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Interactions Between Lexical and Syntactic Knowledge in ESL: Behavioral and Brain Measures of Sentence Comprehension Among Spanish L1 Learners of English

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by

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Dedication

I would like to dedicate this work to all those who have helped, supported, and guided me on this journey. First, I'd like to thank my parents who have always been my support. I would like to thank Gwen, for demonstrating unthinkable patience and understanding during difficult times. Gwen has also provided me with the knowledge and understanding of background materials that have enabled this work to proceed. She has been available at all times to discuss design and interpretation questions and at times has stayed up with me while we work late into the night. This work would not be possible without her expertise, her willingness to allow an undergraduate to produce a scholarly work such as this, and her unwavering faith in my ability to complete this even when I felt like I was in over my head. I'd like to thank Scott, for providing valuable insight into the linguistic concerns of this work. I'd like to thank all the others who have helped along the way including Josh, Anaïs, Nick, Jeci, Omid, Maruf, Milo, and all the rest of the BELLS Lab team for their aid when the going got rough. I'd also like to mention my biggest cheerleader, April, in the Honors Office, who has continually shown me that I'm not alone in this. Finally, I'd like to thank the Language and Literacy Initiative, the Department of Psychology, the Honors College, and the University as a whole for affording students like me the opportunity to pursue our interests and contribute to the body of human knowledge even as undergraduates. Success does not happen in a vacuum; without all of the wonderful people with whom I've had the pleasure to interact, this work would not be possible and my success would not have been realized. So thank you and without further ado, I present my undergraduate honors thesis.

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Interactions between Lexical and Syntactic Knowledge in ESL: Behavioral and Brain Measures of Sentence Comprehension among Spanish L1 Learners of English

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Abstract

We examined event-related brain potentials (ERPs) during comprehension of the English Causative. The main goal was to examine ERP responses to grammatical violations that reflect a mismatch between the verb and the sentence structure. The second goal was to compare effects among native English speakers (NES) and native Spanish speakers learning English as a second language (ESL). We expected group differences to reflect different neurolinguistic processes, particularly for sentences that are well-formed in English, but not in Spanish.

The English Causative is a grammatical construction that is syntactically ditransitive ('SubjNP–V–ObjNP–PP') and means '[someone]–[CAUSED-by-doing-X]–[something]–[change-of-state]'. An example is the sentence, *Jack sent his sister to the store*, which implies that Jack (SubjNP) caused his sister (ObjNP) to undergo a change of location (PP) by sending her (V). Importantly, only certain verbs are permitted within this construction: In English, ditransitive verbs (e.g., *send*), are allowed, as are alternating unaccusatives, such as *walk* (*Jack walked his sister to the store*). Non-alternating unaccusatives, such as *arrive*, are disallowed, even when the sentence has a meaningful interpretation (**Jack arrived his sister to the store*). To comprehend these structures as they unfold in time, a language-user must therefore reconcile word- and clause-level constraints and dynamically update his or her understanding throughout the sentence.

In the present study we asked nine NES and eight ESL participants to view a series of sentences, presented one phrase at a time, while we recorded their EEG. Each sentence was intransitive ('SubjNP–V'), transitive ('SubjNP–V–ObjNP'), or ditransitive ('SubjNP–V–PP'), and was followed by a response probe. The task was to say whether each sentence was acceptable. Brain activity was measured using electroencephalography (EEG) and processed to create ERPs.

We had four predictions. First, we predicted that the ObjNP following an intransitive verb would elicit a P600 effect, reflecting a syntactic violation (e.g., **Jack walked/arrived his sister*). Second, for non-alternating (*arrive*-type) verbs, we predicted that a subsequent PP (e.g., **Jack arrived his sister to the store*) would elicit a P600 effect, whereas Alternating (*walk*-type) verbs would elicit a minimal or no P600. Third, we expected that ESL partiticpants, like NES participants, would show an P600 effect to the ObjNP for sentences containing intransitives. However, in contrast with English, we predicted that the final PP would elicit an error-related response among ESL participants for *walk*-type verbs, as well as for *arrive*-type verbs.

Study results partly confirmed our predictions. The two groups showed similar patterns of acceptability, although ESL participants were slower overall. As predicted, the ObjNP elicited a P600 effect for *arrive*-type verbs for NES participants. Interestingly, ESL participants exhibited N400 rather than P600 effects to the ObjNP. Further, in response to the PP, both groups exhibited N400 effects to *arrive*-type verbs, without a subsequent P600 effect.

In summary, although their behavioral patterns did not differ, ERPs revealed group differences in verb–construction mismatches at different points in the sentence. The pattern of N400 and P600 responses was partly unexpected. We consider implications for syntax-semantic interactions, integration of word- and clause-level information, second-language learning, and functional correlates of N400 and P600 effects.

Keywords: psycholinguistics, syntax, semantics, second language acquisition, EEG/ERP, constructions, verb types, crosslinguistic effects

Interactions between Lexical and Syntactic Knowledge in ESL: Behavioral and Brain Measures of Sentence Comprehension among Spanish L1 Learners of English

1. Introduction

Sentence comprehension is a complex behavior that involves multiple processes, including word-level (lexical) access and sentence-level syntactic and semantic processing (Sprouse and Lau, 2012). Moreover, fluent comprehension depends on finely timed interactions of form and meaning and dynamic updating of language representations as a sentence unfolds in time (Perfetti & Frishkoff, 2008). To examine these processes, recent studies have used event-related brain potentials (ERPs) to measure the brain's response to various syntactic and semantic manipulations (see Sprouse and Lau, 2012, for a recent review). ERPs reflect fluctuations in electrical activity generated in the brain and are measured noninvasively, on the head surface. A major advantage of ERPs is their superior time resolution: Brain activity can be sampled over milliseconds, allowing researchers to capture processes as they unfold in real time. In addition, ERP patterns, such as the N400 and P600, are thought to reflect specific processes, such as word comprehension, syntactic analysis, and sentence-final integration. Armed with these new measures, ERP studies are contributing to our understanding of basic mechanisms underlying sentence comprehension (Sprouse and Lau, 2012).

The present study contributes to this area in two ways. First, there are few ERP studies that have focused on comprehension of complex grammatical constructions, such as the English Causative (but see Ye, Zhan, and Zhou, 2007). Studies of this nature are important because constructions — by definition — involve mapping, or integration, of sentence-level form (syntax) and meaning (propositional semantics). For instance, the Causative is syntactically

ditransitive ('SubjNP–V–ObjNP–PP') and means '[someone]–[CAUSED-by-doing-X]–[something]–[change-of-state]'. In the present study we manipulate this structure to create sentences that are either acceptable or unacceptable in English. The key manipulation is verb type: Some verbs (e.g., *send*) are compatible with the Causative, and some (e.g., *arrive*) are not. Interestingly, linguistic theories differ in their explanation of these patterns. Some rely mainly on word-level constraints (e.g., verb subcategorization) to predict which combinations are acceptable. Other theories recognize an additional role for sentence-level semantic constraints (henceforth "constructional meaning"). These theories therefore make different predictions about neurocognitive responses to mismatches between verbs and constructions. In the present study, we probed responses at different points in a sentence, to clarify the mechanisms underlying comprehension of complex grammatical structures.

Our study also contributes to understanding of cross-linguistic effects in sentence comprehension. We compared behavioral and brain responses of native English speakers (NES) with those of native speakers of Spanish learning English as a second language (ESL). Spanish has similar verb classes and constructions as English, including the ditransitive construction. However, the Spanish ditransitive disallows some verbs (e.g., *walk*) that are acceptable in English (Slobin, 1996, 2005). Thus, in learning English, native Spanish speakers must accept combinations in their second language (L2) that are inadmissible in their native language (L1). We therefore expected that NES and ESL would show different patterns of acceptability ratings to these verb–construction pairings (cf. Cabrera and Zubizarreta, 2005). We also expected to see group differences in ERP responses that would clarify how ESL learners make use of syntactic and semantic information during online processing of the English Causative.

The rest of this thesis is structured as follows. Section 1 describes word- and clause-level constraints on English Causatives and reviews theories of sentence comprehension, contrasting serialist (or syntax-first) and interactionist views. It describes recent bilingual research on sentence comprehension. It then reviews ERP studies of sentence comprehension and recent interpretations of N400 and P600 effects based on studies of argument structure and violations of verb semantics ("selectional restrictions"). Section 3 describes the study methods, and Section 4 presents behavioral and ERP findings. Finally, Section 5 considers implications for models of sentence comprehension and second-language learning.

1.1. The Causative Construction: Basic Features and Cross-linguistic Differences

The Causative (or caused motion) construction is a grammatical structure that is common across languages (Levin, 1993). An example in English is the sentence, *Jack sent his sister to the store* (Figure 1(A)). This sentence indicates that Jack caused his sister (ObjNP) to undergo a change of location. Because the English Causative requires the expression of three noun phrases (NPs), it is syntactically ditransitive ('SubjNP–V–ObjNP–PP'; Figure 1(B)). In addition, each NP is associated with a *semantic* (aka "thematic") *role* (Figure 1(C)): The SubjNP refers to an actor (referred to as an AGENT in linguistics) who carries out an ACTION (expressed by the verb). The ObjNP refers to a person or thing (PATIENT) that undergoes a change of location. Finally, the prepositional phrase (PP) contains a third NP (*the store*), which indicates the end location, or GOAL of the action. Schematically, the clause-level meaning can be represented as CAUSE-MOVE (AGENT, PATIENT, GOAL).

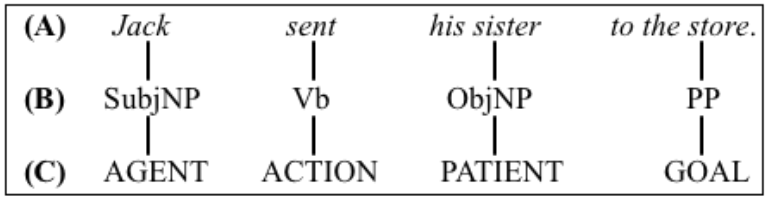

Figure 1. English Causative Construction.

The Causative is of interest to linguists because it expresses a mapping between syntax and semantics (see Fig. 1) and because it relies on integration of word-level constraints (e.g., each verb is associated with a preferred argument structure) and sentence-level constraints (e.g., verb meaning must be compatible with constructional meaning). In English, only certain verbs are permitted within the Causative: ditransitive verbs, such as *send*, are allowed, as are alternating intransitives, such as *walk* (*Mary walked her sister to the party*). Non-alternating intransitives, such as *arrive*, are disallowed, even when the sentence has a meaningful interpretation (**Mary arrived her sister to the party*). Linguists have offered alternative theories to account for these patterns (see Levin & Rappaport, 1989 for a review). For the most part, all theories assume that verbs play a defining role in clause-level meaning (Jackendoff, 1990; Goldberg, 1995; Levin & Rappaport, 1989). Further, most linguists assume that each verb is linked in memory with a preferred syntactic frame (Jackendoff, 1990; Givon, 1979). For example, the meaning of the verb *send* is strongly associated with three participants: an AGENT, a PATIENT, and a GOAL; cf. Fig. 1 (C)). According to some theories, verb frames are so strongly predictive that the verb essentially determines clause-level argument structure. For example, on this view, the meaning of the causative (CAUSE-MOVE) is predictable from (or "projected by") the verb *send*. In line with this view, Levin (1993) divided English verbs into over 50 categories (e.g., *spray/load* verbs, *pound*-type verbs, *find*-type verbs), based on the construction types associated with each verb.. Consider sentences (1)-(4) below.

(1) John pounded the jar. (Subj–V-DO)

(2) John found the jar. (Subj–V-DO)

(3) John pounded the jar shut. (Subj–V-DO-Adj/PPP)

(4) *John found the jar safe. (Subj–V-DO-Adj/PPP)

Sentences (1) and (2) demonstrate that *pound*-type verbs (Levin, 1993: p. 149) and *find*-type verbs can both be used in a simple transitive structure (Subj–V-DO; Levin, 1993: p. 141) . However, only *pound* can be used in a structure such as (3) to mean that the action resulted in the change of state (from open to shut). While sentence (4) appears to have the same structure as sentence (3), it is only acceptable on the interpretation that the jar was safe when John found it: it cannot be used to mean that finding the jar caused it to be safe. According to Levin (1993), this evidence suggests that pound and find belong to distinct syntactic and semantic subclasses, even though they are both transitive.

Clearly, the meaning of a sentence depends at least in part on the words that form the sentence, as illustrated in Sentence (1) through (4). In addition, psycholinguistic studies have suggested that the verb is an especially good predictor of clause-level semantics (Goldberg, 1995). What may be less obvious is that sentences can assume higher-order meanings, beyond the words that make up these structures (Fillmore, 1988, 1989; Goldberg, 1995, 2003, 2006; Goldberg & Jackendoff, 2004). For example, sentence (3) implies that the jar became shut (Change-of-State) due to pounding (Causative Action). Note, however, that causation is not intrinsic to the meaning of *pound*: *John pounded the jar* implies that the jar was affected in some way, but it does not specify a particular outcome: ... *into the ground* and ... *until it broke* are two possible outcomes. Thus, the verb *pound* takes on a special meaning within the causative sentence structure: pounding in this context is more than a transitive act — it also causes a change of state. Thus, according to some linguistic theories, the meaning associated with a particular construction is not entirely predictable from a verb or verb class. If this claim is correct, then comprehension requires processing and integration of meaning at multiple levels (see also, Ye, et al., 2007).

A further implication is that comprehension requires the comprehender to combine word-level information (i.e., verb class) and clause-level constraints in real time. Consider examples (5) through (7).

(5) Jack walked. Intrans = (SubjNP–Vb)

(6) *Jack walked his sister. Trans = (SubjNP–Vb–ObjNP)

(7) Jack walked his sister to the store. Ditrans = (SubjNP–Vb–ObjNP–PP)

The verb *walk* typically implies an action involving a subject noun (e.g., Sentence (5)) and no direct object (e.g., Sentence (6) is ungrammatical). However, in Sentence (7) *walk* is used with a direct object (the package) and takes on a slightly different meaning, namely one that is causative (walking caused the package to change location). Because *walk*-type verbs in English can be used with a direct object in this special context, they are sometimes referred to as *alternating unaccusatives* (or *alternating intransitives)*. By contrast, *arrive*-type verbs are referred to as *non-alternating unaccusatives* (or *non-alternating intransitives*). The contrast between these examples raises an interesting question: How do native speakers of English reconcile word- and clause-level constraints in real time, particularly for Sentences (3), which are temporarily ambiguous? In particular, how does the brain respond to the ObjNP in Sentence (7): Is it perceived as a linguistic violation? If so, does the brain's response reflect a violation of semantic or syntactic expectancies, or both? And how is the following PP processed and integrated into the emerging sentence representation? To address these questions, the present study examines ERP measures of semantic (N400) and syntactic (P600) processing during online comprehension of the English Causative. We ask whether verb-to-construction mismatches elicit semantic or syntactic ERP effects, or both, at different points in the sentence, reflecting dynamic use of multiple sources of information as a sentence unfolds in time.

The Causative construction is also of interest in research on second-language processing, because it is subject to different constraints in different languages. For example, both English and Spanish have a class of verbs that denote nondirected motion (e.g., *walk, slide, climb*). In contrast with English, *walk*-type verbs in Spanish are non-alternating. Thus, although Spanish has a ditransitive construction, with a similar form and meaning as the English Causative, the languages differ in the types of verbs that permitted within this construction. This suggests that NES and ESL groups might engage different neurocognitive (e.g., syntactic and semantic) processes in comprehending ditransitive sentences containing *walk*-type verbs (see Section 1.5 for further discussion).

1.2. Construction Grammar and the Syntax-Semantics Interface

Linguists have long debated the nature of the syntax–semantic interface, that is, how processing of sentence form and meaning interact to determine the final interpretation of a sentence. According to formalist theories of language, syntax can be separated from semantics: e.g., judgments of acceptability, according to this view, can be based solely on how the elements (or "constituents") of a sentence are assembled, independent of the meanings of these elements (Chomsky, 1957). Proponents of this view also tend to embrace a "syntax-first" view (e.g., Friederici, 2002): according to this view, initial assignment of syntactic structure (i.e., sentence parsing) precedes assignment of meaning.

