SECOND LANGUAGE SWEDISH MORPHOSYNTACTIC INSTRUCTION AND CROSS-LANGUAGE SIMILARITY: AN ERP INVESTIGATION

by

Leida C. Tolentino

BS, University of Massachusetts, 2002

MS, University of Pittsburgh, 2008

Submitted to the Graduate Faculty of

the College of Arts and Sciences in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

University of Pittsburgh

2010

UNIVERSITY OF PITTSBURGH

DEPARTMENT OF PSYCHOLOGY

This dissertation was presented

by

Leida C. Tolentino

It was defended on

November 29, 2010

and approved by

Tessa Warren, Department of Psychology

Charles Perfetti, Department of Psychology

Alan Juffs, Department of Linguistics

Dissertation Advisor: Natasha Tokowicz, Department of Psychology

SECOND LANGUAGE SWEDISH MORPHOSYNTACTIC INSTRUCTION AND CROSS-LANGUAGE SIMILARITY: AN ERP INVESTIGATION

Leida C. Tolentino, PhD

University of Pittsburgh, 2010

This small-scale longitudinal experiment evaluated how specific differences among instruction methods, and differences between the first (L1) and second language (L2), interact to influence the beginning stages of L2 learning. Native English speakers learned a miniature version of Swedish according to three methods: contrast and color highlighting (Salience group), contrast and highlighting with grammatical rule explanations (Rule & Salience group), or neither (Control group). Responses to grammatical features that are instantiated similarly in L1 and L2 (demonstrative determiner-noun number agreement), instantiated differently in the two languages (singular definiteness marking), and that only exist in L2 (article-adjective gender agreement) were contrasted with the purpose of examining L1 transfer (e.g., Tokowicz & MacWhinney, 2005). Participants underwent three training sessions on vocabulary and grammar, completed three grammaticality judgment task post-tests, and two L1-L2 sentence translation tasks over a period of approximately three weeks. Grammaticality judgment scores on Swedish sentences: (a) improved across tests for all groups; (b) were lowest for dissimilar features in the Control group; and (c) were highest for similar and unique features, particularly in the Salience and Rule & Salience groups. Event-related potentials showed qualitative neural differences in the three training groups, which differentially varied with cross-language similarity. Sentence translation grammar accuracy was higher for similar and unique features. The findings are

consistent with theories that emphasize cross-language similarity (e.g., MacWhinney, 2005) and input salience (e.g., Ellis, 2006; Schmidt, 1990) in L2 learning. Importantly, these results are novel in demonstrating that instruction methods that direct learners' attention to critical aspects of input and provide rule explanations may be particularly helpful in learning L2 features that are distinct from L1.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

I am sincerely thankful to the several people who, in the long chain of events eventually leading to the completion of my dissertation, exerted a positive influence along the way, pushing me ever closer to my goal.

My wonderful parents and family who recognize the value of education and who, against great odds, allowed me to pursue a college degree in a foreign country, thus laying the foundation for this journey.

My husband Nick, for the boundless love and unfaltering support, particularly during the less rosy moments of my graduate school career, and for buying me ice cream when it was most needed.

Tamar Degani, for coming into my life, being a caring and thoughtful friend and colleague, and for reading all of my manuscripts.

The Pittsburgh dance and music communities for their important role in keeping my sanity intact during graduate school with countless joyful moments of dancing and music making.

Jon Stewart and Stephen Colbert for similar sanity-related reasons.

Chelsea McGrath, Jared DeBona, and the PLUM lab for their dedicated work in the laboratory and many long summer hours of ERP cap gel-filling.

Eva Albertsson, who is the one who actually speaks Swedish in this project, for her cheerful readiness to help develop large amounts of stimuli, and for recording all of the audio materials.

The journal Language Learning and the Pittsburgh Science of Learning Center, for providing the funding that made this project possible.

My teachers, graduate school recommenders, and previous employers, who were all instrumental in one way or another in helping me strive for and achieve my objectives.

The graduate faculty, especially the members of my dissertation committee, who have taught and guided me while also serving on countless of my committees and writing just as many letters of recommendation: Tessa Warren, Charles Perfetti, Erik Reichle, Julie Fiez, Alan Juffs, and Mark Wheeler.

And, of course, my advisor, Natasha Tokowicz, who has contributed most directly to this dissertation project and all the others that came before. Her professional rigor and practical guidance provided me with the tools and confidence that were essential to my graduate career. I am certain that she will have a long and brilliant academic career.

1.0 INTRODUCTION

Some theories of second language (L2) acquisition such as the critical period hypothesis (CPH; DeKeyser & Larson-Hall, 2005; Lenneberg, 1967) postulate that L2 learning becomes increasingly difficult after a critical period around puberty and ultimate L2 attainment never reaches native levels. Indeed, L2 (morpho)syntax and phonology learning outcomes (but not necessarily learning rate) are often inversely related to age of acquisition (e.g., Johnson & Newport, 1989; but see Birdsong, 2005, and MacWhinney, 2005, for alternate explanations). Of particular relevance to the present experiment, the CPH further predicts that whereas children are able to learn languages implicitly, this mechanism is severely constrained in adults who must rely on explicit learning processes. The debate over implicit and explicit teaching and learning mechanisms has generated much research (see Ellis, N., 2005), with a large part of this effort being devoted to the question of which specific cognitive and linguistic factors influence adult L2 learning and long-term retention. In this context, cross-linguistic similarity between the first language (L1) and L2 has emerged as an important factor.

Recent research shows that cross-language similarity affects adult L2 performance and the neural patterns underlying L2 processing. Cross-linguistically similar features are generally associated with a performance advantage over more distinctive L2 features and, furthermore, tend to rely to a greater extent on shared L1 neurocognitive mechanisms (see Tolentino & Tokowicz, 2011, for a recent review of cross-language similarity effects in L2 (morpho)syntactic processing). Nevertheless, it remains unclear to what extent cross-language similarity interacts with other important factors, such as L2 instruction method, particularly in the beginning stages of learning. That is, could specific L2 instructional techniques address the particular learning challenges posed by linguistic features that are implemented differently in L2 or are altogether unique to L2? The present research uses behavioral methods and event-related brain potentials (ERPs) to examine the neurocognitive processes underlying initial L2 learning while simultaneously addressing for the first time the effects of L2 instruction method and cross-language similarity in the same study. In the present experiment, participants were taught a miniature version of Swedish grammar, which included morphosyntactic features of various degrees of L1-L2 correspondence, according to three methods of instruction. Learning was assessed in immediate and delayed comprehension and production post-tests.

Therefore, the goal of the present experiment was to evaluate the effectiveness of different methods of L2 instruction *as a function of* the similarity between L1 and L2 in the domain of morphosyntax, an area that is particularly problematic for adult L2 learners (Hahne, Mueller, & Clahsen, 2006; Parodi, Schwartz, & Clahsen, 2004). The experiment considers the influence of L1 in L2 learning by examining whether specific methods are best suited for teaching grammatical features that vary in their degree of correspondence with L1. Past research and theory on L2 instruction suggest that specific differences in teaching methods have predictable effects on attained adult L2 proficiency, with theoretical accounts postulating prominent roles for the level of explicitness of instruction as well as for the nature of the L2 input. However, despite the literature suggesting that L2 instruction method and degree of cross-language similarity are important independently, no studies have specifically examined the interaction of these two factors. Thus, the present research examined how specific differences between L1 and L2, as well as differences among instruction methods, including the role of salient, contrastive input and the contribution of metalinguistic information, interact to influence the beginning stages of L2 learning.

Furthermore, to my knowledge, only one study to date has examined the effect of different instruction methods on L2 learning from a neurocognitive perspective (Morgan-Short, Sanz, Steinhauer, & Ullman, 2010). To further address this knowledge gap, the present research takes a neurocognitive approach to the investigation of L2 instruction by incorporating two methodologies for the assessment of learning, which vary in their sensitivity to learning responses: ERPs and behavioral measures (i.e., response accuracy). ERPs measure the electrical activity of groups of neural cells that is time-locked to the occurrence of specific cognitive or motor events as captured by scalp electrodes. Therefore, ERPs can be used as a tool to investigate the neurocognitive basis of language processing because they reflect the rapidly unfolding (i.e., on the order of tens of milliseconds) real-time brain mechanisms associated with decoding semantic and syntactic information. Findings from ERP measures often dissociate from those obtained with behavioral methods (e.g., McLaughlin, Osterhout, & Kim, 2004; Thierry & Wu, 2007; Tokowicz & MacWhinney, 2005) and therefore are used in the present experiment as a complementary source of information about the specific mechanisms underlying initial L2 learning.

The most commonly used ERP language research paradigm compares ERPs in response to a lexical, semantic, or syntactic violation to those elicited by a matched control stimulus. Several ERP components characterized by a specific polarity, latency, and scalp distribution have been identified and are widely used as neurocognitive indexes of language processing. Three specific components are of particular relevance to this experiment: the left anterior negativity (LAN), the N400, and the P600. The LAN is a negative-going wave measured at left-hemisphere frontal areas of the scalp with a latency of approximately 300-500 ms; its amplitude increases in response to morphosyntactic anomalies such as subject-verb agreement violations, occasionally even in L2 speakers (e.g., Ojima, Nakata, & Kakigi, 2005; Rossi, Gugler, Friederici, & Hahne, 2006). The N400 component is also a negative deflection peaking at approximately 400 ms post-stimulus presentation but, unlike the LAN, it usually exhibits a centroparietal scalp distribution and is thought to be an index of lexico-semantic processing, such as the contextual fit of a word's meaning features (e.g., Kutas & Hillyard, 1980; Tolentino & Tokowicz, 2009). Lastly, the P600 is a *positive*-going wave with an onset at approximately 500 ms post stimulus and a centroparietal distribution (Osterhout & Holcomb, 1992). The P600 has been widely observed in response to syntactic ambiguity/complexity (e.g., Kaan & Swaab, 2003; Kotz, Holcomb, & Osterhout, 2008) and (morpho)syntactic violations in both L1 and L2 (e.g., Frenck-Mestre, Osterhout, McLaughlin, & Foucart, 2008; Ojima, et al., 2005; Osterhout & Holcomb, 1992; Rossi et al., 2006; Sabourin & Stowe, 2008; Tokowicz & MacWhinney, 2005).

1.1 CROSS-LANGUAGE SIMILARITY IN L2 MORPHOSYNTACTIC PROCESSING

The present experiment examined the role of cross-language similarity in L2 learning as a function of transfer from L1 to L2. Accordingly, similarities and differences in the way specific morphosyntactic features are implemented in L1 and L2 were identified and, along with input characteristics, were used to predict learning outcomes. Cross-linguistic contrastive analysis has its origins in Lado's (1957) influential yet controversial contrastive analysis hypothesis (CAH).

In its strong version, it assumes that specific L2 learning difficulties can be predicted for each individual simply by systematically comparing the L1 and L2 linguistic systems (Wardhaugh, 1970). Cross-linguistically similar features should be easily acquired whereas the opposite is predicted for dissimilar features. On the other hand, the weak or explanatory version of the CAH postulates that, once recurring errors in the use of particular L2 features are identified, they can then be used as the basis for a cross-linguistic contrastive analysis that attempts to explain such errors a posteriori. Following a period of dashed hopes regarding CAH experiments, researchers acknowledged the influence of other factors in language learning beyond the role of L1 transfer, while also maintaining that predictions are important in the context of contrastive analysis. A study by Schachter (1974) demonstrated the value of predictive as opposed to explanatory versions of the CAH through an error analysis of the production of English relative clauses by groups of Persian, Arabic, Chinese, and Japanese L1 backgrounds. Accordingly, as predicted by the CAH, results from error analyses of free compositions of the English learners showed that the Chinese and Japanese L1 groups had the most difficulty acquiring relative clauses, as evidenced by their avoidance strategy in production. Schachter (1974) argues that this result would not have been revealed if only an analysis of explicit errors were conducted, because their proportion was low due to outright avoidance of the problematic feature. Therefore, it appears that a moderate version of the CAH that makes explicit predictions based on cross-language similarity is a valuable tool in L2 acquisition research.

A more recent model that specifically addresses L1-L2 transfer in terms of the role played by cross-language similarity is the Unified Competition Model of language acquisition (UCM; MacWhinney, 2005). It posits general neurocognitive mechanisms to account for input-driven effects of L1-L2 similarity during learning. The model further specifies the role of linguistic cues (mappings between form and function) and the factors that determine their relative strengths during L2 processing. According to the UCM, adult L2 learners are likely to apply their highly "entrenched" (i.e., ingrained) L1 processing strategies and neural resources to the emerging L2 system through transfer, which can be positive, as when linguistic cues are cross-linguistically similar (e.g., attaching "s" to a singular noun for pluralization in both English and Spanish), or negative, as in the case of competing cues that have different instantiations in the two languages (e.g., Spanish word order generally dictates that nouns precede adjectives, but in English adjectives usually precede nouns). The relative strength of linguistic cues determines the outcome of online cue competition, with cue availability, reliability, and salience contributing significantly to cue strength. Thus, linguistic forms that are associated with the strongest cues tend to be highly available in the input, as well as highly reliable as predictors of function. Cross-language similarity between types of cues and their relative strengths in the L2 input are critical determinants of L2 acquisition because they influence the resolution of cue competition in L2 comprehension and production.

Findings from L2 studies that have directly examined the degree of cross-language similarity provide empirical support for the UCM. Tokowicz and MacWhinney (2005) examined the role of cross-language similarity of linguistic forms that are similar in L1 and L2, unique to L2, or present in both L1 and L2 but instantiated differently. They found that whereas native English speaking beginning learners of Spanish performed nearly at chance on all linguistic forms on a behavioral grammaticality judgment task (GJT), their brain activity as indexed by the P600 ERP component was sensitive to violations in sentences that contained forms that were cross-linguistically similar or unique to Spanish. These results are in agreement with the UCM because whereas cross-linguistically similar forms should benefit from positive L1 transfer, dissimilar forms usually suffer from competition; the processing of unique L2 forms, on the other hand, depends on cue strength, which in this case apparently was sufficiently high (see also McDonald, 1987).

Further support for a role of cross-language similarity in L2 processing comes from a study of a similar participant population by Tolentino and Tokowicz (2010), in which a P600 effect was observed in response to violations of cross-linguistically similar (demonstrative determiner-noun number agreement) and dissimilar L2 forms (definite determiner-noun number agreement), the latter result contrasting with the finding of Tokowicz and MacWhinney (2005). Additionally, Tolentino and Tokowicz (2010) did not observe any ERP effects during the processing of unique L2 forms (definite determiner-noun gender agreement; see also Tokowicz & Warren, 2010). Behavioral performance was most accurate for cross-linguistically similar items. It is likely that differences in stimulus set and experimental design were responsible for the discrepancies between the two studies. Specifically, the studies differed on the proportion and type of grammatical constructions as well as the presence of accuracy feedback. The Tolentino and Tokowicz (2010) experiment incorporated a higher proportion of sentences with violations of number agreement features, which could have aided learners in the processing of this type of cue, as well as an experimental block during which participants were exposed to the isolated source of violations in a sentence (e.g., “*estos lago” vs. “*Estos lago es vasto y calmo.” [“*these lake” vs. “*These lake is vast and calm.”) and received accuracy feedback on their grammaticality judgments. This manipulation may have increased the salience of the morphosyntactic violations and thus aided in noticing and subsequent processing.

Cross-language similarity effects have also been reported in native German, English, and Romance-language speakers of L2 Dutch during gender agreement and verb-inflection processing (Sabourin & Stowe, 2008; Sabourin, Stowe, & Haan, 2006). The rationale of this set of experiments was to systematically compare the performance of groups of L2 learners whose L1: 1) contains grammatical gender that closely corresponds to the L2 gender system (German L1 group); 2) contains a grammatical gender system with little correspondence to the L2 system (Romance language L1 group); and 3) contains no grammatical gender (English L1 group). Scores from a Dutch sentence GJT examining noun-relative pronoun gender agreement indeed showed systematic effects of cross-language similarity such that the group of German L1 speakers performed the best, followed by the Romance language L1 group, and the English L1 group performing at chance (Sabourin, et al., 2006). A similar hierarchy of results was obtained in a second experiment that measured the ERPs of native Dutch, German, and Romance language speakers while they made grammaticality judgments to Dutch sentences containing grammatical gender violations and verb inflection violations, the latter of which is implemented similarly in all languages examined (Sabourin & Stowe, 2008). The results showed that whereas all groups of participants displayed a P600 effect in response to (cross-linguistically similar) verb inflection violations, only the native Dutch and German speakers showed a P600 effect to gender violations, despite similar overall proficiency in all groups. Taken together, the results indicate that cross-linguistically similar features are more likely to be subserved by shared L1-L2 neural substrates, as indicated by comparable P600 effects exhibited by both L2 groups during the processing of this type of feature.

Chen and colleagues (Chen, Shu, Liu, Zhao, & Li, 2007) also examined cross-language similarity effects in an ERP experiment that compared the responses of moderately proficient (Mandarin) Chinese-English bilinguals with those of native English speakers on a sentence GJT examining subject-verb number agreement violations, a grammatical feature that is absent in

Chinese. Results showed that despite high GJT accuracy (88%) by Chinese L1 speakers, the two groups showed distinct neural patterns in response to violations: whereas English L1 speakers exhibited a biphasic LAN-P600 pattern, the Chinese L1 speakers instead showed a negativity over anterior-central regions between 500-700 ms (labeled "N600"). Interestingly, the Chinese L1 participants showed a biphasic N400-P600 profile in response to *grammatical* sentences containing number incongruencies as compared to their number-congruent counterparts (e.g., "The price of the *cars was* too high" vs. "The price of the *car was* too high."). No such effect was observed in the English L1 group. It thus appears that, although number agreement cues were sufficiently available in the input to elicit congruency effects in L2 speakers, they were nevertheless not salient enough to induce the fine-grained grammatical discriminability observed in the English L1 control group. This was illustrated by the distinct neural patterns exhibited by the Chinese L1 group during the processing of a grammatical feature that is unique to L2, even when behavioral performance was high.

Collectively, findings from the above studies suggest that whereas the processing of cross-linguistically similar features is generally associated with high performance accuracy and shared L1-L2 neurocognitive resources, the processing of dissimilar and unique features is more often associated with variable performance and distinct L1-L2 neural patterns. Cross-language similarity has thus emerged as an important factor in L2 research and should therefore be investigated or explicitly controlled in experiments employing cross-linguistic stimuli. Several questions pertaining to the role of this variable remain unanswered. For example, does cross-language similarity affect the beginning stages of L2 *learning*? More importantly, does the effect of cross-language similarity interact with method of L2 instruction and level of perceptual salience of L2 input? These are the questions that the present research seeks to address.

1.2 METHODS OF L2 INSTRUCTION

In light of the debate over the effectiveness of various implicit versus explicit adult L2 instructional approaches, many researchers have investigated the nature of L2 input during learning, examining in detail the individual contributions of corrective or accuracy feedback, salience of input, and metalinguistic explanations. Two meta-analytic reviews examining the effectiveness of L2 instruction suggest a benefit of explicitness in the L2 input, i.e., inclusion of metalinguistic information and/or directed attention to forms. Accordingly, Norris and Ortega (2000) quantitatively compared the outcomes from 49 studies that incorporated differing levels of explicitness of L2 input and concluded that not only is L2 instruction superior to simple exposure or meaning-driven communication approaches, but *explicit* instruction in particular, results in superior, durable learning outcomes as compared to more implicit forms of instruction. More recently, Spada and Tomita (2010) reported similar outcomes from a meta-analysis of 41 studies, in which larger effects sizes were found for explicit as compared to implicit instruction of both simple (e.g., regular past tense) and complex (e.g., relativization) English grammatical features.

