapter 3 Section 5.3.1. Performance on these tasks provide insight into participants' (1) L2 lexical knowledge, (2) L2 spoken proficiency skills, and (3) overall L2 proficiency. Descriptively, individual level scores for the verbal fluency task, the EIT, and the DELE scores fell within the expected range of performance expected for intermediate learners (e.g., Bowden, 2016, Montrul, 2005). Additionally, scores were examined for outliers by checking whether any of the scores from the L2 proficiency tasks were more than 2.5 *SD*s from the group mean, and no outliers were identified. Similarly, skewness and kurtosis values for the three tasks were shown to be within the range of less than 2 SE of the ratio of the mean for each of the three proficiency measures, indicating relatively normal distributions for the three L2 proficiency tasks. (Brown, 1997). Descriptive results for the L2 proficiency measures for the L2 group are provided in Table IV.

Table IV

L2 Group: Descriptive Results of Performance on L2 Proficiency Measures

	L2 Verbal Fluency[a]	EIT[b]	DELE[c]
Mean (*SD*)	26.75 (9.11)	66.05 (27.08)	23. 55 (5.55)
[95% CI]	[22.48, 31.01]	[53.37, 78.72]	[20.94, 26.15]

Note.
[a] *Mean number of tokens produced across categories*
[b] *Maximum score on EIT = 120*
[c] *Maximum score on DELE = 50*

Regarding inhibitory control, participants completed two behavioral measures to assess inhibitory control abilities, the Eriksen Flanker task and the Automated Continuous Performance Task (AX-CPT) as described in detail in Chapter 3 Section 5.2.1. Performance on these tasks provide insight into participants' (1) overall inhibitory control, (2) reactive inhibitory control, (3) proactive inhibitory control, (4) and speed of processing abilities. The variable of interest for the Flanker task was operationalized by averaging participants' RT in the incongruent trials minus the congruent trials resulting in what has been commonly characterized as the Flanker effect. Prior to analyzing participants' performance, trials with response times below 100 ms and over 1000 ms were removed comprising 6% of the data. In addition, trials that were over 2.5 standard deviations above the mean were also removed, comprising 3% of the data (see Table V for descriptive results of performance on the Flanker task). Furthermore, scores were examined for outliers by checking whether any of the scores from the L2 proficiency tasks were more than 2.5 *SD*s from the group mean, and no outliers were identified. Descriptively, participants' overall accuracy on the Flanker task was near ceiling (97%) (see Table 5) Analyses revealed that the incongruent trials elicited more erroneous responses (*M*=2.5%) than the congruent trials (*M*=.7%), reflected in a significant main effect of Congruency, $F(1,20) = 21.3$, $p<.005$, $\eta_p{}^2 = .58$. Turning to the Flanker effect itself, we see that that the RT to incongruent trials (*M*= *554* ms) was longer than the RT to congruent trials (*M*= 489 ms), reflecting a significant effect of Congruency, reflecting a significant main effect of Congruency, $F(1,20) = 15.8$, $p=.008$, $\eta_p{}^2 = .38$.

Table V

L2 Group: Descriptive Results of Performance on Flanker Task

	Flanker Task	
	Accuracy	Flanker effect[a]
Mean (*SD*)	97.01 (0.03)	64.37 (33.01)

Note.
[a] *Global inhibitory control ability*

The variables of interest for the AX-CPT task were percentage of error rates and reaction times (RTs) for the AY (i.e., reactive inhibitory control), BX (i.e., proactive inhibitory control), and BY conditions (i.e., baseline control condition hypothesized to index speed of processing abilities). Prior to analyzing participants' performance, trials with response times below 100 ms and over 1000 ms were removed, comprising 7% of the data. In addition, trials that were over 2.5 standard deviations above the mean were also removed, comprising 5% of the data. Furthermore, participant scores were examined for outliers by checking whether any of the scores from the AX-CPT task were more than 2.5 *SD*s from the group mean, and no outliers were identified. Descriptively, participants produced the fewest percentage of errors in the AX and BY conditions, while the BX and AY conditions produced the highest amount of errors, which seemed to be consistent with previous studies that reported performance on the AX-CPT task among language learners (e.g., Morales et al., 2013, Zirnstein et al., 2018) see Table VI for descriptive results of performance on the AX-CPT task)

Table VI
L2 Group: Descriptive Results of Performance on AX-CPT Task

	AX Trials		AY trials[a]		BX trials[b]		BY trials[c]	
	Error Rate	RT	Error Rate	RT	Error Rate	RT	Error Rate	RT
Mean	0.07	320.07	0.24	366.71	0.15	270.53	0.01	273.43
(*SD*)	(0.06)	(27.24)	(0.21)	(62.62)	(0.21)	(47.47)	(0.04)	(51.08)

Note.
[a] *Reactive inhibitory control*
[b] *Proactive inhibitory control*
[c] *Speed of processing (baseline control condition)*

In order to address research question 1, *is there a relationship between inhibitory control abilities and L2 proficiency?,* Correlational analyses were performed between L2 proficiency (calculated as a composite score across the three measures of L2 proficiency)[7], the Flanker effect, and overall RT on the three conditions of interest (AY, BX, and BY trials) from the AX-CPT task (see Table VII and Figures 5a-5d). Results showed no significant relationships between participants' overall inhibitory control ability, as indexed by the Flanker effect, and L2 proficiency (see Figure 6a). However, analyses revealed a medium-sized[8] statistically significant negative correlation between performance on the AY condition (reactive inhibitory control) of the AX-CPT task and L2 proficiency (r = -.507*, $p < .05$) (see Figure 6b), as well as a medium-sized statistically significant negative correlation between performance on the BY condition (speed of processing) of the AX-CPT task and L2 proficiency (r = -.469*, $p < .05$)

[7] As a reminder, the L2 Composite score[7] was compromised of z-score scores [(Participant Score – Average Score) / Standard Deviation] across each of the three L2 proficiency tasks, such that the average and standard deviation used in the z-score calculation reflects the values for each group, rather than the entire participant pool.

8 Effects sizes were interpreted according to Plonsky & Oswald's (2014) field-specific recommendations for correlation analyses, with .25 indicating a small effect, .40 indicating a medium effect, and .60 indicating a large effect.

(see Figure 5c)., but no significant relationships were found between performance on the BX condition (proactive inhibitory control) of the AX-CPT task and L2 proficiency (see Figure 5d).

Table VII

Correlation coefficients of individual difference measures between inhibitory control and L2 proficiency

	M (SD) [95% CI]	L2 Comp	VF	EIT	DELE	Flanker Effect	AY	BX	BY
L2 Comp	-0.073 (0.88) [-0.48, 0.33]	--	.897**	.906**	.923**	-.145	-.507*	0.191	-.469*
DELE	23.55 (5.55) [20.94, 26.15]	--	--	.767**	.748**	-.183	-.588**	0.193	-0.433*t*
EIT	66.05 (27.08) [53.37, 78.72]	--	--	--	.701**	-.158	-0.325	0.014	-.543*
VF	26.75 (9.11) [22.48, 31.01]	--	--	--	--	-.054	-.469*	0.315	-0.306
Flanker Effect	64.37 (33.01) [48.93, 79.82]	--	--	--	--	--	0.108	0.061	-0.279
AY	366.71 (62.62) [337.40, 396.02]	--	--	--	--	--	--	-0.081	0.253
BX	270.53 (47.47) [248.82, 292. 14]	--	--	--	--	--	--	--	0.347
BY	273.43 (51.08) [249.52, 297.33]	--	--	--	--	--	--	--	--

Note. * $p < .05$. ** $p < .01$

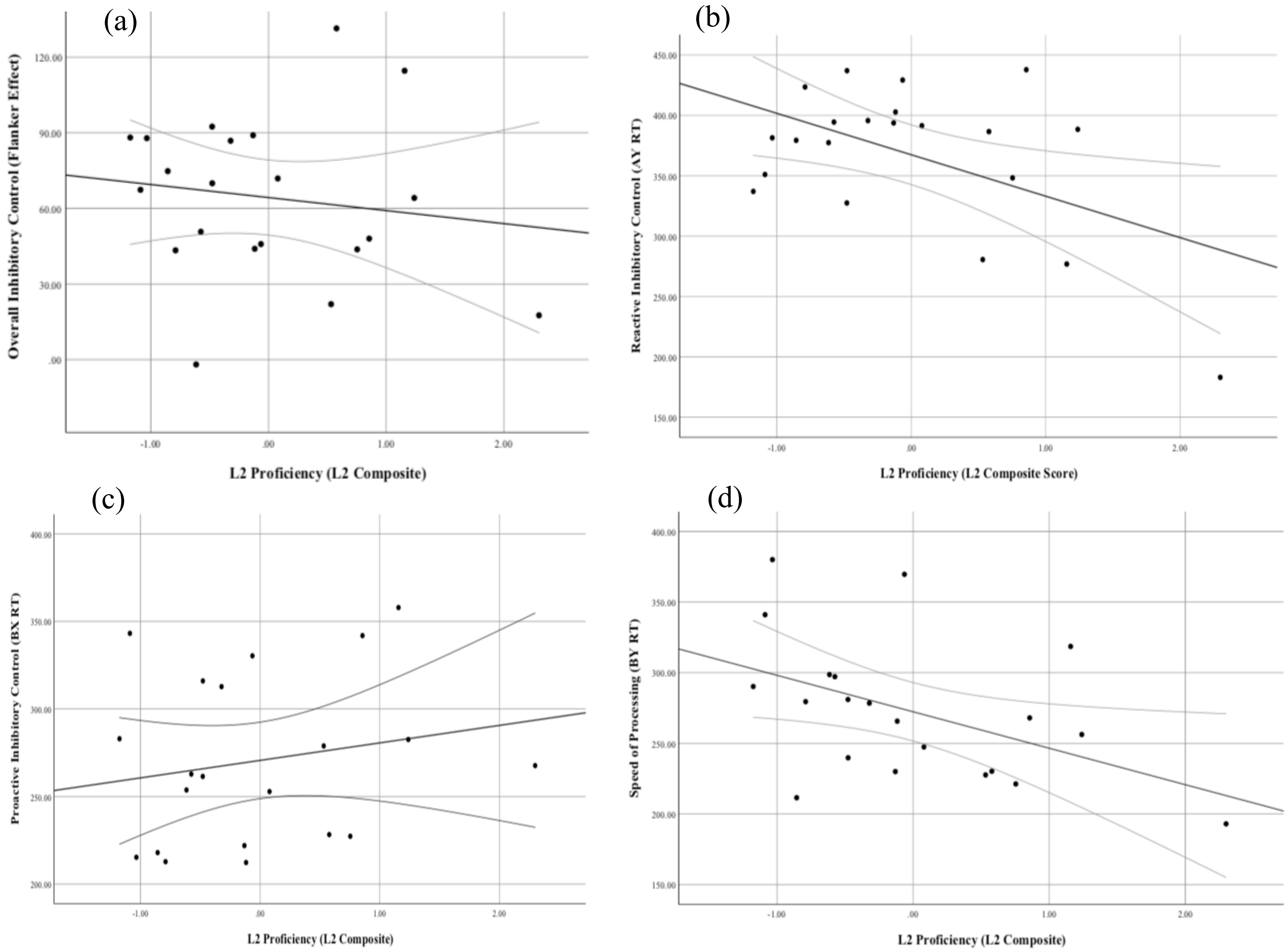

Figure 6. Correlation scatterplots illustrating the relationship between L2 Proficiency and IC abilities.

(a) L2 Proficiency and overall inhibitory control ability,), (b) L2 Proficiency and reactive inhibitory control ability, (c) L2 Proficiency and proactive inhibitory control ability, and (d) L2 Proficiency and speed processing abilities. Each point represents one participant.

4.2 L1 Flexibility and L2 Learning

Participants completed a picture sentence matching task under a Go/No-Go design following Sanoudaki & Thierry (2015) while their brain activity was being recorded using ERPs. Performance on this task is meant to provide insight into participants' degree of L1 flexibility as described in detail in Chapter 3 Section 5.2.2. All trials were included in the participant averages regardless of accuracy (task accuracy for monolinguals: *M*: 0.56, *SD* 0.62; for L2 learners: *M*: 0.78, *SD* 0.6; *SD* 0.53; and for bilinguals: *M*: 0.87, *SD* 0.36).

Visual inspection of the ERP waveforms revealed different patterns of results for the monolingual, L2, and bilingual groups. For the monolingual group, a negative effect for the adjective-first mismatch condition versus the adjective-first match condition is apparent in the time window of interest, suggestive of an N2 effect, but no effect is apparent for the noun-first mismatch ('No-Go') condition versus the noun-first match ('Go') condition (see Figure 7a). However, for the L2 and bilingual groups, a negative effect for both the adjective-first and noun-first mismatch ('No-Go') conditions versus the adjective-first and noun-first match ('Go') conditions, respectively, is apparent in the time window of interest, suggestive of an N2 effect for both speech parts (see Figure 7b-7c). Our analyses revealed the statistical significance of these ERP patterns (See Appendix F for Grand averages across all electrodes for each condition for each group).