By contrast, functionalist theories tend to emphasize interactions between form and meaning at multiple levels of language comprehension. One such approach, Construction Grammar (Fillmore, 1988, 1989; Goldberg, 1995, 2003, 2006, 2009), emphasizes the role of learned pairings of form (syntax) and meaning (semantics). These pairings are called *constructions*. According to Construction Grammar, constructions exist at all levels, from the

morpheme, to the word, to the clause or sentence level (Goldberg, 2006). Interestingly, one implication is that sentence-level ("grammatical") constructions are associated with meanings that are stored in memory, independent of word-level meanings. To understand this claim, consider the following examples.

(8) Elizabeth is running the cake up the steps. (SubjNP–Vb–ObjNP–PP)

(9)*Elizabeth is running the cake. (SubjNP–Vb–ObjNP)

According to Goldberg (1995), Sentence (8) is an instance of the causative construction (compare Sentence (7) above). What is striking about this example is that the verb *run* is normally intransitive — that is, typically it cannot be followed by an ObjNP (e.g., Sentence (9) is clearly ungrammatical). What should we make of its use in Sentence (8)? Is this a different verb — run_2, a ditransitive verb meaning [CAUSE-something-change-of-state-by-running], versus run_1 (simple intransitive)? Goldberg (1995) argues that the more parsimonious account is to regard (8) and (9) as instances of the same verb. The extra meaning [CAUSE-something-change-of-state-by-doing-X] is a property of the construction, not of the verb. If Goldberg is correct, then it will be important to consider how constructional meaning interacts with knowledge of different verb types.

1.3. The Incremental Nature of Sentence Processing: Open vs. Closed Violations

Another key characteristic of language comprehension is that it unfolds rapidly in time. Understanding the time dynamics of language can therefore give important insights on the nature of skilled and less skilled comprehension, e.g., in a second language. As the comprehender is processing incoming words and phrases, he or she updates his or her mental model of the sentence structure and meaning dynamically. According to *syntax-first* theories, the processing of syntax proceeds first, followed by semantic processing. This view suggests that syntactic and

semantic subsystems do not interact directly and that a surface interaction takes place only late in the processing cycle. By contrast, *interactionist* views hold that a direct interaction takes place early and throughout the processing cycle. Optimality Theory (OT; Prince & Smolensky, 1993) can be viewed as an interactionist theory and has been widely adopted by linguists over the past few decades. According to OT, when people make judgments about the acceptability or grammaticality of sentences, they implicitly make use of the semantics of the previously presented sentence parts and knowledge of what further constituents are needed to complete an anticipated meaning. Thus, the list of possible anticipated meanings is continuously refined based on incoming data from the sentence. While at one point in the presentation of a sentence the comprehender may reject the sentence as ungrammatical, as additional elements appear, the comprehender may revise her sentence interpretation, leading to dynamic changes in grammaticality judgment. Given this time-dynamic framework, it is likely that cognitive processes such as the sequencing, working memory, and memory retrieval, are important in sentence processing, as are language-specific processes that support incremental building of syntactic and semantic structures, and clause-level integration.

Another implication is that comprehenders continuously update their evaluation of structure and meaning as they process each part of a sentence. Thus, examining the comprehension of each word or phrase within a sentence is important because it allows us to understand how expectancies are updated. In this context, it is important to distinguish between two types of violation: open vs. closed violations. We will refer to sentences in which a seeming violation can be resolved by additional sentence components as *open violations*. For example, the sentence "*Jack is walking his sister*" (Sentence (6)) represents a grammatical violation, because *walk* is intransitive and therefore cannot take a direct object ("*her sister*"). The violation

is *open*, however, because adding a prepositional phrase ("*to the store*") resolves the error (see Sentence (7)).

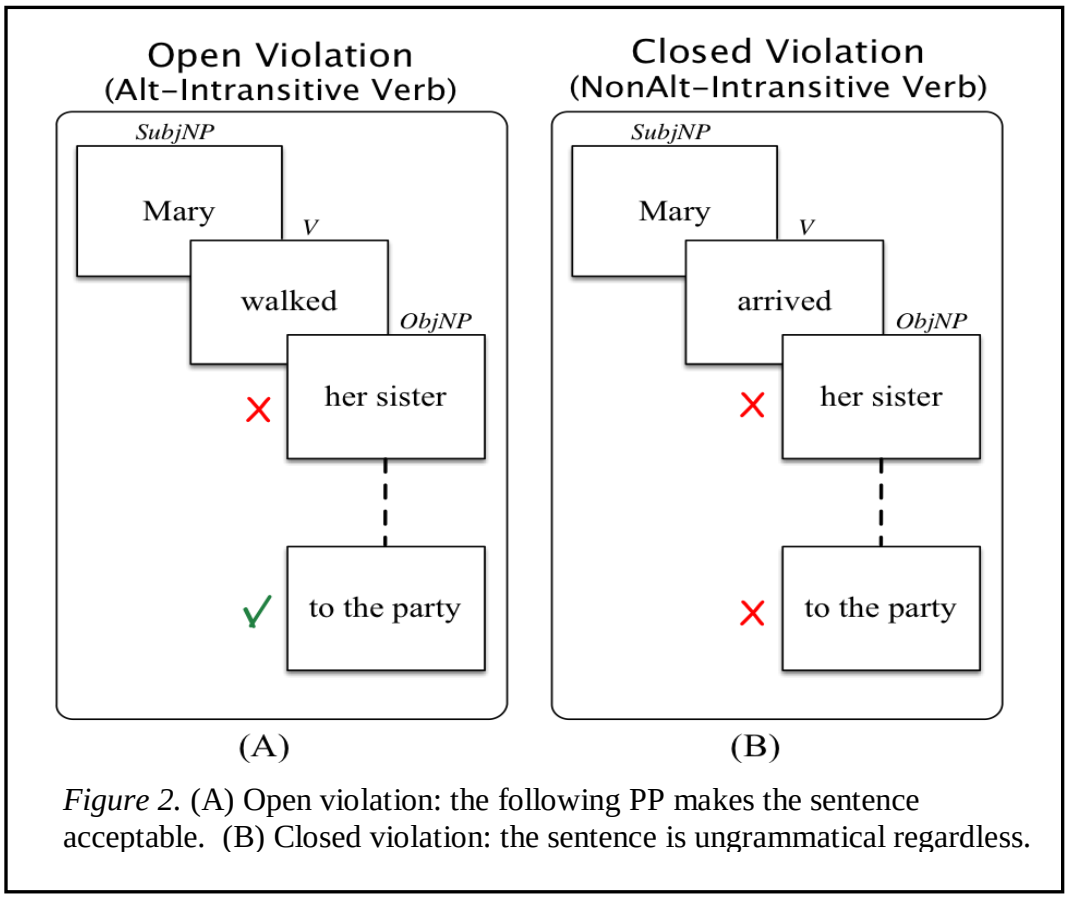

Figure 2. (A) Open violation: the following PP makes the sentence acceptable. (B) Closed violation: the sentence is ungrammatical regardless.

Sentences in which a violation cannot be resolved by additional sentence components will be said to contain *closed violations*. For example, the sentence "*Jack is arriving his sister*" is syntactically anomalous, similar to Sentence (6). By contrast, however, the violation is *closed*, as the error cannot be resolved by adding an additional word or phrase (see Figure 2(B)).

(10) Jack arrived. (SubjNP–Vb)

(11) *Jack arrived his sister. (SubjNP–Vb–ObjNP)

(12) Jack arrived his sister to the store. (SubjNP–Vb–ObjNP–PP)

The idea of closed and open violations is useful in interpreting online comprehension. For example, open violations may elicit different neural responses than closed violations: in the first

instance, comprehenders could pay a price (in terms of processing demands) if they prematurely deem the violation as "fatal" or closed, because additional elements could require re-analysis. On the other hand, maintaining alternative structures in working memory taxes limited cognitive resources, so there is a countervailing pressure to resolve the ambiguity as soon as possible.

In summary, to understand how individuals process a grammatical construction in real time, it is important to probe the brain's response at different time points. In the present study, we probed brain activity and behavior at several points within the causative construction (see Figure 3 below): This allowed us to investigate how violations of expectancy for a particular type of information (e.g., for a particular verb or a phrase) can influence behavioral outcomes.

1.4. Event-related potentials (ERP) Studies of Syntax–Semantics Interactions

Previous ERP studies have described ERP patterns, or "components," that are thought to reflect different cognitive and linguistic mechanisms underlying sentence comprehension. In the present study, we focus on the N400 and P600 effects, because these effects are robust and have been observed in many ERP studies of sentence processing (see Friederici (2002), for a review of the standard account of N400 and 600 effects.).

The N400 component is a negativity that peaks at around 250 to 500 milliseconds in response to words and other meaningful stimuli and is generally maximal over posterior sites. The contrast between stimuli that are more or less difficult to process semantically gives rise to the *N400 effect*. While the classical N400 in sentence processing involved outright violations of semantic congruency (Hagoort, 2003), any word or phrase that is hard to process within the current context can give rise to an N400 effect. For example, if presented with example (10), a reader will have a strong expectancy for the word the *helmet*. If the word *earring* appears, it will

be highly unexpected and will therefore elicit an N400 effect, even though the sentence as a whole is semantically correct.

(13) The biker put on his _____ (SubjNP–Vb _____)

There is some recent evidence that N400 effects can also reflect violations of clause-level meaning. For example, Ye, Zhan and Zhou (2007) presented native Chinese participants with three kinds of sentences: well-formed sentences (*the suspect BA the drug hid*...), sentences with lexical-semantic violations (*the agent BA the bomb combed*...), and sentences with constructional violations (*the citizen BA the painting viewed*...). All three types of sentences contained the particle *ba*, which indicates causation (or change of location, or change of state). Like the English Causative, Chinese *ba*-constructions do not allow certain verb types. In particular, verbs that are stative (such as *view*), are incompatible with the meaning of the *ba*-construction. Participants displayed N400 effects to both types of violations, consistent with the idea that constructions can impose semantic constraints. Similarly, Jiang and Zhou (2012) presented participants with Chinese sentences containing semantic violations that occurred at different stages of the sentence, reflecting local and global mismatches. Local mismatches occurred in response to nouns that were incompatible with a preceding classifier (e.g., Zhao repaired TAI chair...), where TAI is a classifier that is compatible with the verb *repair* but incompatible with the noun *chair*. Sequential mismatches involved verb-classifier mismatches followed by classifier-noun mismatches (e.g., Zhao repaired KE chair...), where KE is incompatible with *repair* and with the noun *chair* (but note that the verb and noun are semantically compatible) Finally, triple mismatches involved mismatches at all three levels, including a mismatch between the verb and the noun (e.g., Zhao sewed KE chair...). N400-like effects were elicited in each case, and triple mismatches elicited significantly larger N400s than either the local or sequential

mismatches. These results suggest that higher-level semantic processing can proceed even in the presence of an earlier semantic violation. Taken together, these studies suggest that the N400 effect can signal violations of constructional semantics, as well as more local semantic violations that affect ease of integration or lexical access.

The *P600 effect* occurs between about 500 and 700ms post-stimulus and is thought to reflect increased demands on syntactic processing (Hagoort, 2003; Hagoort & van Berkum, 2007; Osterhout & Hagoort, 1999; Osterhout and Holcomb, 1992; Osterhout and Nicol, 1999). This effect has been observed in response to mismatched parts-of-speech (i.e. a noun where an adjective should be), disagreement in number or case, and unexpected syntactic structures (Hagoort, 2003; Osterhout & Holcomb, 1992). Violations of syntactic expectancy (particularly clause-level violations) processing give rise to the P600 or syntactic positive shift, SPS (Osterhout & Hagoort, 1999).

There is ongoing debate about whether P600s occur only in response to purely syntactic violations. Kuperberg (2007) reviewed studies in which P600 effects were observed in response to semantic violations. For example, when presented with the sentence, "Every morning at breakfast the *eggs* would *eat*…" (Kuperberg, 2007), the verb elicited a P600 effect and no N400 effect. This finding is somewhat surprising, since the violation reflects a semantic, rather than a syntactic mismatch: that is, "eat" requires an animate subject NP, but "egg" is inanimate (Kuperberg, 2007). Kuperberg also notes that violations of verb argument structure can also elicit P600 effects, in the absence of N400s; however, this finding is not consistent across studies and shows sensitivity the semantic associations between verb and argument (it is more common in the presence of semantic associations), as well as task (it is more common for overt judgments of acceptability as opposed to passive reading). Considering the range of contexts that evoke

P600 effects, Kuperberg (2007) concludes that the P600 reflects difficulty in reconciling combinatorial (sentence-level) processes due to lexical semantic analysis and sentence-level syntax and semantics.

According to the works detailed above, we should expect N400 responses to words that are harder to access in memory, as well as to violations of constructional meaning. On the other hand, we should expect P600 responses to sentences with syntactic and combined violations.

1.5. Bilingual Research and the Syntax-Semantics Interface

There are important cross-linguistic differences in verb and clause-level constraints that determine how language-users process different types of verbs within different constructions (Levin, 1993; Talmy, 1985; Slobin, 1996; Martínez and López, 2008; Wolff and Gentner, 1996; Wolff and Song, 2003; Wolff, et al., 2005). For example, as noted earlier, in English and in Spanish, ditransitive verbs are permitted and non-alternating unaccusatives are prohibited, within ditransitive sentences (i.e., SubjNP–V–ObjNP–PP). The two languages have different rules, though, when it comes to alternating unaccusatives: *walk*-type verbs in English can occur within a ditransitive context, and when they do, they take on additional meaning (caused motion). These same verbs, however, cannot appear in Spanish causatives.

How, then, do English-as-a-Second-Language (ESL) learners reconcile the conflicting rules in L1 vs. L2 concerning which verbs can occur within a ditransitive context? Cabrera and Zubizarreta (2005) have suggested that high proficiency ESL learners rely more on L1 knowledge of verbs and verb-specific constraints, as opposed to construction-level constraints, when asked to judge the acceptability of causative constructions in English. They find that ESL learners in their studies tended to reject causative structures with Alt-Intransitive verbs at higher rates than low and intermediate proficiency ESL learners (Cabrera and Zubizarreta 2004, 2005).

According to Cabrera and Zubizarreta (2005), the pattern of errors reflects overgeneralization of L1 verb-specific constraints: that is, because neither *arrive*-type verbs nor *walk*-type verbs can occur within the Spanish ditransitive, ESL learners apply these same verb-specific constraints in English. Interestingly, Goldberg (1995, 2003, 2006) suggests a different scenario: As L2 learners gain proficiency in English, she proposes that they rely more on constructions (i.e., clause-level constraints) than verbs to predict the meaning of a sentence. Although there is relatively little research in this area, corpus-based studies and experiments by Goldberg and her associates bear out this prediction. Constructions turn out to be better predictors of overall sentence meaning (e.g., who did what to whom) than verbs (Goldberg, 1995), and more advanced learners of English as a second language tend to view sentences that instantiate the same construction as more similar than sentences containing the same verb (e.g., Bencini and Goldberg, 2002).

1.6. Summary

In summary, the present study examines ERP and behavioral responses during comprehension of the English Causative construction. This construction is syntactically ditransitive ('SubjNP–V–ObjNP–PP') and is associated with a specific meaning — '[someone]–[CAUSED-by-doing-X]–[something]–[change-of-state] — which, according to Construction Grammar, is independent of the words that can be used in this construction. In addition, not all verb classes can appear in the causative construction. Perhaps most interesting is the contrast between alternating and non-alternating intransitives (i.e. *walk*- versus *arrive*-type verbs). The former are permitted, and that latter are not, despite their similarity in meaning and syntax. Further, in Spanish, both verb types are prohibited. This suggests that NES and ESL groups might engage different neurocognitive processes in response to ditransitive sentences containing *walk*-type verbs. By examining how the syntactic and semantic knowledge interacts during

comprehension of causative constructions, we hope to improve our understanding of sentence comprehension.

2. The Current Study

The current study aims to further our understanding of how word-level (lexical) and syntactic knowledge interact during comprehension of the Causative construction in English. In addition to behavioral measures, we used ERPs to examine responses to linguistic violations at different points in the sentence. We also compared outcomes for NES and native Spanish speaking ESL learners. We predicted that cross-linguistic differences between English and Spanish would result in qualitatively different ERPs to structures that are acceptable in English, but not in Spanish. The experiment was designed to yield ERP measures of sentence processing at different stages. To this end, we used four types of sentence context — simple intransitive ('SubjNP–V'), intransitive plus prepositional phrase ('SubjNP–V–PP'), transitive ('SubjNP–V–ObjNP') and ditransitive ('SubjNP–V–ObjNP–PP'). As illustrated in Figure 3, there was a response probe after each sentence. Further, because there was no period at the end, subjects could not know when the sentence was complete until the response probe appeared.