Support for an advantage of explicit instructional approaches is illustrated by the results of several studies. N. Ellis (1993) compared the effectiveness of implicit and explicit types of exposure in the learning of the “soft-mutation” grammatical feature of Welsh (e.g., “Boston” becomes “Foston” after the preposition “o”, meaning “from”). Participants were assigned to three experimental groups according to whether they were exposed only to examples in random order illustrating the various mutations (implicit training, “Random” group); whether they were explicitly taught the rules of soft mutations (explicit training, “Rule” group); or whether they were first taught the rules and then saw them applied to specific instances of vocabulary (“structured” training, “Rules & Instances” group). Results from a timed GJT, rule knowledge test, and a translation task indicated that the “Rules & Instances” learners were the most successful; the “Random” (implicit) group showed the poorest performance. Ellis concluded that explicit knowledge provides the attentional focus that the learner needs to abstract relevant structure from the language. Following a similar rationale, Rosa and Leow (2004) demonstrated the benefits of explicit instruction in an experiment that evaluated the acquisition of the Spanish past conditional by adult native English speakers. Participants were trained according to one of six conditions, which differentially incorporated a pretask providing metalinguistic grammatical information, as well as corrective or accuracy feedback. The authors hypothesized that the differing degrees of explicitness of the various tasks would influence the amount of information that learners consciously derive from the input, thus affecting L2 comprehension and production. Results showed that explicit training was associated with higher accuracy in the production of target forms, particularly in the case of novel exemplars.

Despite the demonstrated benefits of L2 instruction per se, some controversy remains regarding the specific contribution of metalinguistic information to learning. A study by Benati (2004) investigated the effect of Processing Instruction, a grammar instruction approach that emphasizes rule explanations, processing strategies, and meaningful practice (Van Patten & Cadierno, 1993), and the question of which specific components -- meaningful practice or rule explanations -- have the most impact on learning. Native English speakers received instruction on Italian noun-adjective gender agreement according to three training groups: processing instruction, consisting of rule explanations and form-meaning connection activities for comprehension; structured input only, consisting of form-meaning connection activities for comprehension; and metalinguisitc information only, which consisted of metalinguistic explanations of rules. Both the processing instruction and the structured input instruction methods resulted in significantly better performance than the metalinguistic instruction method, in both interpretation and (written and oral) production tasks in immediate post-tests. Unfortunately, the presence of feedback during instruction was confounded with manipulated variables in this experiment because only the processing instruction and structured input groups received accuracy feedback. Thus, the question remains whether participants in the metalinguistic information group would have performed better if they too had received feedback during learning. Sanz and Morgan-Short (2004) addressed this question in a computer-assisted study of Spanish OV word order (preverbal direct object pronoun) by native English speakers. They concurrently manipulated the presence of explicit metalinguistic information as well as the type of feedback, thus contrasting four learning groups. Whereas all groups engaged in structured input activities (i.e., task-essential practice) and received accuracy feedback, they differed on whether they received explicit grammar instruction and metalinguistic explanations prior to testing as well as whether accuracy feedback was accompanied by explicit corrective information. Although the performance of all groups improved significantly from pre- to post-test, they found no differences between groups on either interpretation or written production tests, suggesting that structured input activities with accuracy feedback are sufficient for L2 syntactic learning.

The results of Sanz and Morgan-Short (2004) lend support to Benati's (2004) finding of a negligible role for explicit information in L2 learning, suggesting that attention can be drawn implicitly to salient forms, as illustrated by the frequent and sentence-initial position of the target form in the Sanz and Morgan-Short (2004) study. However, findings based on behavioral measures sometimes do not reveal subtle differences in learning mechanisms that may arise under different training conditions. A recent ERP experiment (Morgan-Short et al., 2010) comparing explicit (classroom-like) and implicit (immersion-like) instruction of an artificial language indicated that, whereas behavioral performance was equivalent in the two instruction groups, ERP patterns during a GJT of sentences containing noun-article gender agreement violations differed such that the implicit group exhibited an N400 in response to violations at lower proficiency, but a P600 at higher proficiency. The explicit group, on the other hand, showed only a P600 at higher proficiency (ERPs in response to noun-adjective gender violations in the same study did not differ and showed N400s in both instruction groups at both proficiency levels). The results were interpreted as indicating increased reliance on shared L1-L2 neurocognitive mechanisms with higher levels of L2 proficiency, as illustrated by the P600 effect observed in both groups at higher proficiency but an N400 effect or no sensitivity at low proficiency. The authors further suggest that the lack of observed ERP effects in the explicit group at lower proficiency may reflect inconsistencies in the use of conscious cognitive strategies and/or variability in the timing of ERP components that could have weakened statistical power and thus obscured relevant effects in this group. Thus, the above findings reveal underlying differences in brain mechanisms during L2 learning that vary according to instruction method and proficiency level, even when no differences were observed in behavioral accuracy. More ERP studies examining the neurocognition of L2 learning are needed to expand, and potentially qualify, these findings by examining the effect of other relevant variables such as cross-language similarity and input salience.

Together, results from the above studies point to the importance of input type and activities to which L2 speakers are exposed during learning and, therefore, are highly relevant to the way many foreign language courses are taught. Exposure to task-essential, salient, and meaningful input processing activities appears to lead to effective learning, even in the absence of explicit grammar instruction. This is an interesting set of findings with important implications for theories of L2 acquisition such as the CPH, which make clear predictions regarding the role of explicitness in adult L2 learning. The present research allows a partial evaluation of the CPH by comparing the effectiveness of various L2 instruction methods that differ with regard to the presence of metalinguistic information, including a control (implicit learning) group. In the present experiment, instruction methods also varied according to the perceptual salience of L2 input – i.e., the ease of perceiving or detecting a given morphosyntactic feature.

1.2.1 Perceptual Salience in L2 instruction

In a seminal publication, Schmidt (1990) argued that awareness at the level of "noticing" is necessary for language learning and, furthermore, defined *intake* as the part of the L2 input that learners consciously notice. These claims are based on the assumption that long-term memory storage requires attention and awareness. Nevertheless, Schmidt acknowledges that L2 learning can happen incidentally, that is, without intention or effort, as well as implicitly, i.e. without an understanding of the underlying rules of the language being learned. In an extension of Schmidt's "noticing hypothesis", Robinson (1995) tied the concepts of attention, detection, and awareness into a model that incorporates current findings in cognitive research. He defined noticing as detection with awareness and rehearsal in working memory, conditions that are necessary for subsequent encoding in long-term memory (i.e., learning). Given that perceptual salience refers to ease of detection and the latter is necessary for learning, a highly salient stimulus is more likely to be encoded in memory.

Empirical findings lend support to the noticing hypothesis by showing that the salience of relevant input is crucial for noticing and for the successful establishment of cue-outcome associations during learning (Ellis, 2006). In a meta-analysis of the order of acquisition of English grammatical morphemes, Goldschneider and DeKeyser (2005) showed that perceptual salience (specifically, phonological salience) was the one factor that most powerfully predicted acquisition order, above and beyond other factors including frequency and morpho-phonological regularity. Salience can take various forms, however, and in L2 instruction it can be induced by contrasting forms (negative vs. positive examples, correct vs. incorrect); stress and intonation in oral production; typographical enhancement (boldfacing, underlining, color highlighting); etc. (Sharwood Smith, 1993). Typographical enhancement techniques, in particular, have been extensively investigated in the context of adult L2 instruction (see Han, Park, & Combs, 2008; and Lee & Huang, 2008, for recent reviews). Despite a number of studies indicating an instructional benefit associated with typographically-enhanced texts (e.g., Doughty, 1991; Jourdenais, Ota, Stauffer, Boyson, & Doughty, 1995), many others have failed to show an advantage for this technique, and some even show a detriment in meaning processing when grammatical features are made salient (e.g., Lee, 2007; Overstreet, 1998). Thus, the overall effect of typographical enhancement of input in L2 learning remains inconclusive, largely due to methodological differences in the various studies that may have obscured specific effects. For example, most of the experiments examining the effect of typographical enhancement did not employ a "true" control group, instead comparing treatment groups to an "input flood" condition in which the target forms are made salient through artificially high input frequency. Moreover, as noted by Han et al. (2008), many of the studies employed simultaneous meaning and form processing designs in which participants were encouraged to read passages for meaning while incidentally noticing enhanced grammatical forms. A sequential approach in which learners process input for meaning first and then attend to forms may be more conducive to learning because attention and memory resources are less taxed (see Robinson, 1997). Finally, prior exposure to the target forms were often not controlled in these studies and could have therefore interacted with the effects of typographical enhancement, potentially favoring learners who had prior experience with the forms (Han et al., 2008).

This suggestion is supported by findings from a recent set of experiments by N. Ellis and Sagarra (2010) that specifically addressed the issue of pre-exposure in the learning of typographically-enhanced grammatical forms, and indicate a strong competing influence of earlier learned cues on later learned ones. Specifically, the experiments investigated the effect of pre-training and typographical enhancement of either an adverbial or morphological (verb inflection) cue in the learning of Latin in a laboratory setting, or Spanish in a classroom setting. Results indicated that not only was performance on comprehension and production tests superior in the case of typographically-enhanced forms (inflections were presented in bold and blue color), this effect was also modulated by the L1 background of participants. Thus, English L1 participants showed marked differences in verb inflection processing as compared to Chinese participants, whose L1 does not display inflectional morphology, when no typographical enhancement was used. However, these differences disappeared when relevant forms were typographically enhanced, indicating a marked influence of both input salience and L1 background in L2 learning.

The present experiment also examined the role of L1 transfer and typographical enhancement in initial L2 learning. It extends prior research on these topics by directly investigating L1-L2 similarity within the same participant population and by systematically assessing the individual contributions of input salience (through morphological contrast and typographical enhancement) and metalinguistic information. Furthermore, the present research uses ERPs to measure learning responses that may not be observable with traditional behavioral methods.

.

2.0 THE PRESENT EXPERIMENT

The present research consisted of a small-scale longitudinal experiment that spanned approximately three weeks and included four sessions, three of which involved language training. Participants were native English speakers who were first trained on Swedish vocabulary and then received grammar training according to one of three different instruction methods, described below. Learning was assessed through GJT post-tests (immediate and delayed) concurrent with ERP recording to measure comprehension, and sentence translation tests to measure production.

Therefore, the present experiment investigated the cognitive and neural mechanisms underlying the initial stages of learning of a miniature version of Swedish by adult native English speakers and had three specific aims: 1) to investigate the effect of similarity between L1 and L2 on initial L2 learning; 2) to examine the effectiveness of type of L2 instruction on initial L2 learning; and, most importantly, 3) to examine whether instructional effectiveness varies with cross-language similarity. Secondary aims included an examination of proficiency effects over time, as well as an investigation of the role of individual differences, such as working memory capacity and grammar learning aptitude, in initial L2 learning.

The effect of cross-language similarity was investigated by manipulating the nature of the Swedish training stimuli such that it systematically varied in the degree of correspondence with English when translated word-by-word. Cross-language similarity was thus operationalized according to the framework used by Tokowicz and MacWhinney (2005), and resulted in three types of cross-language similarity features: similar, dissimilar, and unique. A given morphosyntactic feature that exists in both English and Swedish and is instantiated similarly in both languages was considered to be “similar”; here, demonstrative determiner-noun number agreement was used (see Example 1) because pluralization is marked on both the demonstrative and the noun in both languages, thus allowing the learner to transfer the L1 system to the processing and learning of L2. On the other hand, morphosyntactic features that are present in both languages but are instantiated differently in the two were considered “dissimilar”; here, noun phrase definiteness marking was used (see Example 2) because, whereas in English definiteness is marked only on the article, in Swedish it is also marked on the noun as a postfix (e.g., “pojken” = “boy-the”). Thus, if the sentence in Example 2 “The boy is eating.” were translated into Swedish, it could be ungrammatical (“*En$_{\text{INDEF}}$ pojken$_{\text{DEF}}$ äter.”) because English does not mark definiteness on the noun “pojke”. Finally, a feature is considered unique to L2 due to its absence in L1; in the present experiment, definite article-adjective gender agreement was used (see Example 3). Swedish nouns come in two genders: common, which are accompanied by the indefinite article “en” (en pojke [“a boy”]) or neuter, which are accompanied by the “ett” article (ett djur [“an animal”]). Nouns must agree in gender with both the articles and adjectives that accompany them (e.g., “A young animal” [“Ett$_{\text{NEUT}}$ ungt$_{\text{NEUT}}$ djur$_{\text{NEUT}}$”]), a grammatical feature that is absent in English. Importantly, this experiment tested the acquisition of article-adjective gender agreement, which is not to be confused with article-noun gender agreement or *assignment.* The latter tasks rest on the determination of the gender of the noun and usually require lexical knowledge of a noun’s correct gender. In contrast, the present experiment employed a simple article-adjective agreement rule, which in the Swedish language is always available and reliable (i.e., add suffix *-t* to adjectives preceded by the neuter article “ett”). Sentence examples are shown below:

(1) Similar (demonstrative determiner-noun number agreement):

a. Den där$_{SING}$ pojken$_{SING}$ äter. [*That boy is eating*.]

b. *De där$_{PL}$ pojken$_{SING}$ äter. [**Those boy is eating*.]

(2) Dissimilar (singular noun phrase definiteness):

a. Pojken$_{DEF}$ äter. [*The boy is eating*.]

b.*En$_{INDEF}$ pojken $_{DEF}$ äter. [**A*$_{INDEF}$ *boy*$_{DEF}$ *is eating.*]

(3) Unique (indefinite singular article-adjective gender agreement):

a. En$_{COM}$ ung$_{COM}$ pojke äter. [*A young boy is eating*.]

b. *En$_{COM}$ ungt$_{NEUT}$ pojke äter. [**A*$_{COM}$ *young*$_{NEUT}$ *boy is eating.*]

The second goal of comparing the effectiveness of L2 instruction methods was addressed by contrasting three types of computerized instruction that differed in the degree of explicitness of L2 input, namely, presence of morphosyntactic contrast, typographical enhancement, and metalinguistic information. To this end, participants were assigned to one of three grammar training groups (see Appendix A for examples of training protocols): the *Control group* was exposed to pairs of correct, non-salient, grammatically non-contrastive L2 sentence exemplars (e.g., “Pojken äter.” [“The boy eats/is eating.”] and “Flickan springer.” [“The girl runs/is running.”]). The *Salience group* was exposed to the same sentences but structured in pairs that contrasted two different instantiations of a given morphosyntactic feature and included bold and blue-highlighting of the morphemes at the point of agreement (e.g., Definiteness marking: “**En** pojk**e** äter.” [“A boy is eating.”] vs. “Pojke**n** äter.” [“The boy is eating.”]). Lastly, in addition to being exposed to the same contrastive and typographically-enhanced sentences, the *Rule &*

Salience group received metalinguistic explanations of the morphosyntactic rules underlying the L2 feature (e.g., “Definiteness is marked by attaching “(e)n” or “(e)t” to the end of a noun without the preceding articles “en/ett”.)

It is important to note that all groups were exposed to identical stimulus sentences; what differed in each group’s input was the way in which the sentences were presented, namely, the inclusion of morphosyntactic contrast, typographical enhancement, and rule explanations. Therefore, the experiment included a “true” control group whose treatment differed from the other experimental groups only with respect to manipulated variables. The effects of instruction method and cross-language similarity, and the interaction between them, were thus simultaneously investigated by contrasting the performance of the three training groups on comprehension and production tasks that included the three cross-language similarity features. Nevertheless, the current design does not specifically address the individual contributions of morphological contrast and typographical enhancement, which, though interesting, is outside the scope of the present experiment.

In addition to the importance of external factors such as instruction method in L2 learning, previous research suggests that internal factors such as individual differences in cognitive resources influence L2 learning and processing, with some individuals displaying greater ease/speed of L2 learning and ultimate attained proficiency than others (e.g., Michael & Gollan, 2005). Because working memory, or the ability to simultaneously maintain and manipulate active memory representations (e.g., Engle, Laughlin, Tuholski, & Conway, 1999), is one of the cognitive resources that underlie some of the observed individual differences in L2 performance (e.g., higher translation accuracy and speed in individuals with higher working memory, Tokowicz, Michael, & Kroll, 2004), working memory measures were also obtained in the present experiment to allow for an investigation of the effect of individual differences in L2 learning and how they relate to cross-language similarity and instructional manipulation. Similarly, a test of grammatical sensitivity, the "Words-In-Sentences" subtest of the Modern Language Aptitude Test (MLAT-WIS), was administered because this particular subtest has been shown to correlate with GJT accuracy during L2 learning (Robinson, 1997).

Several predictions arise from the present experiment (see Table 1 for a summary of predictions), some of which have been supported by previous studies. Because the main contribution of the present experiment to the literature is the simultaneous investigation of cross-language similarity and instruction method, the most important predictions relate to the interaction of those two factors. Thus, it was predicted that ERPs may reveal quantitative and/or qualitative differences (e.g., presence of different components) in the various training conditions as a function of cross-language similarity that may not be directly observed behaviorally (e.g., Tokowicz & MacWhinney, 2005). Specifically, if similar features indeed rely to a greater extent on shared L1-L2 neurocognitive processing mechanisms (e.g., MacWhinney, 2005) and/or are processed more automatically, then this should be associated with sensitivity of ERP responses in all training groups, potentially eliciting LAN or P600 effects that are most often observed in L1. In the present case, cross-linguistically similar features should encourage reliance on similar L1-L2 processing mechanisms because number agreement is performed in a comparable way in the two languages by requiring that singular demonstrative determiners ("that" [den/det där]) be used with singular nouns, and plural determiners ("those" [de där]) be used with plural nouns, which are marked by a suffix in both languages (i.e., "s" at the end of a noun in English; "a/orna" in Swedish). Therefore, for cross-linguistically similar features, as in L1, learners simply had to match the appropriate demonstrative determiners with their respective noun endings to perform number agreement.

N400 effects in response to morphosytactic violations were also considered because it has been shown that L2 learning progresses through discrete stages that are associated with differential ERP responses (McLaughlin et al., 2010; Morgan-Short et al., 2010; Osterhout, McLaughlin, Pitkänen, Frenck-Mestre, & Molinaro, 2006). Cross-linguistically dissimilar violations were thus expected to elicit N400 or P600 effects in the Salience group, especially at higher proficiency, and N400 effects or no brain sensitivity in the Control and Rule & Salience groups (despite potential above-chance performance) due to negative transfer and rule competition effects arising from the different ways in which definiteness is marked in L1 and L2. Thus, because in English definiteness is marked only on the article (i.e., "*a* boy" versus "*the* boy"), native English speakers learning Swedish may have difficulty shifting proceduralized L1-processing attentional mechanisms to now focus on a different part of speech for definiteness marking, i.e., the noun (e.g., "en pojke" versus "pojken" [boy-THE]). To accurately perform definiteness marking in L2, learners were therefore required to suppress pre-nominal article placement and instead add a noun suffix, a process not usually performed in L1. Due to its reliance on salient and contrastive input, the Salience training condition may be especially beneficial in the learning of dissimilar features because it would boost their salience (e.g., Robinson, 1995; Schmidt, 1990) and increase cue strength, thus helping to overcome negative transfer and competition. The absence of rule explanations in this condition would also prevent exacerbated negative transfer effects associated with explicit L1-L2 rule conflict. Thus, it may be more beneficial to the learning of cross-linguistically dissimilar features if attention is directed to forms in a less explicit manner, through salience as opposed to rules explanations, because it may prevent the active maintenance of two conflicting grammatical rules that interfere with each other, which would adversely affect performance.

Finally, violations of the unique type were expected to elicit brain sensitivity in the Rule & Salience group in the form of N400 effects in earlier post-tests due to lower proficiency and lexico-semantic processing of adjectival agreement, and/or P600 effects in later post-tests at higher proficiency, mainly due to the high availability and reliability of the article-adjective agreement rule employed in the present experiment (i.e., add suffix *-t* to adjectives preceded by the neuter article “ett”). Furthermore, participants in this group could rely on metalinguistic explanations (and salient input) in overcoming the novelty, and thus lack of positive transfer, associated with this type of feature. The rule explanations would help direct learners’ attention to adjectival inflections, a morphological feature that would likely go unnoticed or would be difficult to acquire due to its absence in L1. Moreover, unique L2 violations were predicted to elicit only a reduced P600 or N400 effects in the Salience group, due to the slower acquisition of novel L2 features without supporting explanations. It was further predicted that the Control group would be the slowest to incorporate this feature type during online processing and would therefore show only N400 effects or no sensitivity whatsoever in ERP responses to unique L2 violations.

Behavioral performance, as indicated by d-prime scores, was expected to reflect ERP patterns to some extent, with higher amplitude effects generally being associated with the most accurate conditions (e.g., Tolentino & Tokowicz, 2010). D-prime was used as a measure of grammatical discriminability to correct for response bias because beginning L2 learners are often yes-biased (e.g., Tokowicz & MacWhinney, 2005). D-prime has an effective range of 0 indicating no sensitivity to approximately 6 indicating perfect sensitivity (Green & Swets, 1974).