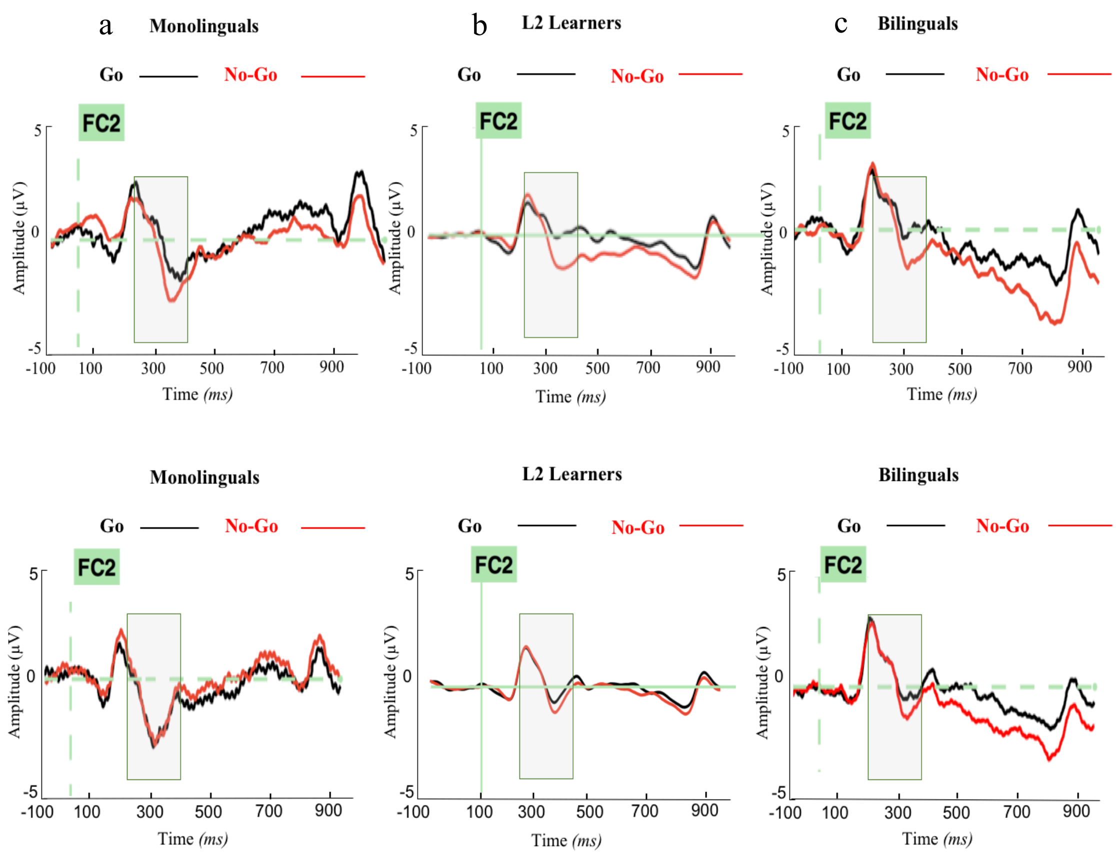

Figure 7. *ERP Results for the L1 Flexibility Task*

Group averaged ERPs for the electrode FC2 for monolinguals (6a), for L2 learners (6b), and bilinguals (6c) for adjective-first (top of columns) and noun-first (bottom of columns) conditions for matching 'Go' and mismatching 'No-Go' trials. The time window that was analyzed in statistical analyses (i.e., 260-360 ms) is indicated through shading.

In order to address research question 2, *do we find evidence of L1 flexibility among L2 learners?*, a three-way repeated measures ANOVA was conducted, which revealed a significant main effect of congruence ($F(1,48)=132.009$ $p<0.001$, $\eta_p{}^2 = 0.733$) that was qualified by a significant interaction of congruence by speech-part ($F(1,48) = 65.892$, $p<0.001$, $\eta_p{}^2 = 0.579$) as well as by a significant interaction of congruence by group ($F(2,48) = 3.985$, $p = 0.026$, $\eta_p{}^2 = 0.142$). Follow-up Bonferroni-corrected comparisons revealed a negative effect of congruence for the adjective-first conditions ($p < .001$), where the adjective-first mismatch condition was more negative than the adjective-first match condition. For the noun-first conditions, a negative effect of congruence was also found ($p = 0.002$), revealing that the noun-first mismatch condition was more negative than the noun-first match condition. No other main effects or interactions were evidenced contrary to S&T (2014; 2015), where a significant three-way interaction of congruence by speech-part by group was found.

As planned, we also conducted separate two-way repeated measures ANOVAs for each group. For monolinguals, the ANOVA revealed a main effect of congruence ($F(1,14) = 127.331$ $p = < 0.001$, $\eta_p{}^2 = 0.901$) that was qualified by a congruence by speech-part interaction ($F(1,14) = 46.267$ $p = < 0.001$, $\eta_p{}^2 = 0.768$). Follow-up Bonferroni-corrected comparisons confirmed a significant effect of congruence for the adjective-first mismatch condition compared to the adjective-first match condition (p < .001), but no effect was evidenced for the noun-first mismatch condition compared to the noun-first match condition ($p = .556$). For the L2 group, the ANOVA revealed a main effect of congruence ($F(1,20) = 71.936$, $p = < 0.001$; $\eta_p{}^2 = 0.782$) that was qualified by a congruence by speech-part interaction ($F(1,20) = 43.032$ $p = < 0.001$, $\eta_p{}^2 =$

0.683). Follow-up Bonferroni-corrected comparisons confirmed a significant effect of congruence for the adjective-first mismatch condition compared to the adjective-first match condition ($p < .001$) as well as a significant effect of congruence for the noun-first mismatch condition compared to the noun-first match condition ($p < .044$). Finally, for the bilingual group, the ANOVA revealed a main effect of congruence ($F(1,14) = 31.881$, $p = < 0.001$; $\eta_p{}^2 = 0.695$) that was qualified by a congruence by speech-part interaction ($F(1,14) = 9.639$ $p = 0.008$, $\eta_p{}^2 = 0.408$). Follow-up Bonferroni-corrected comparisons confirmed (a) a significant effect of congruence for the adjective-first mismatch condition compared to the adjective-first match condition ($p < .001$) as well as a significant effect of congruence for the noun-first mismatch condition compared to the noun-first match condition ($p < .014$), and (b) a significant effect of group for the adjective-first mismatch condition compared to the adjective-first match condition ($p < .001$) as well as a significant effect of congruence for the noun-first mismatch condition compared to the noun-first match condition ($p < .035$).

In order to address research question 3, *is there a relationship between L1 flexibility abilities and L2 proficiency?, c*orrelational analyses were performed between L1 flexibility and the L2 composite score (see Table VIII). Results revealed a medium-sized statistically significant negative correlation between performance on L1 flexibility task and L2 proficiency ($r = -.461$, $p = 0.035$) (see Figure 8).

Table VIII

Correlation coefficients of individual difference measures between L1 flexibility and L2 proficiency

	M (SD) [95% CI]	L1 Flexibility	L2 Composite	VF	EIT	DELE
L1 Flexibility	-.1605 (.154) [-.230, -.090]	--	-.461*	-.473*	-.496*	-0.288
L2 Composite	-0.073 (0.88) [-0.48, 0.33]	--	--	.897**	.906**	.923**
VF	23.55 (5.55) [20.94, 26.15]	--	--	--	.701**	.748**
EIT	66.05 (27.08) [53.37, 78.72]	--	--	--		.767**
DELE	26.75 (9.11) [22.48, 31.01]	--	--	--	--	--

Note. * *p* < .05. ** *p* < .01

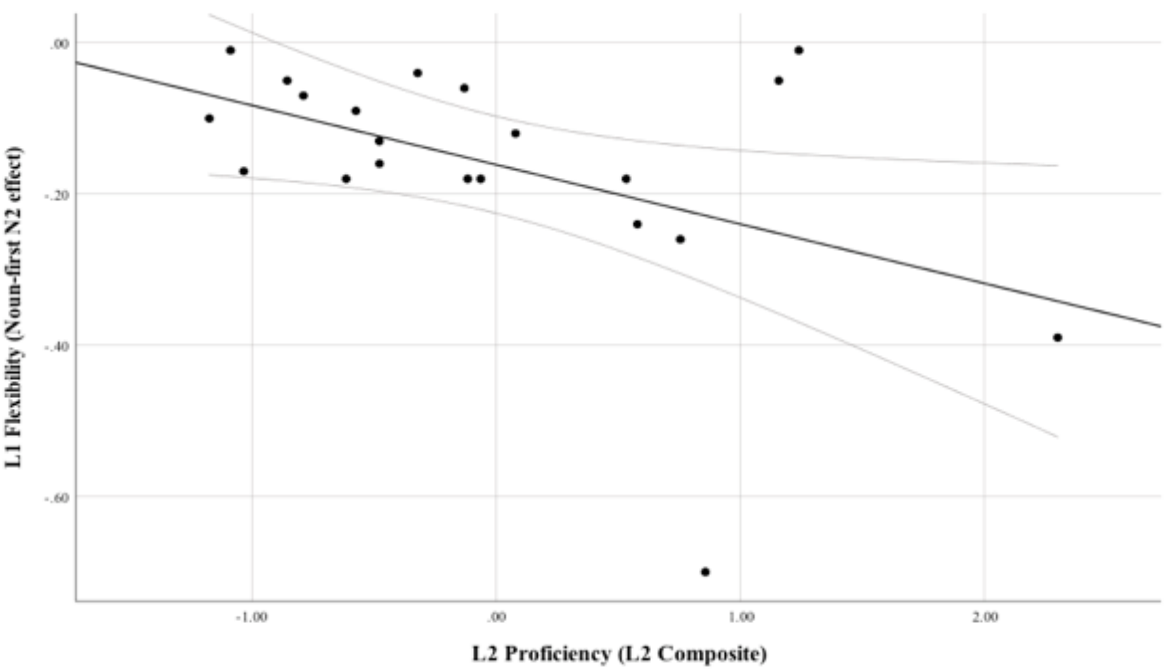

Figure 8. Correlation scatterplot illustrating the relationship between L2 proficiency and L1 Flexibility.

4.3 The Interplay of Inhibitory Control and L1 Flexibility in L2 Learning

Regression analyses were conducted in order to examine research question 4, *Do inhibitory control abilities and degree of L1 flexibility predict L2 proficiency outcomes* A multiple linear regression was conducted with the L2 composite score as the outcome variable. The predictor variables were RT for the AY trials of the AX-CPT, as the index of (reactive) inhibitory control ability[9], and the N2 effect to the noun-first condition in the ERP task, as the index of L1 flexibility.

The model established that, together, inhibitory control abilities and L1 flexibility statistically significantly accounted for L2 proficiency outcomes, $F(2, 18, 20) = 7.440$, $p = .004$. The total R^2 value for this model was .453, meaning the inclusion of these two variables explained 45% of the variance in L2 composite scores. Specifically, the model revealed that gains in overall L2 proficiency were predicted by inhibitory control abilities ($p = .012$), such that for every millisecond that the RT decreased in the AY condition of the AX-CPT task, a participant's L2 composite score would increase by 0.007 points ($B = -.007$). Thus, a 100 *ms* decrease in RT would result in a .7-point increase in proficiency. With regard to L1 flexibility, the model revealed that gains in overall L2 proficiency were also predicted by L1 flexibility ($p = .021$), such that for every additional μV increase in L1 flexibility (larger/more negative response magnitude difference for the N2 effect between the Go and No-Go trials for the noun-first condition), a participant's L2 composite score would increase by approximately 2.5 points ($B = -2.597$) (See Table IX).

[9] The reason behind selecting the AY trials as index of inhibitory control ability for the regression model had to do with participants performing at ceiling on the Flanker task. Thus, our results suggest that the Flanker effect may not be a sensitive enough measure to capture individual differences in inhibitory control abilities.

Table IX
Regression Model 1: Individual Differences in Inhibitory Control, L1 Flexibility and L2 Proficiency

		L2 Proficiency			
Variable	*B*	*SE B*	*β*	*t*	*Sig*
Constant	2.237	.981		2.281	.035
Inhibitory Control	-.007	.003	-.490*	-2.809	.012
L1 Flexibility	-2.597	1.024	-.442*	-2.535	.021
R^2		.453			
F		7.440*			

Note.
B = unstandardized regression coefficient
SEB = standard error of *B*
β = standardized regression coefficient.
* $p < .05$.

To ensure that the pattern of results do not differ based on working memory, IQ, and language switching tendencies, we ran the same regression but added these three variables as control variables in step 1 of the regression. In step 2, we added the predictor variables – inhibitory control and L1 flexibility. Again, the model came out as significant, $F(5, 15, 20) = 5.412$, $p = .005$, explaining 64% amount of the variance. Also, inhibitory control abilities ($p = .003$) and L1 flexibility ($p = .018$) continued to predict L2 proficiency outcomes (see Table X).

Table X

Regression Model 2: Individual Differences in Inhibitory Control, L1 Flexibility and L2 Proficiency

	L2 Proficiency				
Variable	*B*	*SE B*	*β*	*t*	*Sig*
		Step 1			
Constant	-1-069	1.213		-.882	.390
Working Memory	-.126	.386	-.072	-.328	.747
IQ	.112	.068	.453	1.653	.117
Language Switching	-.005	.280	-.005	-.017	.987
		Step 2			
Constant	-1.609	1.213		.999	.334
Working Memory	.341	.300	.195	1.134	.275
IQ	.112	.048	.456*	2.337	.034
Language Switching	.244	.207	.235	1.176	.258
Inhibitory Control	-.009	.003	-.606*		
L1 Flexibility	-2.505	.943	-.427*		
R^2		.643			
F		5.412*			

Note.
B = unstandardized regression coefficient
SEB = standard error of *B*
β = standardized regression coefficient.
* $p < .05$.

Chapter 5. Discussion and Conclusions

5.1 Introduction

This chapter reviews the open questions put forth in Chapter 2 and situates the findings of the study within the broader context of adult L2 learning and bilingualism research specifically in regard to cognitive and neurocognitive factors related to adult L2 development. Results that speak to each particular open question are addressed first, followed by limitations and future research directions, and general conclusions drawn from the present study.