To create grammatically acceptable and unacceptable sentences, we combined the four Contexts with four Verb Types —Alt-Intransitive (e.g., *walk*), NonAlt-Intransitive (e.g., *arrive*), Transitive (e.g., *pound*), and Ditransitive (e.g., *send*). Thus, the design included two within-subject independent measures (VerbType and Context). See Tables 1-2 for design matrix and predicted outcomes. Our between-subjects independent measure is Group, with two levels (NES, ESL). The key comparison of interest for the two groups is that of Contrast 4: Whereas NES participants are expected to show no difference in response to Alt-Intransitive verbs versus Ditransitive verbs (baseline) in ditransitive contexts, ESL participants are likely to experience

these sentences containing Alt-Intransitive verbs as violations. Note that ERP responses can detect such a response, even if it does not translate to group differences in behavior.

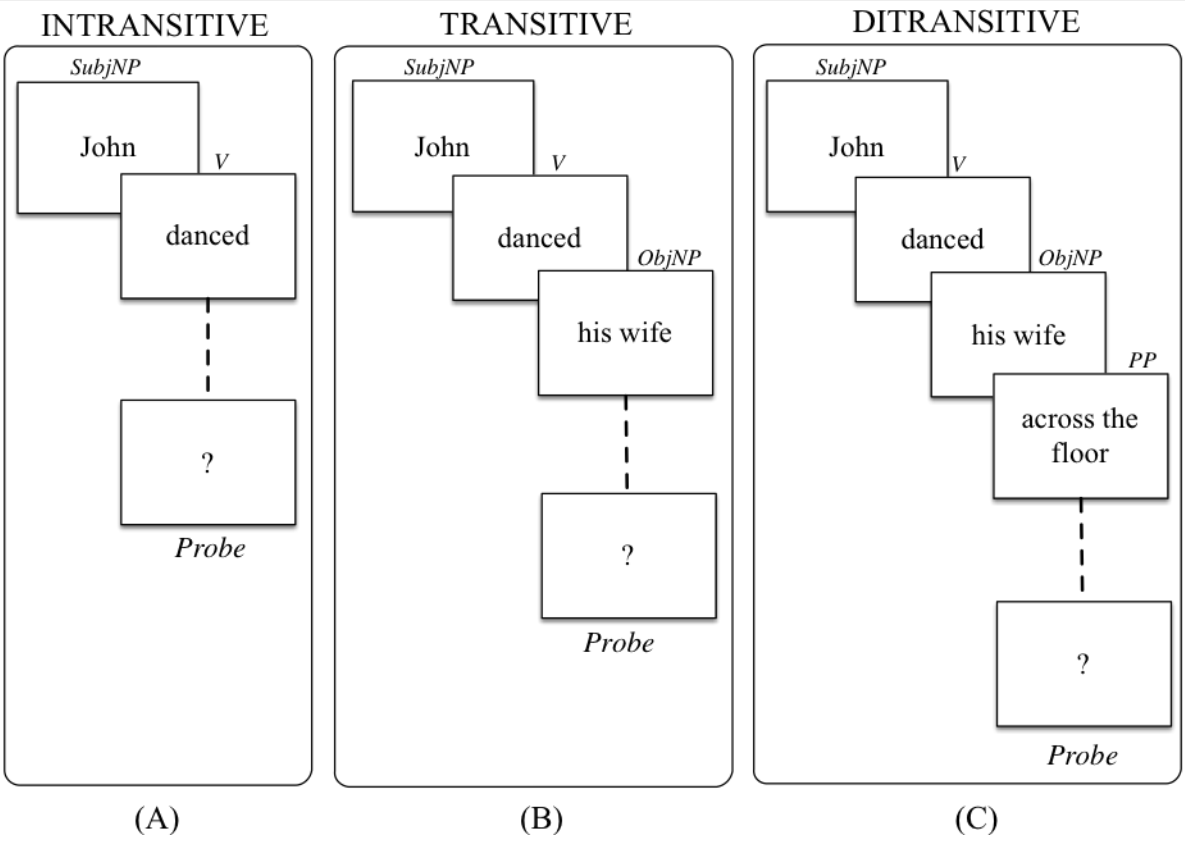

Figure 3. Incremental presentation of sentences. (A) Intransitive, (B) Transitive, and (C) Ditransitive contexts.

Our outcome measures included behavior (accuracy, response time) and ERP effects for the four contrasts of interest. For purposes of this study, the N400 effect was defined as an increased negativity over centroparietal electrodes at around 300 to 500 ms post-stimulus in response to violations (minus the baseline condition, which was defined separately for transitive and ditransitive contexts. The P600 effect was operationally defined as an increased positivity over posterior sites from about 500 to 700 ms.

2.1. Goal and Hypotheses

This section summarize study goals and hypotheses.

1.) **Goal 1** is to determine how ERP measures of semantic and syntactic processing are modulated during online comprehension of English causative constructions.

2.) **Goal 2** is to compare outcomes for the two participant groups (NES vs. ESL).

To achieve these goals, we examine behavioral and ERP effects for different verb-construction combinations. We are particularly interested in the following comparisons.

(1) Response to ObjNP (Transitive Context)

a. **Contrast 1**: NonAlt-Intransitive Verbs vs. Baseline (Transitive Verbs)

b. **Contrast 2**: Alt-Intransitive Verbs vs. Baseline (Transitive Verbs)

(2) Response to PP (Ditransitive Context)

a. **Contrast 3**: NonAlt-Intransitive Verbs vs. Baseline (Ditransitive Verbs)

b. **Contrast 4**: Alt-Intransitive Verbs vs. Baseline (Ditransitive Verbs)

Our hypotheses are as follows (also see Tables 1-2).

1. **Hypothesis 1**. NES participants will reject transitive sentences if they contain either Alt-Intransitive verbs (e.g., *walk*) or NonAlt-Intransitive verbs (e.g., *arrive*). Because these violations are syntactic in nature, we expect to see a larger (more positive) P600 to the ObjNP when it is preceded by an intransitive verb than when it is preceded by a transitive (baseline) verb.

There are two important things to note with respect to Hypothesis 1. First, when subjects encounter the ObjNP they do not know whether it marks the end of the sentence or whether there will be additional sentence constituents following the ObjNP. Therefore, while Alt-Intransitive verbs are acceptable in full ditransitive structures (SubjNP–V–ObjNP–PP), they could lead to temporary ("open") violations at the ObjNP, reflecting the fact that the caused motion reading is not the dominant reading for these verbs. Second, to the extent that these

violations are perceived as open, P600 effects to the ObjNP may be smaller, or even nonexistent, for alt-intransitive vs. nonalt-intransitive verbs.

2. **Hypothesis 2**. NES participants will accept ditransitive sentences if they contain either Alt-Intransitive or ditransitive verbs. However, they will reject such sentences if they contain NonAlt-Intransitive verbs. Again, because these violations are syntactic in nature, we expect to observe a larger (more positive) P600 when it is preceded by a NonAlt-Intransitive verb than when it is preceded by either an Alt-Intransitive or a transitive (baseline) verb.

NonAlt-Intransitive verbs are prohibited as a class from appearing in ditransitive structures. Therefore, the effect in Hypothesis 2 is at least partly syntactic in nature. At the same time, there is a key difference between the violation to the PP (Hypothesis 2) and the violation to the ObjNP (Hypothesis 1). The violation to the ObjNP holds for any intransitive verb. It therefore seems plausible that the meanings of different subclasses (e.g., *arrive*- vs. *walk*- type verbs) may have little relevance in this case. By contrast, the violation to the PP is specific to NonAlternating-Intransitives (e.g., *arrive*). As Levin (1993) and others have pointed out, many such verbs express manner of motion (walk, run, etc.). Levin refers to this subclass of verbs as "agentive manner of motion verbs" (Levin, 1993; p. 111). She notes that when these verbs do appear in transitive structures (e.g., *We ran <u>the race</u>*) and in distransitive structures (e.g., *We ran the mouse <u>through the maze</u>*), they often impose specific semantic constraints (called "selectional restrictions") on the ObjNP. This suggests that semantics may play a greater role in processing PP in these contexts (since ditransitive structures are only compatible with certain verb meanings). Given these considerations, when the structure contains a NonAlt-Intransitive verb, it seems equally likely that the PP will elicit either a P600 syntactic effect or an N400 semantic

effect. The actual pattern of results may have important implications for theories of verb-to-construction integration (see also Ye, et al., 2007).

3. **Hypothesis 3**. In Spanish, as in English, Alt-Intransitive and NonAlt-Intransitive verbs are incompatible with transitive sentences. In contrast with English, however, the violation for alt-intransitives is fatal, or "closed": that is, it cannot be resolved with the addition of other constituents, such as a following PP. Thus, for Spanish speakers, we predict that the ObjNP will elicit P600 effects when it occurs after an intransitive verb, regardless of whether the verb is classified as alternating or non-alternating in English.

Note that Hypothesis 3 follows from previous work that suggests that syntactic or semantic violations at one point in a sentence also affect downstream processes (e.g., Kuperberg et al., 2009; Ye, et al., 2007).

4. **Hypothesis 4**. ESL participants are expected to show N400 effects to PPs within a Ditransitive context, particularly when the sentence contains an Alt-Intransitive verb. These are precisely the contexts where rules in their L1 come into conflict with rules in their L2. In addition work by Kuperberg (reviewed above) and others (e.g., Hagoort, 2003; Ye, et al., 2007) suggests that sentence-final violations may elicit N400 effects, reflecting difficulty in integrating syntactic and semantic information. If so, then violations elicited by an ObjNP following an intransitive verb may elicit N400 semantic effects for sentences containing NonAlt-Intransitive verbs, as well.

Table 1.

Predicted pattern of responses to ObjNP (Transitive Context).

		Example	Acceptability (Eng)	Acceptability (Sp)	Cognitive Violation (Eng)	Linguistic Violation (Eng)	ERP Effect (Intrans –BL)
Verb Types	**Alt-Intransitive**	John is *walking* *<u>the box</u>	NO	NO	Open	Syn	P600
	NonAlt-Intransitive	John is *arriving* *<u>the box</u>	NO	NO	Closed	Syn	P600
	Transitive (BL)	John is *kicking* <u>the box</u>	YES	YES	*N/A*	*N/A*	*N/A*

Note: No = Not Acceptable; Yes = Acceptable; Open = meaning violation can be resolved by adding further syntactic constituents; Closed = meaning violation cannot be resolved in any way; Syn = Syntactic/Constructional; Sem = Semantic/Verb-Lexical; BL = baseline; Eng = English; Sp = Spanish; Transitive verbs are acceptable in transitive constructions and therefore constitute the baseline for these comparisons.

Table 2.

Predicted pattern of responses to PP (Ditransitive Context).

		Example	Acceptability (Eng)	Acceptability (Sp)	Cognitive Violation (Eng)	Linguistic Violation (Eng)	ERP Effect (Intrans –BL)
Verb Types	**Alt-Intransitive**	John is walking the box <u>to the post office</u>	YES	NO	*N/A*	*N/A*	*N/A*
	NonAlt-Intransitive	John is arriving the box *<u>to the post office</u>	NO	NO	Closed	Syn? Sem?	P600? N400?
	Ditransitive (BL)	John is sending the box <u>to the post office</u>	YES	YES	*N/A*	*N/A*	*N/A*

Note: No = Not Acceptable; Yes = Acceptable; Open = meaning violation can be resolved by adding further syntactic constituents; Closed = meaning violation cannot be resolved in any way; Syn = Syntactic/Constructional; Sem = Semantic/Verb-Lexical; BL = baseline; Eng = English; Sp = Spanish; Ditransitive verbs are acceptable in ditransitive constructions and therefore constitute the baseline for these comparisons.

2.2. Participants

Thirty-six adult participants participated in this study. The experimental group consisted of 10 L1 Spanish learners of English with a high proficiency in the L2 (mean age 20.10, standard deviation = 1.8, 7 females, 3 males). The control group consisted of 26 L1 English speakers (mean age 19.69, standard deviation = 4.2, 16 females, 10 males). All participants were students at Georgia State University and were right-handed with normal or corrected-to-normal vision and hearing. No participants indicated learning or intellectual disabilities. Participants were recruited through Georgia State University's psychological research testing site and through the use of flyers posted around campus. Participants were compensated with either course credit or monetary compensation.

2.3. Materials

2.3.1. Stimuli.

The stimuli in this study consist of full sentences or sentence fragments that either encode causative meaning or do not encode causative meaning based on the type of verb used in that particular stimulus and its level of completeness. Verb exemplars (e.g. "sneak" or "walk") were controlled for frequency, neighborhood size, age-of-acquisition, and length effects. The same control scheme was used to constrain the set of prepositional objects and direct object nouns. Subject noun phrases were selected from the top 40 most-common male and top 40 most-common female names as compiled by the Social Security Administration. Four verb types were used (as described in Background); alternating intransitive verbs, non-alternating intransitive verbs, ditransitive verbs, and transitive verbs. Each verb type was presented in four constructional contexts (as described in Background); intransitive, intransitive plus prepositional phrase, transitive, and ditransitive. 32 verb exemplars (e.g. *is running*) were selected; eight verb

exemplars per verb type. Each of the 32 verb exemplars occurred in ten unique sentences, each of which were displayed twice per session (in two different syntactic contexts). Thus all 32 verb exemplars were presented five times per block for a total of 160 trials in each of four blocks. In order to account for the fact that there are only four contexts in which to place the 32 verbs exemplars, the fifth instance of any particular verb exemplar was counterbalanced across blocks. Thus, during the first block the fifth instance of each exemplar was assigned to the intransitive context; during the second block to the Intransitive+PP context; during the third block to the ditransitive context; and during the fourth block to the transitive context. All verbs were presented in the present progressive (*is (verb)-ing*), so that Spanish L1 participants would not need to worry about variations in form for different past tense verbs.

2.3.2. Assessments.

2.3.2.1 Edinburgh Handedness Survey.

The Edinburgh Handedness Survey was used to assess handedness. Spanish participants had a mean EHI score of 81.3 (n=10) while English participants had a mean EHI score of 74 (n=26).

2.3.2.2. Language History Questionnaire.

The Language History Questionnaire was used to ascertain how L2 English learners learned Spanish and English. All seven L1 Spanish speakers who completed these assessments reported having learned Spanish in the home before learning English at school. Four of these individuals had been born outside of the United States; the other three were born in the United States to parents who spoke Spanish as their native language.

2.3.2.3. Nelson-Denny Vocabulary Assessment.

The Nelson-Denny Vocabulary Assessment determines the level of vocabulary development of a particular participant. It was used here to indicate how well participants understood English vocabulary in context. Spanish participants had a mean scaled N-D vocabulary score of 220.29 (n=6), a mean vocabulary percentile rank of 50.14 (n=6), and a mean N-D grade equivalency of 14.46 (n=6). English participants had a mean scaled N-D vocabulary score of 231.79 (n=14), a mean N-D vocabulary percentile rank of 73.36 (n=14), and a mean N-D grade equivalency score of 16.00 (n=14). This assessment was utilized to ensure that all participants were at or above the reading level of our stimuli.

2.3.2.4. Freewrite Evaluation.

A Freewrite task, developed by Crossley, Salsbury, and McNamera (2012), was used to determine ESL participant's proficiency in English. Instructions were written in English and in Spanish, and the form was approved by the local IRB (see Appendix F).

Seven of the eight ESL participants completed the Freewrite task. Based on linguistic properties that have been found to be highly predictive of ESL proficiency in prior work (primarily the sophistication of the vocabulary), six participants were determined to be intermediate proficiency in their L2 (English), and one participants was classified as advanced.

2.3.2.5. Verb Translation Task.

Spanish L1 participants were given a verb translation test (VTT) to test their knowledge of the specific verbs used in our task. This task is standardly used in bilingual studies (e.g., Montrul, 2001a,b). Verb-specific knowledge is crucial for our task, since the meaning of a verb is an important factor in determining whether or not it can occur within a particular construction.