Alternatively, the GTJ may display less sensitivity than ERP measures, as has been the case in some studies (e.g., Tokowicz & MacWhinney, 2005).

Finally, it was predicted that participants who exhibit higher working memory capacity as measured by the operation span task (LaPointe & Engle, 1990) would achieve higher levels of proficiency because, as described earlier, noticing entails maintenance of a representation in active memory, which is necessary for subsequent learning (but see Juffs, 2006). Furthermore, working memory reflects the capacity to maintain active representations (e.g., a grammar rule) in the face of interference, as in the case of negative L1 transfer, and could thus be associated with better learning outcomes in the case of cross-linguistically unique and dissimilar features. It was also expected that GJT performance would be lowest for all training groups in post-test 2 because this test was administered after a two-week delay without immediately preceding training, unlike post-tests 1 and 3. Comprehension abilities were predicted to surpass production abilities, especially for the Control group, which would not benefit from the type of structured, salient input that has been shown to contribute to production skills (e.g., VanPatten & Cadierno, 1993).

Table 1. Summary of Main Experimental Predictions

Cross-language Similarity	ERPs in response to violations	GJT and translation accuracy
Similar	P600 in all groups	Control = Salience = R&S
Dissimilar	N400/P600 in Salience group (N400 or no sensitivity in R&S and Control)	Salience > Control, R&S
Unique	N400/P600 in R&S (N400/reduced P600 in Salience; N400 or no sensitivity in Control)	R&S > Salience > Control

2.1 METHOD

2.1.1 Participants

Participants were 39 native-English speaking adults who were students at the University of Pittsburgh or Carnegie Mellon University, or members of the community. Participants had no knowledge of Swedish, Danish, Norwegian, German, or Dutch, and were not exposed to any language other than English before age 13. They each participated in four separate experimental sessions for which they were paid $10 per hour at the end of the last session. All participants had normal or corrected-to-normal visual acuity, were right-handed (shortened version of the Edinburgh Handedness Inventory; Coren, 1992), and had no implanted brain devices.

Four participants did not complete the entire protocol due to drop-out and one participant was terminated early due to non-compliance and high levels of artifact in the ERP data. Thus, behavioral data from the 34 participants (17 female) who completed the study were analyzed. ERP data obtained from six participants were excluded due to high levels of artifact. Therefore, data from a total of 28 participants (16 female) were included in the final ERP analyses. The participants in the Control, Salience, and Rule & Salience groups did not differ on age, years of education, or duration of exposure to other foreign languages (see Table 2 for additional participant information). There was, however, a difference in age of initial exposure to an L2 between the Salience (M = 13.78, SD = 0.67) and Rule & Salience (M = 15.60, SD = 1.84) groups, t (27) = -3.22, p = .011. [1]

Table 2. Participants' Background Information. N = 34

Measure	Control	Salience	Rule & Salience
Age (years)	24.33 (11.18)	23.36 (4.37)	25.40 (6.64)
Age of L2 acquisition (years)	14.40 (1.17)	13.78 (0.67)	15.60 (1.84)
L2 learning period (years)	3.78 (1.86)	4.81 (1.31)	4.05 (1.89)
Education (years)	15.75 (2.34)	17.00 (2.45)	17.82 (3.22)

Note: Standard deviations are provided in parentheses.

2.1.2 Design

A 3 x 3 x 3 mixed design with the within-subject factors of Cross-Language Similarity (similar, dissimilar, unique) and Post-Test (post-test 1, post-test 2, post-test 3), and the between-subject factor Group (Control, Salience, Rule & Salience) was employed. ERP data included the additional repeated factors of Grammaticality (grammatical, ungrammatical), Laterality (left, midline, right), and Electrode Site (frontal, central, parietal).

The experiment was divided into four separate sessions lasting approximately 1.5-2 hours each, during which participants completed a pre-test (session 1) and received computerized training in Swedish vocabulary (sessions 1 and 2), and grammar (sessions 1, 2, and 4). Participants' comprehension was tested in the GJT post-tests (sessions 2-4) and production ability was tested in a sentence translation task (sessions 2 and 3).

2.1.3 Stimuli

A total of 372 original Swedish sentences differing in degree of L1-L2 similarity were used. The sentences were identical in all cross-language similarity conditions except for the point of grammatical agreement at the critical noun in the case of similar and dissimilar cross-language similarity types, and at the critical adjective in the case of the unique type (see Appendix B for sentence exemplars). The 372 sentences were divided into training sentences and test sentences. Sixty grammatical sentences were equally split across cross-language similarity types and used as training exemplars, for a total of 20 sentences per cross-language similarity type. For the cross-linguistically similar type, half of the training exemplars featured a singular noun and half a plural noun; for the dissimilar type, half featured a definite noun and half an indefinite noun; and for the unique type, half of the training exemplars were of the neuter gender and half of the common gender (neuter-gender nouns constituted 1/3 of the stimuli and therefore were repeated in different sentence frames). Two-hundred and eighty-eight sentences were equally split among the three post-tests, for a total of 96 sentences per post-test. The sentences were grouped into nine lists combining the three levels of cross-language similarity and three levels of post-test. Each sentence appeared in both its grammatical and ungrammatical form in each of the cross-language similarity conditions across all post-tests and participants. Therefore, each participant was exposed to 60 training sentences (20 per similarity type) as well as 96 test sentences in each post-test.

Sentences ranged from two to eight words and efforts were made to balance sentence length across similarity types. Because sentences of the unique type contained adjectives in addition to other sentence constituents, adverbs were often included in sentences of the similar and dissimilar types to achieve equivalent lengths. All nouns and adjectives (critical words) used in the post-test sentences appeared only once in the experiment; the articles, verbs, and adverbs were repeated from the training exemplars. Critical nouns and adjectives never appeared in sentence-final positions. The remaining 24 sentences were used in the pre-test; 12 of these were also used as practice sentences in all post-tests. Thirty-five Swedish words, consisting of articles, nouns, verbs, adjectives, and adverbs were used during vocabulary training. A native Swedish speaker verified the acceptability of all stimuli and provided voice recordings of all training stimuli. Finally, 24 grammatical English sentences were used in the translation task. These were equally distributed among similar, dissimilar, and unique cross-language similarity types, for a total of 12 sentences (four of each similarity type) in each of post-tests 1 and 2. Test sentences included the same proportion of exemplars featuring each instantiation of cross-language similarity as training exemplars. All stimulus sentences were semantically plausible.

2.1.4 Procedure

Participants completed the experimental tasks (described in detail below) in the following order (see Table 3 for a schematic overview of the overall procedure): on session 1, participants first completed the operation-span task, followed by a GJT pre-test that evaluated their knowledge of Swedish. Following the pre-test, participants were pseudorandomly assigned to the Control, Salience, or Rule & Salience training groups based on matched pre-test d-prime scores. Participants then received vocabulary and grammar training, after which they completed a language history questionnaire (adapted from Tokowicz et al., 2004). The first session lasted approximately 1.5 hours.

Table 3. Schematic Overview of Experimental Procedure.

Session	Procedure	Task Sequence
1 (Day 1)	Pre-tests; Training	Operation Span GJT Pre-Test Training (Vocabulary) Training (Grammar) Language History Questionnaire
2 (Day 3)	Training; Post-tests	Training (Vocabulary) Vocabulary Test (L2-L1) Training (Grammar) PT1 (GJT + ERP) Sentence Translation 1 (L1-L2) Task & Handedness Questionnaire
3 (Day 16)	Post-tests	PT2 (GJT + ERP) Sentence Translation 2 (L1-L2)
4 (Day 18)	Training; Post-tests	Training (Grammar) PT3 (GJT + ERP) MLAT-WIS

Note: GJT=Grammaticality Judgment Task. MLAT-WIS=Modern Language Aptitude Test – Words-In-Sentences subtest. Days are based on average values.

Session 2 of the experiment occurred approximately two days (M = 1.97, range: 1-3) after session 1. Returning participants underwent the same vocabulary training as in session 1, and were subsequently tested in an L2-L1 vocabulary translation task. Following the vocabulary test, participants received the same grammar training as on session 1, in accordance with the different training group protocols. Subsequently, participants completed post-test 1 on which they made grammaticality judgments, concurrent with ERP recording. They then completed a brief sentence translation task in which they provided the Swedish translations of English sentences. Lastly, participants answered a general questionnaire about the experimental task, in which they were asked whether they noticed any recurring grammatical patterns during the GJT, as well questions about handedness, and medication or drug use. Session 2 lasted approximately 2.5 hours.

Session 3 occurred approximately two weeks (M = 13 days; range: 10-16) after session 2. Returning participants immediately underwent post-test 2 (delayed), in which they again made grammaticality judgments concurrent with ERP recording. Following post-test 2, participants completed the second (and final) L1-L2 sentence translation task. Session 3 lasted approximately 1 hour.

Participants returned approximately two days (M = 1.38; range: 1-4) after session 3 for the final session 4. Participants first underwent a "refresher" grammar training session in accordance with the protocol of each of the three training groups. Subsequently, they completed post-test 3 in which they made grammaticality judgments, concurrent with ERP recording. The last task of the experiment consisted of the Modern Language Aptitude Test "Words-In-Sentences" (MLAT-WIS) subtest. Experimental session 4 lasted approximately 1.5 hours.

2.1.4.1 Operation-span task . Participants judged whether mathematical equations were solved correctly while maintaining sets of English words in memory, in an isolated computer room. After a fixation cross, participants saw one operation at a time (e.g., "(8/4) – 1 = 3"), which was displayed in the center of the computer screen for 2500 ms and then immediately replaced by a question mark probe. The probe remained on the screen until participants indicated that the operation was correct by pressing a button on the response pad with their right finger, or incorrect by pressing a different button with their left finger. Following the participant's response, a word was flashed in the center of the screen for 1250 ms, which was subsequently replaced by the fixation cross. After each set, participants were prompted to recall and type in all of the words in the order in which they were presented; word sets ranged in size from two to six. The measures derived from the operation-span task included set size span, total span, and operation accuracy, which are described in more detail in the Data Pre-processing section.

2.1.4.2 GJT: Pre-test. Participants made grammaticality judgments to Swedish sentences presented one at a time at the center of a computer screen in white, 36-point Arial font on a black background, using the E Prime software program (Psychology Software Tools, Pittsburgh, PA). Participants were instructed to guess the grammaticality of sentences by pressing two of four buttons on a response pad; no feedback was provided in this phase.

2.1.4.3 Vocabulary training. In this task, an English word was presented visually in the center of the computer screen, accompanied by its respective grammatical class in parentheses (using the same visual parameters as the pre-test), and aurally through computer speakers. After 500 ms, the word's Swedish translation (bare form) was presented visually in the lower half of the screen, and aurally (pronounced by a native Swedish speaker); both words remained on the screen until the participant pressed a button. Participants were instructed to listen to the word pairs and to repeat the Swedish translation aloud twice before pressing a button. Time-on-task during the vocabulary training phase was controlled such that computerized presentation was programmed to last 20 minutes, during which 35 word pairs were presented repeatedly.[2] The same procedure and materials were used in days 1 and 2 of the experiment.

2.1.4.4 Grammar training. Grammar training differed according to each of the three training group protocols. All three groups were exposed to randomly-selected pairs of grammatical Swedish sentences (composed entirely of the training vocabulary) presented aurally through computer speakers and visually in black, 36-point Arial font on a white background, using the E Prime software program. Each trial began with a fixation cross that remained in the center of the screen until the participant pressed a key on the response pad. This caused the next screen containing the sentence pair to appear, and participants were instructed to pay attention to any grammatical patterns, and to repeat the sentence pair aloud once after seeing and hearing it pronounced. The Control group was exposed to non-highlighted, grammatically non-contrastive pairs of L2 sentence exemplars, one third of which belonging to each cross-language similarity type. The Salience group was exposed to the same sentences as the Control group but they were grouped in pairs that contrasted instantiations of a given morphosyntactic feature and included blue highlighting of morphemes at the locus of agreement. Participants were not explicitly informed of the function of blue-highlighted morphemes. Finally, the Rule & Salience group was exposed to the same pairs of salient, contrastive sentences as the Salience group, but received additional metalinguistic explanations of the morphosyntactic rules underlying the L2 feature. The metalinguistic explanations appeared outlined in a box, after the participant made a button press, and remained on the screen with the sentence pair, until the next button press. Time-on-task during the grammar training phase was controlled such that computerized presentation was programmed to last 40 minutes for all groups; the same procedure and materials were used in sessions 1 and 2 of the experiment. Session 4 followed an identical procedure except that it lasted only 20 minutes ("refresher session").

2.1.4.5 Vocabulary translation test. In this test, participants translated Swedish words into English. Each trial began with a fixation cross that remained in the center of the screen until the participant pressed a key on the response pad. This caused the next screen to appear, which showed a Swedish word randomly selected from the training set. Participants then spoke the

English translation of the Swedish word into a microphone and digital recorder, or said “I don’t know” if they did not remember the translation. The word stayed on the screen until the onset of a vocal response, at which time the word was replaced by the fixation cross preceding the next trial.

2.1.4.6 GJT Post-test with ERP recording. Participants made grammaticality judgments concurrent with ERP recording. Sentences were presented one word at a time in the center of a computer screen, in white-on-black 36-point Arial font, with a visual angle of 2.47 degrees, using the E Prime software program. The computer screen was situated inside a sound-attenuated, electrically-shielded booth (Industrial Acoustics, Inc.) that also contained a response pad and the electroencephalographic amplifiers. Each trial began with a fixation cross that remained in the center of the screen until the participant pressed a key on the response pad. Based on optimized parameters from pilot testing, each word in a trial was presented for 450 ms followed by a 350 ms blank screen between words. The final word in the sentence was presented with a period, after which a question mark probe appeared and remained on the screen until the participant made a response. Participants were instructed to indicate, as quickly and accurately as possible following the probe, whether the sentence was grammatically correct by pressing a key on the response pad with their right thumb, or ungrammatical by pressing a key with their left thumb. A feedback screen displaying “Correct!” or “Incorrect” immediately followed the participants’ response and remained on the screen for 1000 ms. Sentences were presented in random order. EEG was recorded continuously during the task. The presentation of a single word at a time ensured that participants did not need to move their eyes to read the sentence and that ERPs could be time-locked to the onset of the critical word. Participants were asked to blink only during the fixation-cross screen and to sit still and not move their eyes during word presentation to reduce movement artifact in the ERP analysis windows. Participants completed twelve practice trials prior to the test items. All GJT post-tests followed the same procedure (but employed different sentences) and lasted approximately 20 minutes.

2.1.4.7 Sentence translation task. In this task, participants were instructed to read grammatical English sentences presented in an Excel sheet, and then type the corresponding Swedish translation next to each sentence (participants were instructed to ignore diacritics and special characters). The same procedure (with different sentences) was employed in post-tests 1 and 2.

2.1.4.8 Modern Language Aptitude Test (MLAT-WIS). An untimed, paper-and-pencil version of the MLAT-WIS was administered. In this multiple-choice test, participants had to choose the word with a grammatical function that best corresponded to an underlined word or phrase in a key sentence. All materials were in English and participants took approximately 20 minutes to complete the test.

2.1.4.9 EEG recording and pre-processing procedures. Electrophysiological activity was recorded continuously during GJT post-tests at a sampling rate of 1000 Hz and the EEG signal was amplified with Neuroscan SynAmps2 amplifiers with 24-bit analog-to-digital conversion (Compumedics NeuroScan, Inc.). Participants wore an electrode cap fitted with 64 Ag/AgCl electrodes (QuikCap, Compumedics NeuroScan, Inc.). In addition to the cap electrodes, hanging electrodes were placed over the right and left mastoid bones for referencing purposes, as well as below and above the left eye to monitor blinks, and in the outer canthi of the left and right eyes to monitor eye movements.

EEG data were processed off-line using Neuroscan Edit 4.3 software (Compumedics

NeuroScan, Inc.). All electrodes were re-referenced offline to averaged right and left mastoids and low-pass filtered at 30 Hz. Average ERPs were formed from trials that were corrected for ocular and movement artifacts. Ocular artifact reduction was based on estimates of average eye blink duration. Channels that contained large artifacts (fewer than 10% of electrodes) were excluded from the averages. This corresponded to a maximum of three excluded channels in each of the six participants whose data showed artifact contamination. For a participant's data to be included, a minimum of 8 trials (50%) of each grammaticality by cross-language similarity type in each post-test had to be artifact-free (M = 15 in post-test 1; M = 14.2 in post-test 2; M = 14.9 in post-test 3). The ERP epoch ranged from 100 ms pre-stimulus (baseline) to 1000 ms post-stimulus. The data were quantified by calculating the mean amplitude (relative to the 100 ms pre-stimulus baseline) for each stimulus type, in the following two time windows: 300 to 500 ms (N400/LAN) and 500 to 700 ms (LAN/P600). (Two additional windows, 500 to 650 ms, and 650 to 800 ms were also analyzed but will not be reported here because the pattern of results remained the same.) All windows were selected based on previous research and visual inspection of the waveforms.

2.1.5 Data Pre-processing

2.1.5.1 Behavioral data. Pre- and post-test accuracy scores were converted into d-prime scores and submitted to repeated measures analyses of variance (ANOVA). Analyses of covariance (ANCOVA) including the covariates set size span, total span, and MLAT-WIS score were also conducted. Any significant interactions in the ANOVAs ($p < .05$) were followed-up using the Duncan's multiple-range test to locate the source of the effect.

Two measures of working memory were derived from the operation-span data: set size span and total span. Operation accuracy was calculated as a percentage of mathematical expressions responded to correctly, and scores were checked to verify that participants did not ignore the operations in favor of word memorization. Set size span was defined as the set size at which the participant correctly recalled all words (in no particular order) in at least two of the three series. Total span (effective range: 0 to 60) was calculated by counting the total number of words correctly recalled only in sets that were recalled in their entirety.

MLAT-WIS, set size span, and total span scores were submitted to correlational analyses to examine their relationship with ERP magnitude differences (i.e., difference in amplitude between grammatical and ungrammatical items). Outliers identified using the standardized beta-fit measure were excluded from the analyses (Cohen, Cohen, West, & Aiken, 2003).

Sentence translation data were coded separately for grammar and vocabulary accuracy on a binary scale and were submitted to ANOVAs for grammar and vocabulary scores that included the factors cross-language similarity, post-test, and group.

2.1.5.2 ERP data. Statistical analyses were performed on averaged ERPs using a subset of 15 electrodes corresponding to International 10-20 Electrode System (Jasper, 1958) locations, which were distributed among nine clusters according to the variables of laterality and electrode site: left anterior (F7, F3), midline anterior (FZ), right anterior (F4, F8), left central (T7, C3), midline central (CZ), right central (C4, T8), left posterior (P7, P3), midline posterior (PZ), and right posterior (P4, P8). Thus, ERPs in the lateral clusters were calculated by using the average of two electrodes each. The clusters cover regions underlying the scalp distribution of ERP components relevant to L2 morphosyntactic processing (e.g., LAN, N400, P600).

Repeated measures ANOVAs or planned contrasts were conducted on all trials, including those associated with an incorrect response (see also Chen et al., 2007; Ojima, et al., 2005;

Tokowicz & MacWhinney, 2005). Greenhouse-Geisser (1959) non-sphericity corrections were applied for effects with more than one degree of freedom in the numerator; following convention, corrected *p*- and mean square error values, uncorrected degrees of freedom, and the Greenhouse-Geisser epsilon value (ε) are reported (Picton et al., 2000). Effect size partial eta-squared measures are reported. Data from all four time windows were analyzed; however, because they were representative of the findings, only results from the 300-500 ms (corresponding to N400 and LAN) and 500-700 ms (P600) time windows are reported.

2.2 RESULTS AND DISCUSSION

Results from primary outcome measures consisting of GJT and ERP findings are reported first, followed by relevant findings from secondary outcome measures consisting of operation span, MLAT-WIS, sentence translation and rule verbalization tasks, as well as correlational analyses between specific behavioral measures and ERP data.

2.2.1 Behavioral Data

2.2.1.1 Grammaticality Judgment Task. Pre-test scores d-prime scores were submitted to a two-way analysis of variance (ANOVA) with the factors Cross-Language Similarity (similar, dissimilar, unique) and Group (Control, Salience, Rule & Salience). Significant interactions in the ANOVAs ($p < .05$) were followed-up using the Duncan's multiple-range test to locate the source of the effect. Differences in specific means leading to criterion-based significance in the Duncan's follow-up tests are reported.