5.2 Discussion

Inhibitory Control and L2 learning

Research question 1 attempted to investigate whether relationships could be found between inhibitory control abilities and L2 proficiency among intermediate adult L2 learners of Spanish. Results revealed a statistically significant relationship between inhibitory control and L2 proficiency. Nonetheless, this relationship only emerged when participants were asked to complete a more complex inhibitory control task, such as the AX-CPT task, that required participants to not only exercise inhibitory control to successfully complete the task, but, crucially, it also demanded participants to coordinate multiple control process. More specifically, the AX-CPT task requires participants to regulate the amount of inhibitory control that needed to be applied to successfully complete the task. This key methodological difference seemed to have allowed individual differences to emerge on the AX-CPT task unlike the Flanker task where our results indicated near-ceiling performance. The relationship that was evidenced between inhibitory control and L2 proficiency on the AX-CPT task was with reactive inhibitory control (AY trials), suggesting that participants who were better at inhibiting their response when the wrong target appeared had higher L2 proficiency. Additionally, results revealed a relationship between processing speed abilities, as indexed by the control condition (BY trials) on the AX-

CPT task, suggesting that individuals with higher processing speed abilities may be better equipped to engage cognitive control mechanisms, in order to, for example, inhibit a previously formed expectation (see Zirnstein, Van Hell & Kroll, 2018 for a similar pattern of results with proficient bilingual speakers).

This set of outcomes is in line with the emerging body of research addressing the role of inhibitory control abilities in L2 learning among young adults. In this literature, relationships between inhibitory control abilities and adult L2 learning are not always found, specifically in those studies that assess inhibitory control using simpler or less cognitively demanding tasks such as the Flanker task (Linck & Weiss, 2015; Stone & Pili-Moss, 2015), but instead emerge when more complex tasks are used (Kapa & Colombo, 2014; Bice & Kroll, 2015). Thus, the results from our study suggest that in order to capture individual differences in reactive inhibitory control abilities among young adults, especially considering the fact that young adults are at the peak of their cognitive performance during early adulthood, more complex measures of inhibitory control ability may need to be incorporated in order to fully understand the distinctive role that inhibitory control abilities play at different stages of L2 learning, for learners with different types of L2 experience, as well as for different age groups.

More generally, the positive relationship between inhibitory control abilities and adult L2 proficiency is consistent with previous research with proficient bilinguals that has suggested that inhibitory control may be among the factors that allow bilinguals to functionally manage and use their languages (e.g., Hoshino & Thierry, 2012; Morales, Paolieri, & Bajo, 2011; Misra et al., 2012; Wu & Thierry, 2017), although this is not without controversy (e.g., Costa et al., 2009; Paap & Greenberg, 2013, Wu & Thierry, 2013; Duñabeitia & Carreiras, 2015), suggesting that experience of managing two languages in constant interaction may hold consequences that extend beyond the domain of language.

Overall, the results of this study support the hypothesis posited by the IC (Green, 1998) and BIA+ (Dijkstra & Van Heuven, 2002) models that propose that the amount of control that needs to be exerted for bilingual language selection to occur is of a reactive nature. In addition, our results also support the hypothesis posited by Green and Abutalebi (2013) in their Adaptive Control Hypothesis (ACH) model which (a) situates inhibitory control as one of the underlying mechanisms that may allow the human mind and brain to accommodate the presence of two languages, but also (b) argues that bilingual, or in the case of our study emerging bilingual, language control may also involve the ability to coordinate a different set of cognitive processes, in addition to reactive inhibitory control mechanisms, to achieve proficient language performance, as the results of this study indicate.

L1 Flexibility and L2 Learning

Research question 2 attempted to investigate whether evidence of L1 flexibility could be found among intermediate adult L2 learners of Spanish. Our study examined the neural responses that Spanish-English bilinguals and English monolinguals elicited to a picture-sentence relatedness Go/No-Go task that contained noun phrases embedded in English sentences that either followed English noun-phrase word order (adjective-first) or Spanish noun phrase word order (noun-first). Our results revealed that L2 learners showed a different neural response to the noun phrases that followed Spanish syntax (noun-first) than the English monolinguals control group did, suggesting that the knowledge of the grammar of one of the bilinguals' languages (i.e., Spanish) may have influenced the way in which L2 learners processed sentences in their L1 (i.e., English).

This study is the first, to the author's knowledge, to show neurocognitive evidence of L1 flexibility during grammatical processing with L2 learners and is consistent with previous research that has shown that the L2 affects the L1 during both lexical and phonological processing and use among L2 learners (e.g., Kroll et al., 2012; Bice & Kroll, 2015; Baus et al., 2013; Chang, 2012; Kartushina et al., 2016). Interestingly, our results revealed that the L2 learners showed a pattern of results very similar to the Spanish-English bilingual control group, in other words, the way in which the L2 learners processed their L1 looked more bilingual-like than monolingual-like, suggesting that the experience of learning an L2 during adulthood induces changes to the way in which languages are processed in the brain, which reinforces the famous claim by Grosjean (1989) that posits that a bilingual is not like two monolinguals in one. Also , the pattern of results is consistent with previous research both with proficient bilinguals that have shown evidence of L2 to L1 influence during lexical, phonological, and grammatical processing/use (e. g., Van Assche, et al., 2009; van Hell & Dijkstra, 2002, De Leeuw, et al., 2010; Chang, 2013; Mora & Nadeu, 2012, Cabrelli, Luque, & Finestrat-Martinez, 2019; Wu & Thierry, 2013; Sanoudaki & Thierry, 2015; Luque, Mizyed, & Morgan-Short, 2018). Thus, the results are suggestive of a continuous role for L1 flexibility on the continuum of bilingualism.

Additionally, our results shed light into theories about the ways in which languages interact in the emerging bilingual mind, in particular those that suggest permeability between the boundaries of bilinguals' two languages (Kroll & Dussias, 2012; Bice & Kroll, 2015). Our findings are consistent with such perspectives given the available evidence suggesting that cross-linguistic influence during bilingual language processing is bi-directional (not only from the L1 to the L2, but also from the L2 to the L1), revealing that the knowledge of the learners' L2 grammar (i.e., Spanish) seemed to not only be active but also influenced and interacted with the way in which both the adult L2 learners and the Spanish-English bilingual control group processed the grammar of their L1 (i.e., English).

As S&T (2014) and Luque, Mizyed, & Morgan-Short (2018) highlighted, this finding is particularly interesting given the fact that the entire experiment was solely conducted in English. This scenario was not arbitrary. By conducting the entire experiment in English, the intention was to induce our participants in the most "monolingual mode" (Grosjean, 2001) possible, which had the purpose of generating the most adverse conditions for cross-linguistic influence at the grammatical level to take place, and yet the results of our study evidence L2 to L1 grammatical influence, which we have denominated as evidence of L1 flexibility, while participants processed English sentences, revealing the intrinsically dynamic and interactive nature of bilingual language processing.

Research question 3 aimed at further investigating the recently proposed hypothesis by Kroll (2015) that suggests that learners with more flexible L1 systems may be better at acquiring an L2. Our results revealed a significant relationship between degree of L1 flexibility and L2 proficiency, as would be predicted by Kroll's hypothesis (2012; 2015). These results are consistent with Bice & Kroll's study (2015), the first to investigate the role of L1 flexibility during lexical processing, by showing that learners who showed greater L2-to-L1 influence had also higher L2 proficiency. Also, the results of this study suggest that the becoming bilingual experience may require, among other things, learners to be open to L2-to-L1 influences as crucial step to accommodate the emerging L2 into the already existing L1 network.

Finally, research question 4 aimed at exploring how inhibitory control abilities and L1 flexibility, together, could account for L2 proficiency. Indeed, our results revealed that both these factors together significantly accounted for variability in L2 proficiency. Specifically, our results revealed that for every 100 *ms* decrease in RT in reactive control would result in a .7-point increase in L2 proficiency and that for every 1 μV increase in L1 flexibility (larger/more negative N2 effect) would result in a 2.5-point increase in L2 proficiency. Again, these results are also consistent with Bice & Kroll's (2015) study, which was the first one to look at the relative contribution of reactive inhibitory control abilities and L1 lexical flexibility among adult L2 learners with different levels of proficiency, suggesting that both the ability to control and regulate the activation of the L1 during L2 learning as well as the ability to be open to L2 to L1 influences may be among the factors related to successful adult L2 development.

5.3 Limitations/Future Research Directions

This study is the first, to the author's knowledge, to specifically advance our understanding of the role of inhibitory control and L1 grammatical flexibility in adult L2 learning by using both behavioral and neurocognitive measures. Thus, importantly, the results of this study contribute to the existing body of knowledge on individual difference factors related to adult L2 development and provide critical new insight into the underlying cognitive and brain mechanisms that may contribute to successful adult L2 learning. However, there are obvious limitations that affect the study's reliability and generalizability.

The first and clearest limitation of the present study is related to the sample size, especially given the research goals of exploring individual differences. This limitation applies to both the cognitive and neurocognitive aspects of the study, but they are particularly limiting with respect to the ERP effects that were found. Because of that, the results of this study may be revealing effects that do not persist once a larger sample of participants are included in further analyses. Our a priori power analysis indicated that 60 number of participants were needed per group in order to find main effects. For this dissertation, data from 21 L2 learners, 15 bilinguals, and 15 monolinguals could be collected. Further data collection is planned, but for now, the results of the study should be interpreted more as preliminary evidence about the role of inhibitory control and L1 flexibility in adult L2 learning at intermediate stages, as opposed to conclusive evidence.

In addition to increasing the number of participants, future research should incorporate adult L2 learners from a wider range of L2 proficiency and experience in order to confirm and extend the results from the present study. Examining the research questions among a larger range of L2 learners will inform our understanding of the continuum of bilingualism and the trajectory of L2 learning to more reliably investigate the role of inhibitory control and L1 grammatical flexibility in adult L2 learning as well as the interactions with other factors that have been posited to be important for proficient bilingualism.

A second limitation of the present study is related to the number of tasks used to capture the multidimensional nature of inhibitory control among adult L2 learners, especially as it relates to other sub-domains of executive function. Even though in this study we have managed to incorporate two different tasks that differed in level of cognitive complexity and demands and that provide valuable insight into the role of inhibitory control in adult L2 learning, future research should aim to incorporate additional measures of inhibitory control, for example those that have been proven to be reliable to assess individual differences in inhibitory control among proficient bilinguals, such as the Stop-Signal Task (Verbruggen & Stevens, 2008). The inclusion of these tasks in future research would allow us to take a more fine-grained approach to understanding what other aspects of IC may contribute to adult L2 learning, how they relate to each other, as well as their relative contribution to explain variability in L2 success during the different stages of learning as well as for different contexts of learning. Additionally, future research should continue to investigate the relationship between the other sub-components of executive control, inhibitory control being just one of them, and adult L2 development at different stages of learning and for different age groups, in order to expand our current knowledge on the role of the executive functions and emerging bilingualism.

A third limitation to the present study is related to the way we chose to assess L1 grammatical flexibility among adult L2 learning. Even though this study makes a novel contribution by providing neurocognitive evidence of L1 grammatical flexibility among adult L2 learners at the intermediate level, future research needs to be carried out that incorporates other experimental paradigms, both at the behavioral and processing level, that would allow us to deepen our understanding about the role that individual differences in L1 grammatical flexibility may play in adult L2 learning. It would be good to see the overall pattern of results replicated with the current task and reproduced with other tasks that may be able to capture L1 flexibility, in order to have confidence that the results are not task-dependent and are robust. In addition, ideally, we would test if the results are generalizable to other grammatical structures to ascertain that the results are not specific to noun-phrase word order.

A fourth limitation of the present study is related to the fact that the EEG data was collected using two different EEG systems, which might have introduced additional noise or artifacts during data processing and analyses that might have or might have imposed limitations or interfered with the effects that were found.

Finally, the current study was limited in the ways in which we were able to investigate the ways in which inhibitory control and L1 flexibility may contribute to successful adult L2 development. Thus, future research should aim to expand the current findings by studying other factors that may be inherently related to one’s ability to control and tolerate influences from the

L2 to the L1, as well as other characteristics that may be associated to one's ability to exercise flexibility in one's daily life. , for example those related to socio-affective or environmental factors.

5.4 Conclusions

The present study investigated whether individual differences in inhibitory control and L1 grammatical flexibility are related to L2 proficiency among adult L2 learners at the intermediate level by using both behavioral and neurocognitive measures. The results suggest that both inhibitory control abilities, specifically reactive inhibitory control, and L1 grammatical flexibility helped account for the variability found in L2 proficiency among our adult L2 learners of Spanish, and thus, may be added to the list of existing individual factors that have been posited to be related to successful adult L2 learning.

Specifically, the results of this study revealed that individuals with higher inhibitory control abilities exhibited higher proficiency in their L2. Also, this study revealed that learners who showed greater flexibility in their L1 during grammatical processing also exhibited higher proficiency in their L2. Importantly, these results extend our current knowledge by providing critical new insight into the underlying cognitive and brain mechanisms that may contribute to successful adult L2 learning. Additionally, the results of this study, using both theories and methods from cognitive psychology, bilingualism, and adult L2 learning have the potential to inform research in these fields by expanding previous literature about the ways in which the adult brain is able to accommodate and regulate the presence of a new language and the functional role that allowing your L2 to influence/change the way individuals process their L1, thus, making it more flexible, may play for adult L2 learning, as well for the becoming bilingual experience as a whole.

Taken together, the results of this study provide support for both Green and Abutalebi's (2016) Adaptive Control model as well as for Bice & Kroll's (2015) L1 flexibility hypothesis, suggesting that both the ability to control, adapt to, and regulate the resulting cross-linguistic interference from having both languages active at all times, as well as the ability to tolerate/accept L2-to-L1 influences may be among the factors related with proficient bilingualism. Although the results cannot be interpreted unambiguously as evidence that these executive abilities lead to successful L2 development, because ultimately the study is correlational and not causal in nature. Future research that expands on these preliminary findings by (a) investigating the role of L1 flexibility and inhibitory control among beginner and advanced L2 learners, as well as (b) by incorporating additional behavioral and neurocognitive measures that would allow us to examine the interplay between L1 flexibility, inhibitory control and other individual factors, such as socio-affective variables or learning contexts, is likely to provide further insight into the relationships between internal factors in adult L2 development and have significant implications for identifying the predictors of successful adult L2 learning.