During the VTT, participants were shown an infinitive verb in English (e.g., *to arrive*) and were instructed to translate the verb into Spanish. If participants did not provide a correct

translation, the experimenter would verify knowledge by asking participants to use the English verb in a sentence. Participants had a mean VTT score of 90.187 (n=10) out of 100, indicating that all of our Spanish participants understood the meaning of our stimuli verbs. Each of the thirty-two verbs that was used in the ERP task was tested. A standardized form, approved by the local IRB, was used to collect VTT data (see Appendix G).

2.4. Procedure

Participants were welcomed to the lab and asked to read and signed informed consent documents. After signing the documents, participants completed the EHI, LHS, and Nelson-Denny Vocabulary Assessment. Spanish participants were also administered the VTT and Freewrite Evaluation. After completion of standardized assessments, participants were accompanied to the EEG acquisition room for the acceptability judgment task and the confidence-rating task. Participants were seated in front of the acquisition monitor and the EEG net was positioned on their scalps. Impedance tests were carried out with a threshold of 40 kOhms. Once net application was complete, participants were shown how different movements produce various artifacts in their EEG so that they would understand why they would be asked not to move or blink during trials. Participants were then instructed in the acceptability judgment test. Participants were asked to determine if the sentence or sentence fragment presented before the "?" acceptability probe were complete and meaningful sentences of English (i.e. does the sentence have all of its parts and does it constitute a complete thought). If the presented stimulus was deemed to be a complete and meaningful English sentence, participants were instructed to press either the one or four key on a four-key response box. Assignment of the yes-key was counterbalanced across participants. A small practice block of five trials was presented before the experimental blocks. After participants self-initiated a trial by pressing both the one and four

keys simultaneously, white stimuli (Courier New font, pt 14, all lowercase except sentence-initial letter) were presented on black background inside a white frame box in four blocks of 160 trials. Every 40 trials within a block, participants were offered the opportunity to rest and blink if they needed to before being instructed to settle down and remain still and beginning again. Stimuli segments (SubjNP, Verb, ObjNP, PP) were presented with a maximal vertical visual angle of 1.78 degrees and with a maximal horizontal visual angle of 10.02 degrees. During each trial, a fixation point ('+' symbol) appeared for 500 ms, followed by a sentence, presented one segment (SubjNP, Verb, ObjNP, PP) at a time. Each segment was presented for 1000 ms and the inter-word interval was 300 ms (see Figure 4). After the last sentence segment was presented, a question-mark ('?') response probe was displayed.

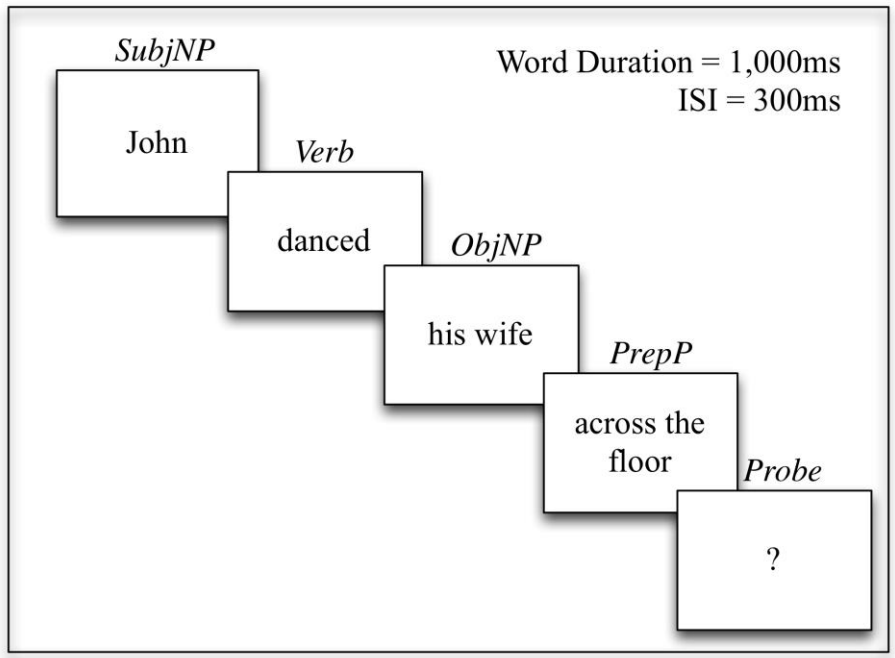

Figure 4. Stimulus Presentation Procedure

Participants were instructed to make their response as soon as the response probe was displayed. At the beginning of each trial, participants were presented with an empty frame box and instructed to self-initiate the next trial by pressing the 1 and 4 keys on the response box at the

same time. To minimize eye and jaw movements, participants were instructed to remain still and not blink during the trial (from self-initiation to disappearance of response probe).

2.5. Data acquisition and preprocessing

ERPs were recorded using a 256-channel electrode EGI HydroCel net. Datasets were filtered using a 0.1Hz highpass and a 30Hz lowpass filter. Trials were segmented into 1300-ms epochs, starting at 300-ms before onset of target syntactic constituents (verbs, object noun phrases, and prepositional phrases) and lasting for 1000-ms after target constituent onset. All segmentations took into account a 7-ms offset to account for hardware delay as calculated through a visual timing test. This segmentation scheme resulted in 16 categories (verb type/syntactic context cross) and segments in which the target syntactic constituent began at 300-ms into the epoch. Bad channel analysis was performed both automatically and manually. The data were baseline corrected using the average of the first 300-ms of the epoch, re-referenced to the average of the 256 recording sites. Only correct responses entered into final analysis as it is impossible to determine the causes of incorrect responses.

Exclusion criteria were used in an attempt to minimize electrophysiological artifacts and to minimize influence of participants with too few correct trials. Participants with less than five correct trials in any one category were excluded from analyses. This resulted in the loss of three NES and one ESL participant. We were left with a set of nine ESL participants and 24 NES participants. To remove participants based on quality of EEG datasets, automatic detection was used for initial identification of bad channels with bad segments including those with eye blinks/movements. Afterwards, qualitative analysis was conducted and participants who exhibited low signal-to-noise ratios were removed from analysis. This resulted in a final ESL participant set of eight participants and a final NES participant set of nine participants. The sets

of eight participants matched for age and gender within-groups. The ESL set included five females and three males with a mean age of 21.6 years. The NES set included four females and five males with a mean age of 21.1 years.

2.6. Data Analysis

2.6.1. Behavioral Data Analysis.

Behavioral data (accuracy, RT) were analyzed using mixed analysis of variance (ANOVA), with two within-subjects factors – VerbType (Alt-Intransitive, NonAlt-Intransitive, Transitive, and Ditransitive) and Context (Intransitive, Intransitive+PP, Transitive, and Ditransitive) – and one between-subjects factor – participant Group (NES and ESL). Greenhouse-Geisser corrections were used to correct for violations in sphericity. Paired Sample T-Tests were performed for post-hoc analyses, to clarify omnibus effects.

2.6.2. ERP Data Analysis.

For the purposes of this submission, we carried out qualitative analyses on ERP data, looking for the presence of N400 and/or P600 effects within each participant group. Future manuscripts will include a full statistical analysis of ERP outcomes, including specification of the time window and topographic distribution for each effect.

3. Results

3.1. Behavioral Results

3.1.1. Accuracy.

There was a main effect of VerbType ($F(1.43, 21.39) = 8.71$, $p < .05$): participants were less accurate in judging the acceptability of sentences containing Ditransitive verbs versus Transitive verbs, $t(16) = 2.43$, $p < .05$, Alt-Intransitive verbs, $t(16) = 2.96$, $p < .05$, or Non-Alt-Intransitive verbs, $t(16) = 3.24$, $p < .05$. They were also overall less accurate in judging the

acceptability of sentences with Transitive verbs versus Alt-Intransitive verbs $t(16) = 3.03$, $p < .05$ or NonAlt-Intransitive verbs $t(16) = 3.46$, $p < .05$.

Accuracy analyses also revealed a main effect of Context ($F(2.15, 32.29) = 49.64$, $p < .05$). Paired samples t-tests revealed lower accuracy overall for Transitive contexts compared with either Ditransitive contexts, $t(16) = -12.43$, $p < .05$, or Intransitive+PP contexts, $t(16) = -11.29$, $p < .05$. Responses to Intransitive contexts were also less accurate overall than responses to Intransitive+PP contexts, $t(16) = -6.18$, $p < .05$ and responses to Ditransitive contexts, $t(16) = -6.98$, $p < .05$.

The main effects of VerbType and Context were clarified by a two-way interaction of VerbType X Context**,** ($F(1.97, 29.6) = 24.90$, $p < .05$). Paired samples t-tests indicated much lower accuracy for Ditransitive verbs when they appeared a Transitive context (mean, 32%) than when they appeared in a Ditransitive context (mean, 94%), $t(16) = -16.92$, $p < .05$, an Intransitive context (mean, 71%), $t(16) = -6.76$, $p < .05$, or in an Intransitive+PP context (80%), $t(16) = -3.17$, $p < .05$. Participants tended to accept sentences like *Bob sent the box*, which, according to standard rules of English grammar, should be anomalous (see Fig. 5). Fortunately, this condition (ditransitive verbs in transitive contexts) was not needed to test our four main hypotheses. Thus, for present purposes, this finding was of little significance. Nonetheless, we address this finding in the General Discussion.

Mirroring the accuracy results for Ditransitive verbs, responses to Transitive verbs were less accurate when they appeared in an Intransitive context (mean, 56%) versus a Transitive Context (mean, 76%), $t(16) = -2.05$, $p < .05$, or a Ditransitive context (mean, 85%), $t(16) = -2.95$, $p < .05$. Like the previous case, this finding is not relevant to our main hypotheses. We report these findings merely for completeness. In addition, like the reduced accuracy for Ditransitive

verbs in transitive contexts, this finding has a ready explanation. In fact, as we discuss later, the same process (ellipses) may be at work in both cases.

Post-hoc comparisons also showed lower accuracy to sentences containing NonAlt-

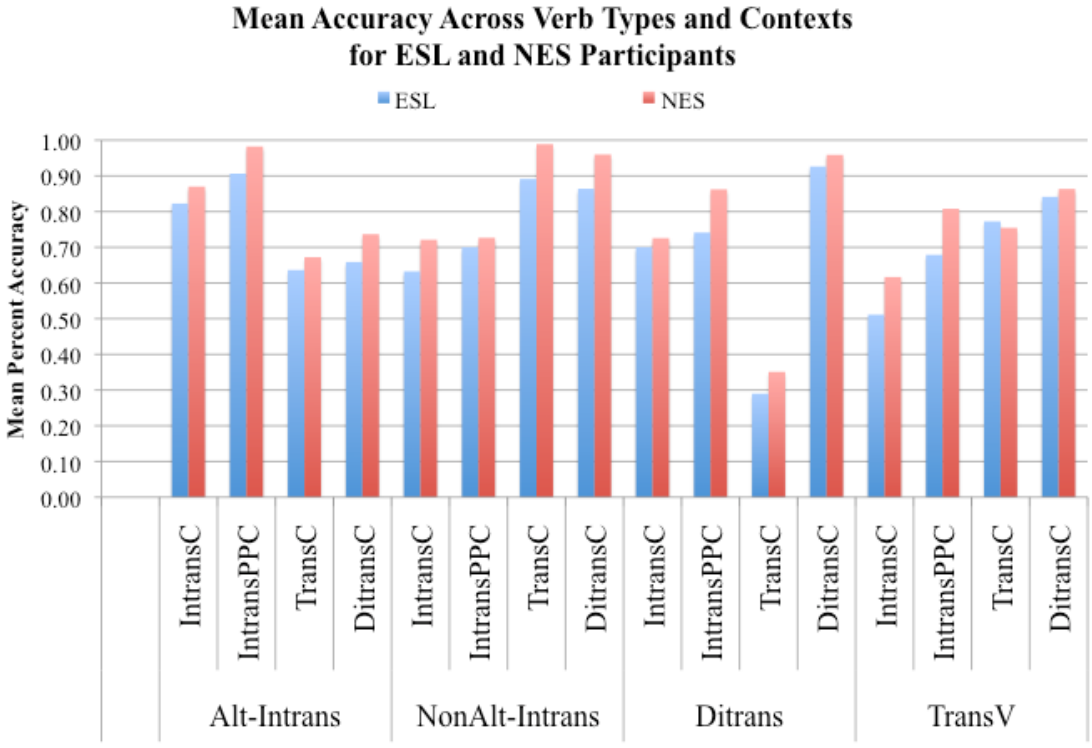

Figure 5. Mean Accuracy

Intransitive verbs versus Intransitive contexts (mean, 68%) or Transitive contexts (mean, 94%), t(16) = -5.35, $p < .05$, or Ditransitive contexts (mean, 91%), t(16) = -4.79, $p < .05$. Alt-Intransitive verbs showed the reverse pattern: responses to sentences with these verbs were more accurate for Intransitive contexts (mean, 85%; and 94% for Intransitive+PP contexts) as compared with Transitive contexts (mean, 65%), t(16) = 4.07, $p < .05$, or Ditransitive contexts (mean, 70%), t(16) = 3.87, $p < .05$.

Finally, there was an overall main effect of Group ($F(1,15) = 12.96$, $p < .05$): ESL participants were slightly less accurate overall (mean, 72%) as compared with NES participants

(79%). Importantly, however, as shown in Figure 5, the two groups showed very similar patterns of performance across conditions: the ANOVA confirmed that Group did not interact with Context or VerbType.

3.1.2. Reaction Time.

Only correct responses entered into the reaction time analysis. Analyses showed a main effect of VerbType**,** $F(1.44, 21.54) = 10.13$, $p < .05$: participants were faster to judge the acceptability of sentences containing Ditransitive verbs versus Transitive verbs, $t(16) = -4.24$, $p < .05$ and Alt-Intransitive verbs, $t(16) = -3.42$, $p < .05$. They were also faster to evaluate sentences with NonAlt-Intransitive verbs versus Alt-Intransitive verbs $t(16) = 3.19$, $p < .05$ or Transitive verbs $t(16) = -3.53$, $p < .05$.

There was a main effect of Context**,** $F(2.15, 32.29) = 49.64$, $p < .05$. Paired samples t-tests revealed faster responses overall to Ditransitive contexts compared with Transitive contexts, $t(16) = -12.11$, $p < .05$, Intransitive contexts, $(16) = -15.97$ $p < .05$, and Intransitive+PP contexts, $t(16) = -9.27$, $p < .05$. Responses to Intransitive+PP contexts were faster than responses to Intransitive contexts, $t(16) = -12.04$, $p < .05$ and Transitive contexts, $t(16) = -5.89$, $p < .05$.

The main effects of VerbType and Context were again clarified by an interaction of VerbType X Context**,** $F(3.34, 50.05) = 11.60$, $p < .05$. Paired samples t-tests indicated faster RTs for Ditransitive verbs when they appeared a Ditransitive context (mean, 555 ms.) than when they appeared in a Transitive context (mean, 674 ms.), $t(16) = -5.93$, $p < .05$, an Intransitive context (mean, 1105 ms.), $t(16) = -8.27$, $p < .05$, or in an Intransitive+PP context (762 ms.). Note that the largest differences are between Ditransitive and Transitive contexts, on the one hand, and Intransitive contexts (with or without the optional PP), on the other. These results fold important clues for interpreting accuracy results for Ditransitive verbs. Although participants accepted

sentences like *Bob sent the box,* at much higher rates than expected, they were relatively quick to reject these sentences when they viewed them as anomalous.

Responses to Transitive verbs were faster when they appeared in a Transitive context (mean, 674 ms.) versus an Intransitive Context (mean, 1104 ms.), $t(16) = -7.99$, $p < .05$. Interestingly, they were slower to these verbs when they appeared in a simple Transitive context versus a Ditransitive context (mean, 555 ms.), $t(16) = -7.69$, $p < .05$. When participants rejected these verbs in a Ditransitive context, they did so quickly and confidently (analysis of Confidence ratings will be reported in a separate manuscript).

Post-hoc comparisons also showed faster responses to sentences containing NonAlt-Intransitive verbs in Intransitive+PP contexts (mean, 655 ms.) versus Transitive contexts (mean, 914 ms.), $t(16) = 9.56$, $p < .05$, or Intransitive contexts (mean, 954 ms.), $t(16) = 8.93$, $p < .05$. At first blush this last results appears surprising, but makes sense when we consider that NonAlt-Intransitive verbs are not just any type of intransitive verb: they are motion verbs, and specifically, ones that denote path of motion. Thus, there is a strong expectancy for a final prepositional phrase (e.g., *John arrived... at the store*).