The analysis comparing pre-test GJT d-prime scores showed no significant difference as a function of group. There was, however, a significant effect of similarity, F (2, 62) = 3.35, MSE = 2.25, p = .04, η_p^2 = 0.1. Follow-up comparisons indicated that d-prime scores were significantly higher for the similar type (M = .81) than for the dissimilar (M = -.01) and unique types (M = -.013). There was no difference between scores for the dissimilar and unique types (mean difference of .01).

Post-test d-prime scores were submitted to an analysis of covariance (ANCOVA), which included the additional repeated measure Post-Test (PT1, PT2, PT3), and the covariates set size span, and total span, to measure the influence of working memory on GJT scores. Mean d-prime scores for the three groups for each cross-language similarity type and post-test are presented in Figures 1 (organized by group) and 2 (organized by similarity). The analysis comparing GJT post-test scores revealed a marginally-significant interaction between post-test, similarity, and group, F (8, 124) = 2.09, MSE = .66, p = .055, η_p^2 = .12. Follow-up Duncan's tests comparing scores for each similarity type within each group indicated significantly higher d-prime scores for similar (M = 2.53) than dissimilar (M = 1.54) types in PT1 for the Salience group (similar M = 1.96; dissimilar M = 1.06), and in PT3 for the Control group. Scores for the unique type (M =

2.02) were higher than for the dissimilar (*M* = .99) type in PT1 in the Rule & Salience group. Additional comparisons of each group's d-prime scores within each similarity type showed that scores were higher in the Salience group than in the Control group for both unique (Salience *M* = 2.81; Control *M* = 1.99) and dissimilar types (Salience *M* = 3.02; Control *M* = 1.54) in PT3. Scores in the Rule & Salience group (*M* = 2.02) were also higher than those in the Control group (*M* = 1.12) for the unique type in PT1. Because pre-test scores for the similar type were significantly higher than those for the dissimilar and unique types, an ANCOVA was conducted on post-test scores including similar type pre-test d-prime as a covariate to examine whether pre-test scores for the similar type significantly influenced post-test scores. There were no significant effects (p = .49) or interactions with this variable.

The above interaction qualified main effects of post-test, F (2, 62) = 26.4, *MSE* = 1.08, p = .00, η_p^2 = .46, and similarity, F (2, 62) = 4.69, *MSE* = 1.95, p = .018, η_p^2 = .13. Follow-up tests indicated higher d-prime scores in PT3 (*M* = 2.4) than in both PT1 (*M* = 1.4) and PT2 (*M* = 1.8). There was no significant difference between PT1 and PT2 (mean difference of .34). Raw scores indicated a trend toward higher grammatical discriminability in the similar (*M* = 2.07) and unique (*M* = 2.01) types than in the dissimilar type (*M* = 1.56). However, this trend was not reliable in follow-up tests. There was no main effect of group (p = .5).

In summary, findings from the GJT post-tests suggest an influence of both instruction method and cross-language similarity in the early stages of L2 grammar learning. Although performance improved across post-tests for all groups, it was poorest in the Control group, which was exposed to non-salient input and received no metalinguistic information. Moreover, performance associated with cross-linguistically dissimilar items was comparatively low in all groups, but this deficit was observed in PT3 only in the Control group. The results suggest that metalinguistic information may be particularly useful for learning unique L2 features, as indicated by the higher performance on this feature type in PT1 by the Rule & Salience group. Salient, contrastive input may be sufficient for learning features that exist in L1 but are instantiated differently in L2, as shown by higher performance on this feature type in PT3 by the Salience group. In this case, rule explanations may actually hinder learning because they conflict with an existing L1 rule.

Figure 1. Mean d-prime scores of the three groups in each cross-language similarity type and post-test (group comparison). N = 34.

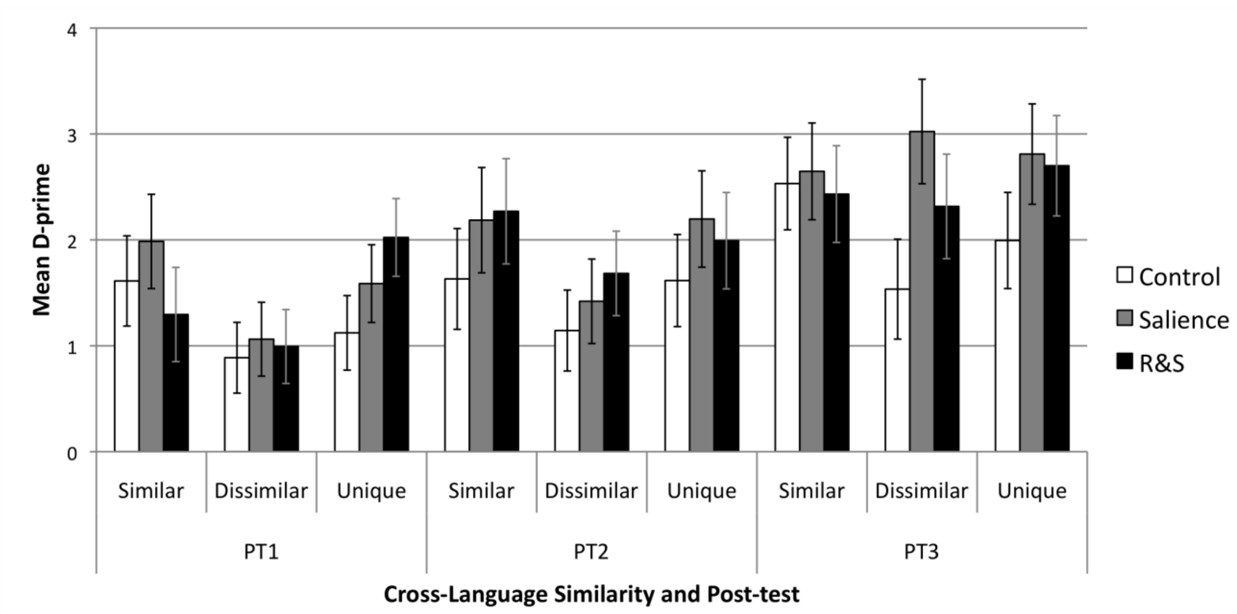
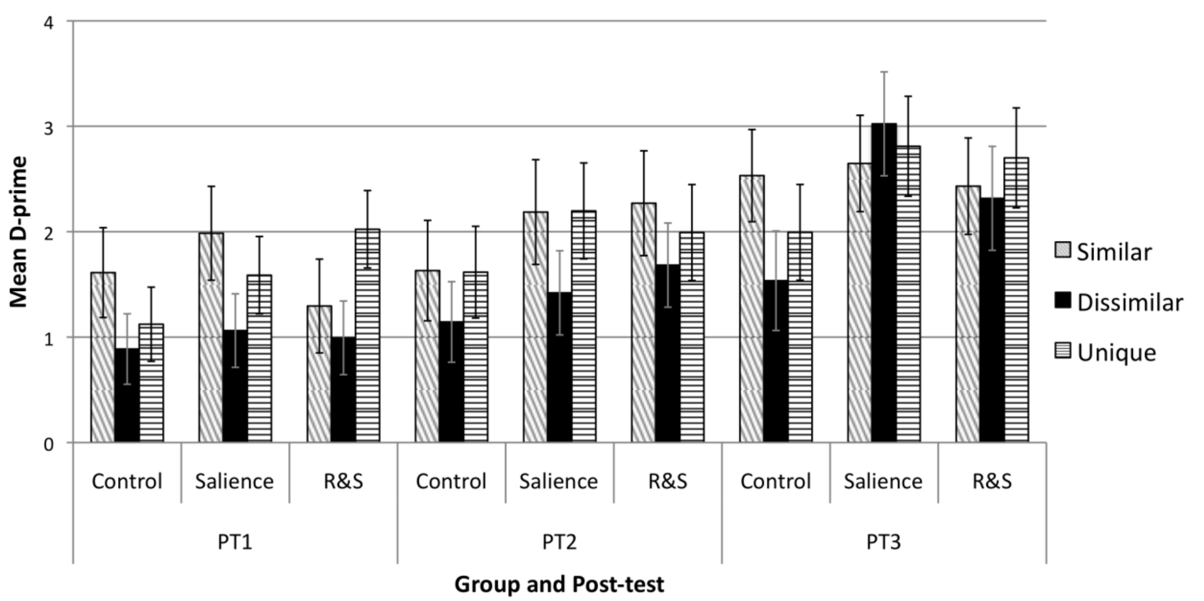


Figure 2. Mean d-prime scores of the three cross-language similarity types in each group and post-test (similarity comparison). N = 34.



2.2.2 ERP Data

Results from averaged ERPs in the 300 to 500 ms and 500 to 700 ms time windows are reported; because the effects observed in the 500 to 650 ms and 650 to 800 ms followed a similar pattern as the entire P600 window, they are not considered further. Moreover, because the focus of the ERP analyses was on participants' ability to discriminate between grammatical and ungrammatical sentences, only significant effects that involve the grammaticality variable (suggesting differential brain sensitivity to grammatical and ungrammatical stimuli) or its interaction with another relevant variable are reported. Following convention, main effects of laterality or electrode site, or interactions of these two factors, are not reported because they reflect the dipolar nature of ERPs and are not theoretically relevant when they do not interact with manipulated variables.

Figures 3-5 illustrate grand average ERPs for the Control, Salience, and Rule & Salience groups in the three post-tests for the similar (Figure 3), dissimilar (Figure 4), and unique (Figure 5) cross-language similarity types. A global ANOVA included the within-subject factors of Cross-Language Similarity (similar, dissimilar, unique), Post-Test (PT1, PT2, PT3), Grammaticality (grammatical, ungrammatical), Laterality (left, midline, right), and Electrode Site (frontal, central, parietal), and the between-subject factor Group (Control, Salience, Rule & Salience). Significant interactions were followed-up using the Duncan's multiple-range test (with $p < .05$ cutoffs).

Figure 3. Grand average ERPs in the Control, Salience, and Rule & Salience groups at nine electrode sites for the similar type. N = 28.

Figure 4. Grand average ERPs in the Control, Salience, and Rule & Salience groups at nine electrode sites for the dissimilar type. N = 28.

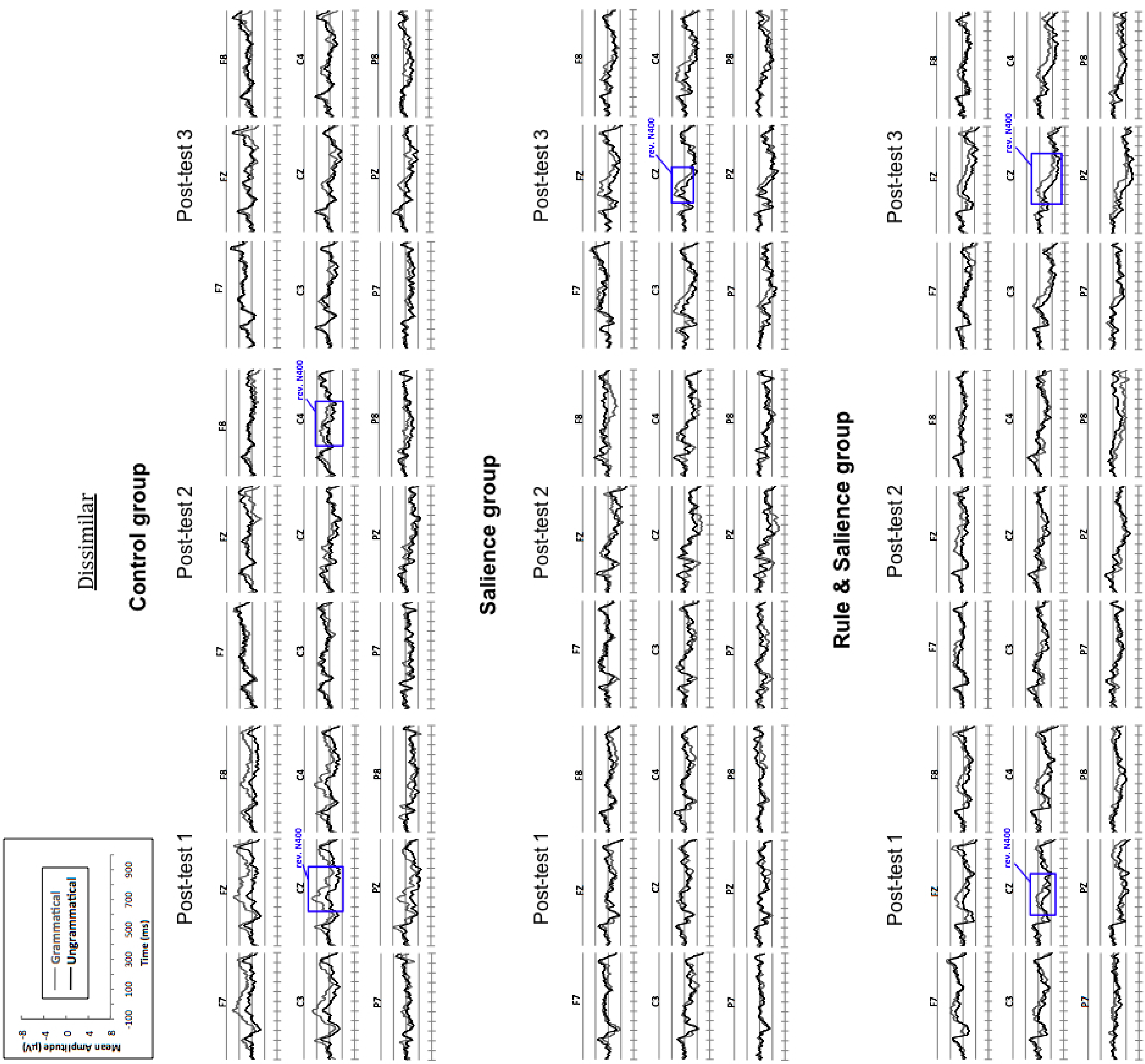


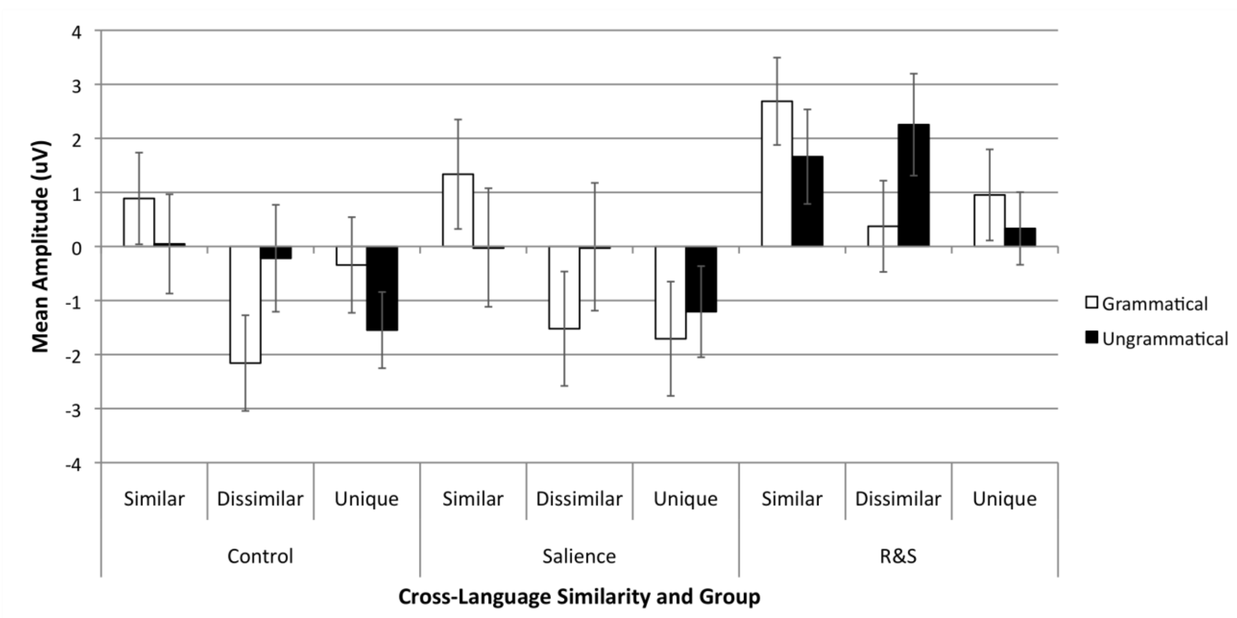
Figure 5. Grand average ERPs in the Control, Salience, and Rule & Salience groups at nine electrode sites for the unique type. N = 28.

2.2.2.1 300 to 500 ms. Figure 6 illustrates the mean ERP amplitudes of central midline electrode sites for grammatical and ungrammatical stimuli for each cross-language similarity type in the 300 to 500 ms time window. The omnibus ANOVA comparing ERPs in response to grammatical and ungrammatical stimuli in this time window revealed a significant interaction between post-test, similarity, grammaticality, and electrode site, F (8, 200) = 3.73, MSE = 4.92, p = .008, η_p^2 = .13. Follow-up tests revealed a widespread negativity over all sites for the similar type (mean difference of 1.58, 1.56, and 1.55, at frontal, central, and parietal sites, respectively) in PT1 as well as a *positivity* at frontal (mean difference of 1.99) and central (mean difference of 1.64) sites for the dissimilar type in PT1. This positivity was also significant in PT3 for the dissimilar type but was of largest amplitude at parietal (mean difference of 2.04) and central (mean difference of 2.03) sites.

An additional interaction was observed between similarity, grammaticality, and laterality, F (4, 100) = 3.26, MSE = 1.85, p = .015, η_p^2 = .12. Follow-up tests indicated a negativity for the similar type that was of largest amplitude at midline (mean difference of 1.04) and left (mean difference of .89) locations, as well as a positivity for the dissimilar type that was of largest amplitude at midline (mean difference of 1.6) and right (mean difference of 1.27) locations. These interactions qualified several lower-order interactions between similarity and grammaticality, F (2, 50) = 9.62, MSE = 50.16, p = .00, η_p^2 = .13, and between grammaticality and site, F (2, 50) = 3.77, MSE = 2.73, p = .047, η_p^2 = .13.

Together the results indicate a negativity at midline sites in response to violations of the similar type, particularly in PT1; its onset and distribution is consistent with an N400-like component. A *reverse* N400 associated with items of the dissimilar type in which responses to ungrammatical items were more positive than those associated with grammatical items was also observed. Its centroparietal distribution, particularly in PT3, is typical of the N400. Therefore, ERPs in the 300 to 500 ms time window showed an N400-like effect across all groups although, strikingly, this effect was reversed in response to violations of the dissimilar type, suggesting interference from L1 during the learning of morphosyntactic features that are instantiated differently in L2.

Figure 6. Mean ERP amplitudes of central midline electrode sites in each cross-language similarity type for each group in the 300 to 500 ms time window. N = 28.



2.2.2.2 500 to 700 ms. Figures 7 and 8 illustrate the mean ERP amplitudes of centroparietal midline and left frontal electrode sites, respectively, for grammatical and ungrammatical stimuli for each cross-language similarity type in the 500 to 700 ms time window. The omnibus

ANOVA comparing ERPs in response to grammatical and ungrammatical items in this time window revealed a significant interaction between similarity, grammaticality, electrode site, laterality, and group, F (16, 200) = 1.84, MSE = .70, p = .028, η_p^2 = .13. Follow-up tests revealed a *negativity* in response to items of the similar type that was of largest amplitude over centroparietal midline (mean difference of 1.57) and right (mean difference of 1.41) locations in the Control group, but restricted to frontal left locations (mean difference of 1.09) in the Salience group. These different distributions are suggestive of distinct components underlying the effects observed in the two groups. Indeed, visual inspection of the waveforms examining the onset and distribution of the effects indicate an ongoing N400 in response to similar items in the Control group, but a LAN instead in the Salience group. Although the N400 and LAN are typically observed in the 300 to 500 ms time window, such effects often extend into later time windows, particularly in L2 learners (e.g., Hahne et al., 2006; Weber-Fox & Neville, 1996). Furthermore, the N400 is typically found at centroparietal sites and the LAN is usually located at left frontal areas, as the name indicates, but variations in these distributions are not uncommon (e.g., Hahne et al., 2006; Holcomb, Kounios, Anderson, & West, 1999; Tolentino & Tokowicz, 2010; van Schie, Wijers, Mars, Benjamins, & Stowe, 2005).