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Appendix A: Language and History Background Questionnaire (LEAP-Q)

(Marian et al., 2007)

Language Experience and Proficiency Questionnaire (LEAP-Q)

Last Name		First Name		Today's Date			
Age		Date of Birth		Male ☐		Female ☐	

(1) Please list all the languages you know **in order of dominance**:

1	**2**	**3**	**4**	**5**

(2) Please list all the languages you know **in order of acquisition** (your native language first):

1	**2**	**3**	**4**	**5**

(3) Please list what percentage of the time you are *currently* and *on average* exposed to each language.
(*Your percentages should add up to 100%*):

List language here:					
List percentage here:					

(4) When choosing to read a text available in all your languages, in what percentage of cases would you choose to read it in each of your languages? Assume that the original was written in another language, which is unknown to you.
(*Your percentages should add up to 100%*):

List language here					
List percentage here:					

(5) When choosing a language to speak with a person who is equally fluent in all your languages, what percentage of time would you choose to speak each language? Please report percent of total time.
(*Your percentages should add up to 100%*):

List language here					
List percentage here:					

(6) Please name the cultures with which you identify. On a scale from zero to ten, please rate the extent to which you identify with each culture. (Examples of possible cultures include US-American, Chinese, Jewish-Orthodox, etc):

List cultures here					
	(click here for scale)	(click here for scale)	(click here for scale)	(click here for scale)	(click here for scale)

(7) How many years of formal education do you have? ____________________
Please check your highest education level (or the approximate US equivalent to a degree obtained in another country):

☐ Less than High School	☐ Some College	☐ Masters
☐ High School	☐ College	☐ Ph.D./M.D./J.D.
☐ Professional Training	☐ Some Graduate School	☐ Other:

(8) Date of immigration to the USA, if applicable ____________________
If you have ever immigrated to another country, please provide name of country and date of immigration here.
____

(9) Have you ever had a vision problem ☐, hearing impairment ☐, language disability ☐, or learning disability ☐ ? (Check all applicable). If yes, please explain (including any corrections):
____

Language:

This is my (please select from pull-down menu)language.

All questions below refer to your knowledge of .

(1) Age when you…:

began acquiring :	*became fluent* in :	*began reading* in :	*became fluent reading* in :

(2) Please list the number of years and months you spent in each language environment:

	Years	Months
A country where is spoken		
A family where is spoken		
A school and/or working environment where is spoken		

(3) On a scale from zero to ten, please select your *level of* ***proficiency*** in speaking, understanding, and reading from the scroll-down menus:

Speaking	(click here for scale)	Understanding spoken language	(click here for scale)	Reading	(click here for scale)

(4) On a scale from zero to ten, please select how much the following factors contributed to you learning :

Interacting with friends	(click here for pull-down scale)	Language tapes/self instruction	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Watching TV	(click here for pull-down scale)
Reading	(click here for pull-down scale)	Listening to the radio	(click here for pull-down scale)

(5) Please rate to what extent you are currently exposed to in the following contexts:

Interacting with friends	(click here for pull-down scale)	Listening to radio/music	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Reading	(click here for pull-down scale)
Watching TV	(click here for pull-down scale)	Language-lab/self-instruction	(click here for pull-down scale)

(6) In your perception, how much of a foreign accent do you have in ?

(click here for pull-down scale)

(7) Please rate how frequently others identify you as a non-native speaker based on your accent in :

(click here for pull-down scale)

Appendix B: Bilingual Switching Questionnaire (BSWQ)

(Rodriguez-Fornells et al., 2012)

APPENDIX

BSWQ SPANISH VERSION

Trate de contestar en que medida las siguientes preguntas representan o se ajustan a su forma de hablar y expresarte en los idiomas que conoce (p. ej., Catalán–Español), en términos generales. Muchas de estas preguntas hacen referencia a si usted cambia o mezcla frecuentemente el catalán y el castellano en sus conversaciones. Cambiar o mezclar lenguajes es una característica muy particular de algunos entornos bilingües, como es el caso en Cataluña. El siguiente cuestionario pretende investigar sobre dichos hábitos de cambio y mezcla de lenguas. Si tiene dudas sobre algunas respuestas, intente comparar su forma de hablar y expresarte con el de la mayoría, o de las personas que conoce bien.

1. Me faltan o no recuerdo algunas palabras en CATALÁN cuando estoy hablando en dicho idioma.
   ☐ nunca ☐ muy raramente ☐ ocasionalmente ☐ frecuentemente ☐ siempre
2. Me faltan o no recuerdo algunas palabras en ESPAÑOL cuando estoy hablando en dicho idioma.
3. Tiendo a mezclar idiomas durante una conversación (por ejemplo, cambio de español a catalán o a la inversa).
4. Cuando no me sale una palabra en CATALÁN, tiendo a producirla inmediatamente en ESPAÑOL.
5. Cuando no me sale una palabra en ESPAÑOL, tiendo a producirla inmediatamente en CATALÁN.
6. Cuando cambio de idioma (p. ej., de catalán a español) o los mezclo, no me doy cuenta de que lo estoy haciendo y suelen ser los otros los que me lo dicen.
7. Cuando mezclo un idioma lo hago conscientemente.
8. Me resulta difícil controlar los cambios de idioma que introduzco (p. ej., de catalán a castellano) a lo largo de una conversación.
9. Sin quererlo, a veces me sale primero la palabra en ESPAÑOL cuando estoy hablando en CATALÁN.
10. Sin quererlo, a veces me sale primero la palabra en CATALÁN cuando estoy hablando en español.
11. Hay situaciones en las cuales siempre mezclo dos idiomas.
12. Hay asuntos o temas sobre los cuales suelo hablar mezclando ambos idiomas.

POR FAVOR, COMPRUEBE SI HA RESPONDIDO A TODAS LAS PREGUNTAS

BSWQ ENGLISH TRANSLATION

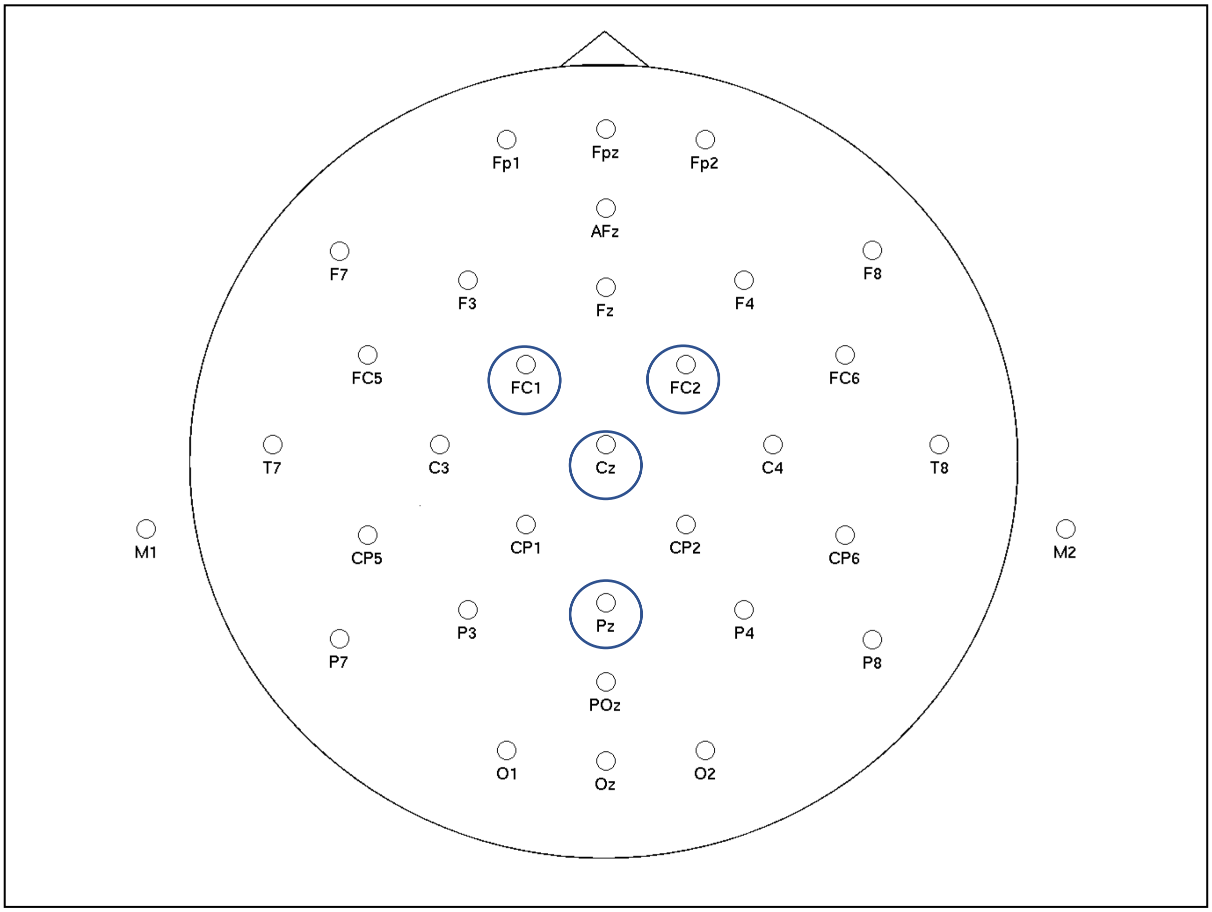
Please, try to answer to what degree the following questions are representative of the manner you use to talk or speak in the language you know (e.g., Catalan–Spanish). Many of these questions ask you to report your tendency to switch or mix languages during a conversation. Switching and mixing languages is a characteristic of some bilingual contexts or environments, as for example in Catalonia. The present questionnaire aims to identify the language switching patterns that exist in these languages. If you have doubts about how to rate yourself in the following questions, please try to compare your manner of speaking and talking with that of most people, or those who you know very well.

1. I do not remember or I cannot recall some Catalan words when I am speaking in this language.
   ☐ never ☐ very infrequently ☐ occasionally ☐ frequently ☐ always
2. I do not remember or I cannot recall some Spanish words when I am speaking in this language.
3. I tend to switch languages during a conversation (for example, I switch from Spanish to Catalan or vice versa).
4. When I cannot recall a word in Catalan, I tend to immediately produce it in Spanish.
5. When I cannot recall a word in Spanish, I tend to immediately produce it in Catalan.
6. I do not realize when I switch the language during a conversation (e.g., from Catalan to Spanish) or when I mix the two languages; I often realize it only if I am informed of the switch by another person.
7. When I switch languages, I do it consciously.
8. It is difficult for me to control the language switches I introduce during a conversation (e.g., from Catalan to Spanish).
9. Without intending to, I sometimes produce the Spanish word faster when I am speaking in Catalan.
10. Without intending to, I sometimes produce the Catalan word faster when I am speaking in Spanish.
11. There are situations in which I always switch between the two languages.
12. There are certain topics or issues for which I normally switch between the two languages.

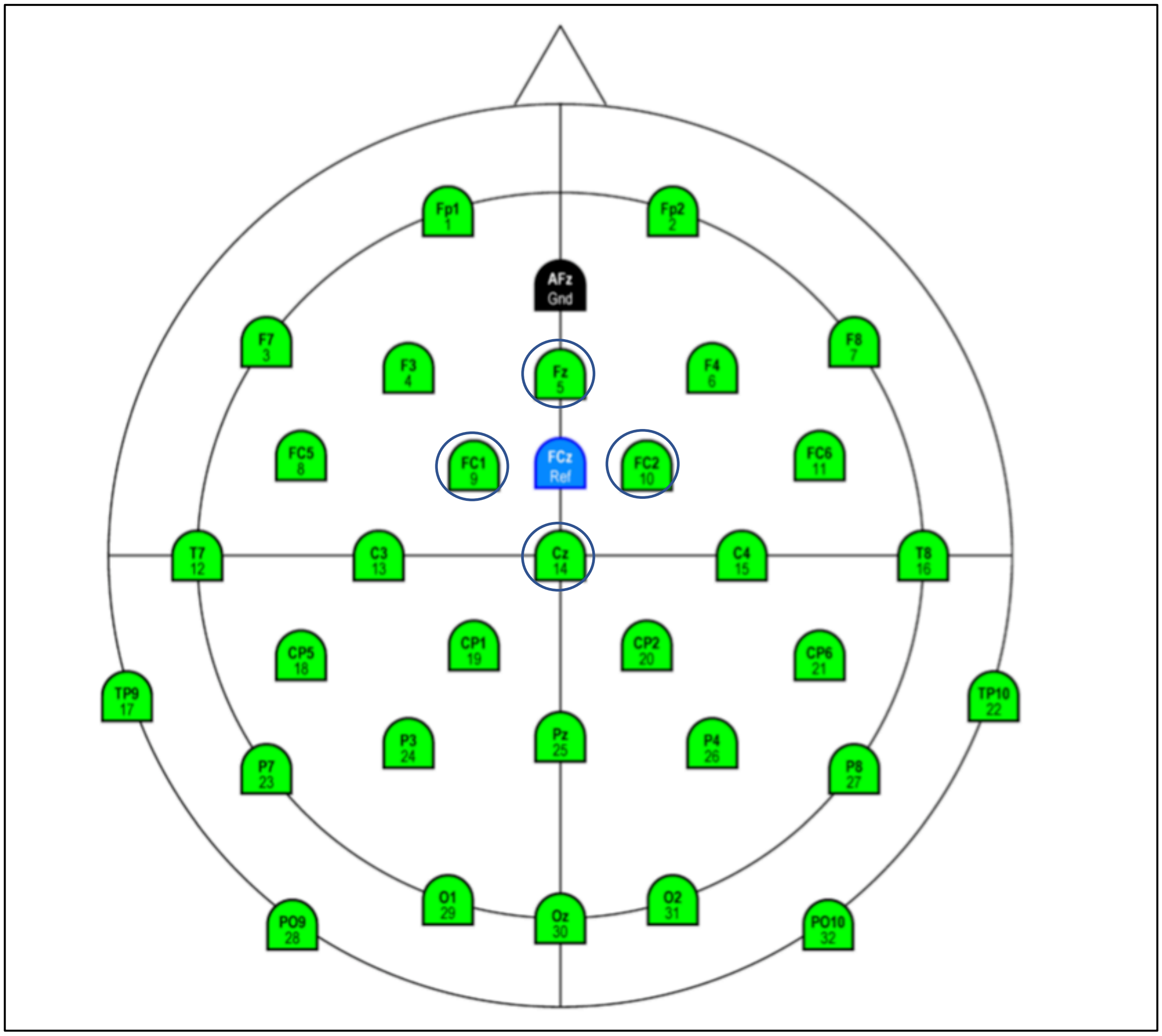
PLEASE, CHECK IF YOU HAVE ANSWERED ALL THE QUESTIONS

Appendix C. Electrode Cap Layouts

Waveguard 32 Channel Electrode Scheme (ANT Neuro System)



actiCap 32 Channel Standard-2 Electrode Scheme (Brain Vision System)



Appendix D. Diploma de Español como Lengua Extranjera (DELE)

Tests, Answer Key, Grading Guide
(Montrul, 2005)
Multiple Choice Test

Each of the following sentences contains a blank indicating that a word or phrase has been omitted. Select the choice that best completes the sentence.