Alt-Intransitive verbs also elicited faster responses when they appeared in Intransitive+PP contexts (mean, 811 ms.) as compared with Transitive contexts (mean, 1076 ms.), $t(16) = -1.86$, $p < .05$, or Intransitive contexts (mean, 1148 ms.), $t(16)= -9.03$, $p < .05$. Again, this class of verbs denotes motion (e.g., *walk*), and motion tends to result in a change of location, which is expressed in an oblique (PP; *John walked... to the store*).

Finally, there was an overall main effect of Group ($F(1,15) = 12.96$, $p < .05$): ESL participants were slower overall (mean, 941 ms.) as compared with NES participants (716 ms.).

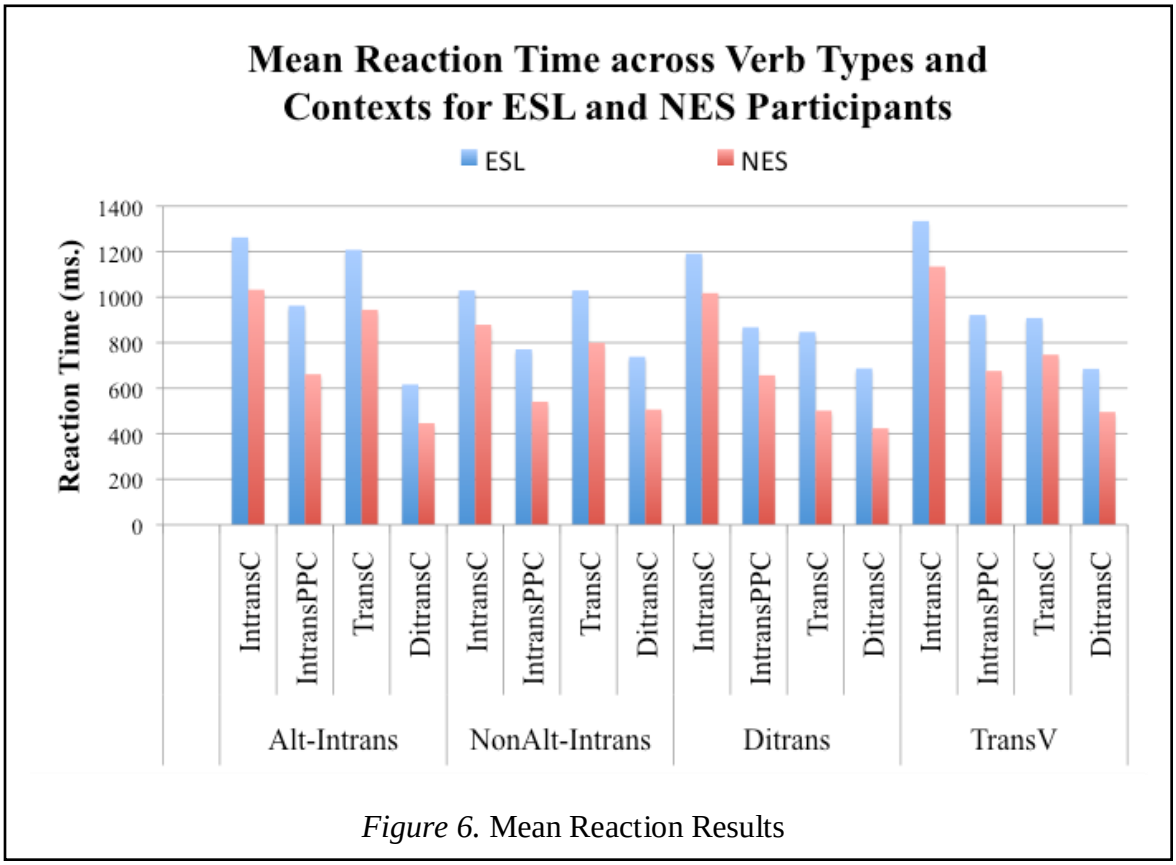

Figure 6. Mean Reaction Results

Again, the two groups showed very similar patterns of performance across conditions: the ANOVA confirmed that Group did not interact with Context or VerbType (Figure 6).

3.2. ERP Results

Two sets of ERP analyses were performed. For the first, ERPs were time-locked to the ObjNP (Transitive context). For the second, they were time-locked to the PP (Ditransitive context; Intransitive+PP contexts were fillers and did not enter into this analysis).

Results are summarized in Table 3. NES participants exhibited a P600 effect with a peak amplitude at 800-ms in response NonAlt-Intransitive verbs in the Transitive context (**John is arriving his daughter*), but did not exhibit any differential effects in for the other three verbs

types in this condition (see Figure 7). ESL participants exhibited N400 effects (peak amplitude at 400-ms) to each verb type presented in the Transitive context (see Figure 8). Scalp topographies indicated similar processing in both groups to all verb types until approximately 300-ms when differential processing courses begin to become evident (see Figure 9). The P600 effect is quite a bit larger and longer-lasting to NonAlt-Intransitive verbs than to Alt-Intransitive verbs in NES participants. ESL participants, however, do not present a strong P600 effect to the NonAlt-Intransitive verbs versus Alt-Intransitive verbs (see Figures 7 & 8).

Table 3
ERP Results Summary

ERP CONTRAST		NES	ESL
ObjNP (Transitive)			
NonAlt-Intrans vs. Trans	Predicted	P600	P600
	Observed	P600	N400
Alt-Intrans vs. Trans	Predicted	(P600)	P600
	Observed	*NE*	N400
PP (Ditransitive)			
NonAlt-Intrans vs. Ditrans	Predicted	P600	P600?/N400?
	Observed	N400	N400
Alt-Intrans vs. Ditrans	Predicted	*NE*	P600?/N400?
	Observed	*NE*	MFN/P3b

In the Ditransitive Contest, NES participants showed a large N400 effect in response to PPs following NonAlt-Intransitive verbs (see Figure 10). ESL participants exhibited an N400 effect in response to PPs following NonAlt-Intransitive verbs, as well as a P3b/MFN effect to Alt-Intransitive verbs (see Figure 11). Scalp topographies indicate that ESL participants have

different processing stages that are not reflected as readily in the waveforms (see Figure 12). It is evident that different processes occur between NES and ESL participants in this context.

3.3. Results Summary

Behavioral results showed main effects and interactions of VerbType and Context. Sentences contexts with matching verb types (e.g., Transitive verbs in Transitive contexts, Ditransitive verbs in Ditransitive contexts) elicited faster and more accurate responses than other Verb-Context pairings. There was also a main effect of Group: ESL participants were less accurate than NES participants (72% versus 79%) and slower (941 ms. versus 716 ms.). Critically, though, Group did not interact with VerbType or Context: The patterns of accuracy and response time across conditions were nearly identical for the two groups (see Figures 5-6).

ERP results indicate the existence of a P600 effect in NES participants in response to NonAlt-Intransitive verbs but not to other verb types in the Transitive Context (Figure 7). These results confirm Hypothesis 1: we expected P600s to NonAlt-Intransitive verbs, as well. Moreover, we did not observe N400 or P600 effects to Ditransitive verbs in this context.

ESL participants did not display P600 effects to any verb type presented in the Transitive Context but did display N400 effects in response to Alt-Intransitive, NonAlt-Intransitive, and Ditransitive verbs presented in the Transitive Context. These results go against our initial hypotheses in that the type of response seen did not match what was expected.

ERP results for the Ditransitive Context indicated that our predictions were correct as a large N400 effect was observed in response to NonAlt-Intransitive verbs preceding PPs in NES participants. ESL participants also displayed N400s to PPs following NonAlt-Intransitive verbs but displayed N400s to PPs following Alt-Intransitive verbs as well. In addition, a P3b effect was elicited in ESL responding to PPs following Alt-Intransitive verbs.

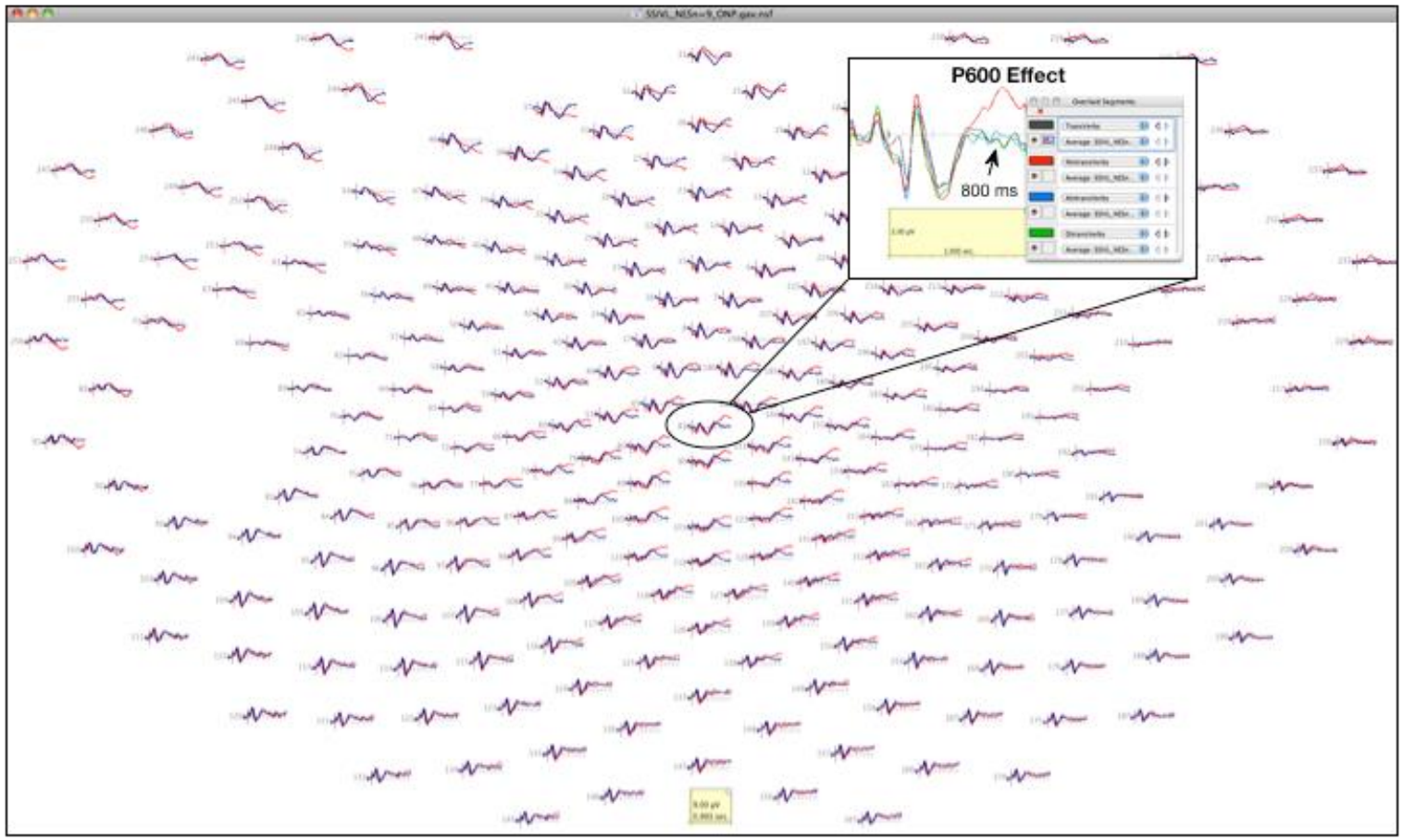

Figure 7. 256-channel waveplot for grand averaged data (n = 9) showing NES participant responses to object noun phrases (Transitive context) presented with NonAlt-Alternating and Transitive Verb Types; *Inset* Waveforms in response to each verb type showing P600 effect in response to NonAlt-Intransitive verbs.

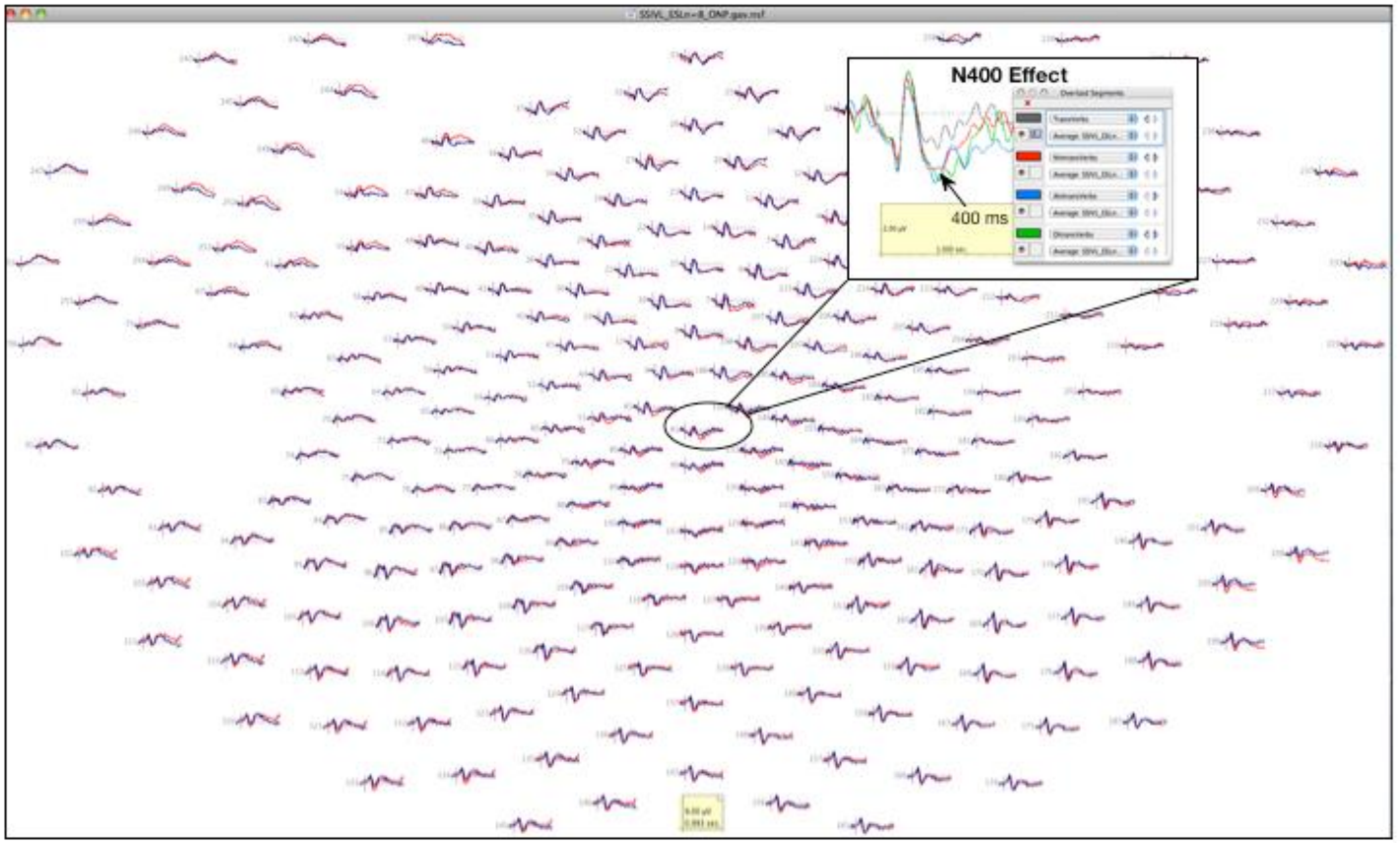

Figure 8. 256-channel waveplot for grand averaged data (n = 8) showing ESL participant responses to object noun phrases (Transitive context) presented with NonAlt-Alternating and Transitive Verb Types; *Inset* Waveforms in response to each Verb Type showing N400 effect in response to NonAlt-Intransitive, Alt-Intransitive, Ditransitive verbs.