Follow-up tests further revealed a positivity in response to dissimilar items that was of largest amplitude over centroparietal midline (mean difference of 1.2) and right (mean difference of .98) locations in the Control group, and over frontal and central midline (mean difference of 1.21) and right (mean difference of 1.07) locations in the Rule & Salience group. Visual inspection of the waveforms indicated that the positivity began in the previous time window (300 to 500 ms). Therefore, the effects are consistent with an ongoing reverse N400 in response to dissimilar items in the Control and Rule & Salience groups.

Finally, items of the unique type elicited a positivity in the Salience group that was of largest amplitude at centroparietal left (mean difference of 2.07) and midline (mean difference of 2.05) locations. This positivity was also significant over parietal midline (mean difference of .97) locations in the Rule & Salience group as well as at frontal sites (mean difference of 1.1). These effects are consistent with a P600-like effect, even though they do not fully exhibit the typical centroparietal distribution in each group.

There was also a significant interaction involving post-test, similarity, grammaticality, and site, F (16, 200) = .146, MSE = 6.57, p = .037, η_p^2 = .09. Follow-up tests indicated a positivity over frontal (mean difference of 2.31) and central (mean difference of 1.68) sites for the unique type only in PT2. There was also an interaction between similarity, grammaticality, site, and laterality, F (8, 200) = 2.14, MSE = .70, p = .034, η_p^2 = .08. Follow-up tests revealed a widely distributed positivity for the unique type that was of largest amplitude over centroparietal left (mean difference of 1.04) and midline (mean difference of .94) locations. Violations of the dissimilar type also elicited a positivity that was of largest amplitude at frontal (mean difference of .79) and central midline (mean difference of .77) locations. Finally, cross-linguistically similar items elicited a negativity that was largest at parietal midline locations (mean difference of .54).

To summarize, ERPs in the 500 to 700 ms time window showed qualitative differences as a function of both cross-language similarity and training group. Thus, whereas violations of the cross-linguistically similar type were associated with an ongoing N400 effect in the Control group, this type of violation elicited a LAN instead in the Salience group. Cross-linguistically dissimilar violations, on the other hand, continued to elicit reverse N400 responses in the Control and Rule & Salience groups. Moreover, unique L2 violations elicited strong P600 effects in both the Salience and Rule & Salience groups, particularly in post-test 2.

Figure 7. Mean ERP amplitudes of centroparietal midline electrode sites for each similarity type in the 500 to 700 ms time window. N = 28.

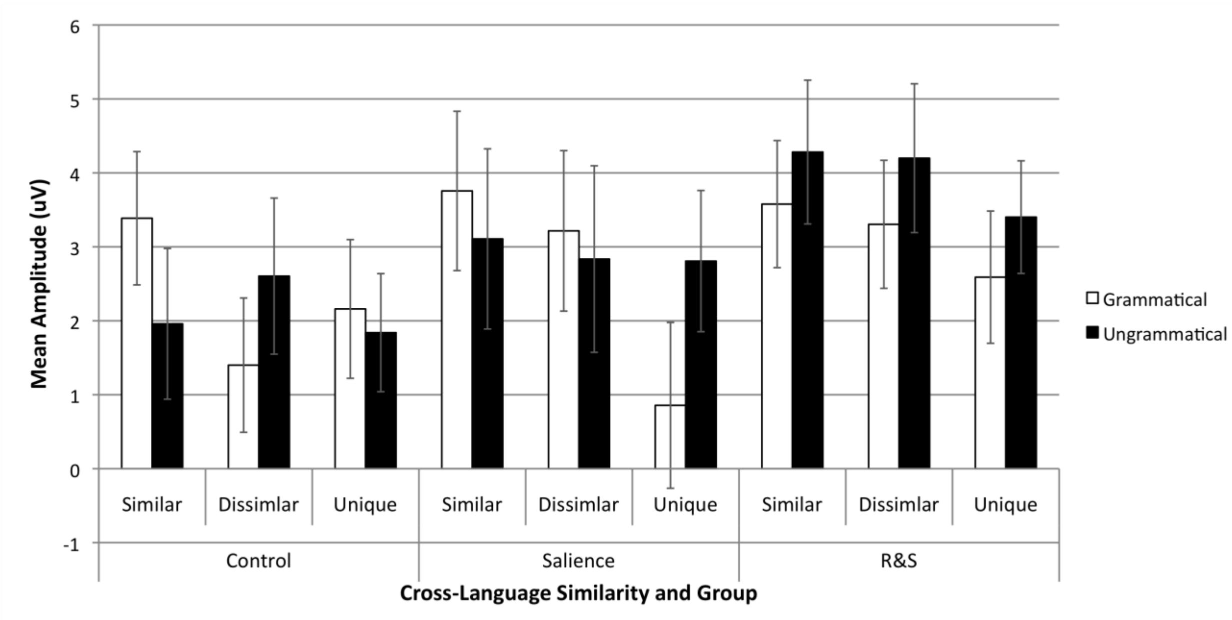
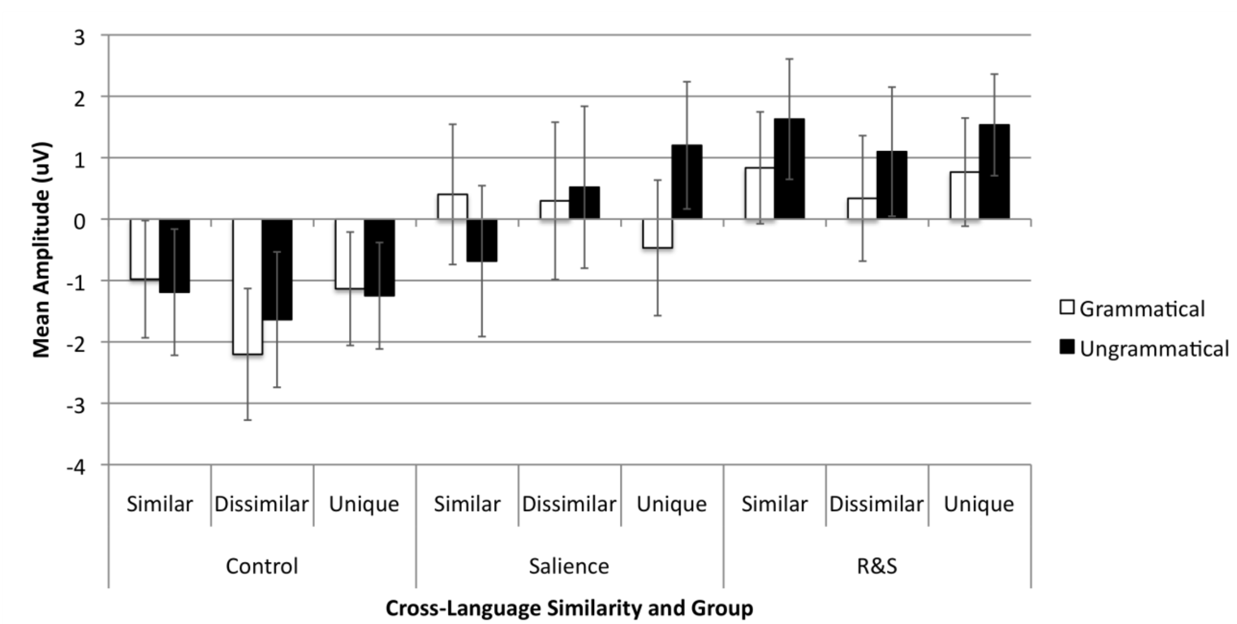


Figure 8. Mean ERP amplitudes of left frontal electrodes for each similarity type in the 500 to 700 ms time window. N = 28.



Taken together, ERPs from both time windows reveal shifting patterns of grammatical sensitivity in the different training groups and, although commonalities exist, the data point to qualitatively different neural patterns in response to the three cross-language similarity types. Violations of the similar type elicited an N400-like effect in all groups in the earlier time window, particularly in PT1. This effect continued into the later time window for the Control group, but emerged as a LAN effect in the Salience group. The Rule & Salience group did not show statistically significant effects in this later time window in response to similar items, potentially due to a biphasic N400-P600 response that is apparent in this group's waveforms at centroparietal and frontal sites. These opposing polarities could have statistically weakened each individual effect, thus cancelling each other out. This observation is discussed further in the General Discussion section.

Furthermore, ERPs in response to dissimilar violations showed a robust *reverse* N400 effect in all groups in the early time window. This effect continued into the later time window in the Control and Rule & Salience groups, but not in the Salience group. Finally, ERPs in response to violations of unique items did not show statistically significant effects in the earlier time window; however, follow-up tests probing a marginally-significant interaction involving similarity, grammaticality, site, laterality, and group, F (16, 200) = 1.71, MSE = .81, p = .08, η_p^2 = .12 showed an N400-like negativity in response to items of the unique type in the Control group that was significant at centroparietal midline (mean difference of 1.16) and right locations (mean difference of 1.12). Inspection of the waveforms suggests that there was a noteworthy trend towards a comparable N400 effect in the Rule & Salience group, particularly in PT1, although this did not reach significance. Nevertheless, unique violations elicited a robust P600-like effect in the later time window in both the Salience and Rule & Salience groups, particularly in PT2. Thus, whereas the Control group showed an N400 in response to unique violations, the Salience and Rule & Salience groups showed more complex response patterns that evolved across post-tests.

2.2.3 Secondary Outcome Measures

2.2.3.1 Operation span. Set size span ranged from 0 to 6 (M = 3.9, SD = 1.5), and total span ranged from 27 to 60 (M = 49.6, SD = 8.4). The three training groups did not significantly differ on set size span (p = .18) or total span (p = .16). Results from ANCOVAs on post-test scores including each of these as a covariate showed only marginally-significant effects of set size span, F (1, 30) = 3.22, MSE = 34.76, p = .083, η_p^2 = .1. There was no effect of total span (p = .41).

2.2.3.2 MLAT-WIS. Scores for the MLAT-WIS were based on 40 multiple-choice items (five items were removed due to scoring problems) and ranged from 33% to 88% (M = 62.6%, SD = 14.2%). The three training groups did not differ on MLAT-WIS score (p = .75) Results from the ANCOVA on post-test scores including MLAT-WIS score as a covariate showed an interaction between MLAT-WIS score, post-test, and similarity, F (4, 116) = 2.15, MSE = .68, p = .045, η_p^2 = .09. To further examine this effect, an additional ANOVA with median-split MLAT-WIS scores as a between-subjects categorical factor was conducted. Results showed only a marginally-significant interaction between MLAT-WIS score, post-test, and similarity, F (4, 108) = 2.08, MSE = .73, p = .11, η_p^2 = .07. Nevertheless, follow-up tests indicated significantly higher post-test scores in higher-MLAT-WIS score participants in PT2 for the unique type (M = 2.44 vs. 1.69); scores were higher in PT1 (M = 1.55 vs. .59) and PT3 (M = 3.05 vs. 1.9) in higher-MLAT-WIS score participants for the dissimilar type only. This suggests that high language-learning aptitude, at least as indicated by MLAT-WIS performance, may be particularly relevant when learning grammatical features that are different from L1.

2.2.3.3 Sentence translation. Sentence translation data were coded separately for grammar and vocabulary accuracy on a binary scale. Therefore, a participant received a grammar score of 1 if he/she produced the correct morphology at the critical points of agreement in a sentence, but only a score of 0 if he/she used incorrect agreement morphology, even in the case of correct vocabulary use. The reverse was true for vocabulary coding. Accuracy scores from the translation tests were submitted to two separate 3-way ANOVAs for grammar and vocabulary scores that included the factors cross-language similarity, post-test, and group.

Analysis of grammar scores (range: 0 to 100%, *M* = 32%, *SD* = 31%) showed a main effect of post-test, F (1, 31) = 32, *MSE* = .065, p = .00, η_p^2 = .51, indicating higher grammatical accuracy in sentence translation PT1 (*M* = 43%) than PT2 (*M* = 22%), probably due to the intervening two weeks between PT1 and PT2 and absence of feedback in this task. An additional analysis of grammar scores from all similarities but including only definite sentences of the dissimilar type (range: 0% to 100%, *M* = 26%, *SD* = 33%) was conducted because only the sentences containing the singular definite, as opposed to the indefinite, instantiate a cross-linguistically dissimilar feature (e.g., "$\text{Pojken}_{\text{DEF}}$ äter" vs. "En_{INDEF} pojke äter."). Results showed an interaction between post-test and cross-language similarity, F (2, 62) = 5.89, *MSE* = .04, p = .01, η_p^2 = .16. Follow-up tests indicated higher grammar scores in PT1 than PT2 for similar (PT1 *M* = 35%; PT2 *M* = 19%; mean difference of 16%) and unique types only (PT1 *M* = 49%; PT2 = 22%; mean difference of 26%). Furthermore, PT1 scores were higher for both similar and unique than for the dissimilar type (*M* = 17%; mean difference of 18% and 31%, respectively); scores for the unique type were higher than for the similar type (mean difference of 14%), based on follow-up tests. The interaction qualified main effects of post-test, F (1, 31) = 19.65, MSE = .06, p = .00, η_p^2 = .39, and similarity, F (2, 62) = 6.74, MSE = .1, p = .002, η_p^2 = .18. Follow-up tests indicated significantly higher scores in PT1 (34%) than PT2 (19%), and also for the unique (36%) than dissimilar type (16%). There were no group effects in this analysis (p = .38).

Lastly, the analysis of sentence translation vocabulary scores (range: 0 to 100%, M = 49%, SD = 39%) also showed an interaction between post-test and similarity, F (2, 62) = 4.09, MSE = .02, p = .02, η_p^2 = .12. Follow-up tests indicated higher scores for both similar (M = 42%) and dissimilar (M = 35%) types than for the unique type (M = 24%; mean difference of 18% and 11%, respectively) in PT2 only. The interaction qualified main effects of post-test, F (1, 31) = 46.49, MSE = .1, p = .00, η_p^2 = .6, and similarity, F (2, 62) = 6.23, MSE = .04, p = .003, η_p^2 = .17. Follow-up tests indicated higher scores in PT1 (M = 64%) than PT2 (M = 34%), and higher scores overall for the similar (53%) than unique (M = 43%) type.

Error analysis. Translation errors were analyzed and coded into specific categories for each cross-language similarity type; they were further coded as proportion of errors that reflect negative transfer from L1. Errors were coded as resulting from L1 transfer in the cross-linguistically similar type if a singular demonstrative determiner was correctly used in the absence of the required noun inflection (e.g., “*den där buss” instead of “den där bussen”). This type of error is likely to occur because, although number agreement is performed similarly in both L1 and L2, in English singular nouns are not inflected for definiteness when used with a demonstrative determiner. Transfer errors in the cross-linguistically dissimilar type included article overuse (e.g., “*en pojken”), article placement (e.g., “en pojke” instead of “pojken”), and article omission (e.g., “pojke” instead of “pojken” or “en pojke”). Such errors would likely result from word-by-word translation from L1 and failure to morphologically decompose the inflected noun (“a boy” [“*en pojken”]), as well as from outright avoidance of article use due to confusion as to the correct rule to apply (e.g., Schachter, 1974). Finally, errors were classified as transfer errors in the unique type if participants failed to inflect a neuter adjective to agree with the article “ett” (e.g., “*Ett fin huss”), because in English adjectives are never inflected to agree with articles.

Results from sentence translation task 1 show that the majority of errors across similarity types belonged to the gender assignment (26%) and miscellaneous (26%) categories. Gender assignment errors included using an article, demonstrative determiner, noun, or adjective of the incorrect gender (e.g., “*ett pojke”); miscellaneous errors consisted mainly of incomplete sentences (e.g., “leker varje morgen”; “Hon ??? En ??? Mycket.”). Moreover, 38% of errors were made in the cross-linguistically similar type, 33% in the dissimilar type, and 28.7% in the unique type.

The majority of errors in the cross-linguistically similar type were due to the absence of noun inflection (30%), as exemplified above, and use of an incorrect determiner (25.9%; e.g., “den där” [that] instead of “de där” [those]). Of these two error types, 11.7% were classified as resulting from L1 transfer and all belonged to the noun inflection category. Errors in the cross-linguistically dissimilar type were mainly due to article omission (27%) and article placement (28%) errors. Importantly, half of all errors were classified as resulting from negative L1 transfer, and belonged to article omission, placement, and overuse categories. Finally, the majority of errors in the unique L2 type were due to incorrect gender assignment (53%), and only a small number (.03%) could be attributed to L1 transfer in the form of absence of adjective inflection, as described above.

Results from sentence translation task 2 showed a greater proportion (57.3%) of all errors belonging to the miscellaneous category, likely due to forgetting in the preceding two weeks and resulting high proportion of incomplete sentences. Errors in the cross-linguistically similar type constituted 35.3% of all errors; the dissimilar type accounted for 31.6%; and the unique type constituted 33%. The majority of errors in all similarity types belonged to the miscellaneous category (similar: 41.7%; dissimilar: 63.9%; unique: 67.8%) and cross-linguistically dissimilar features had the highest proportion of L1 transfer errors (13.9%; similar: .07%; unique: .03%) as in the first translation task.

In summary, sentence translation performance was relatively low in all groups, particularly in PT2, for both grammar and vocabulary. Notably, performance was generally poorer for grammar than vocabulary translation, particularly in the case of dissimilar features. Unique grammatical features were translated most accurately, but vocabulary scores associated with this feature type were lowest. The lower vocabulary translation accuracy associated with sentences employing unique L2 features (i.e., article-adjective gender agreement) may be due to difficulties translating the adjective itself because these appeared only 1/3 of the time during training and testing, as compared to adverbs, which were used in both the similar and dissimilar sentence types (2/3 of the time) to balance sentence length across all similarity types.

Error analyses showed that most translation errors were due to incomplete sentences or incorrect gender assignment. Errors translating features of the cross-linguistically similar type were common, possibly due to the lower reliability of the agreement rule (i.e., plural nouns carry the suffix “a/orna” except for neuter nouns, which carry the suffix “en”; see Appendix B) as well as confusion regarding the singular ("*den/det* där") and plural determiners ("*de* där"). L1 transfer errors were most commonly observed for cross-linguistically dissimilar features, and most often resulted from article omission and incorrect placement. These data suggest that cross-language similarity differentially influences vocabulary and grammar production, and that although dissimilar grammatical features may be difficult to produce (and acquire), processing of vocabulary embedded in this type of grammatical feature is less difficult.

2.2.3.4 Rule verbalization. Data from the Task and Handedness questionnaire in which participants were asked whether they noticed any grammatical patterns during the GJT were scored for accuracy. Participants received a score of 1 for each of the three cross-language similarity features if they were able to provide an accurate description of the rule employed; otherwise they received a score of 0.

Results showed no effect of training group in rule verbalization (p = .54), although a trend was observed toward higher accuracy in the Rule & Salience group (46%; Salience: 39%; Control: 31%). An effect of cross-language similarity was observed instead, F (2, 62) = 5.08, MSE = .178, p = .009, η_p^2= .14, and follow-up tests indicated that scores for cross-linguistically similar rules (M = 53%) were significantly higher than those associated with dissimilar (M = 21%) rules. This finding illustrates the importance of cross-language similarity in L2 rule knowledge acquisition, above and beyond any effect of instruction.

2.2.3.5 Correlational analyses: ERP and behavioral measures. Results from correlational analyses between ERP magnitude differences (i.e., difference in amplitude between grammatical and ungrammatical items) in each group and cross-language similarity, and MLAT-WIS, set size span, and total span are reported (see Appendix D). Outliers excluded from the analyses were identified using the standardized beta-fit measure (Cohen, Cohen, West, & Aiken, 2003).

300 to 500 ms. Amplitude differences in response to grammatical and ungrammatical items at central midline electrodes, where the majority of significant ANOVA effects were found in the 300 to 500 ms time window, showed a positive correlation in the case of cross-linguistically similar items and set size span and total span in the Control group in PT2 ($r = .9$, $p = .00$) and PT3 ($r = .8$, $p = .02$). ERP magnitude differences in response to violations of the unique type also correlated with set size span in the Rule and Salience group in PT1 and PT2 ($r = .73$, $p = .02$, and $r = .63$, $p = .05$, respectively). It may be useful to note that behavioral performance was higher for items of the similar type in the Control group, and items of the unique type benefitted from explanations provided in the Rule & Salience group, which could be related to the greater underlying grammatical sensitivity associated with a working memory advantage.