1. Al oír del accidente de su buen amigo, Paco se puso __________.

a. alegre   b. fatigado   c. hambriento   d. desconsolado

2. No puedo comprarlo porque me_______________.

a. falta   b. dan   c. presta   d. regalan

3. Tuvo que guardar cama por estar ______________.

a. enfermo   b. vestido   c. ocupado   d. parado

4. Aquí está tu café, Juanito. No te quemes, que está muy ______________.

a. dulce   b. amargo   c. agrio   d. caliente

5. Al romper los anteojos, Juan se asustó porque no podía _______ sin ellos.

a. discurrir   b. oír   c. ver   d. entender

6. ¡Pobrecita! Está resfriada y no puede ________________.

a. salir de casa   b. recibir cartas   c. respirar con pena   d. leer las noticias

7. Era una noche oscura sin _______.

a. estrellas   b. camas   c. lágrimas   d. nubes

8. Cuando don Carlos salió de su casa, saludó a un amigo suyo: -Buenos días,____.

a. ¿Qué va?   b. ¿Cómo es?   c. ¿Quién es?   d. ¿Qué tal?

9. ¡Qué ruido había con los gritos de los niños y el _______ de los perros!

a. olor   b. sueño   c. hambre   d. ladrar

10. Para saber la hora, don Juan miró el __________.

a. calendario b. bolsillo c. estante d. despertador

11. Yo, que comprendo poco de mecánica, sé que el auto no puede funcionar sin _ ______.

a. permiso b. comer c. aceite d. bocina

12. Nos dijo mamá que era hora de comer y por eso ____________.

a. fuimos a nadar b. tomamos asiento c. comenzamos a fumar
d. nos acostamos pronto

13. ¡Cuidado con ese cuchillo o vas a ___________ el dedo!

a. cortarte b. torcerte c. comerte d. quemarte

14. Tuvo tanto miedo de caerse que se negó a ___________ con nosotros.

a. almorzar b. charlar c. cantar d. patinar

15. Abrió la ventana y miró: en efecto, grandes lenguas de _______ salían llameando de las casas.

a. zorros b. serpientes c. cuero d. fuego

16. Compró ejemplares de todos los diarios pero en vano. No halló ____________.

a. los diez centavos b. el periódico perdido c. la noticia que deseaba
d. los ejemplos

17. Por varias semanas acudieron colegas del difunto profesor a ________ el dolor de la viuda.

a. aliviar b. dulcificar c. embromar d. estorbar

18. Sus amigos pudieron haberlo salvado pero lo dejaron ______________.

a. ganar b. parecer c. perecer d. acabar

19. Al salir de la misa me sentía tan caritativo que no pude menos que _________ a un pobre mendigo que había allí sentado.

a. pegarle b. darle una limosna c. echar una mirada d. maldecir

20. Al lado de la Plaza de Armas había dos limosneros pidiendo ________.

a. pedazos b. paz c. monedas d. escopetas

21. Siempre maltratado por los niños, el perro no podía acostumbrarse a ________ de sus nuevos amos.

a. las caricias b. los engaños c. las locuras d. los golpes

22. ¿Dónde estará mi cartera? La dejé aquí mismo hace poco y parece que el necio de mi hermano ha vuelto a ________.

a. dejármela b. deshacérmela c. escondérmela d. acabármela

23. Permaneció un gran rato abstraído, los ojos clavados en el fogón y el pensamiento ___ _____________.

a. en el bolsillo b. en el fuego c. lleno de alboroto d. Dios sabe dónde

24. En vez de dirigir el tráfico estabas charlando, así que tú mismo ____________ del choque.

a. sabes la gravedad b. eres testigo c. tuviste la culpa
d. conociste a las víctimas

25. Posee esta tierra un clima tan propio para la agricultura como para _________.

a. la construcción de trampas b. el fomento de motines c. el costo de vida
d. la cría de reses

26. Aficionado leal de obras teatrales, Juan se entristeció al saber _____________ del gran actor.

a. del fallecimiento b. del éxito c. de la buena suerte d. de la alabanza

27. Se reunieron a menudo para efectuar un tratado pero no pudieron __________.

a. desavenirse b. echarlo a un lado c. rechazarlo d. llevarlo a cabo

28. Se negaron a embarcarse porque tenían miedo de ___________.

a. los peces b. los naufragios c. los faros d. las playas

29. La mujer no aprobó el cambió de domicilio pues no le gustaba ____________.

a. el callejeo b. el puente c. esa estación d. aquel barrio

30. Era el único que tenía algo que comer pero se negó a ______________.

a. hojearlo b. ponérselo c. conservarlo d. repartirlo

Cloze Test

In the following text, some of the words have been replaced by blanks numbered 1 through 20. First, read the complete text in order to understand it. Then reread it and choose the correct word to fill each blank from the answer sheet. Mark your answers by circling your choice on the answer sheet, not by filling in the blanks in the text.

El sueño de Joan Miró

Hoy se inaugura en Palma de Mallorca la Fundación y Joan Miró, en el mismo lugar en donde el artista vivió sus últimos treinta y cinco años. El sueño de Joan Miró se ha ________________ (1). Los fondos donados a la ciudad por el pintor y su esposa en 1981 permitieron que el sueño se ________________(2); más tarde, en 1986, el Ayuntamiento de Palma de Mallorca decidió ___________________(3) al arquitecto Rafael Moneo un edificio que ___________________(4) a la vez como sede de la entidad y como museo moderno. El proyecto ha tenido que ___________________(5) múltiples obstáculos de carácter administrativo. Miró, coincidiendo ______________(6) los deseos de toda su familia, quiso que su obra no quedara expuesta en ampulosos panteones de arte o en _______________(7) de coleccionistas acaudalados; por ello, en 1981, creó la fundación mallorquina. Y cuando estaba ________________(8) punto de morir, donó terrenos y edificios, así como las obras de arte que en ellos ______________(9).

El edificio que ha construido Rafael Moneo se enmarca en ______________(10) se denomina "Territorio Miró", espacio en el que se han __________________(11) de situar los distintos edificios que constituyen la herencia del pintor.

El acceso a los mismos quedará _________________ (12) para evitar el deterioro de las obras. Por otra parte, se __________________(13), en los talleres de grabado y litografía, cursos _________________(14) las distintas técnicas de estampación. Estos talleres también se cederán periódicamente a distintos artistas contemporáneos, _____________(15) se busca que el "Territorio Miró" ____________(16) un centro vivo de creación y difusión del arte a todos los ______(17).

La entrada costará 500 pesetas y las previsiones dadas a conocer ayer aspiran______(18) que el centro acoja a unos 150.000 visitantes al año. Los responsables esperan que la institución funcione a______(19) rendimiento a principios de la______(20) semana, si bien el catálogo completo de las obras de la Fundación Pilar y Joan Miró no estará listo hasta dentro de dos años.

Cloze Test Answer Sheet

1.	a. cumplido	b. completado	c. terminado
2.	a. inició	b. iniciara	c. iniciaba
3.	a. encargar	b. pedir	c. mandar
4.	a. hubiera servido	b. haya servido	c. sirviera
5.	a. superar	b. enfrentarse	c. acabar
6.	a. por	b. en	c. con
7.	a. voluntad	b. poder	c. favor
8.	a. al	b. en	c. a
9.	a. habría	b. había	c. hubo
10.	a. que	b. el que	c. lo que
11.	a. pretendido	b. tratado	c. intentado
12.	a. disminuido	b. escaso	c. restringido
13.	a. darán	b. enseñarán	c. dirán
14.	a. sobre	b. en	c. para
15.	a. ya	b. así	c. para
16.	a. será	b. sea	c. es
17.	a. casos	b. aspectos	c. niveles
18.	a. a	b. de	c. para
19.	a. total	b. pleno	c. entero
20.	a. siguiente	b. próxima	c. pasada

Answer Key: Multiple Choice Test

1. d	11. c	21. a
2. a	12. b	22. c
3. a	13. a	23. d
4. d	14. d	24. c
5. c	15. d	25. d
6. a	16. c	26. a
7. a	17. a	27. d
8. d	18. c	28. b
9. d	19. b	29. d
10. d	20. c	30. d

Answer Key: Cloze Test

1. a	8. c	15. b
2. b	9. b	16. b
3. a	10. c	17. c
4. c	11. b	18. a
5. a	12. c	19. b
6. c	13. b	20. b
7. b	14. a	

Strict Evaluation
Total points possible: 50

Near native	46 to 50
Advanced	39 to 45
Intermediate	25 to 38
Low	0 to 24

Lenient Evaluation
Total points possible: 50

Near native	46 to 50
Advanced	37 to 45
Intermediate	25 to 36
Low	0 to 24

Appendix E. Elicited Imitation Task

Stimuli List and Scoring Procotol
(Ortega et al, 2002)

ELICITED IMITATION TASK STIMULI

1. Quiero cortarme el pelo (7 syllables)
2. El libro está en la mesa (7 syllables)
3. El carro lo tiene Pedro (8 syllables)
4 Él se ducha cada mañana (9 syllables)
5. ¿Qué dice usted que va a hacer hoy? (9 syllables)
6. Dudo que sepa manejar muy bien (10 syllables)
7. Las calles de esta ciudad son muy anchas (11 syllables)
8. Puede que llueva mañana todo el día (12 syllables)
9. Las casas son muy bonitas pero caras (12 syllables)
10. Me gustan las películas que acaban bien (12 syllables)
11. Después de cenar me fui a dormir tranquilo (13 syllables)
12. El chico con el que yo salgo es español (13 syllables)
13. Quiero una casa en la que vivan mis animales (14 syllables)
14. A vosotros os fascinan las fiestas grandiosas (14 syllables)
15. Ella ha terminado de pintar su apartamento (14 syllables)
16. El niño al que se le murió el gato está triste (14 syllables)
17. Ella sólo bebe cerveza y no come nada (15 syllables)
18. Me gustaría que el precio de las casas bajara (15 syllables)
19. Cruza a la izquierda y después sigue todo derecho (15 syllables)
20. Me gustaría que empezara a hacer más calor pronto (15 syllables)

21. Una amiga mía cuida a los niños de mi vecino (16 syllables)

22. El gato que era negro fue perseguido por el perro (16 syllables)

23. Antes de poder salir él tiene que limpiar su cuarto (16 syllables)

24. La cantidad de personas que fuman ha disminuido (17 syllables)

25. Después de llegar a casa del trabajo tomé la cena (17 syllables)

26. El ladrón al que cogió la policía era famoso (17 syllables)

27. Le pedí a un amigo que me ayudara con la tarea (16 syllables)

28. El examen no fue tan difícil como me habían dicho (17 syllables)

29. ¿Serías tan amable de darme el libro que está en la mesa? (17 syllables)