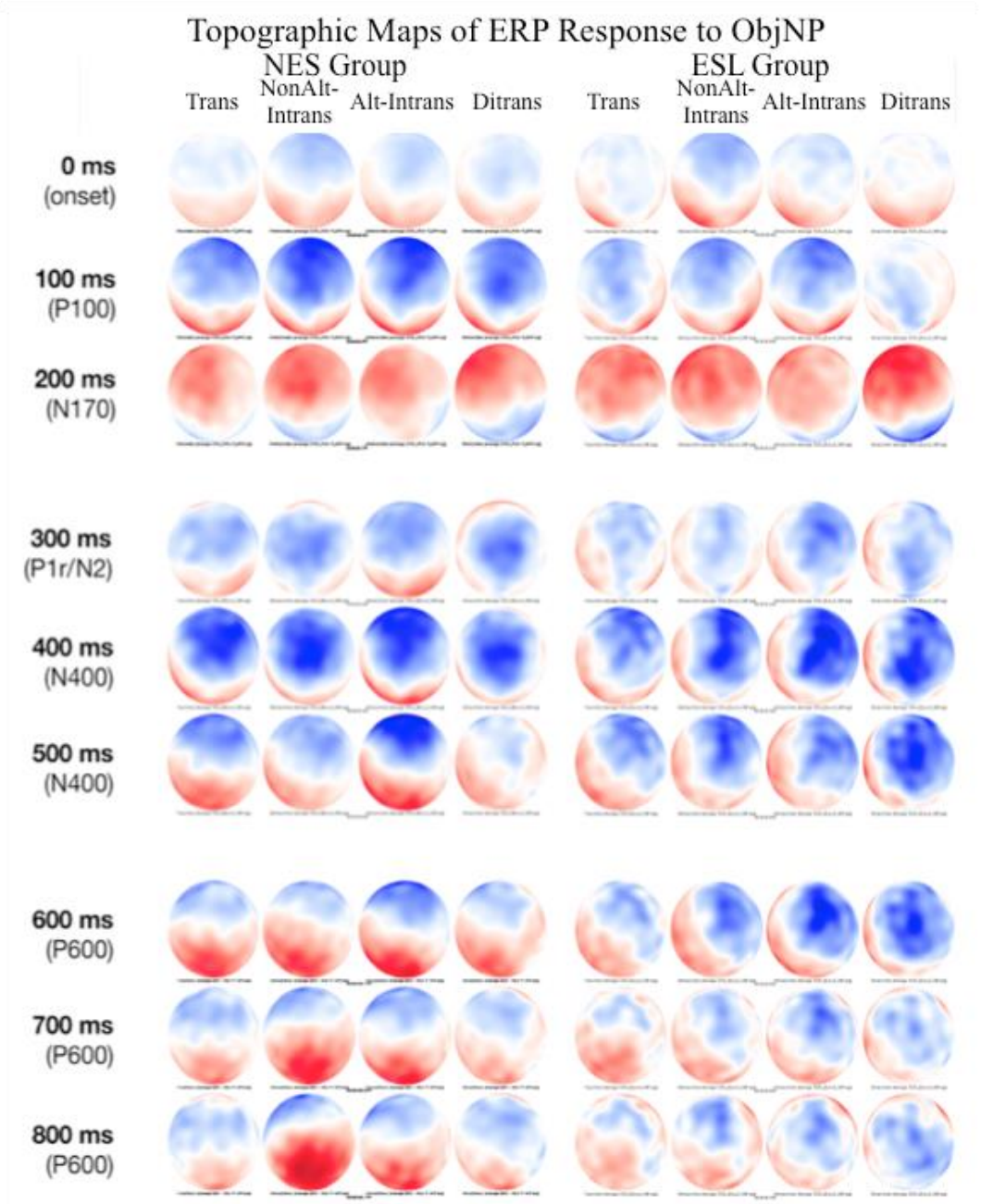

Figure 9. Scalp topographies of ERP effects in response to object noun phrases (Transitive context) by Group and Verb Type.

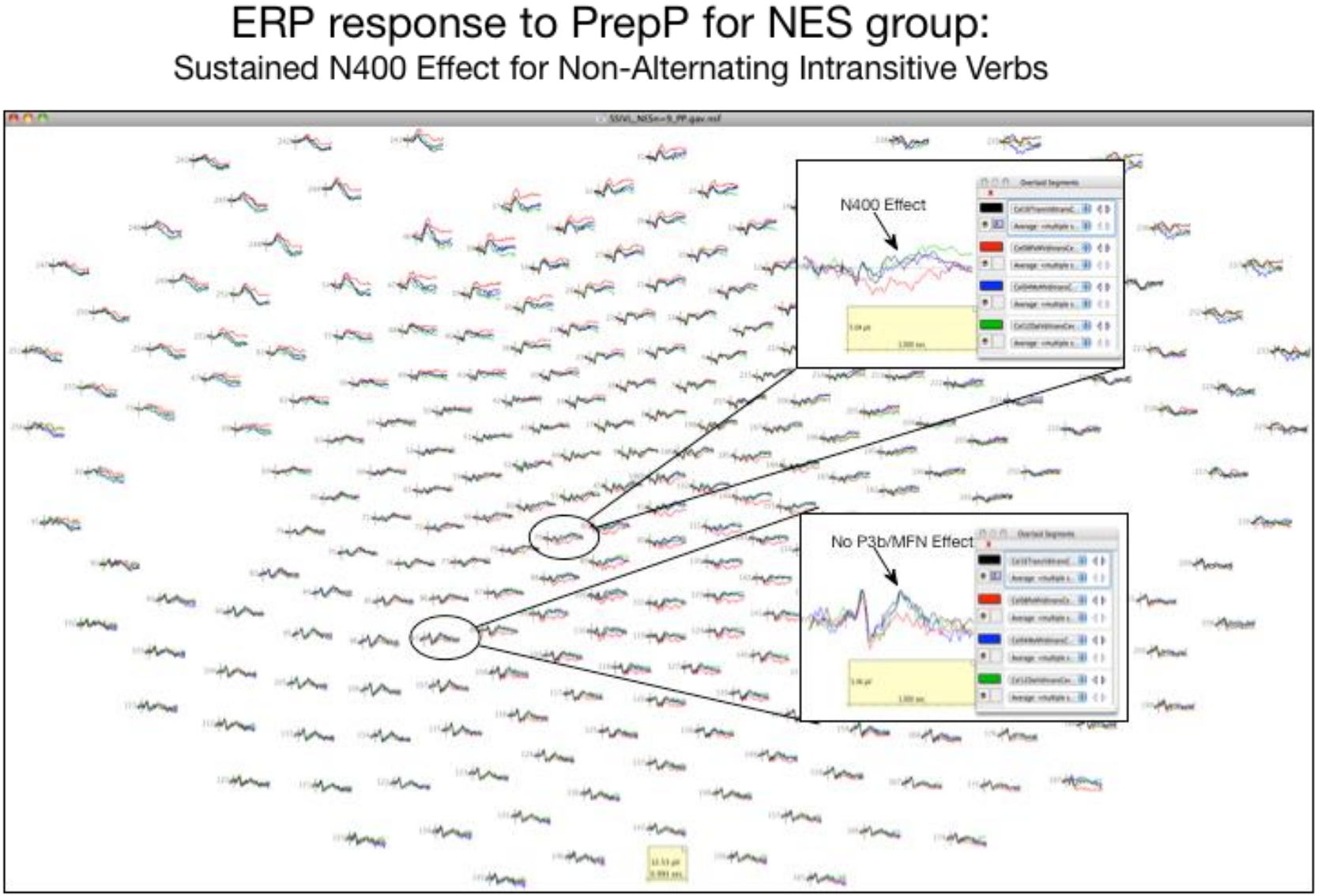

Figure 10. 256-channel waveplot for grand averaged data (*n* = 9) showing NES participant responses to prepositional phrases (Ditransitive context) to all verb types; *Inset A* Waveforms in response to each Verb Type showing N400 effect in response to NonAlt-Intransitive; *Inset B*

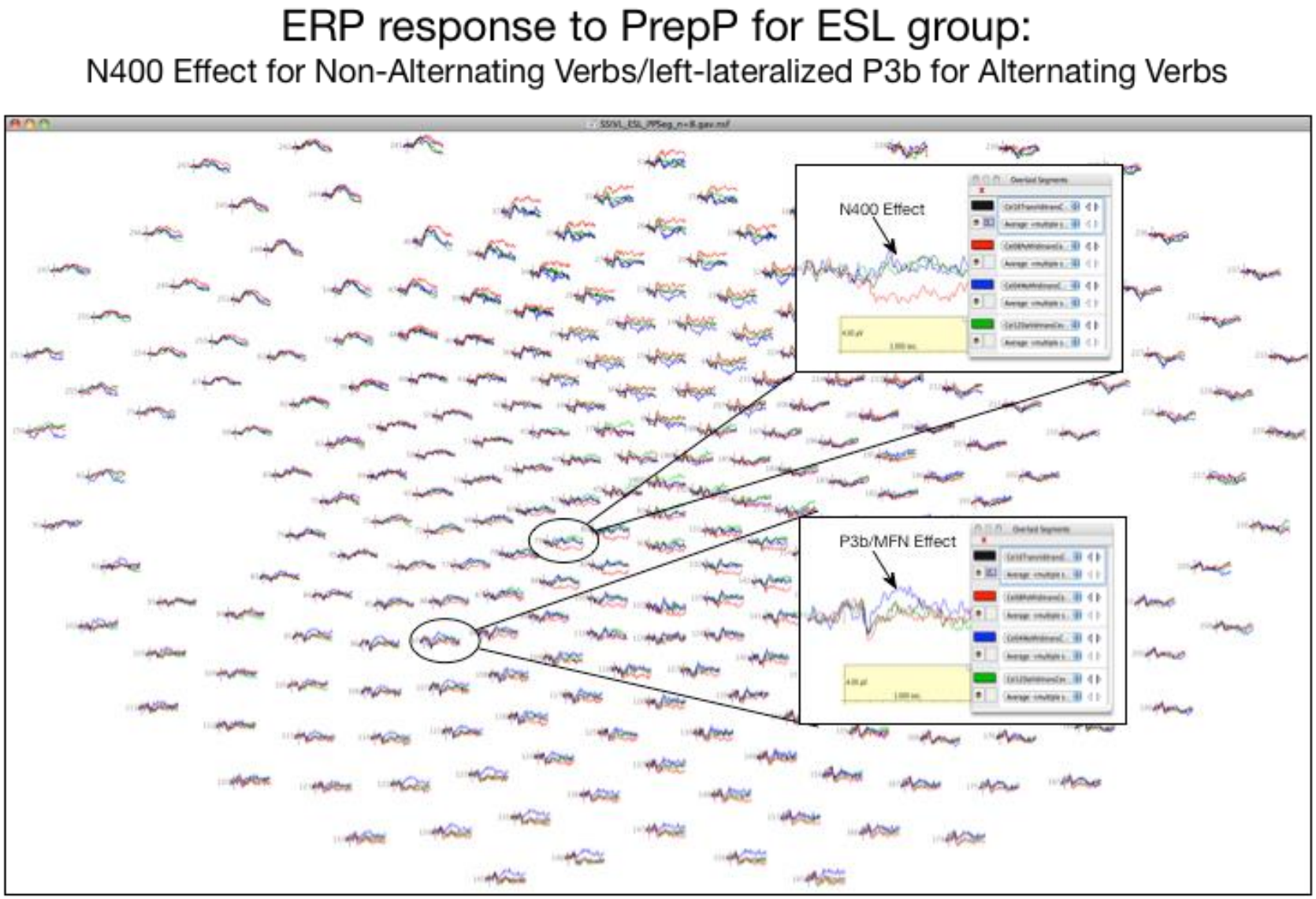

Figure 11. 256-channel waveplot for grand averaged data (n = 8) showing ESL participant responses to prepositional phrases (Ditransitive context) to all verb types; *Inset* Waveforms in response to each Verb Type showing inconclusive effects.

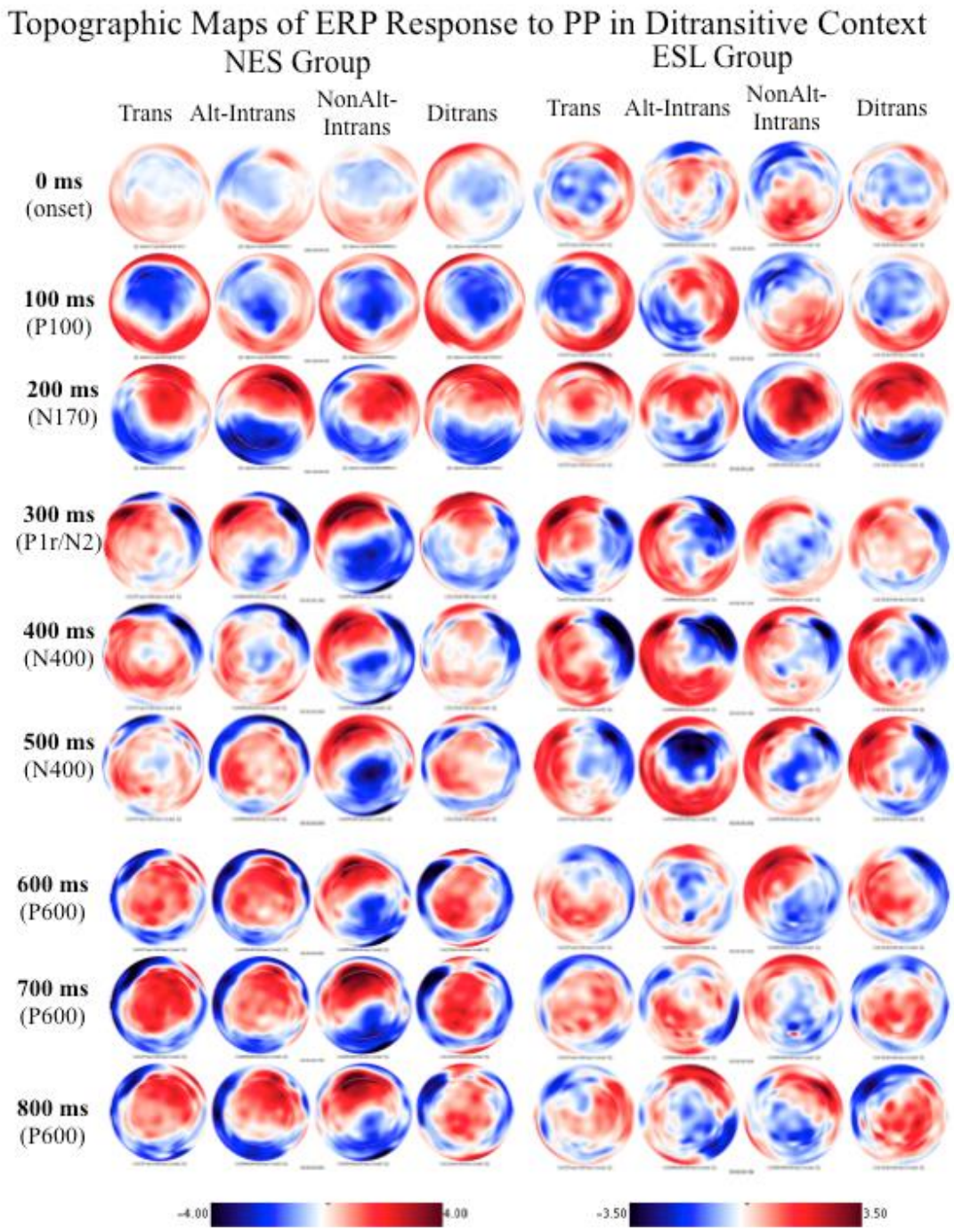

Figure 12. Scalp topographies of ERP effects in response to prepositional phrases (Ditransitive context) as a function of Group and Verb type.

4. Discussion

4.1. Behavioral Results

Accuracy judgments across conditions were remarkably similar for NES and ESL participants, and statistical analyses confirmed that Group did not interact with any of the within-subjects factors (i.e., VerbType or Context). Interestingly, this pattern of results differs from that of Cabrera and Zubizarreta (2005). Cabrera and Zubizarreta (2005) found that ESL participants rejected Alt-Intransitive verbs in a causative structure: Our results found the opposite. This may be due to the slightly different methodologies that were used: Cabrera and Zubizarreta (2005) used a Likert-style acceptability scale, whereas we used a forced-choice yes/no scale. However, if that were the case, we would have expected to find that our ESL would reject Alt-Intransitive verbs more than they did. Thus the reasons for the discrepancy are not clear. This result seems to indicate that high proficiency ESL learners not only rely on L1 knowledge of the construction but integrate L2 constructional knowledge before making their judgment.