ERP magnitude differences in response to violations of the similar type in the Salience group were *negatively* correlated with MLAT-WIS score ($r = -.97$, $p = .01$) and set size span ($r = -.9$, $p = .04$) in PT2, and total span ($r = -.86$, $p = .059$) in PT3. It is possible that this negative correlation at central midline sites reflects a shift from central midline N400 effects to more left frontal LAN-like effects for participants with higher MLAT-WIS scores. Alternatively, it could simply reflect the wide scalp distribution of effects observed in response to cross-linguistically similar violations. However, results should be interpreted with caution because the correlational analyses comprised relatively small sample sizes, with the N being quite low (e.g., 5) in some similarity conditions within given groups and tests, mainly due to the removal of participants who qualified as outliers.

500 to 700 ms. The majority of significant ANOVA effects in the 500 to 700 ms time window were found at centroparietal midline electrodes. Results of correlational analyses of these electrodes showed a significant positive correlation between ERP magnitude differences in response to dissimilar features and set size span in the Rule & Salience group in PT2 ($r = .7$, $p = .02$), as well as between ERP magnitude differences to unique features and MLAT-WIS scores in PT1 ($r = .78$, $p = .01$). This could reflect an increased ongoing reverse N400 associated with higher working memory potentially due to L1-L2 rule conflict effects in the case of dissimilar features, as well as increased brain sensitivity to grammaticality (N400 in PT1) associated with higher MLAT-WIS scores in the case of unique features. There was also a negative correlation between ERP magnitude differences in response to unique features and set size span in the Control group ($r = -.74$, $p = .02$); between ERP magnitude differences to cross-linguistically similar features and MLAT-WIS scores in the Salience group ($r = -.86$, $p = .03$) like in the previous time window; and between ERP magnitude differences to unique features and total span ($r = -.95$, $p = .01$) in PT1 in the same group.

In summary, differences in ERP amplitude of grammatical and ungrammatical stimuli in the earlier time window were positively correlated with measures of working memory for cross-linguistically similar violations in the Control group, and for unique L2 violations in the Rule & Salience group. ERP magnitude differences for cross-linguistically similar violations were negatively correlated with working memory and MLAT-WISC measures in the Salience group only, potentially reflecting distributional effects. Results from the 500 to 700 ms time window were less conclusive but show a positive correlation between ongoing reverse N400 effects sizes for violations of the dissimilar type and set size span in the Rule and Salience group, potentially reflecting active cross-linguistic rule conflict. Nevertheless, as mentioned above, results from correlational analyses should be interpreted with caution because sample sizes were often small and the wide scalp distribution of some effects prevents a coherent description of effects encompassing all electrode sites.

3.0 GENERAL DISCUSSION

The present research evaluated and compared the effectiveness of three L2 instruction methods as a function of L1-L2 similarity in the context of a miniature longitudinal ERP experiment. Results showed an overall effect of cross-language similarity during the initial stages of L2 learning such that morphosyntactic features that are instantiated similarly in both L1 and L2 were generally associated with higher accuracy in post-tests as well as with increased brain sensitivity to morphosyntactic violations (e.g., Tolentino & Tokowicz, 2011). Importantly, cross-language similarity effects were qualified by an interaction with instruction method: the learning of dissimilar morphosyntactic features was particularly effective when instruction emphasized contrastive and salient input (Salience group), as was the learning of unique features when grammatical rule explanations were provided (Rule & Salience group). The present findings provide support for L2 pedagogical strategies that account for the influence of L1 in L2 learning and, furthermore, suggest specific ways in which variations in the nature of L2 input can be manipulated for effective and efficient instruction.

The main findings from the present research are largely consistent with the UCM's postulation of a learning advantage associated with L2 features that are similarly implemented in the learner's L1 and L2, and that are salient and reliable. Specifically, in the present experiment cross-linguistically similar (demonstrative determiner-noun number agreement) and unique (article-adjective gender agreement) features were more rapidly acquired than dissimilar features (singular noun phrase definiteness marking), the learning of which was slower and less accurate. According to the UCM, cross-linguistically similar features benefit from positive L1-L2 transfer, and could thus explain the present results. The learning of unique L2 features, on the other hand, does not benefit from positive transfer but neither does it suffer from negative transfer; the present results indicate that the Swedish article-adjective agreement rule was available and reliable enough to be rapidly acquired by beginning learners. However, this gain differed according to instruction method such that performance in the Control group, which did not benefit from salient input or metalinguistic explanations, was consistently higher for cross-linguistically similar features only. It thus appears that the learning of unique L2 features is boosted by increased salience and rule explanations to a greater extent than the learning of cross-linguistically similar features. The mechanism underlying this effect could be such that contrastive and salient input draws the necessary attention to unique L2 features that could otherwise go unnoticed due to their absence in L1 (e.g., Ellis, 2006; Schmidt, 1990) and, furthermore, metalinguistic information provides supporting explanations of those features that help to consolidate them in memory (e.g., Robinson, 1995, 1997).

Also consistent with the UCM, cross-linguistically dissimilar features were the most difficult to acquire, particularly in the Control group, possibly due to online competition (i.e., interference) from the L1. Despite this, instruction methods that focused attention on crucial elements of the input by increasing their salience (i.e., Salience group), were able to alleviate the negative influence of L1 during L2 learning, as illustrated by the performance of the Salience group on this feature type. Despite the fact that the present experiment's design does not allow for a determination of the individual contributions of morphosyntactic contrast and typographical enhancement, it nevertheless indicates that an implicit attentional focus on relevant information associated with L2 features that are instantiated differently in L2 may not only be desirable but also sufficient during initial learning. Accordingly, rule explanations did not seem to provide extra support in the learning of this type of feature, potentially because exposure to metalinguistic information that directly contradicts existing (L1) knowledge shifts the focus from more mechanistic rule application to the costly maintenance and interpretation of conflicting information, thus negatively affecting performance. Directing attention to cross-linguistically dissimilar features without rule explanations may thus circumvent this problem through the more efficient allocation of cognitive resources.

It is possible that the poorer performance on cross-linguistically dissimilar features in the present experiment was not necessarily due to L1 transfer processes per se but instead reflects an inherent difficulty in learning the Swedish system of definiteness marking. Many of the studies investigating the learning of L2 Swedish have focused on child populations, and are therefore less relevant to the present findings. It may nevertheless be informative to know that these studies show that, along with noun plurals, definiteness marking is an early-acquired morphosyntactic feature (Andersson, 19992, 1994; Pienemann & Håkansson, 1999); the definite suffix being one of the earliest manifestations of emerging productive morphology in both Swedish monolingual children and children learners of L2 Swedish. The definite suffix thus exerts a prominent role in the acquisition of Swedish *gender* marking because gender is marked on the definite article itself. Interestingly, those studies report periods of overgeneralization during which productive errors in the use of definiteness marking such as "en_{INDEF} $\text{pojken}_{\text{DEF}}$" occur, thus seeming to reflect a common linguistic developmental trajectory in the acquisition of Swedish definiteness marking. However, other studies have shown systematic L1 transfer effects during the processing of L2 Swedish definiteness (Portin, Lehtonen, Harrer, Wande, Niemi, &

Laine, 2008). Portin and colleagues (2008) tested the recognition of Swedish nouns that were either inflected for definiteness (e.g., “bollen” [“ball-the”]) or were presented in their bare indefinite form (e.g., “konst” [“art”]) in a lexical decision task. They contrasted the responses of two groups of late, proficient adult learners of Swedish of two distinct L1 backgrounds – Chinese and Hungarian– and found that whereas the Hungarian L1 group displayed longer reaction times in response to low- and medium-frequency inflected nouns, the Chinese group showed equivalent reaction times for both inflected and non-inflected nouns from all frequency ranges. The authors interpreted this result as reflecting the transfer of L1 processing mechanisms to L2 processing such that whereas the Chinese L1 group employed a whole-word processing strategy in the recognition of inflected Swedish nouns, the Hungarian L1 group used a word-segmentation strategy that was more sensitive to inflection, as would be expected based on the agglutinative nature of Hungarian as compared to the more isolating Chinese. Therefore, these results suggest that Swedish definiteness marking is not equally difficult to process for participants of all language backgrounds; instead, L1 processing strategies influence L2 Swedish performance, even in proficient adult speakers. Studies employing self-paced reading tasks (Fender, 2003) as well as phonological processing concurrent with functional magnetic resonance imaging (fMRI) (Tan et al., 2003) have also shown differential adult L2 performance and brain activity patterns as a function of L1 background.

It should be acknowledged that the current experiment employed a quasi-experimental design in which similarities and differences between a single language pair was examined in only one direction of learning. Despite the obvious practical difficulties, ideally the present results would be compared to others based on the examination of a language pair in which the similarities and differences here operationalized are inversed, thus implementing a full experimental design. Therefore, it could be that the observed differences in performance here attributed to an effect of cross-language similarity are instead due to more subtle differences in the individual grammatical structures employed and associated processing mechanisms. Specifically, it could be that performing a matching operation between determiner and noun, and between article and adjective is cognitively less taxing than suppressing the production of an article and shifting attention to the noun ending, as in the case of cross-linguistically dissimilar features in the present experiment. However, it is also possible that the latter mechanism is rendered particularly difficult precisely because it is proceduralized in a conflicting manner in L1. Support for this view comes not only from the Portin et al. (2008) results described above in which different outcomes were observed for participants of differing L1 backgrounds, but also from previous studies examining cross-linguistic dissimilar and unique L2 features in which other cognitive operations were required to successfully implement a feature in L2. For example, native English speakers showed poor performance and no brain sensitivity to violations of the cross-linguistically dissimilar type when Spanish article-noun number agreement was used and which required that, unlike in L1, pluralization be marked in the article in addition to the noun (e.g., "the books" versus "*los* libros"; Tokowicz & MacWhinney, 2005). Furthermore, a similar participant population showed relatively more difficulty performing Spanish article-noun gender agreement, a process that, in principle, can be performed simply by matching phonological patterns (e.g., nouns ending in "a" are preceded by the feminine article "la"; and nouns ending in "o" are preceded by the masculine "el", such as "la casa" versus "el gato") (Tolentino & Tokowicz, 2010). Therefore, the collective results from cross-language similarity studies suggest that participants' poor performance on features deemed cross-linguistically dissimilar or unique to L2 relative to cross-linguistically similar features is more likely due interference from L1 or absence of proceduralized mechanisms due to the feature's absence in L1 (see also Tolentino & Tokowicz, 2011, for a review of studies examining cross-language similarity effects).

ERP results from the present experiment are also generally consistent with the UCM's predictions: the learning of cross-linguistically similar features was associated to a greater extent with neurocognitive mechanisms usually found in L1 than was the learning of dissimilar and unique L2 features. Furthermore, this finding was modulated by the nature of instruction, such that learning under salient instruction conditions elicited ERP components that are commonly associated with L1 processing and/or highly proceduralized responses. Accordingly, in the present experiment, only the processing of cross-linguistically similar features in the Salience group elicited a LAN in response to morphosyntactic violations. Although this ERP component has proven to be somewhat elusive, as illustrated by experiments in which it is not observed in either L1 or L2 (e.g., Allen, Badecker, & Osterhout, 2003; Frenck-Mestre et al., 2008; Kim & Osterhout, 2005; Tolentino & Tokowicz, 2010), it has nevertheless been found in response to (morpho)syntactic violations in both L1 (e.g., Chen et al., 2007; Hahne et al., 2006; Weber-Fox & Neville, 1996) and L2 (e.g., Ojima et al., 2005; Rossi et al., 2006; Weber-Fox & Neville, 1996). In L2 speakers, the LAN has most often been elicited during the processing of features that are associated with high proficiency and/or early acquisition, sometimes exhibiting a more bilateral distribution than in native speakers (e.g., Hahne et al., 2006; Weber-Fox & Neville, 1996). Hahne and colleagues (2006) suggested that L2 features associated with high behavioral proficiency are processed quickly and automatically by L2 speakers through processes of morphological decomposition. In the context of dual-processing mechanisms, morphological decomposition is contrasted with more holistic processes of lexical storage, in which L2 forms are not segmented into stem-inflection parts. Results from the present experiment expand Hahne et al.'s (2006) findings by indicating a role of cross-language similarity and input type, in addition to proficiency, in eliciting more proceduralized morphological processing. Thus, LAN effects were observed only in response to cross-linguistically similar morphosyntactic features under instructional conditions that emphasized salient input, possibly because participants in this training group could not only rely on positive L1 transfer, but also focus on crucial parts of the input without the need to mentally evoke an explicit grammatical rule. Participants in the Salience group also displayed high behavioral accuracy.

In the present experiment, morphosyntactic violations initially elicited an N400 response in all training groups, which persisted into later post-tests particularly in the Control group. This finding suggests that learners were processing morphological inflections as whole lexical items instead of engaging in morphological decomposition, at least initially. Such an outcome is predicted by dual-processing mechanism accounts of L2 processing, such as the declarative/procedural (DP) model (Ullman, 2001), which proposes that the neurocognitive mechanisms underlying L2 *grammar* learning largely rely on declarative memory temporal-lobe systems, which also subserve lexico-semantic processing in L1 and L2. This stands in contrast to L1 grammar processing, which relies on procedural memory frontal lobe-basal ganglia systems. Despite an initial reliance on lexico-semantic processing mechanisms, the learning trajectories observed in the present experiment reveal that L2 learners can indeed engage in L1-like grammar processing at very early stages of learning. Therefore, the present findings are not compatible with a dual-processing account and instead are more consistent with a general processing mechanism view of L2 learning that accounts for the influence of cross-language similarity and input type during learning. Whereas an N400-like response was generally associated with the processing of cross-linguistically dissimilar features as well as Control group neural patterns, LAN and P600 effects were instead elicited by morphosyntactic violations of cross-linguistically similar and unique features in the Salience and Rule & Salience groups. It thus appears that L2 learners can engage in proceduralized morphological decomposition when the L2 input is sufficiently salient and similarly implemented in L1. Nevertheless, it is important to note that the present experiment did not employ a control group of native Swedish speakers, thus preventing a direct group comparison of ERP patterns elicited by the various cross-language similarity features.

Other studies have reported N400 effects in response to morphosyntactic anomalies in L2 speakers. Osterhout et al. (2006) described an evolving ERP profile in low-proficiency English learners of French who, after one month of classroom instruction displayed an N400 effect in response to subject-verb agreement violations, but a P600 effect instead after four months of instruction. French native speakers showed only a P600 to the same violations. This shift in the learners' ERP profile from an N400 to a P600 effect was taken to reflect a transition from lexical storage processes to processes of morphological decomposition, which begins to emerge with increased L2 exposure and proficiency. However, findings from an experiment that tested late, proficient German-English bilinguals on verb inflection violations in a sentence acceptability task indicate that N400 effects in response to morphosyntactic violations can still be elicited in highly proficient L2 speakers in later stages of learning (Weber & Lavric, 2008). Specifically, it was found that, in addition to a P600 effect, morphosyntactic violations elicited an N400 effect in L2 but not in L1. This result was obtained despite the fact that the violations that were used were deemed cross-linguistically similar. The authors suggest that the N400 effect to L2 violations could have been due to exacerbated end of sentence wrap-up effects in L2 because the critical word to which ERPs were time-locked was always the last word of the sentence. It is not clear how those results relate to the findings in the present experiment in which N400 and LAN effects were observed in response to cross-linguistically similar violations, potentially due to differences in participant population (i.e., proficient versus novice learners) and experimental parameters (e.g., sentence-final versus sentence-internal critical words).

A recent study by McLaughlin et al. (2010) sheds some light on biphasic N400-P600 ERP profiles in L2 learners by offering an alternative explanation based on individual differences. In a study of adult native English speakers who were beginning learners of German, it was found that biphasic N400-P600 patterns in grand average waveforms in response to subject-verb agreement violations actually reflected two separate patterns that were obscured by group averaging: whereas one subgroup of learners showed mainly an N400 response, another showed mainly a P600 response, with magnitude differences between the two components being negatively correlated. Moreover, the amplitude of the P600 effect, but not N400, correlated positively with d-prime scores on a sentence acceptability judgment task. In the present experiment, there was a trend toward a biphasic N400-P600 pattern apparent at centroparietal right electrode sites in the grand average waveforms of the Rule & Salience group in response to cross-linguistically similar and unique items. Results from correlational analyses examining ERPs in the 300 to 500 ms (N400) and 500 to 700 ms (P600) time windows in the Rule and Salience group could help explain why the Rule & Salience group did not show any statistically significant effects in response to violations of cross-linguistically similar items in the later time window: the difference in amplitude between grammatical and ungrammatical items in the 300 to 500 ms time window was positively correlated with that in the 500 to 700 ms time window ($r = .87$, $p = .00$; $r = .76$, $p = .01$, for cross-linguistically similar items in PT1 and PT2, respectively; *r* = .85, *p* = .00, for unique items in PT1), meaning that early negativities may have been statistically cancelled out in the overall averages by associated later positivities.

It is worth noting that the distribution of some of the ERP components observed in the present experiment was not always restricted to areas where they are typically found. Violations of cross-linguistically similar features elicited a negativity in the 300 to 500 ms time window that was widely distributed and quite large at frontal scalp sites in all training groups, particularly in earlier post-tests. It could be argued that such an anterior distribution reflects working memory processes (e.g., Martín-Loeches, Muñoz, Casado, Melcón, & Fernández-Frías, 2005), specifically, verbal working memory, as some authors have argued (e.g., Coulson, King, & Kutas, 1998). In the present experiment, noun phrases of the cross-linguistically similar type differed from those of the dissimilar and unique types in that the relevant segment "den" or "de" of the demonstrative determiners "den där" ("that") and "de där" ("those") was non-adjacent to the point of violation in the noun phrase (e.g., "**Den* där pojk*arna*" ["*That boys"]). In the context of word-by-word presentation during ERP recording, it could be that the cost of keeping "den" or "de" active in working memory until the appearance of the noun becomes inflated, thus resulting in increased verbal working-memory related brain activity that potentially reflects participants' silent rehearsal. Effects of structural distance of sentence constituents during L2 processing have also been reported in a recent eye tracking experiment in which learners of Spanish were sensitive to the distance between nouns and adjectives in a sentence, affecting their ability to detect gender agreement violations (Keating, 2009).

Somewhat surprisingly, in the present experiment, measures of working memory capacity were positively correlated with ERP magnitude differences in response to cross-linguistically similar violations in the Control group only, indicating greater grammatical sensitivity in higher-span participants. It is possible that the ability to maintain relevant morphemes in mind was particularly helpful to this group because it did not benefit from typographical enhancement during training, thus placing higher-span participants at a noticing advantage that would later help to bridge the memory gap during ERP single word presentation. The present findings also showed ERP magnitude differences that were positively correlated with set size span for unique L2 violations in the Rule & Salience group, with higher-span participants showing greater grammatical sensitivity. Because this group alone received metalinguistic rule explanations, it could be that this increased sensitivity reflects the fact that higher working memory participants were able to memorize and apply relevant rule information to a greater extent than lower-span participants during the acquisition of novel L2 features. This mechanism would seem plausible in light of the fact that behavioral GJT performance was particularly high for unique features in the Rule & Salience group. However, measures of working memory capacity did not significantly correlate with (behavioral) post-test scores in this group. Dissociations between ERP and behavioral measures are not uncommon (e.g., McLaughlin, et al. 2004; Tokowicz & MacWhinney, 2005), but the pattern of results based on these two measures suggests that metalinguistic information and high working memory are helpful in the learning of unique L2 features. Nevertheless, results from correlational analyses should be interpreted with caution due to several limitations including sample sizes and distribution of effects.

In conclusion, the present research demonstrated that specific differences between languages and among instruction methods interact to influence adult L2 learning, as assessed through behavioral and ERP measures. Instruction methods that emphasized salient, contrastive L2 input were particularly effective in the teaching of morphosyntactic features that have different instantiations in L1 and L2. In contrast, methods that provided grammatical rule explanations were especially useful in the teaching of unique L2 features, helping to overcome their novelty. Along the same lines, participants' L2 grammar learning aptitude, as assessed by the MLAT-WIS subtest, predicted performance only on cross-linguistically dissimilar and unique features, suggesting that higher learning aptitude is more relevant when learning grammatical features that are distinct from the L1. In addition to its effect on comprehension, cross-language similarity influenced L2 *production*, as evidenced by the sentence translation task (as well as rule verbalization) results, although this effect differed with respect to vocabulary and grammar production. Thus, performance was generally poorer when translated sentences were scored for grammatical accuracy than for vocabulary accuracy, and this was particularly apparent in the case of dissimilar features, suggesting that the lower performance and brain sensitivity associated with this feature type was not due to vocabulary processing difficulties per se but instead cross-linguistic morphosyntactic interference. Moreover, analyses of translation errors suggest that learners tend to omit constructions that are implemented dissimilarly in L1 and L2, consistent with previous findings (Schachter, 1974).