30. Me pregunto si el tren de las ocho habrá llegado ya o no (17 syllables)

SCORING PROTOCOL FOR ELICITED IMITATION TASK

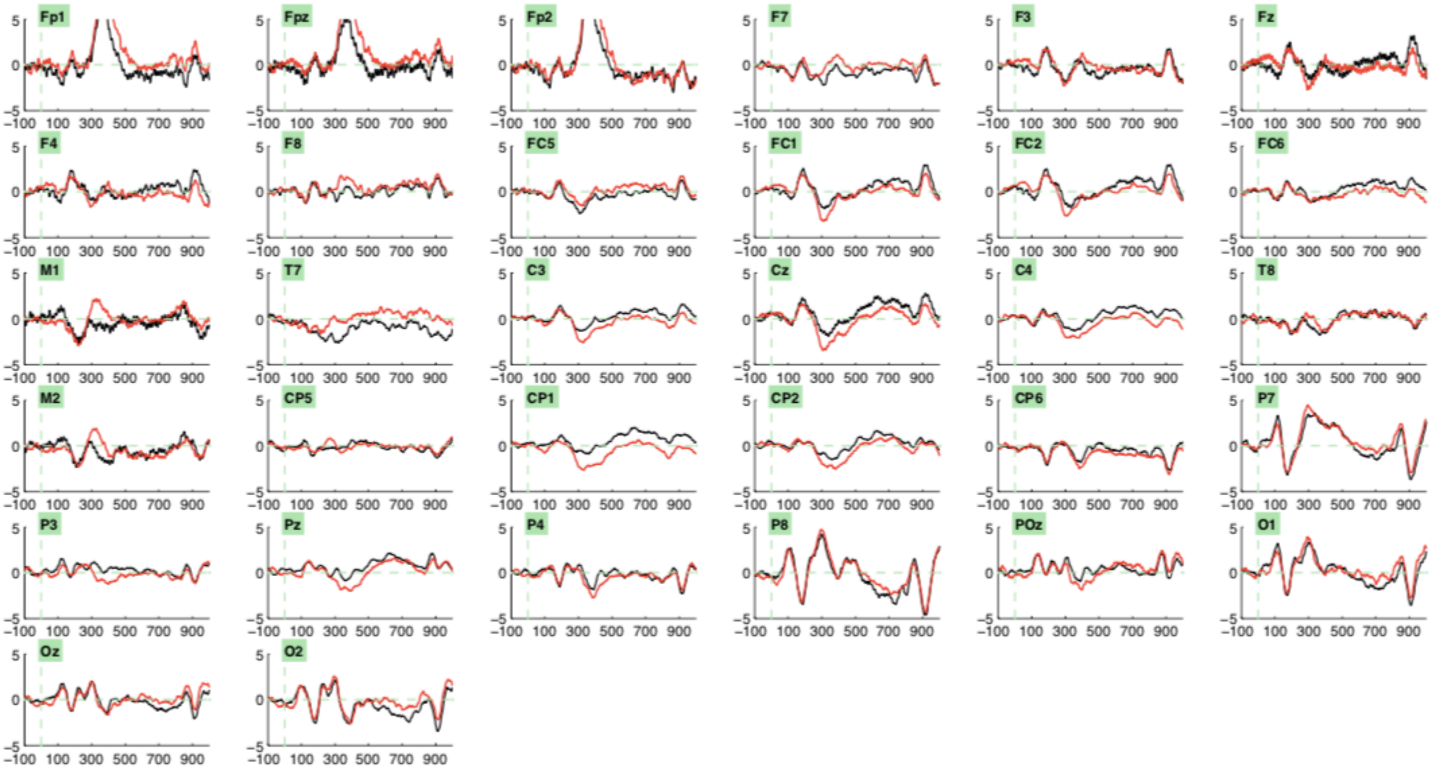
EIT score 0 descriptor

Criteria	**Examples**
• Nothing (Silence)	
• Garbled (unintelligible, usually transcribed as XXX)	
• Minimal repetition, then item abandoned: - Only 1 word repeated - Only 1 content word plus function word(s) - Only function word(s) repeated - Only 1 or 2 content words out of order plus extraneous words that weren't in the original stimulus	- Manana (10- item 4) - El examen que [gibberish] (09- item 28) - Despues mue- XX tranquilo (01-item 11) - Tu que sepa a- m- muy bien (12-item 6) - Me gustaria las se se se el XXX (16-item 18)

. EIT score 1 descriptor

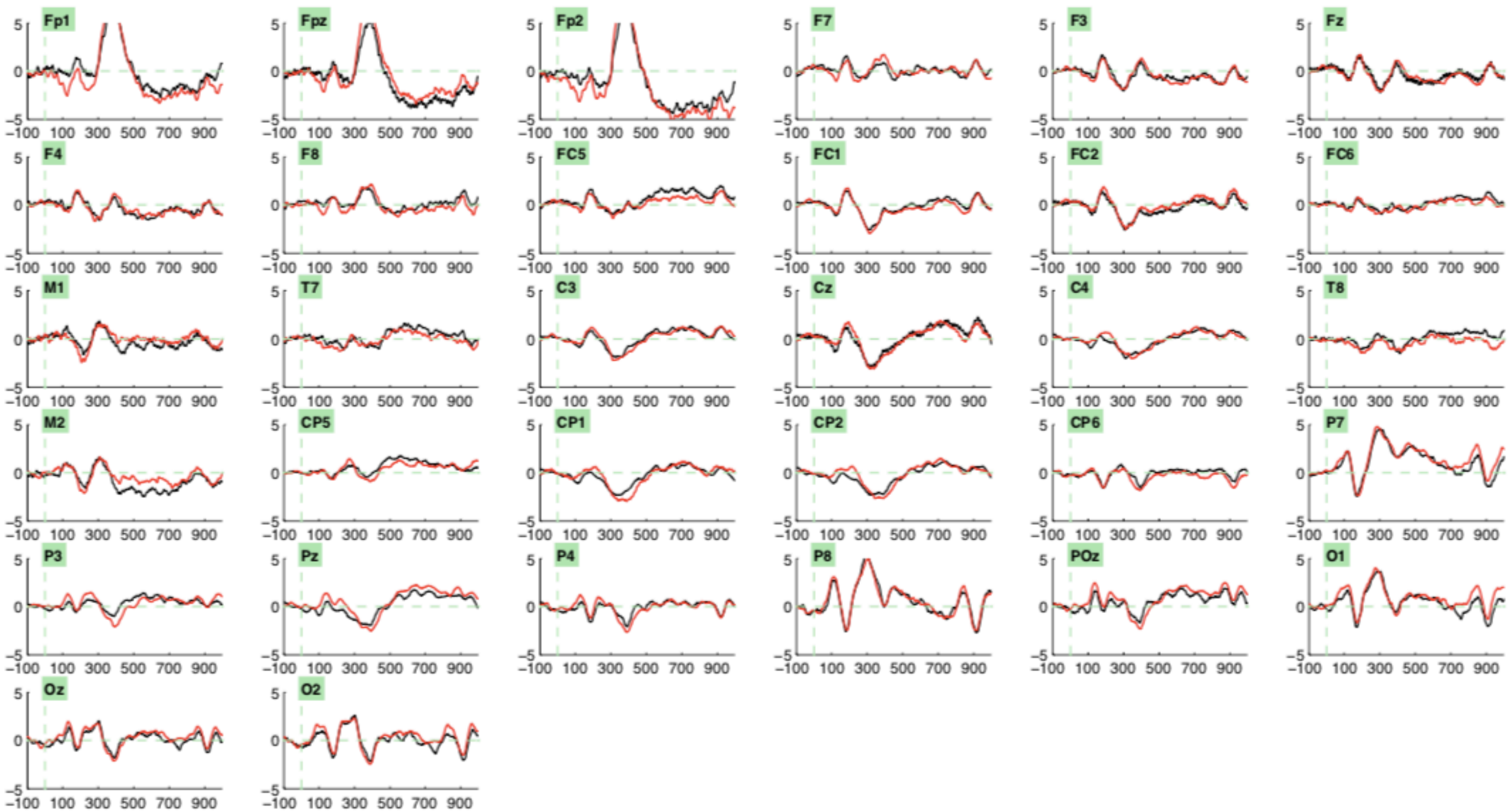
Criteria	**Examples**
• When only about half of idea units are represented in the string but a lot of important information in the original stimulus is left out; sometimes the resulting meaning is unrelated (or opposed) to stimulus	-Antes de poder seguir (3 sec.) perdio su cuarto (02-item 23) -Dudo que sepa ma- tambien (04-item 6) -Seria en que el libro esta en la mesa (11-item 29) -El gato que eran pelo negro dan something el perro (14-item 22)
• Or when string doesn't in itself constitute a self-standing sentence with some (related or not to stimulus) meaning (This may happen when only 2 of 3 content words are repeated and no grammatical relation between them is attempted)	-El ladron que XX la policia famoso (11-item 26) -Despues de cenar fue en- tranquilo (03-item 11) -Le pendu una amiga que XXX la tarea (01-item 27) -La cantidad de personas fumar alguno, alguno (03-item 24)

Appendix E. ERP Data: Grand Averages Across All Electrodes for All Groups



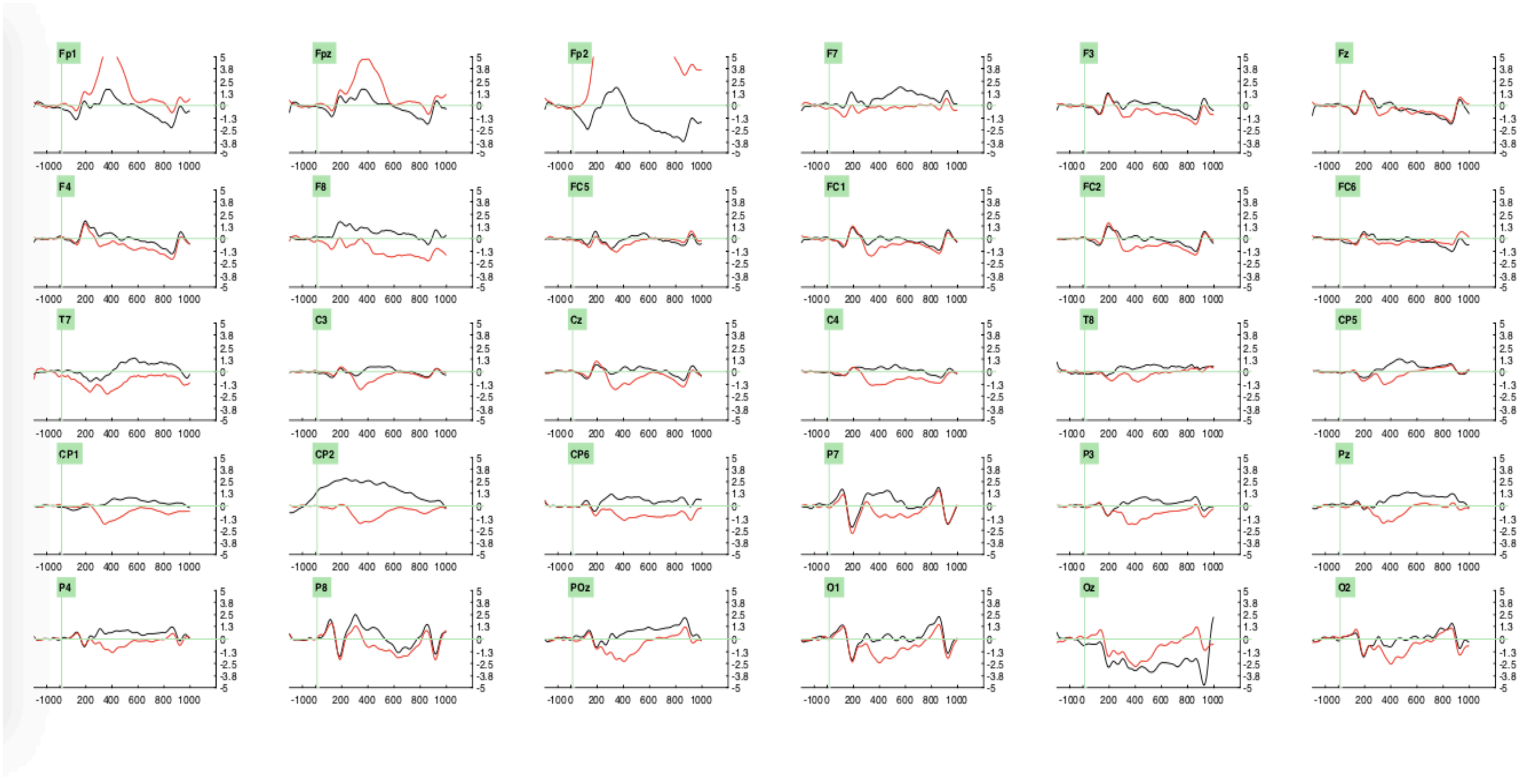
Grand average ERPs for Monolingual group across all electrodes for the Adjective-First Condition.

Note. In waveforms, onset of the critical word (adjective-first condition) is indicated by the vertical bar; x-axis: time (ms); y-axis: voltage (µV, positive voltage is up down). Voltage maps represent difference in voltage (µV) between Go (in black) and No-Go (in red) trials.



Grand average ERPs for Monolingual group across all electrodes for the Noun-First Condition.

Note. In waveforms, onset of the critical word (noun-first condition) is indicated by the vertical bar; x-axis: time (*ms*); y-axis: voltage (μV, positive voltage is up down). Voltage maps represent difference in voltage (μV) between Go (in black) and No-Go (in red) trials.



Grand average ERPs for L2 Learner group across all electrodes for the Adjective-First Condition.

Note. In waveforms, onset of the critical word (adjective-first condition) is indicated by the vertical bar; x-axis: time (ms); y-axis: voltage (µV, positive voltage is up down). Voltage maps represent difference in voltage (µV) between Go (in black) and No-Go (in red) trials.