Reaction time results likewise showed similar patterns for the two participant groups, although ESL participants were considerably slower overall. Recall that, according to the freewrite evaluation, six of the seven participants were rated as intermediate, rather than advanced, in proficiency. Thus, it is not surprising that they were less fluent than NES participants. This lack of fluency may be due in part to L1 transfer effects. In particular, ESL learners may first process the input according to word- and clause-level constraint in their L1. The main point, however, is that the two groups exhibited the same pattern of results for accuracy and reaction time. These results contrast with those of Cabrera and Zubizarreta (2004, 2005), who found qualitatively different patterns in acceptability ratings for ESL and NES participants in a similar task.

4.2. ERP Results

4.2.1. Transitive Context (ObjNP).

4.2.1.1. Response to NonAlt-Intransitive Verbs (vs. Transitive Baseline).

The first point of interest was the object noun phrase (ObjNP). At this stage of the sentence, participants could not know whether the sentence was complete (i.e., was a simple Transitive context) or whether there were additional constituents following the ObjNP. Thus, verbs that are anomalous within a simple transitive context could be perceived as syntactic violations. In line with this interpretation, NES participants exhibited P600 effects in response to NonAlt-Intransitive verbs when compared to the baseline Transitive verb. This result was expected as an additional sentence constituent was present in NonAlt-Intransitive trials making this a syntactic violation of the verb type (**Susan is arriving her daughter)*. Unexpectedly, ESL participants exhibited N400 effects in response to NonAlt-Intranstive verbs. We think this may mean ESL participants had difficulty reconciling verb-lexical knowledge (i.e. meaning) within the presented sentence structure, supporting Friederici, Steinhauer, and Frisch's (1999) "classical" view that the N400 is a measure of semantic integration with the syntax of a sentence.

4.2.1.2. Response to Alt-Intransitive Verbs (vs. Transitive Baseline).

In response to Alt-Intransitive verbs (*Susan is walking the package*), NES participants displayed no P600 response; ESL participants exhibited N400 effects. These results are consistent with the idea that NES participants view these sentences as open and thus are maintaining the sentence is working memory. ESL results are also consistent with the prediction that responses from ESL participants to Alt-Intransitive verbs would be similar to their responses to NonAlt-Intransitive Verbs. In both cases, ESL participants displayed N400 effects: We take this result to indicate a problem with semantic integration into the sentence context.

4.2.2. Ditransitive Context (Prep Phrase).

4.2.2.1. Response to NonAlt-Intransitive Verbs (vs. Ditransitive Baseline).

The second point of interest was the prepositional phrase (PP) — that is, the final constituent of the ditransitive context (**Susan is arriving her daughter to the school*). We observed N400 effects in response to the PP constituent following NonAlt-Intransitive verbs for both groups within this context. This finding could be interpreted as providing support for the classical view of the N400, assuming the N400 effect signals difficulties with integrating the lexical knowledge of the verb with the sentence structure.

4.2.2.2. Response to Alt-Intransitive Verbs (vs. Ditransitive Baseline).

NES participants showed no differences in response to the PP constituent following Alt-Intransitive verbs versus baseline (*Susan is walking the package to the doorstep*). This suggests that they were able to resolve the meaning and syntax with little effort. By contrast, ESL participants displayed a P3b effect to the PP. The P3b effect is commonly thought to measure the subjective probability of an event (Duncan-Johnson and Donchin, 1977), context updating (Donchin and Coles, 1988), or attention allocation during online processing (Polich and Kok, 1995). The class of verbs that function as Alt-Intransitive verbs in English belong to a different category in Spanish, namely, NonAlt-Intransitive. This suggests that ESL participants may initially rely on their L1 representation of these verbs, but are able to revise their analysis later in the sentence in order to arrive (on average) at a correct judgment. It seems likely that low-proficiency ESL participants would show a different pattern of response in this context.

4.3. Summary & General Discussion

Behavioral results did not duplicate Cabrera and Zubizarreta (2005). The findings from this study illustrate how ERP measures can complement and extend behavioral responses. In this

case, there were no group differences in the comparison of different verb–context pairings. By contrast, ERPs displayed a qualitatively different between-group pattern regarding the main contrast of NonAlt-Intranstive verbs and Alt-Intransitive verbs. These results also suggest that a later process reconciles the ESL participants' treatment of the non-baseline verb types because accuracy results indicate similarity in accuracy rates. This process may be reflected by the P3b found in ESL participants. Finally, results did not replicate claims from Kuperberg's (2007) meta-analysis as no P600 effect was observed in response to Ditransitive verbs without patient direct object or goal prepositional phrase.

4.4. Limitations and Future Directions

One limitation of this study was the small number of ESL participants. Because it was important to equate the number of participants and to match them in age, gender, and handedness, we were also forced to select a subsample of NES participants for comparison. Future studies will aim to increase the sample size to give more robust measures.

Another limitation of this study is that many participants exhibited eye movements. Although extra care was taken to instruct participants on the adverse effects of eye movements to the EEG dataset's value, it is possible that residual eye movement artifacts remained in our datasets. To address this issue, future analyses of these data will use blind source separation methods such as Independent Components Analysis (ICA) to isolate and remove eye movements, as well as eye blinks, from the data (Frank and Frishkoff, 2007).

An interesting challenge was that Ditransitive verbs in the Transitive context admit a middle interpretation. For example, "*John is sending the mail*" is generally regarded as acceptable through the middle interpretation. Thus, although ditransitive verbs are technically supposed to require an indirect object or PP as well as a direct object, the existence of the Middle

Construction in English allows for a reinterpretation of these sentences that renders them acceptable (for some verbs). As a result, NES speakers rated these sentences, on average, as more acceptable than we would have expected based on a straight-forward consideration of verb types and their acceptability within transitive contexts.

To address the short-comings of the present study, future work may be carried out using more fine-grained behavioral measures. These measures could include an acceptability Likert-scale instead of a forced-choice yes/no scale and the inclusion of a confidence rating concerning the accuracy of participant responses. Additionally, the inclusion of low-proficiency ESL participants would help to determine the role of the P3b effect and how the ERP results fit with theories of second language acquisition.

4.5. Conclusions

The present work attempted to shed light on the cognitive processes underlying grammaticality judgments in bilinguals using verb types with differential acceptability in each of four contexts. We found that although behavioral patterns are essentially the same for Native English speakers and speakers of English-as-a-Second-Language, cognitive processing differences are present and observed in the dataset. These results have intriguing implications for both theory of second language acquisition and practice, as it seems that a later resolving process is at work in L2 learners that realigns grammaticality judgments based on L2 rules. Additionally results support constructionist theories of language, which emphasize ongoing interactions between syntax and semantics at multiple stages of sentence comprehension.

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Appendix A

Alternating Intransitive Verbs in English

	Word Length	Verb Stem	Verb Stem Length	CELEX[1]	KF_FRQ[2]	FAM[3]	AOA[4]	AOA2[5]	AOA3[6]
is sneaking	11	sneak	5	3.35	2	—	—	—	—
is dancing	10	dance	5	46.31	93	550	—	269	269
is running	10	run	3	229.89	246	—	—	—	—
is floating	11	float	5	16.87	3	466	296	321	308.5
is climbing	11	climb	5	35.53	12	540	240	—	240
is walking	10	walk	4	121.01	103	625	206	230	218
is jumping	10	jump	4	27.26	24	551	222	—	222
is sliding	10	slide	5	16.42	21	506	217	247	232
MEAN:	10.4		4.5	62.08	63.00	539.67	236.20	266.75	248.25
MEDIAN:	10.0		5.0	31.40	22.50	545.00	222.00	258.00	236.00
STDDEV:	0.48		0.71	71.92	78.42	48.44	31.85	34.24	31.61

Note: 1= No. of Occurrences in COBUILD/ECT corpus divided by 17.9; 2 = Kucera & Francis Word Frequency; 3 = Subjective Familiarity from MRC Database; 4 = Age of Acquisition from Bristol/Gilhooly-Logie [Scale: 100-700]; 5 = Age of Acquisition from Bird,Franklin,Howard [Scale: 100-700]; 6 = Combined Age of Acquisitions Measures (from AOA and AOA2): Where both measures have values (other than "-1"), AOA3 is the average of the two values.

Appendix B

Non-Alternating Intransitive Verbs in English

	Word Length	Verb Stem	Verb Stem Length	CELEX[1]	KF_FRQ[2]	FAM[3]	AOA[4]	AOA2[5]	AOA3[6]
is arriving	12	arrive	6	35.03	24	607	291	—	291
is emerging	12	emerge	6	22.96	18	—	—	—	—
is arising	10	arise	5	21.4	28	464	517	—	517
is disappearing	15	disappear	9	17.6	11	—	—	346	346
is coming	10	come	4	871.84	632	608	—	244	244
is vanishing	12	vanish	6	5.81	5	486	315	—	315
is going	8	go	2	1054.13	633	618	—	221	221
is appearing	13	appear	6	95.42	118	542	335	359	347
MEAN:	11.5		5.5	265.52	183.63	554.17	364.50	292.50	325.86
MEDIAN:	12		6	29.00	26.00	574.50	325.00	295.00	315.00
STDDEV:	2		1.87	406.04	261.28	61.49	89.41	60.72	89.78

Note: 1= No. of Occurrences in COBUILD/ECT corpus divided by 17.9; 2 = Kucera & Francis Word Frequency; 3 = Subjective Familiarity from MRC Database; 4 = Age of Acquisition from Bristol/Gilhooly-Logie [Scale: 100-700]; 5 = Age of Acquisition from Bird,Franklin,Howard [Scale: 100-700]; 6 = Combined Age of Acquisitions Measures (from AOA and AOA2): Where both measures have values (other than "-1"), AOA3 is the average of the two values.

Appendix C

Prototypical Ditransitive Verbs in English

	Word Length	Verb Stem	Verb Stem Length	CELEX[1]	KF_FRQ[2]	FAM[3]	AOA[4]	AOA2[5]	AOA3[6]
is giving	9	give	4	483.63	392	595	—	243	243
is handing	10	hand	4	459.11	470	601	—	—	—
is lending	10	lend	4	12.29	14	558	341	—	341
is transferring	14	transfer	8	30.45	39	502	489	—	489
is offering	11	offer	5	103.07	80	—	—	389	389
is sending	10	send	4	83.91	74	614	283	314	298.5
is feeding	10	feed	4	52.63	125	—	—	275	275
is awarding	11	award	5	11.01	46	—	—	402	402
MEAN:	10.6		4.75	154.5125	155	574	371	324.6	348.21
MEDIAN:	10.0		4.00	68.27	77.00	595.00	341.00	314.00	341.00
STDDEV:	?		1.30	185.51	163.44	40.52	86.73	62.24	78.68

Note: 1= No. of Occurrences in COBUILD/ECT corpus divided by 17.9; 2 = Kucera & Francis Word Frequency; 3 = Subjective Familiarity from MRC Database; 4 = Age of Acquisition from Bristol/Gilhooly-Logie [Scale: 100-700]; 5 = Age of Acquisition from Bird,Franklin,Howard [Scale: 100-700]; 6 = Combined Age of Acquisitions Measures (from AOA and AOA2): Where both measures have values (other than "-1"), AOA3 is the average of the two values.

Appendix D

Transitive Verbs in English (that take PP)

	Word Length	Verb Stem	Verb Stem Length	CELEX[1]	KF_FRQ[2]	FAM[3]	AOA[4]	AOA2[5]	AOA3[6]
is pounding	11	pound	5	44.75	35	652	277	340	308.5
is mixing	10	mix	3	23.63	13	—	—	325	325
is hitting	10	hit	3	91.34	125	—	—	279	279
is cutting	10	cut	3	177.88	206	581	—	—	—
is squeezing	12	squeeze	7	12.79	11	497	266	—	266
is breaking	11	break	5	105.03	93	529	-1	230	230
is blowing	10	blow	4	40.28	33	536	259	—	259
is kicking	10	kick	4	19.72	18	563	228	243	235.5
MEAN:	10.5		4.25	64.43	66.75	559.67	205.80	283.40	271.86
MEDIAN:	10.0		4.00	42.52	34.00	549.50	259.00	279.00	266.00
STDDEV:	0.71		1.39	53.09	65.19	49.02	104.67	43.44	32.71

Note: 1= No. of Occurrences in COBUILD/ECT corpus divided by 17.9; 2 = Kucera & Francis Word Frequency; 3 = Subjective Familiarity from MRC Database; 4 = Age of Acquisition from Bristol/Gilhooly-Logie [Scale: 100-700]; 5 = Age of Acquisition from Bird,Franklin,Howard [Scale: 100-700]; 6 = Combined Age of Acquisitions Measures (from AOA and AOA2): Where both measures have values (other than "-1"), AOA3 is the average of the two values.

Appendix E

Final Set of Stimuli.

Alt-Intransitive				In-Alt-Intransitive			
SubjNP	**Verb**	**AltObjNP**	**PP**	**SubjNP**	**Verb**	**AltObjNP**	**PP**
Amanda	is sneaking	the drugs	past her mother.	Amanda	is arriving	the drugs	at the clinic.
Amy	is sneaking	the game	into the party.	Amy	is arriving	the game	in the yard.
Andrew	is sneaking	his girlfriend	to the cinema.	Andrew	is arriving	his girlfriend	to the car.
Angela	is sneaking	the prop	out of the theater.	Angela	is arriving	the prop	at the theater.
Anthony	is sneaking	his friends	up the street.	Anthony	is arriving	his friends	to the party.
Ashley	is sneaking	the candy	into her mouth.	Ashley	is arriving	the candy	in the bowl.
Barbara	is sneaking	the dancer	into the outfit.	Barbara	is arriving	the dancer	at the club.
Betty	is sneaking	the food	past her teacher.	Betty	is arriving	the food	to the customers.
Brandon	is sneaking	the pie	out of the kitchen.	Brandon	is arriving	the pie	in the window.
Brenda	is sneaking	the present	past her brother.	Brenda	is arriving	the present	in the box.
Brian	is dancing	the broom	into the closet.	Brian	is emerging	the broom	from the closet.
Carol	is dancing	her partner	through the hall.	Carol	is emerging	her partner	through the door.
Charles	is dancing	the lady	into the room.	Charles	is emerging	the lady	on the stairs.
Christine	is dancing	her boyfriend	along the wall.	Christine	is emerging	her boyfriend	into the room.
Christopher	is dancing	his wife	past his father.	Christopher	is emerging	his wife	onto the street.
Cynthia	is dancing	her husband	along the beach.	Cynthia	is emerging	her husband	out of the bedroom.
Daniel	is dancing	his fiance	into the rain.	Daniel	is emerging	his fiance	from the church.
David	is dancing	the girl	around the square.	David	is emerging	the girl	from school.
Deborah	is dancing	the animal	through the park.	Deborah	is emerging	the animal	from the cage.
Debra	is dancing	the gentlemen	across the floor.	Debra	is emerging	the gentlemen	into the open.
Donald	is running	the ideas	past his uncle.	Donald	is arising	the ideas	from his head.
Donna	is running	the model	through the office.	Donna	is arising	the model	from the basement.
Dorothy	is running	the cake	up the steps.	Dorothy	is arising	the cake	from the oven.
Edward	is running	the actors	off the stage.	Edward	is arising	the actors	onto the stage.
Elizabeth	is running	the men	down the road.	Elizabeth	is arising	the rabbit	from the hat.
Emily	is running	the sheets	up to bed.	Emily	is arising	the sheets	from the sofa.

Appendix E (cont.)