Although participants in all of the present experiment's training groups learned to apply the various morphosyntactic rules to some extent, as illustrated by increasing scores in the three post-tests, implicit training conditions were associated with less robust learning. This result is partly in support of predictions of a strict version of the CPH, which postulates that adult L2 implicit learning is severely constrained. However, the present findings are more elegantly explained within a general-cognitive framework that accounts for L1 transfer effects and input characteristics as opposed to a biologically-specified age-based mechanism. Thus, the present results clearly point to an instructional advantage of attentional focus on critical aspects of the input, as predicted by the noticing hypothesis (Robinson, 1995; Schmidt, 1990). Instruction methods that achieve this goal, through typographical enhancement or other means, are likely to be more effective than simple exposure to unstructured input.

The present results contribute to our current understanding of the cognitive processes underlying L2 processing and learning and may hold critical implications for decisions regarding the improvement of existing L2 education programs and the design of future ones. In the US and the world, this type of research is important because we live in increasingly multi-lingual societies in which foreign language instructors want to know how to teach most effectively and efficiently. Some specific recommendations can be derived from the present results although, clearly, they do not encompass all aspects that are relevant to adult L2 learning. One such recommendation is that adult learners be exposed to L2 input that is structured and conducive to the noticing of patterns, particularly with respect to (morpho)syntax and phonology (e.g., Goldschneider & DeKeyser, 2005). Importantly, the present results suggest that instructors emphasize L2 linguistic structures that are commonly problematic for adult learners of specific linguistic backgrounds through increased salience in the input as well as targeted practice, while decreasing the focus on cross-linguistically similar features that are more easily acquired. Cross-linguistically dissimilar features could be made salient through form contrast (e.g., negative vs. positive examples, correct vs. incorrect), typographical enhancement or stress and intonation in oral production, and through examples directly contrasting L1 and L2 forms (Kupferberg, 1999; Kupferberg & Olshtain, 1996). Based on the present results, the use of rule explanations would be reserved for the teaching of features that are absent in L1, thus addressing their novelty, but not necessarily for the teaching of features that are instantiated differently in L1 and L2. In the latter case, not only may conflict between L1 and L2 rules ensue, but also salient input seems to be sufficient for the learning of dissimilar features. Despite these suggestions, differences in both comprehension and production abilities are likely to be observed depending on a number of factors, including individual differences in working memory and language learning aptitude.

Footnotes

1. An analysis of covariance (ANCOVA) examining post-test d-prime scores including initial L2 age of acquisition as a covariate was conducted to examine whether the difference between the Salience and Rule & Salience groups with regard to this variable affected performance. There were no significant effects or interactions with this variable ($p = .28$), suggesting that this difference was not responsible for the observed results.

2. In addition to time on task, the number of computerized iterations of training stimuli to which each participant was exposed was controlled during both vocabulary and grammar training. An analysis of the number of viewing trials of each vocabulary item and sentence pair showed no differences between groups ($p > .5$).

APPENDIX A

TRAINING PROTOCOLS IN EACH CROSS-LANGUAGE SIMILARITY TYPE FOR EACH INSTRUCTION GROUP

Similar

Control: | Salience:

De där pojkarna leker.

De där flickorna springer.

Den där flick**an** springer.

De där flick**orna** springer.

Rule & Salience:

Den där flick**an** springer.

De där flick**orna** springer.

Notice that the demonstratives "den/det där" are used with singular nouns and "de där" with plural nouns.

Dissimilar

Control:

Pojken leker.

Filckan springer.

Salience:

Pojke**n** leker.

En pojke leker.

Rule & Salience:

Pojke**n** leker.

En pojke leker.

Notice that definiteness is marked by attaching "(e)n" or "(e)t" to the end of a noun without the preceding articles "en/ett".

Unique

Control:

En ung pojke leker.

En fin flicka springer.

Salience:

En ung pojke leker.

Ett ung**t** djur leker.

Rule & Salience:

En ung pojke leker.

Ett ung**t** djur leker.

Notice that you add a "t" to adjectives that follow the "ett" article, but not the "en" article.

APPENDIX B

TRAINING MATERIALS

B.1 VOCABULARY

A [indefinite article]	En/Ett
That [demonstrative]	Den där/Det där
Those [demonstrative]	De där
I [pronoun]	Jag
She [pronoun]	Hon
He [pronoun]	Han
Boy [noun]	Pojke
Girl [noun]	Flicka
Bus [noun]	Buss
Woman [noun]	Kvinna
Car [noun]	Bil
Sandwich [noun]	Smörgås
Duck [noun]	Anka
Animal [noun]	Djur
Table [noun]	Bord
House [noun]	Hus
Bedroom [noun]	Sovrum
With [preposition]	Med
To play [verb]	Leker
To run [verb]	Springer
To take [verb]	Tar
To sleep [verb]	Sover
To own [verb]	Äger
To like [verb]	Gillar
To walk [verb]	Vandrar
To eat [verb]	Äter
To have [verb]	Har
Every morning [adverb]	Varje morgon
Every afternoon [adverb]	Varje eftermiddag
Proudly [adverb]	Stolt
Very much [adverb]	Mycket
Young [adjective]	Ung
Beautiful [adjective]	Fin
Old [adjective]	Gammal
White [adjective]	Vit

B.2 GRAMMAR

Sentence pair	Similar (Demonstrative determiner-noun number agreement)	Dissimilar (Singular noun phrase definiteness marking)	Unique (Indefinite singular article-adjective gender agreement)
1	Den där pojken leker. De där pojkarna leker.	Pojken leker. En pojke leker.	En ung pojke leker. Ett ungt djur leker.
2	Den där flickan springer. De där flickorna springer.	Flickan springer. En flicka springer.	En fin flicka springer. Ett fint djur springer.
3	Hon tar den där bussen varje morgon. Hon tar de där bussarna varje morgon.	Hon tar bussen varje morgon. Hon tar en buss varje morgon.	Hon tar en gammal buss. Hon tar ett gammalt bord.
4	Den där kvinnan sover. De där kvinnorna sover.	Kvinnan sover. En kvinna sover.	En ung kvinna sover. Ett ungt djur sover.
5	Jag äger den där bilen stolt. Jag äger de där bilarna stolt.	Jag äger bilen stolt. Jag äger en bil stolt.	Jag äger en gammal bil. Jag äger ett gammalt hus.
6	Hon gillar den där smörgåsen mycket. Hon gillar de där smörgåsarna mycket.	Hon gillar smörgåsen. Hon gillar en smörgås.	Han gillar en vit smörgås. Han gillar ett vitt bord.
7	Den där ankan vandrar. De där ankorna vandrar.	Ankan vandrar. En anka vandrar.	En fin anka vandrar. Ett fint djur vandrar.
8	Det där djuret äter varje eftermiddag. De där djuren äter varje eftermiddag.	Djuret äter varje eftermiddag. Ett djur äter varje eftermiddag.	Ett gammalt djur äter. En gammal kvinna äter.
9	Han äger det där bordet stolt. Han äger de där borden stolt.	Han äger bordet stolt. Han äger ett bord stolt.	Han äger ett vitt bord. Han äger en vit bil.
10	Det där huset har sovrum. De där husen har sovrum.	Huset har sovrum. Ett hus har sovrum.	Ett fint hus har sovrum. En fin buss har sovrum.

APPENDIX C

TESTING MATERIALS

C.1 GRAMMATICALITY JUDGMENT TASK

Note: Shown below is one of six versions of test sentences, which were counterbalanced for grammaticality, cross-language similarity, and post-test across participants.

Sent. Number	**Similarity**	**Grammaticality**	**Post-Test**	**Sentence**
Practice	Similar	Grammatical		Hon äger de där filtarna stolt.
Practice	Similar	Grammatical		Han tar den där flaskan varje eftermiddag.
Practice	Similar	Ungrammatical		Jag gillar de där ropet mycket.
Practice	Similar	Ungrammatical		Jag äger den där sofforna stolt.
Practice	Dissimilar	Grammatical		En sköterska vandrar.
Practice	Dissimilar	Grammatical		Fysikeren äter varje eftermiddag.
Practice	Dissimilar	Ungrammatical		En matematikeren sover.
Practice	Dissimilar	Ungrammatical		En forskaren leker.
Practice	Unique	Grammatical		En vis mästare springer.
Practice	Unique	Grammatical		Jag tar ett tunt stativ.
Practice	Unique	Ungrammatical		Hon äger ett stram fack.
Practice	Unique	Ungrammatical		Hon äger en brett vägg.
1	Similar	Grammatical	PT1	Hon tar det där betyget varje morgon.
2	Similar	Grammatical	PT1	Hon äter de där plommonen varje morgon.
3	Similar	Grammatical	PT1	Hon äter det där äpplet stolt.
4	Similar	Grammatical	PT1	Den där åsna vandrar.
5	Similar	Grammatical	PT1	Hon tar de där gängen stolt.
6	Similar	Grammatical	PT1	Hon äter den där sellerin varje eftermiddag.
7	Similar	Grammatical	PT1	Han tar den där lådan varje morgon.
8	Similar	Grammatical	PT1	Hon leker med den där leksaken stolt.
9	Similar	Grammatical	PT1	Hon gillar det där skärpet mycket.
10	Similar	Grammatical	PT1	Den där zebran sover.
11	Similar	Grammatical	PT1	Hon tar det där syskonet stolt.
12	Similar	Grammatical	PT1	Han gillar de där frukterna mycket.
13	Similar	Grammatical	PT1	Jag gillar de där kastanjerna mycket.
14	Similar	Grammatical	PT1	Jag tar den där vägen varje morgon.
15	Similar	Grammatical	PT1	Jag äger den där jackan stolt.
16	Similar	Grammatical	PT1	Den där åhöraren springer.
17	Similar	Ungrammatical	PT1	Jag äger de där resväskan stolt.
18	Similar	Ungrammatical	PT1	Hon äter de där köttet varje morgon.
19	Similar	Ungrammatical	PT1	Den där konstnärerna vandrar.

20	Similar	Ungrammatical	PT1	Han tar de där klotet mycket.
21	Similar	Ungrammatical	PT1	Han tar de där flygplanet stolt.
22	Similar	Ungrammatical	PT1	De där tjuren springer.
23	Similar	Ungrammatical	PT1	De där kassören vandrar.
24	Similar	Ungrammatical	PT1	De där träet springer.
25	Similar	Ungrammatical	PT1	Hon tar de fordonet varje morgon.
26	Similar	Ungrammatical	PT1	Jag tar den där måltiderna varje eftermiddag.
27	Similar	Ungrammatical	PT1	Han gillar den där penslarna mycket.
28	Similar	Ungrammatical	PT1	Hon tar de där strumpan varje morgon.
29	Similar	Ungrammatical	PT1	Hon äger de där konditoriet stolt.
30	Similar	Ungrammatical	PT1	Hon äter de där ägget varje morgon.
31	Similar	Ungrammatical	PT1	De där duvan vandrar.
32	Similar	Ungrammatical	PT1	De där pigan vandrar.
33	Dissimilar	Grammatical	PT1	Han gillar röret mycket.
34	Dissimilar	Grammatical	PT1	Han leker med plasten varje morgon.
35	Dissimilar	Grammatical	PT1	Kuriren sover.
36	Dissimilar	Grammatical	PT1	Hon äger tvålen stolt.
37	Dissimilar	Grammatical	PT1	Scouten springer.
38	Dissimilar	Grammatical	PT1	Arkitekten sover.
39	Dissimilar	Grammatical	PT1	Jag äger slipsen stolt.
40	Dissimilar	Grammatical	PT1	Han leker med yxan varje eftermiddag.
41	Dissimilar	Grammatical	PT1	Han tar myntet varje eftermiddag.
42	Dissimilar	Grammatical	PT1	Hon tar stoet varje morgon.
43	Dissimilar	Grammatical	PT1	Hon tar fönstret stolt.
44	Dissimilar	Grammatical	PT1	En dansör leker.
45	Dissimilar	Grammatical	PT1	Hon leker med örat varje eftermiddag.
46	Dissimilar	Grammatical	PT1	Han gillar en frukost mycket.
47	Dissimilar	Grammatical	PT1	En fasa vandrar.
48	Dissimilar	Grammatical	PT1	Hon gillar geväret mycket.
49	Dissimilar	Ungrammatical	PT1	En kaninen äter.
50	Dissimilar	Ungrammatical	PT1	Han gillar en kyrkan mycket.
51	Dissimilar	Ungrammatical	PT1	En advokaten vandrar.
52	Dissimilar	Ungrammatical	PT1	Hon äter en rovan varje morgon.
53	Dissimilar	Ungrammatical	PT1	Han gillar en kakan mycket.
54	Dissimilar	Ungrammatical	PT1	En aktören leker.
55	Dissimilar	Ungrammatical	PT1	Hon leker med en statyn varje morgon.
56	Dissimilar	Ungrammatical	PT1	Jag äger en börsen stolt.
57	Dissimilar	Ungrammatical	PT1	Han gillar en grädden mycket.
58	Dissimilar	Ungrammatical	PT1	Han gillar en boken mycket.
59	Dissimilar	Ungrammatical	PT1	Han tar en stolen varje morgon.
60	Dissimilar	Ungrammatical	PT1	En katten sover.
61	Dissimilar	Ungrammatical	PT1	En fågeln leker.
62	Dissimilar	Ungrammatical	PT1	Han tar en bunten varje morgon.

63	Dissimilar	Ungrammatical	PT1	En kamelen sover.
64	Dissimilar	Ungrammatical	PT1	En bocken springer.
65	Unique	Grammatical	PT1	Hon äger en farlig kriminal.
66	Unique	Grammatical	PT1	Jag gillar ett svårt språk.
67	Unique	Grammatical	PT1	En varm giraff springer.
68	Unique	Grammatical	PT1	Hon tar ett blankt verk varje morgon.
69	Unique	Grammatical	PT1	Han gillar ett kyligt erbjudande mycket.
70	Unique	Grammatical	PT1	Han tar en förnuftig tallrik varje eftermiddag.
71	Unique	Grammatical	PT1	Hon leker med en grov padda varje eftermiddag.
72	Unique	Grammatical	PT1	Hon äter ett fredligt ris.
73	Unique	Grammatical	PT1	Hon äter ett böjligt kex varje morgon.
74	Unique	Grammatical	PT1	Hon äter ett trendigt hallon.
75	Unique	Grammatical	PT1	Han gillar ett rödt spöke.
76	Unique	Grammatical	PT1	Han gillar ett jämnt lamm.
77	Unique	Grammatical	PT1	Hon äger en dyr klocka.
78	Unique	Grammatical	PT1	En artig främling leker.
79	Unique	Grammatical	PT1	Jag äger en kreativ lampa.
80	Unique	Grammatical	PT1	En stark komiker springer.
81	Unique	Ungrammatical	PT1	Hon leker med ett frasig rep varje eftermiddag.
82	Unique	Ungrammatical	PT1	En rikt skapare vandrar.
83	Unique	Ungrammatical	PT1	Han tar en blidt kurs varje eftermiddag.
84	Unique	Ungrammatical	PT1	En stadigt snickare springer.
85	Unique	Ungrammatical	PT1	En fornt drottning springer.
86	Unique	Ungrammatical	PT1	Han tar en färgrikt målning.
87	Unique	Ungrammatical	PT1	En dåsigt tupp springer.
88	Unique	Ungrammatical	PT1	Hon tar ett fattig bi varje morgon.
89	Unique	Ungrammatical	PT1	En sjukt förare vandrar.
90	Unique	Ungrammatical	PT1	En kunnigt schimpans vandrar.
91	Unique	Ungrammatical	PT1	Jag äger en tydligt cykel.
92	Unique	Ungrammatical	PT1	En rymligt bödel sover.
93	Unique	Ungrammatical	PT1	Han tar en skötsamt gata varje eftermiddag.
94	Unique	Ungrammatical	PT1	Han gillar en matvraket sylt mycket.
95	Unique	Ungrammatical	PT1	En dåligt diktare vandrar.
96	Unique	Ungrammatical	PT1	Han tar en magiskt korg varje eftermiddag.
1	Similar	Grammatical	PT2	Den där dirigenten sover.
2	Similar	Grammatical	PT2	Jag äger den där kvasten stolt.
3	Similar	Grammatical	PT2	Han leker med den där maskinen varje eftermiddag.
4	Similar	Grammatical	PT2	Hon äger det där förklädet stolt.
5	Similar	Grammatical	PT2	Han gillar den där ärten mycket.
6	Similar	Grammatical	PT2	Hon äger den där skulpturen stolt.
7	Similar	Grammatical	PT2	Jag äger den där vasen stolt.
8	Similar	Grammatical	PT2	Han gillar de där barnen mycket.
9	Similar	Grammatical	PT2	Den där gruppen vandrar.

10	Similar	Grammatical	PT2	Den där reptilen leker.
11	Similar	Grammatical	PT2	Den där munken springer.
12	Similar	Grammatical	PT2	Den där lotsen leker.
13	Similar	Grammatical	PT2	De där rävarna springer.
14	Similar	Grammatical	PT2	Hon tar det där ombudet varje morgon.
15	Similar	Grammatical	PT2	Den där tjuven vandrar.
16	Similar	Grammatical	PT2	Den där apan sover.
17	Similar	Ungrammatical	PT2	De där apotekaren vandrar.
18	Similar	Ungrammatical	PT2	De där krokodilen sover.
19	Similar	Ungrammatical	PT2	Hon tar de där nederlaget varje morgon.
20	Similar	Ungrammatical	PT2	Han gillar de där soppan mycket.
21	Similar	Ungrammatical	PT2	Han gillar de där hemmet mycket.
22	Similar	Ungrammatical	PT2	De där bävern sover.
23	Similar	Ungrammatical	PT2	De där eleven vandrar.
24	Similar	Ungrammatical	PT2	Han leker med den där flaggorna varje morgon.
25	Similar	Ungrammatical	PT2	Jag äger de där madrassen stolt.
26	Similar	Ungrammatical	PT2	Han gillar de där vapnet mycket.
27	Similar	Ungrammatical	PT2	Jag tar de där trumman varje eftermiddag.
28	Similar	Ungrammatical	PT2	De där elden springer.
29	Similar	Ungrammatical	PT2	De där atleten springer.
30	Similar	Ungrammatical	PT2	Hon gillar de där talet mycket.
31	Similar	Ungrammatical	PT2	De där pliten sover.
32	Similar	Ungrammatical	PT2	Jag gillar de där födan mycket.
33	Dissimilar	Grammatical	PT2	Han gillar en penna mycket.
34	Dissimilar	Grammatical	PT2	Kalkonen springer.
35	Dissimilar	Grammatical	PT2	En ödla sover.
36	Dissimilar	Grammatical	PT2	Han leker med en stjärna varje morgon.
37	Dissimilar	Grammatical	PT2	Jag äger en kni stoltv.
38	Dissimilar	Grammatical	PT2	En simmare vandrar.
39	Dissimilar	Grammatical	PT2	Hon äger spisen stolt.
40	Dissimilar	Grammatical	PT2	Hon äger en kam stolt.
41	Dissimilar	Grammatical	PT2	Konen vandrar.
42	Dissimilar	Grammatical	PT2	Jag tar noten varje eftermiddag.
43	Dissimilar	Grammatical	PT2	Hon tar lejonet varje morgon.
44	Dissimilar	Grammatical	PT2	Han gillar offret mycket.
45	Dissimilar	Grammatical	PT2	Hon äter vinbäret varje morgon.
46	Dissimilar	Grammatical	PT2	Hon gillar måttet mycket.
47	Dissimilar	Grammatical	PT2	En präst äter.
48	Dissimilar	Grammatical	PT2	Hon leker med häftet varje eftermiddag.
49	Dissimilar	Ungrammatical	PT2	Han tar en observatören varje eftermiddag.
50	Dissimilar	Ungrammatical	PT2	Hon äger en spegeln stolt.
51	Dissimilar	Ungrammatical	PT2	En arbetstagaren vandrar.
52	Dissimilar	Ungrammatical	PT2	Han leker med en musikern varje morgon.