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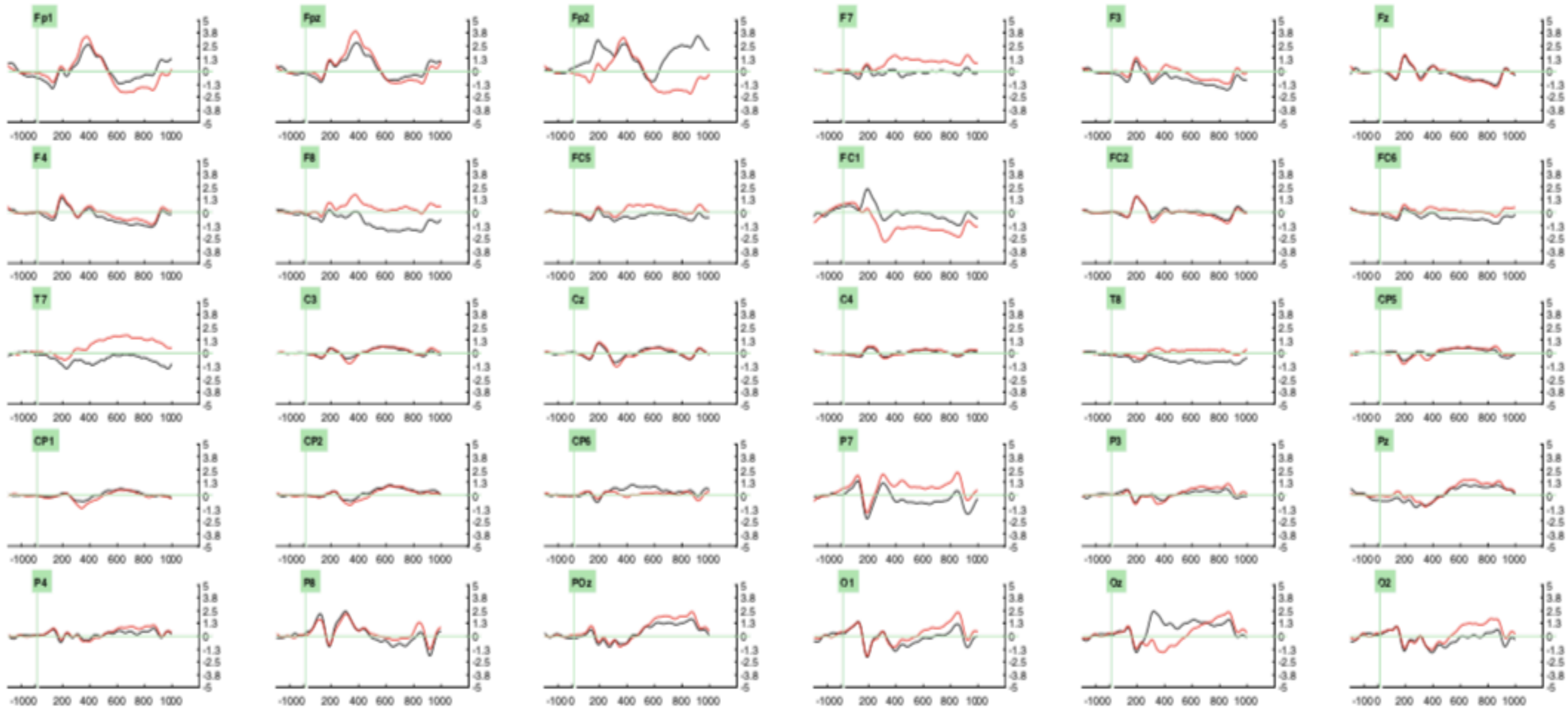
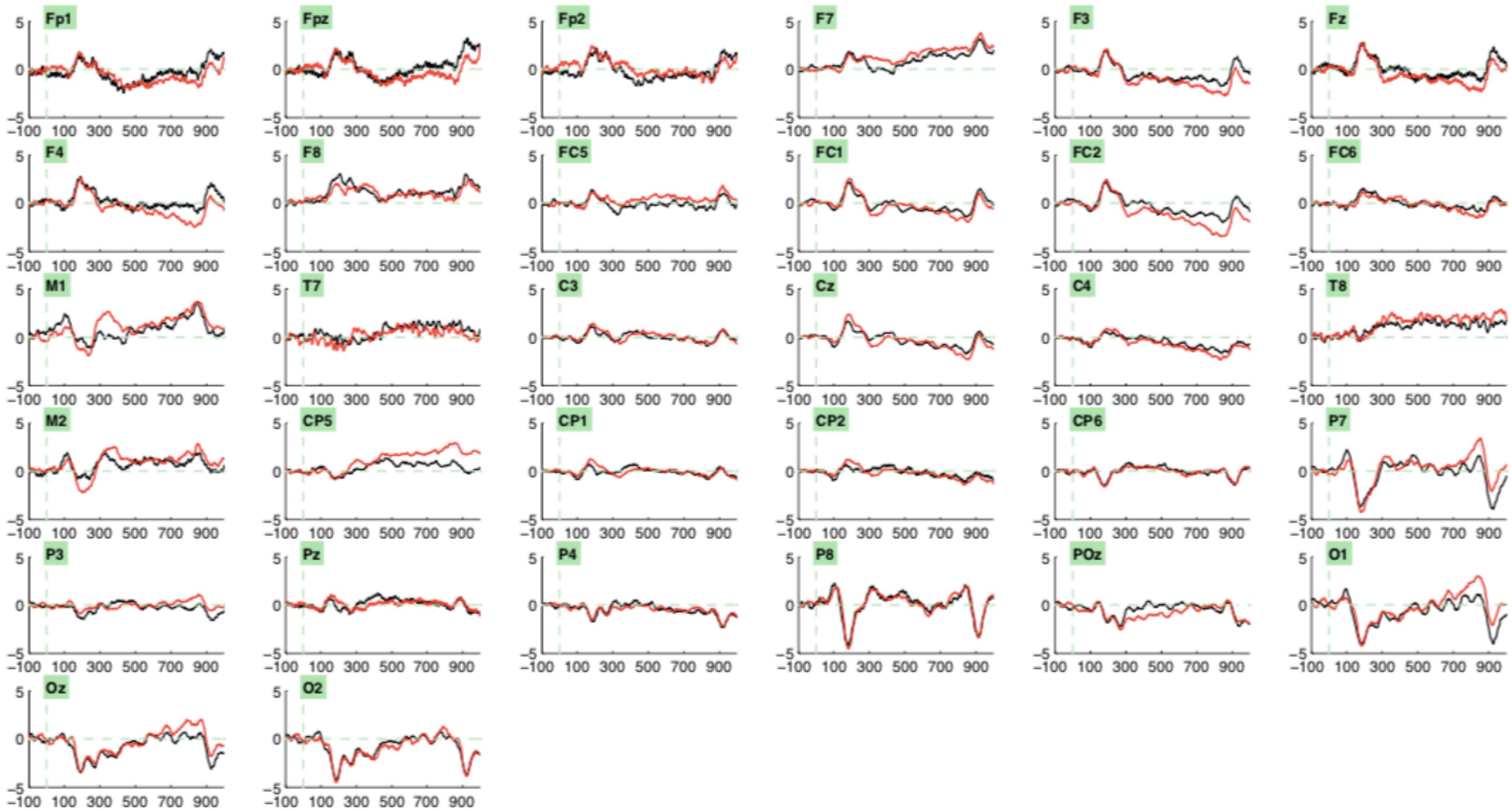


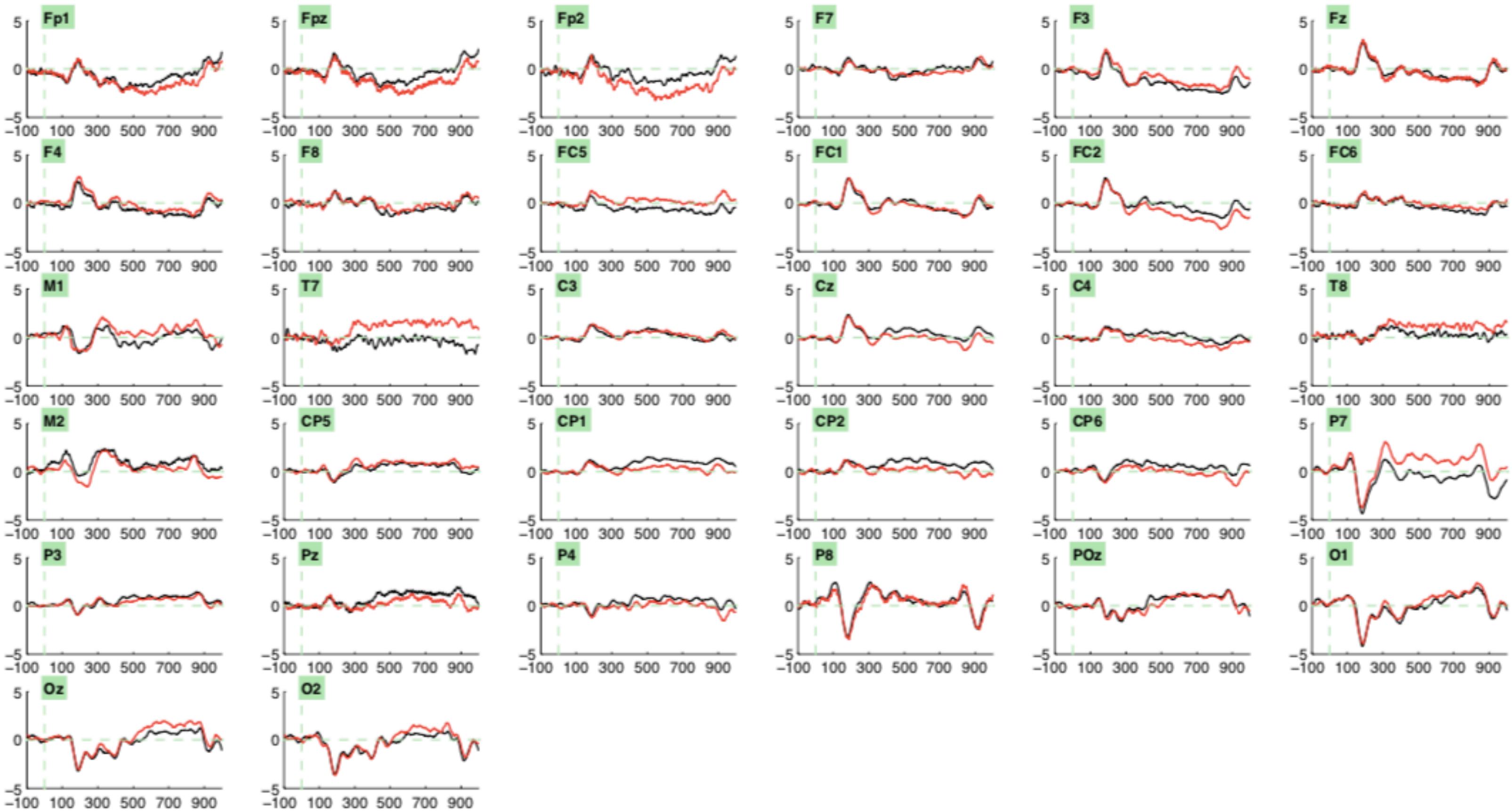
Grand average ERPs for L2 Learner group across all electrodes for the Noun-First Condition.

Note. In waveforms, onset of the critical word (noun-first condition) is indicated by the vertical bar; x-axis: time (*ms*); y-axis: voltage (µV, positive voltage is up down). Voltage maps represent difference in voltage (µV) between Go (in black) and No-Go (in red) trials



Grand average ERPs for Bilingual group across all electrodes for the Adjective-First Condition.

Note. In waveforms, onset of the critical word (adjective-first condition) is indicated by the vertical bar; x-axis: time (ms); y-axis: voltage (µV, positive voltage is up down). Voltage maps represent difference in voltage (µV) between Go (in black) and No-Go (in red) trials.



Grand average ERPs for Bilingual group across all electrodes for the Noun-First Condition.

Note. In waveforms, onset of the critical word (noun-first condition) is indicated by the vertical bar; x-axis: time (*ms*); y-axis: voltage (µV, positive voltage is up down). Voltage maps represent difference in voltage (µV) between Go (in black) and No-Go (in red) trials.

VITA

EDUCATION

2019	Ph.D. in Spanish Linguistics Specialization: Second Language Acquisition & Bilingualism Advisor: Dr. Kara Morgan-Short	University of Illinois at Chicago
2014	M.A. in Spanish Graduate Certificate in Second Language Acquisition & Teaching (SLAT)	University of Oregon
2011	M.A. in Advanced English Studies, Multilingual & Intercultural Communication	University of Málaga (Spain)
2010	M.S. in Psychobiology & Cognitive Neuroscience	Autonomous University of Barcelona (Spain)
2009	B.A. in English	University of Málaga (Spain)

DISSERTATION

Title

"Inhibitory Control and First Language Flexibility in Adult Second Language Learning: A Neurocognitive Investigation"

Committee

Dr. Kara Morgan-Short (Chair), Dr. Jennifer Cabrelli (UIC), Dr. Luis López (UIC), Dr. Judith F. Kroll (University of California-Riverside), & Dr. Guillaume Thierry (Bangor University, UK)

HONORS & AWARDS

Research

2019	1st Place Award (Category Undergraduate Research) to Ana Hernandez (Undergraduate mentee)	In/Between Conference University of Illinois at Chicago	
2018	Doctoral Dissertation Improvement Grant (BCS #1132289)	National Science Foundation	$10,844
2018	Audrey Lumsden-Kouvel Dissertation Fellowship	University of Illinois at Chicago	$6,142
2017	Provosts & Deiss Award for Graduate Research	University of Illinois at Chicago	$1,777
2017	2nd Place Award (Category Social Siences) to Nethaum Mizyed (Undergraduate mentee)	Student Research Forum University of Illinois at Chicago	$300
2016	Chancellor's Graduate Research Fellowship Award	University of Illinois at Chicago	$6,000
2013	Graduate School Research Award	University of Oregon	$500

RESEARCH INTERESTS

Adult Second Language Acquisition, Heritage Speaker Bilingualism, Language Development & Processing of Syntax and Morphosyntax in Classroom & Study-Abroad Settings; Learner Individual Differences; Cognitive Neuroscience of Language; Psycholinguistics; (Becoming) Bilingual Cognition; Task-Based Language Teaching; Spanish in the US, Bilingualism as Tool to Promote Social Justice

PUBLICATIONS

Peer-reviewed

2019 Morgan-Short, K., Finestrat, I., **Luque, A.,** & Abugaber, D. (under review). Exploring New Insights into Explicit and Implicit Second Language Processing: Event-Related Potentials Analyzed by Source Attribution. *Language Learning.*

2019 Cabrelli Amaro, J., **Luque, A**., & Finestrat, I. (2019). Influence of L2 English Phonotactics in L1 Brazilian Portuguese Illusory Vowel Perception. Special Issue of *Journal of Phonetics: Plasticity of Native Phonetic and Phonological Domains*.

2018 **Luque, A**., Mizyed, N., & Morgan-Short, K. (2018). Event-Related Potentials Reveal Evidence for Syntactic Co-Activation in Bilingual Language Processing: A Replication of Sanoudaki and Thierry (2014, 2015). In L. López (Ed.), *Code-switching: theoretical questions, experimental answers (177–194)*. Amsterdam: John Benjamins.

PRESENTATIONS

Invited Talks

2018 **Luque, A**. (2018, June). What Can We Learn about Adult Second Language Learning by Studying the Brain? Invited talk given at the XVI Psychology Seminar. Department of Psychology. Loyola University of Andalucía, Sevilla, Spain.