Eric	is running	the note	out of the classroom.	Eric	is arising	the note	out of the drawer.
Gary	is running	the figures	by the artist.	Gary	is arising	the grapes	from the refrigerator.
George	is running	the rats	through the maze.	George	is arising	the rats	out of the box.
Gregory	is running	the boxes	past his coworker.	Gregory	is arising	the boxes	into the attic.
Jacob	is floating	the apples	to the boat.	Jacob	is disappearing	the apples	from his mouth.
James	is floating	the boat	up to the edge.	James	is disappearing	the boat	from the water.
Jason	is floating	the treasure	up to the surface.	Jason	is disappearing	the treasure	into the chest.
Jeffrey	is floating	the minerals	out of the cave.	Jeffrey	is disappearing	the minerals	from the rocks.
Jennifer	is floating	the passengers	down the river.	Jennifer	is disappearing	the passengers	off the ship.
Jessica	is floating	the logs	through the tunnel.	Jessica	is disappearing	the fish	from the river.
John	is floating	the bait	along the shore.	John	is disappearing	the money	from the container.
Jonathan	is floating	the ship	across the lake.	Jonathan	is disappearing	the ship	from the dock.
Joseph	is floating	the visitors	across the pond.	Joseph	is disappearing	the visitors	from the museum.
Joshua	is floating	the suggestion	by the doctor.	Joshua	is disappearing	the car	from the garage.
Justin	is climbing	the gift	to the window.	Justin	is coming	the gift	toward the restaurant.
Karen	is climbing	her backpack	over the fence.	Karen	is coming	her backpack	toward the classroom.
Kathleen	is climbing	the books	onto the shelf.	Kathleen	is coming	the books	onto the shelf.
Kenneth	is climbing	the goods	over the gate.	Kenneth	is coming	the goods	to the store.
Kevin	is climbing	the medicine	up the mountain.	Kevin	is coming	the medicine	to the hospital.
Kimberly	is climbing	the bicycle	up the hill.	Kimberly	is coming	the bicycle	off the hook.
Larry	is climbing	the furniture	up the stairs.	Larry	is coming	the furniture	into the park.
Laura	is climbing	the horses	up the path.	Laura	is coming	the horses	to the stables.
Linda	is climbing	the paint	up the ladder.	Linda	is coming	the paint	up the ladder.
Lisa	is climbing	the mule	up the slope.	Lisa	is coming	the mule	down the path.
Margaret	is walking	the sugar	over to her neighbor.	Margaret	is vanishing	the sugar	from the cabinet.
Mark	is walking	his cat	to the car.	Mark	is vanishing	his cat	from the bucket.
Mary	is walking	his kids	to the restaurant.	Mary	is vanishing	his kids	from the kitchen.
Matthew	is walking	the package	to the store.	Matthew	is vanishing	the package	to the university.

Appendix E (cont.)

Melissa	is walking	her daughter	to her aunt.	Melissa	is vanishing	her daughter	from the mall.
Micheal	is walking	the bananas	to the boy.	Micheal	is vanishing	the bananas	from the vendor.
Michelle	is walking	the baby	to the dog.	Michelle	is vanishing	the baby	to the bed.
Nancy	is walking	the woman	down the path.	Nancy	is vanishing	the woman	from the chair.
Nicholas	is walking	the painter	around the house.	Nicholas	is vanishing	the painter	off the latter.
Nicole	is walking	the doctor	to the hospital.	Nicole	is vanishing	the doctor	from the office.
Pamela	is jumping	the lion	through the hoops.	Pamela	is going	the lion	to the cage.
Patricia	is jumping	the dress	through the hole.	Patricia	is going	the dress	to the wedding.
Paul	is jumping	the stone	across the water.	Paul	is going	the stone	down the road.
Rebecca	is jumping	the water	to the girl.	Rebecca	is going	the water	down the drain.
Richard	is jumping	the frog	through the rings.	Richard	is going	the frog	into the pond.
Robert	is jumping	his shoes	over the crack.	Robert	is going	his shoes	to the beach.
Ronald	is jumping	the ball	down the track.	Ronald	is going	the ball	into the woods.
Ryan	is jumping	the glasses	over the counter.	Ryan	is going	the glasses	off his face.
Samantha	is jumping	the ducks	over the rocks.	Samantha	is going	the ducks	to the lake.
Sandra	is jumping	the mouse	over the plate.	Sandra	is going	the mouse	into the trap.
Sarah	is sliding	the lemons	into the bowl.	Sarah	is appearing	the lemons	on the plate.
Scott	is sliding	the documents	off the desk.	Scott	is appearing	the documents	on the desk.
Sharon	is sliding	the skates	off the ice.	Sharon	is appearing	the skates	on her feet.
Shirley	is sliding	the wipes	across the mirror.	Shirley	is appearing	the light	in the bathroom.
Stephanie	is sliding	the chair	across the rug.	Stephanie	is appearing	the chair	at the table.
Steven	is sliding	the message	into the box.	Steven	is appearing	the message	in the mail.
Susan	is sliding	the dust	into the trashcan.	Susan	is appearing	the shirts	on the hangers.
Thomas	is sliding	the letter	into the slot.	Thomas	is appearing	the letter	in his hand.
Timothy	is sliding	the carpet	through the door.	Timothy	is appearing	the carpet	in the truck.
William	is sliding	the stapler	off the table.	William	is appearing	the stapler	to his father.

Appendix E (cont.)

DiTrans				Trans			
SubjNP	**Verb**	**AltObjNP**	**PP**	**SubjNP**	**Verb**	**AltObjNP**	**PP**
Amanda	is giving	the drugs	to her mother.	Susan	is pounding	the nail	through the hole.
Stephanie	is giving	the game	to an acquaintance.	Scott	is pounding	the meat	on the table.
Micheal	is giving	the candy	to his brother.	David	is pounding	the hook	into the wood.
Donna	is giving	the gold	to her father.	Melissa	is pounding	the gravel	onto the street.
Ryan	is giving	the grapefruit	to his professor.	John	is pounding	the rod	into the ceiling.
Justin	is giving	the prop	to the actor.	Charles	is pounding	the support	through the floor.
Rebecca	is giving	the broom	to the lady.	Brenda	is pounding	the handle	into the gate.
Gary	is giving	the orange	to the shopper.	Paul	is pounding	the pin	into the board.
Richard	is giving	the dog	to his children.	Dorothy	is pounding	the sign	into the ground.
Brandon	is giving	the treasure	to the bank.	Karen	is pounding	the door	into the house.
Barbara	is handing	the note	to her aunt.	Jeffrey	is mixing	some flour	into the dough.
Sharon	is handing	the bananas	to her niece.	William	is mixing	the ice cream	into the container.
Gregory	is handing	the message	to her uncle.	Larry	is mixing	the carrot	into the soup.
Brenda	is handing	the goods	to her nephew.	Nicole	is mixing	the soup	into a pot.
Melissa	is handing	the ball	to the player.	Mark	is mixing	some milk	into the coffee.
Larry	is handing	the grapes	to the woman.	Donna	is mixing	some sugar	into the water.
Anthony	is handing	the animal	to his son.	Andrew	is mixing	the cereal	into the milk.
Mark	is handing	the boxes	to his coworker.	Barbara	is mixing	the glue	into the crack.
Ashley	is handing	the sheets	to the people.	Nancy	is mixing	some paint	into a bucket.

Appendix E (cont.)

Charles	is handing	the frog	to his sister.	Gregory	is mixing	some fruit	into the pie.
Edward	is lending	the model	to the builder.	Elizabeth	is hitting	the boy	on the head.
Ronald	is lending	the boat	to his neighbor.	Linda	is hitting	the baseball	to first base.
Elizabeth	is lending	the medicine	to the traveler.	Sandra	is hitting	her brother	in the arm.
Paul	is lending	the car	to his friend.	James	is hitting	the mark	across the stadium.
Scott	is lending	the paint	to the artist.	Carol	is hitting	the fly	on the wall.
Angela	is lending	the flour	to the baker.	Kathleen	is hitting	a homerun	over the field.
Michelle	is lending	the dress	to her daughter.	Thomas	is hitting	the spike	into the opening.
Nancy	is lending	the sugar	to the cook.	Jessica	is hitting	the object	into the basket.
Cynthia	is lending	the bicycle	to the boy.	Jacob	is hitting	the disc	over the fence.
Lisa	is lending	the cash	to her parents.	Deborah	is hitting	the target	with an arrow.
Andrew	is transferring	the water	to the tank.	Amanda	is cutting	the lettuce	into the salad.
Christine	is transferring	the house	to the buyer.	Michelle	is cutting	the vegetables	on the counter.
William	is transferring	the stone	to his desk.	Christopher	is cutting	the strawberries	into the bowl.
Dorothy	is transferring	the furniture	to storage.	Laura	is cutting	the garlic	onto the dish.
Betty	is transferring	the socks	to the drawer.	Sharon	is cutting	the onion	into a pan.
Laura	is transferring	the hat	to the rack.	Mary	is cutting	a branch	off the tree.
Karen	is transferring	the shirt	onto the hanger.	Richard	is cutting	some fat	off the meat.
Christopher	is transferring	the shoes	into the closet.	Matthew	is cutting	the stick	off the bush.
Matthew	is transferring	the lemons	to the refrigerator.	Patricia	is cutting	the feathers	off the bird.

Appendix E (cont.)

Jennifer	is transferring	the package	down the street.	Ashley	is cutting	her hair	into the sink.
Joshua	is offering	the carrot	to the horse.	Joseph	is squeezing	some mustard	onto her hotdog.
Sarah	is offering	the carpet	to the office.	Robert	is squeezing	some ketchup	onto her food.
David	is offering	the pencil	to the students.	Nicholas	is squeezing	the money	into the bag.
James	is offering	the glass	to his grandfather.	Shirley	is squeezing	the broom	up the chimney.
Mary	is offering	the coins	to the shop.	Eric	is squeezing	himself	through the crowd.
Jeffrey	is offering	the apple	to his teacher.	Samantha	is squeezing	her body	out the window.
Nicole	is offering	the lettuce	to the customer.	Rebecca	is squeezing	the couch	through the door.
Patricia	is offering	the skates	to the skater.	Emily	is squeezing	the juice	out of the orange.
Steven	is offering	the painting	to his client.	Amy	is squeezing	some lemon	into her tea.
Kevin	is offering	the backpack	to the hiker.	Daniel	is squeezing	some toothpaste	out the tube.
Deborah	is sending	her daughter	up to bed.	Donald	is breaking	the stem	off the apple.
Emily	is sending	the book	across the country.	Timothy	is breaking	the bread	onto the plate.
Susan	is sending	a letter	to the president.	Margaret	is breaking	some ice	into a glass.
Debra	is sending	a present	to the officer.	Kenneth	is breaking	a pencil	in his hand.
Daniel	is sending	his son	to his room.	Pamela	is breaking	a petal	off the flower.
Brian	is sending	the soldier	off to war.	Debra	is breaking	a leaf	off the plant.
Jonathan	is sending	the children	into the yard.	Jason	is breaking	a leg	off the chicken.
Jacob	is sending	a thank-you	to the nurse.	Kimberly	is breaking	the board	across his leg.
John	is sending	a card	to the doctor.	Jonathan	is breaking	a sprout	off the potato.

Appendix E (cont.)

Donald	is sending	a gift	to his in-laws.	George	is breaking	the furniture	into the trash.
Jason	is feeding	the sauce	to his rabbit.	Joshua	is blowing	the dirt	off the chair.
Jessica	is feeding	the soup	to her grandmother.	Kevin	is blowing	the dust	into the air.
Kathleen	is feeding	the bread	to the child.	Christine	is blowing	some air	into the fireplace.
Kimberly	is feeding	the cake	to the group.	Ronald	is blowing	some smoke	out the pipe.
Kenneth	is feeding	the pizza	to the team.	Steven	is blowing	the sand	at his sister.
Joseph	is feeding	the cereal	to his baby.	Sarah	is blowing	the fumes	out of the space.
George	is feeding	the food	to his dog.	Justin	is blowing	some steam	out the roof.
Eric	is feeding	some dinner	to the lawyers.	Micheal	is blowing	the letter	across the yard.
Carol	is feeding	the pie	to her family.	Gary	is blowing	the ash	into the fire.
Robert	is feeding	some milk	to the cats.	Lisa	is blowing	the crumb	off her lip.
Thomas	is awarding	the money	to his school.	Cynthia	is kicking	the girl	out of the bar.
Samantha	is awarding	the trophy	to the winner.	Jennifer	is kicking	his toy	across the room.
Linda	is awarding	the prize	to her friend.	Stephanie	is kicking	the actors	off the stage.
Margaret	is awarding	a ribbon	to the champion.	Ryan	is kicking	the ball	into the goal.
Nicholas	is awarding	a star	to the soldier.	Betty	is kicking	the rock	to his friend.
Amy	is awarding	a crown	to the prince.	Brandon	is kicking	the hockey puck	to his teammate.
Timothy	is awarding	a loan	to the couple.	Angela	is kicking	the marble	to his brother.
Sandra	is awarding	the lease	to the man.	Anthony	is kicking	the paper	to his father.
Shirley	is awarding	a badge	to the boyscout.	Edward	is kicking	the animal	out of the store.
Pamela	is awarding	a medal	to the hero.	Brian	is kicking	his son	out of the meeting.

Appendix F

Freewrite Task
NOTE: This task was adapted from Crossley, et al. (2012)

Freewriting Description/Descripción de Escritura Libre

Freewriting is the process of generating a lot of ideas by writing non-stop. It allows you to focus on a topic, but forces you to write so quickly that you might not have time to edit any of your ideas. The idea is simply to write for a set amount of time. In freewriting you don't stop. You never stop to look back, to cross something out, to wonder how to spell something, to wonder what word or thought to use, or to think about what you are doing. There are no wrong answers in freewriting. You just write as much as possible.

Escritura libre es el proceso de generar una gran cantidad de ideas por escrito sin parar. Que le permite centrarse en un tema, pero te obliga a escribir tan rápidamente que usted podría no tener tiempo para modificar cualquiera de sus ideas. La idea es simplemente de escribir para una determinada cantidad de tiempo. En escritura libre no se detiene. Uno nunca deja de mirar hacia atrás, para cruzar algo, a preguntarse cómo se escribe algo, a preguntarse qué palabra o pensamiento de usar, o para pensar en lo que está haciendo. No hay respuestas incorrectas en escritura libre. Sólo hay que escribir tanto como sea posible.

Instructions/Instrucciones

In this project, you will be asked to freewrite using English for 15 minutes on the topic of your choosing. The freewriting should be written on this handout in the space below. Do not worry about time. An instructor will let you know when you have a few minutes left. If you cannot think of a topic, some general topics are provided below:

En este proyecto, se le pedirá a freewrite utilizando Inglés durante 15 minutos sobre el tema de su elección. La escritura libre debe ser escrito en este folleto en el espacio de abajo. No te preocupes por el tiempo. Un instructor le hará saber cuando tiene unos cuantos minutos. Si usted no puede pensar en un tema, algunos de los temas generales se proporcionan a continuación:

1. Family	1. Familia
2. Weather	2. Tiempo
3. Favorite day of the week	3. Día favorito de la semana
4. Work	4. Trabajo
5. A favorite memory	5. Un recuerdo favorito
6. An important item in your life	6. Un elemento importante en su vida
7. Your daily schedule	7. Su horario diario
8. Your history	8. Su historia
9. Holidays	9. Vacaciones
10. Why you're studying English	10. ¿Por qué estás estudiando Inglés
11. Friends	11. Amigos

Appendix G

Verb Translation Task

NOTE: This task was adapted from Montrul (2001a, b).

Instructions: Please translate the following English verbs into Spanish.

Instrucciones: Por favor, traducir los siguientes verbos Inglés al Español.

Verb Type	English/Inglés	Spanish/Español [answer key]
Alt-Intransitive (Manner of Motion)	Sneak	Escurrirse/Escabullirse
	Dance	Bailar
	Run	Correr
	Float	Floatar
	Climb	Escalar, Trepar, Treparse
	Walk	Caminar
	Jump	Saltar
	Slide	Deslizarse, Resbalar
NonAlt-Intransitive (Path of Motion)	Arrive	Llegar
	Emerge	Salir, Emerger
	Arise	Levantarse
	Disappear	Desaparecer
	Come	Venir
	Vanish	Desaparecer
	Go	Ir
	Appear	Aparecer

Appendix G

Verb Translation Task (cont.)

Instructions: Please translate the following English verbs into Spanish.

Instrucciones: Por favor, traducir los siguientes verbos Inglés al Español.

Verb Type	English/Inglés	Spanish/Español [answer key]
Transitive	Pound	Machacar
	Mix	Mezclar
	Hit	Pegar, Golpear, Herir
	Cut	Cortar
	Squeeze	Apretar, Exprimer
	Break	Romper
	Blow	Soplar
	Kick	Patear, Darle una patata
Ditransitive	Give	Dar
	Hand	Pasarle, Dar, Entregar
	Lend	Prestar, Dejar
	Transfer	Transferir, Pasar
	Offer	Ofrecer
	Send	Mandar, Enviar
	Feed	Alimentar, Dar(le) de comer
	Award	Conceder, Otorgar, Conferir