2018 **Luque, A**. (2018, May). A Neurocognitive Investigation of Dominant Language Flexibility in Bilingualism and Adult Second Language Learning. Invited poster presented at the 1st Harmonious Bilingualism Network Colloquium (HaBilNet), La Hulpe, Belgium.

2017 **Luque, A**. (2017, December). Investigating the Role of L1 Change as an Individual Difference in Adult Second Language Acquisition: An ERP Study. Invited talk given to the Bilingualism, Mind, and Brain Lab (Directed by Dr. Judith F. Kroll). University of California at Riverside. Riverside, CA, USA.

2016 **Luque, A**. (2016, September). Exploring the Role of Internal and External Factors in Successful Adult Second Language Acquisition. Invited talk given to the Neurolinguistics Lab (Directed by Dr. Loraine Obler). The Graduate Center, City University of New York (CUNY). New York City, NY, USA.

Refereed Conference Papers & Posters

2019 Morgan-Short, K., **Luque, A**., Finestrat, I., &, Abugaber, D. (2019, March). Exploring Event-Related Potentials by Subjective Report as Insight into Explicit and Implicit Second Language Grammatical Knowledge. Poster to be presented at the 26th Annual Meeting of the Cognitive Neuroscience Society (CNS). San Francisco, CA, USA.

2019 **Luque, A**. (2019, March). The Bilingual (Cognitive) Advantage in Young Adults: The Role of Verbal Fluency and Degree of Bilingualism. Paper to be presented at the American Association for Applied Linguistics (AAAL) 2019 Conference. Atlanta, GA, USA.

2018 **Luque, A**., & Morgan-Short, K. (2018, November). Investigating Syntactic Co-Activation in Bilingual Language Processing: An Event-Related Potential Study. Poster presented at the 59th Annual Meeting of the Psychonomic Society. New Orleans, LA, USA.

2018	Morgan-Short, K., Abugaber, D., Finestrat, I., & **Luque, A.** (2018, September). Event-Related Potentials with Subjective Measures: Exploring New Insights into Second Language Processing. Paper presented at the Cognitive Neuroscience of Second and Artificial Language Learning Conference (ConSALL 2018). Bangor, Wales, UK.
2018	Finestrat, I., **Luque, A**., Abugaber, D., & Morgan-Short, K. (2018, March). Native Language Processing as an Individual Difference Explaining Variability in L2 Processing: An Event-Related Potential Study. Paper presented at the American Association for Applied Linguistics (AAAL) 2018 Conference. Chicago, IL, USA.
2017	Abugaber. D., Finestrat, I., **Luque, A**., & Morgan-Short, K. (2017, November). Event-Related Potentials Indicate A Role for Word Frequency in L1 And L2 Grammatical Processing. Poster presented at the 9th Annual Meeting of the Society for the Neurobiology of Language. Baltimore, MD, USA.
2017	**Luque, A**., & Morgan-Short, K. (2017, October). Two Languages in One Mind: Examining the Role of Syntactic Co-Activation in Bilingual Language Processing: An ERP Study. Paper presented at the 36th Second Language Research Forum (SLRF). Columbus, OH, USA.
2017	**Luque, A**., & Morgan-Short, K. (2017, September). Investigating the Role of First Language Change as An Individual Difference in Adult Second Language Acquisition: An ERP Study. Paper presented at the Researchers' Session of the 5th Barcelona Summer School on Bilingualism and Multilingualism. Universitat Pompeu Fabra, Barcelona, Spain.
2017	Cabrelli Amaro, J., **Luque, A**., & Finestrat, I. (2017, June). Phonotatic Restructuring in L1 Brazilian Portuguese. Paper presented at the 11th International Symposium on Bilingualism (ISB 11). University of Limerick, Limerick, Ireland.
2016	**Luque, A**., Rebuschat, P., & Morgan-Short, K. (2016, September). Exploring the Role of Bilingualism in The Development of L2 Syntactic Knowledge. Paper presented at the 35th Second Language Research Forum (SLRF). New York City, NY, USA.
2016	**Luque, A**., Phipps, A., Rebuschat, P., Morgan-Short, K. (2016, April). Exploring the Role of Inhibitory Control in The Development of Implicit L2 Syntactic Knowledge. Paper presented the American Association for Applied Linguistics (AAAL) 2016 Conference. Orlando, FL, USA.
2014	**Luque, A**., (2014, March). The Effect of Second Language Proficiency on L1 Lexical Retrieval in Healthy Older Adults: A Pilot Study. Poster presented at the American Association for Applied Linguistics (AAAL) 2014 Conference. Portland, OR. USA.
2011	**Luque-Ferreras, A**., Guerrero, C., & Luque-Martin, JS. (2011, June). Does Folstein's Mini-Mental Test Predict Early Language Impairment? Poster presented at the 10th Spanish National Symposium on Clinical Psychology. Donosti, Spain
2010	**Luque, A**. (2010, November). How Can Linguists Deal with The Neuropsychological Evaluation of Cognitive Disorders? Paper presented at the 6th International Conference on Clinical Linguistics. University of Valencia, Spain.
2010	**Luque-Ferreras, A**., Luque-Martín, J., & García-Carrascal, L. (2010, November). Exploring the Relationship between Syntax Impairment and Mild Cognitive Impairment (Language-Based) In Patients with Cardiovascular Risk

Factors. Poster presented at the 20th Andalusian Conference of the Society of Arterial Hypertension and Cardiovascular Disease Risk Factors. Punta Umbria, Huelva, Spain

Other

(Note: * denotes undergraduate mentee)

2019	*Hernandez, A. & **Luque, A.** (2019, April). Investigating the Role of First Language Flexibility in Adult Second Language Learning: An ERP Study. Poster presented at the 2019 In/Between Conference. University of Illinois at Chicago, Chicago, IL, USA.
2017	*Mizyed, N. & **Luque, A.** (2017, April). Two Languages in One Mind: Examining the Role of Syntactic Co-Activation in Bilingual Language Processing. Poster presented at the 2017 UIC Student Research Forum. University of Illinois at Chicago, Chicago, IL, USA.
2017	**Luque, A**. & Morgan-Short, K. (2017, March). Investigating the Role of L1 Change as Individual Difference in Adult Second Language Acquisition: An ERP Investigation. 1st Chicago-Area Sentence Processing Flash Talks. University of Illinois at Chicago, Chicago, IL, USA.
2016	*Kadakia, N. & **Luque, A**. (2016, April). Exploring the Role of Executive Function in Adult Second Language Acquisition. Poster Presented at the 2016 UIC Student Research Forum. University of Illinois at Chicago, Chicago, Illinois, USA.
2015	*Phipps, A., **Luque, A**., & Morgan-Short, K. (2015, April). Methodological Considerations in Implicit Adult Second Language Learning. Poster presented at the 2015 UIC Student Research Forum. University of Illinois at Chicago, Chicago, IL, USA.
2014	Holguín-Mendoza, C. & **Luque-Ferreras, A**. (2014, March). Implicit Measures of Dialectical Attrition in Mexican Spanish. Presented at the 3rd Annual Romance Languages Works in Progress Symposium. Department of Romance Languages, Eugene, OR, USA.

RESEARCH EXPERIENCE

2018-2015	**Lab Manager** Cognition of Second Language Acquisition Lab Director: Dr. Kara Morgan-Short	University of Illinois at Chicago
2018-2017 Summer	**Graduate Research Assistant** Chicago Spanish Corpus Project (CHISPA) Director: Dr. Kim Potowski	University of Illinois at Chicago
2015 Summer	**Graduate Research Assistant** Multilingual Phonology Lab Director: Dr. Jennifer Cabrelli Amaro	University of Illinois at Chicago
2014-2013	**Volunteer Graduate Research Assistant** Brain Development Lab Director: Dr. Helen Neville	University of Oregon
2013	**BULATS Certified English Examiner** The Business Language Testing Service	Cambridge English (UK) & University of Salamanca (Spain)

TEACHING EXPERIENCE

Guest Lectures

2018	**Luque, A**. (2018, October). Research Methods in Adult Second Language Acquisition. Invited lecture given to Spanish/Linguistics 556: Graduate Seminar on Second Language Acquisition. Department of Hispanic & Italian Studies, University of Illinois at Chicago, Chicago, IL, USA.
2018	**Luque, A**. (2018, August). Fostering Independent Language Learning: A Task-Based Approach. Invited talk given at the Spanish Basic Language Program New Faculty Orientation. University of Illinois at Chicago, Chicago, IL, USA.
2018	**Luque, A**. (2018, February). The Chicago Spanish Corpus (CHISPA): Transcribing and Translating Sociolinguistic Data. Invited lecture given to Dr. Kim Potowski's Spanish/Linguistics 507: Graduate Seminar on Bilingualism. Department of Hispanic & Italian Studies, University of Illinois at Chicago, Chicago, IL, USA.
2016	**Luque, A**. (2016, December). Experimental Methods in Adult Second Language Acquisition: A Brain-Based Perspective. Invited lecture given to Dr. MaryAnn Paradas' Spanish 5400: Graduate Seminar on Research Methods. Department of Modern Language and Literatures. California State University at Bakersfield, Bakersfield, CA, USA.

Courses taught

Present-2014	**Graduate Teaching Assistant** Department of Hispanic & Italian Studies - Spanish 556: Second Language Acquisition - Spanish 206: Intro to Hispanic Linguistics - Spanish 202: Advanced Grammar in Practice - Spanish 114: Spanish for Heritage Learners II - Spanish 113: Spanish for Heritage Learners I - Spanish 101-102: Elementary Spanish I & II	University of Illinois at Chicago
2014-2012	**Graduate Teaching Assistant** Department of Romance Languages - Spanish 201-203: Intermediate Spanish I-III - Spanish 101-103: Elementary Spanish I-III	University of Oregon
2013	**BULATS Certified English Examiner** The Business Language Testing Service	Cambridge English (UK) & University of Salamanca (Spain)
2012	**Lecturer** Department of English - English 4: Advanced English IV - History of the English Language	University of Huelva (Spain)

MENTORING & ADVISING EXPERIENCE

Present-2014	**Supervising Graduate Mentor** Cognition of Second Language Acquisition Lab *Honors College Capstone Projects (4)* *Undergraduate Research Initiative (3)* *Volunteer and Course Credit only (12)*	University of Illinois at Chicago
2012	**M.A. Thesis Examination Committee**	University of Huelva (Spain)

Secondary Teacher Education | Specialization in Second Language Acquisition & Teaching

ADMINISTRATIVE EXPERIENCE

2018-2016	**Language Program Coordinator** Department of Hispanic & Italian Studies Spanish Basic Language Program (Spanish 102)	University of Illinois at Chicago

PROFESSIONAL DEVELOPMENT

2019	Arctic MSCA-IF Symposium	University of Tromsø (Norway)
2017	5th Barcelona Summer School on Bilingualism & Multilingualism (BSBM)	Universitat Pompeu Fabra (Spain)
2016	Pre-Conference Workshop on Statistics for Applied Linguistics with R	AAAL 2016 Conference
2015	Workshop on Bilingualism and Executive Function: An Interdisciplinary Approach	City University of New York-Graduate Center (CUNY)
2013	Linguistic Society of America Summer Institute	University of Michigan

SERVICE

To the Profession

Present-2019	Early Career Researchers Committee	SPARK Society
Present-2018	Applied Linguistics & Social Justice Working Group	American Association of Applied Linguistics (AAAL)
2016	Graduate Student Volunteer	Chicago Language Symposium
2015	Graduate Student Volunteer	Neurobiology of Language Conference
2014	Graduate Student Volunteer	NWAV43 Conference

To the Community

Present-2009	Volunteer Spanish-English Bilingual Interpreter	Spain & USA
Present-2009	Volunteer Spanish-English Bilingual Translator	Spain & USA
Present-2003	Volunteer Spanish-English Bilingual Tutor	Spain & USA

To the University of Illinois at Chicago

2019-2018	Hispanic & Italian Studies Student Representative	Graduate Council
2017	Graduate Student Judge	Student Research Forum
2016	Organizing Committee, Session Chair, Abstract Reviewer	UIC Bilingualism Forum
2016	Graduate Student Volunteer	LAS Undergraduate Visiting Day
2017-2015	Head Organizer	Talks in Linguistics (TiL)
2017-2015	Cognition of Second Language Acquisition Lab Liaison	Psychology Visiting Day
2014	Session Chair, Abstract Reviewer	UIC Bilingualism Forum

To the University of Oregon

2014	Presenter	Foreign Languages Day
2014-2013	M.A. Students' Representative	Romance Languages Dept.

OTHER AWARDS

Scholarship

2008	Undergraduate Research Fellowship	University of Málaga (Spain)	$2000
2006	Erasmus-Mundus Scholarship	University of Stirling	$3000

Travel

2018-2014	Ph.D. Conference Travel Award (x4)	UIC College of Liberal Arts & Sciences (LAS)	$500
2018-2014	Conference Travel Award (x4)	UIC Graduate Student Council	$300
2018-2014	Conference Travel Award (x4)	UIC Graduate College	$300
2013	Conference Travel Award	University of Oregon Romance Languages Department	$1000

LANGUAGES

Spanish: Native proficiency
English: Near-native proficiency
Italian: Low-Intermediate proficiency
French: Reading proficiency
Portuguese: Reading proficiency

TECHNOLOGY & SOFTWARE

Event-Related Potentials: MatLab, EEGLab, ERPLab, ASA, Brain Vision Analyzer
Acoustic Analysis/Transcription: PRAAT, Audacity, ELAN
Experimental Implementation: E-Prime, Paradigm, pebl, SuperLab, Qualtrics
Statistical Analysis: SPSS, R

MEMBERSHIP IN ACADEMIC ORGANIZATIONS

American Association of Applied Linguistics (AAAL)
Psychonomic Society
Society for Neuroscience (SfN)
Women in Cognitive Science (WiSC)