53	Dissimilar	Ungrammatical	PT2	En kontoristen springer.
54	Dissimilar	Ungrammatical	PT2	Jag tar en duschen varje eftermiddag.
55	Dissimilar	Ungrammatical	PT2	En grävlingen springer.
56	Dissimilar	Ungrammatical	PT2	En vargen springer.
57	Dissimilar	Ungrammatical	PT2	Han gillar en honungen mycket.
58	Dissimilar	Ungrammatical	PT2	En juristen äter.
59	Dissimilar	Ungrammatical	PT2	En delfinen leker.
60	Dissimilar	Ungrammatical	PT2	En björnen sover.
61	Dissimilar	Ungrammatical	PT2	Hon äter en omeletten varje morgon.
62	Dissimilar	Ungrammatical	PT2	En byggaren springer.
63	Dissimilar	Ungrammatical	PT2	Hon äger en kängan stolt.
64	Dissimilar	Ungrammatical	PT2	En kusinen springer.
65	Unique	Grammatical	PT2	En verklig ledare vandrar.
66	Unique	Grammatical	PT2	En ovanlig vessla vandrar.
67	Unique	Grammatical	PT2	Hon äger ett saftigt paraply.
68	Unique	Grammatical	PT2	En begåvad hund springer.
69	Unique	Grammatical	PT2	Jag gillar ett känt föremål.
70	Unique	Grammatical	PT2	En grundlig noshörning vandrar.
71	Unique	Grammatical	PT2	En styv demonstrant vandrar.
72	Unique	Grammatical	PT2	Jag gillar ett mörkt skåp.
73	Unique	Grammatical	PT2	En blodig moster vandrar.
74	Unique	Grammatical	PT2	Han gillar ett fult svin.
75	Unique	Grammatical	PT2	Hon leker med en skamligt kollega.
76	Unique	Grammatical	PT2	Hon äter ett rostigt ostron.
77	Unique	Grammatical	PT2	Han leker med en farlig färg.
78	Unique	Grammatical	PT2	Jag äger en kryddig blus.
79	Unique	Grammatical	PT2	En fuktig myra vandrar.
80	Unique	Grammatical	PT2	Hon tar ett modigt tåg.
81	Unique	Ungrammatical	PT2	Jag gillar en glatt dryck.
82	Unique	Ungrammatical	PT2	En propert mus leker.
83	Unique	Ungrammatical	PT2	Hon gillar ett motsträvig fikon.
84	Unique	Ungrammatical	PT2	En tjockt berättare vandrar.
85	Unique	Ungrammatical	PT2	En nytt häst springer.
86	Unique	Ungrammatical	PT2	Jag äger en rödt kostym.
87	Unique	Ungrammatical	PT2	Han gillar en snabbt skinka.
88	Unique	Ungrammatical	PT2	En skärt fisk äter.
89	Unique	Ungrammatical	PT2	Han gillar en litet apelsin.
90	Unique	Ungrammatical	PT2	Hon tar ett grön sår.
91	Unique	Ungrammatical	PT2	Han gillar en kraftigt stek.
92	Unique	Ungrammatical	PT2	En långt prinsessa leker.
93	Unique	Ungrammatical	PT2	En tomt städare äter.
94	Unique	Ungrammatical	PT2	En vildt spion springer.
95	Unique	Ungrammatical	PT2	Hon äter en hårigt potatis.

96	Unique	Ungrammatical	PT2	Hon leker med ett smaklig träd.
1	Similar	Grammatical	PT3	Hon äger den där mattan stolt.
2	Similar	Grammatical	PT3	Den där barberaren sover.
3	Similar	Grammatical	PT3	Jag äger den där behån stolt.
4	Similar	Grammatical	PT3	Den där läkaren äter.
5	Similar	Grammatical	PT3	Hon leker med den där tejpen varje eftermiddag.
6	Similar	Grammatical	PT3	Hon gillar den där förslagen mycket.
7	Similar	Grammatical	PT3	Jag gillar de där pumporna mycket.
8	Similar	Grammatical	PT3	Han leker med den där grannen varje morgon.
9	Similar	Grammatical	PT3	Den där hönan vandrar.
10	Similar	Grammatical	PT3	Jag tar de där spårvagnarna varje eftermiddag.
11	Similar	Grammatical	PT3	Jag gillar det där bladet mycket.
12	Similar	Grammatical	PT3	De där juvelerarna vandrar.
13	Similar	Grammatical	PT3	Hon tar de där behållarna varje morgon.
14	Similar	Grammatical	PT3	De där ungarna sover.
15	Similar	Grammatical	PT3	Han gillar de där morötterna mycket.
16	Similar	Grammatical	PT3	De där optikerna sover.
17	Similar	Ungrammatical	PT3	De där strutsen springer.
18	Similar	Ungrammatical	PT3	Den där väktarna sover.
19	Similar	Ungrammatical	PT3	De där läraren leker.
20	Similar	Ungrammatical	PT3	Den där insekterna sover.
21	Similar	Ungrammatical	PT3	Jag äger den där skorna stolt.
22	Similar	Ungrammatical	PT3	Hon tar den där båtarna varje eftermiddag.
23	Similar	Ungrammatical	PT3	Han gillar de där fruntimret mycket.
24	Similar	Ungrammatical	PT3	Hon äter de där korven varje morgon.
25	Similar	Ungrammatical	PT3	Jag äger de där kastrullen stolt.
26	Similar	Ungrammatical	PT3	Han gillar de där alternativet mycket.
27	Similar	Ungrammatical	PT3	Han leker med de där utrustningen varje eftermiddag.
28	Similar	Ungrammatical	PT3	Han tar den där kuddarna varje morgon.
29	Similar	Ungrammatical	PT3	Han gillar den där jordgubbarna mycket.
30	Similar	Ungrammatical	PT3	Hon äger de där halsbandet stolt.
31	Similar	Ungrammatical	PT3	Den där ugglorna äter.
32	Similar	Ungrammatical	PT3	Han tar den där lektionerna varje morgon.
33	Dissimilar	Grammatical	PT3	Han gillar lunchen mycket.
34	Dissimilar	Grammatical	PT3	Hon tar hugget stolt.
35	Dissimilar	Grammatical	PT3	Jag äger hyllan stolt.
36	Dissimilar	Grammatical	PT3	Frisören äter.
37	Dissimilar	Grammatical	PT3	Hon tar skeppet varje morgon.
38	Dissimilar	Grammatical	PT3	Hon äger skjortan stolt.
39	Dissimilar	Grammatical	PT3	Hon äter körsbäret varje morgon.
40	Dissimilar	Grammatical	PT3	Hon leker med spöet varje morgon.
41	Dissimilar	Grammatical	PT3	Jag gillar silket mycket.
42	Dissimilar	Grammatical	PT3	Jag äger nyckeln stolt.

43	Dissimilar	Grammatical	PT3	En orm sover.
44	Dissimilar	Grammatical	PT3	Hon tar biträdet varje eftermiddag.
45	Dissimilar	Grammatical	PT3	Hon tar en kruka varje morgon.
46	Dissimilar	Grammatical	PT3	Han tar tefatet varje eftermiddag.
47	Dissimilar	Grammatical	PT3	Han leker med en boll stolt.
48	Dissimilar	Grammatical	PT3	Hon tar en kittel varje morgon.
49	Dissimilar	Ungrammatical	PT3	En bagaren äter.
50	Dissimilar	Ungrammatical	PT3	En soldaten springer.
51	Dissimilar	Ungrammatical	PT3	Han gillar en blåsten mycket.
52	Dissimilar	Ungrammatical	PT3	Han gillar en oliven mycket.
53	Dissimilar	Ungrammatical	PT3	Han tar en ryggsäcken varje morgon.
54	Dissimilar	Ungrammatical	PT3	En dottern leker.
55	Dissimilar	Ungrammatical	PT3	En målaren springer.
56	Dissimilar	Ungrammatical	PT3	En seglaren sover.
57	Dissimilar	Ungrammatical	PT3	Hon tar en portföljen varje eftermiddag.
58	Dissimilar	Ungrammatical	PT3	Jag gillar en linsen mycket.
59	Dissimilar	Ungrammatical	PT3	En mannen sover.
60	Dissimilar	Ungrammatical	PT3	Han gillar en örten mycket.
61	Dissimilar	Ungrammatical	PT3	Han gillar en gången mycket.
62	Dissimilar	Ungrammatical	PT3	Hon leker med en tändaren varje eftermiddag.
63	Dissimilar	Ungrammatical	PT3	Hon äter en grytan varje morgon.
64	Dissimilar	Ungrammatical	PT3	Hon äger en ugnen stolt.
65	Unique	Grammatical	PT3	Jag gillar en ensam ost.
66	Unique	Grammatical	PT3	Han leker med en dum kamrat.
67	Unique	Grammatical	PT3	Han gillar en senfärdig tidning.
68	Unique	Grammatical	PT3	En svår löpare springer.
69	Unique	Grammatical	PT3	Hon äger ett blå fönster.
70	Unique	Grammatical	PT3	En listig mekaniker äter.
71	Unique	Grammatical	PT3	En billig ekorre sover.
72	Unique	Grammatical	PT3	Han leker med en tung docka.
73	Unique	Grammatical	PT3	Jag gillar en rolig bröd.
74	Unique	Grammatical	PT3	En vänlig kamrer äter.
75	Unique	Grammatical	PT3	En berömd kock springer.
76	Unique	Grammatical	PT3	Hon äger en gul näsduken.
77	Unique	Grammatical	PT3	En driftig detektiv vandrar.
78	Unique	Grammatical	PT3	Hon leker med ett ljust fiskespö.
79	Unique	Grammatical	PT3	En hög aktris leker.
80	Unique	Grammatical	PT3	En fluffig fjärilen sover.
81	Unique	Ungrammatical	PT3	Hon äter ett grå bär.
82	Unique	Ungrammatical	PT3	En stiligt skräddare springer.
83	Unique	Ungrammatical	PT3	Han tar ett långsam badkar.
84	Unique	Ungrammatical	PT3	En ruskigt skribent vandrar.
85	Unique	Ungrammatical	PT3	En rundt betjänt sover.

86	Unique	Ungrammatical	PT3	Han gillar en klart rädisa.
87	Unique	Ungrammatical	PT3	En beskt bärare springer.
88	Unique	Ungrammatical	PT3	Hon tar ett bördig kollit.
89	Unique	Ungrammatical	PT3	En tålmodigt ingenjör äter.
90	Unique	Ungrammatical	PT3	Hon äter ett impulsiv korn.
91	Unique	Ungrammatical	PT3	Han gillar ett smutsig tak.
92	Unique	Ungrammatical	PT3	Hon tar ett orolig kuvert.
93	Unique	Ungrammatical	PT3	En stort pingvin vandrar.
94	Unique	Ungrammatical	PT3	Jag äger en hätskt mössa.
95	Unique	Ungrammatical	PT3	Hon äger ett brun spänne.
96	Unique	Ungrammatical	PT3	Han tar ett dyr brev.

C.2 TRANSLATION TASK

Sent. Number	Similarity	Sentence
		Translation Test 1
1	Similar	Those ducks sleep every afternoon.
2	Similar	I like those sandwiches very much.
3	Similar	He takes that bus every morning.
4	Similar	She owns that house proudly.
5	Dissimilar	A boy runs every morning.
6	Dissimilar	A girl sleeps every afternoon.
7	Dissimilar	He owns the car proudly.
8	Dissimilar	She runs with the animal.
9	Unique	I like an old house very much.
10	Unique	A young girl walks every afternoon.
11	Unique	A white woman plays.
12	Unique	She owns a beautiful table.
		Translation Test 2
1	Similar	I take that bus every afternoon.
2	Similar	Those women run every morning.
3	Similar	Those boys sleep every afternoon.
4	Similar	She takes that table.
5	Dissimilar	She likes a car very much.
6	Dissimilar	The duck plays every morning.
7	Dissimilar	He eats a sandwich every afternoon.
8	Dissimilar	An animal sleeps every morning.
9	Unique	He eats an old sandwich proudly.
10	Unique	She owns a white house.
11	Unique	I own a beautiful bus.
12	Unique	An old duck eats every morning.

APPENDIX D

CORRELATION TABLES 4 - 12

ERP Magnitude Differences In Each Post-Test/Cross-Language Similarity And MLAT, Set Size Span, And Total Span Scores In The Control, Salience, And Rule & Salience Groups

Note: N's are given below each Pearson r value. “Sim” = similar; “Diss” = dissimilar; “Unq” = unique.

* = Correlation is significant at the 0.05 level (2-tailed).

** = Correlation is significant at the 0.01 level (2-tailed).

Control group

Table 4. Correlations for the Similar Type in the Control group.

300 to 500 ms	Outliers excluded						Outliers included					
	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span
PT1_Sim	1.00	-0.22	.778*	0.61	-0.36	0.64	1.00	-0.26	.82**	0.43	0.49	.68*
	8	8	8	9	8	8	10	10	10	10	10	10
PT2_Sim	-.22	1.00	-.39	-.04	.90**	.02	-.26	1.00	-.26	-.11	.29	-.27
	8	8	8	9	8	8	10	10	10	10	10	10
PT3_Sim	.78*	-.39	1.00	.62	-.38	.80*	.82**	-.26	1.00	.58	.18	.54
	8	8	8	9	8	8	10	10	10	10	10	10
MLAT	.61	-.04	.62	1.00			.43	-.11	.58	1.00	.27	.53
	9	9	9	10			10	10	10	10	10	10
Set Size Span	-.36	.90**	-.38		1.00		.49	.29	.18	.27	1.00	.59
	8	8	8		10		10	10	10	10	10	10
Total Span	.64	.02	.80*			1.00	.68*	-.27	.54	.53	.59	1.00
	8	8	8			10	10	10	10	10	10	10

500 to 700 ms	Outliers excluded						Outliers included					
	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span
PT1_Sim	1.00	-0.59	0.50	0.41	-0.29	0.26	1.00	-0.59	0.50	0.33	0.38	0.61
	9	9	9	9	9	8	10	10	10	10	10	10
PT2_Sim	-.59	1.00	.13	.10	.06	.00	-.59	1.00	.13	.08	-.10	-.46
	9	9	9	9	9	8	10	10	10	10	10	10
PT3_Sim	.50	.13	1.00	.64	-.55	.65	.50	.13	1.00	.47	-.01	.37
	9	9	9	9	9	8	10	10	10	10	10	10
MLAT	.41	.10	.64	1.00			.33	.08	.47	1.00	.27	.53
	9	9	9	9			10	10	10	10	10	10
Set Size Span	-.29	.06	-.55		1.00		.38	-.10	-.01	.27	1.00	.59
	9	9	9		9		10	10	10	10	10	10
Total Span	.26	.00	.65			1.00	.61	-.46	.37	.53	.59	1.00
	8	8	8			8	10	10	10	10	10	10

Table 5. Correlations for the Dissimilar Type in the Control group.

300 to 500 ms	Outliers excluded						Outliers included					
	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span
PT1_Diss	1.00	.43	-.47	-.53	.10	.03	1.00	.655*	-.08	-.41	.09	.10
	9	9	9	9	9	9	10	10	10	10	10	10
PT2_Diss	.43	1.00	-.25	-.21	.03	-.43	.655*	1.00	-.03	-.22	.04	-.30
	9	9	9	9	9	9	10	10	10	10	10	10
PT3_Diss	-.47	-.25	1.00	.25	-.35	-.15	-.08	-.03	1.00	.21	-.32	-.12
	9	9	9	9	9	9	10	10	10	10	10	10
MLAT	-.53	-.21	.25	1.00	.28	.54	-.41	-.22	.21	1.00	.27	.53
	9	9	9	9	9	9	10	10	10	10	10	10
Set Size Span	.10	.03	-.35	.28	1.00	.59	.09	.04	-.32	.27	1.00	.59
	9	9	9	9	9	9	10	10	10	10	10	10
Total Span	.03	-.43	-.15	.54	.59	1.00	.10	-.30	-.12	.53	.59	1.00
	9	9	9	9	9	9	10	10	10	10	10	10

500 to 700 ms	Outliers excluded						Outliers included					
	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span
PT1_Diss	1.00	.741*	-.06	-.14	-.10	.15	1.00	.741*	-.06	-.14	-.10	.15
	10	10	10	10	10	10	10	10	10	10	10	10
PT2_Diss	.741*	1.00	-.07	-.04	.14	-.16	.741*	1.00	-.07	-.04	.14	-.16
	10	10	10	10	10	10	10	10	10	10	10	10
PT3_Diss	-.06	-.07	1.00	.10	-.48	-.42	-.06	-.07	1.00	.10	-.48	-.42
	10	10	10	10	10	10	10	10	10	10	10	10
MLAT	-.14	-.04	.10	1.00	.27	.53	-.14	-.04	.10	1.00	.27	.53
	10	10	10	10	10	10	10	10	10	10	10	10
Set Size Span	-.10	.14	-.48	.27	1.00	.59	-.10	.14	-.48	.27	1.00	.59
	10	10	10	10	10	10	10	10	10	10	10	10
Total Span	.15	-.16	-.42	.53	.59	1.00	.15	-.16	-.42	.53	.59	1.00
	10	10	10	10	10	10	10	10	10	10	10	10

Table 6. Correlations for the Unique Type in the Control group.

300 to 500 ms	Outliers excluded						Outliers included					
	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span
PT1_Unq	1.00	-.40	-.49	-.50	-.35	-.38	1.00	-.40	-.49	-.50	-.32	-.22
	10	10	10	10	9	9	10	10	10	10	10	10
PT2_Unq	-.40	1.00	.23	.41	-.42	-.29	-.40	1.00	.23	.41	-.21	-.13
	10	10	10	10	9	9	10	10	10	10	10	10
PT3_Unq	-.49	.23	1.00	.20	-.25	-.19	-.49	.23	1.00	.20	-.26	-.33
	10	10	10	10	9	9	10	10	10	10	10	10
MLAT	-.50	.41	.20	1.00			-.50	.41	.20	1.00	.27	.53
	10	10	10	10			10	10	10	10	10	10
Set Size Span	-.35	-.42	-.25		1.00		-.32	-.21	-.26	.27	1.00	.59
	9	9	9		10		10	10	10	10	10	10
Total Span	-.38	-.29	-.19			1.00	-.22	-.13	-.33	.53	.59	1.00
	9	9	9			10	10	10	10	10	10	10

500 to 700 ms	Outliers excluded						Outliers included					
	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span
PT1_Unq	1.00	-.17	-.27	-.53	-.34	.13	1.00	-.17	-.27	-.53	-.42	-.16
	10	10	10	10	9	9	10	10	10	10	10	10
PT2_Unq	-.17	1.00	.52	.56	-.742*	.01	-.17	1.00	.52	.56	-.31	-.04
	10	10	10	10	9	9	10	10	10	10	10	10
PT3_Unq	-.27	.52	1.00	.32	-.54	-.16	-.27	.52	1.00	.32	-.39	-.24
	10	10	10	10	9	9	10	10	10	10	10	10
MLAT	-.53	.56	.32	1.00			-.53	.56	.32	1.00	.27	.53
	10	10	10	10			10	10	10	10	10	10
Set Size	-.34	-.742*	-.54		1.00		-.42	-.31	-.39	.27	1.00	.59
	9	9	9		9		10	10	10	10	10	10
Total Span	.13	.01	-.16			1.00	-.16	-.04	-.24	.53	.59	1.00
	9	9	9			9	10	10	10	10	10	10

Salience group

Table 7. Correlations for the Similar Type in the Salience group.

300 to 500 ms	Outliers excluded						Outliers included					
	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span
PT1_Sim	1.00 5	0.54 5	-0.44 5	-0.50 5	0.35 5	0.74 5	1.00 7	0.38 7	-0.35 7	-0.41 7	0.35 7	0.42 7
PT2_Sim	0.54 5	1.00 5	0.49 5	-.970** 5	-.897* 5	-0.09 5	0.38 7	1.00 7	-0.03 7	-.866* 7	-0.54 7	-0.11 7
PT3_Sim	-0.44 5	0.49 5	1.00 5	-0.52 5	0.18 5	-0.86 5	-0.35 7	-0.03 7	1.00 7	-0.25 7	-0.09 7	-.835* 7
MLAT	-0.50 5	-.970** 5	-0.52 5	1.00 7			-0.41 7	-.866* 7	-0.25 7	1.00 7	0.58 7	0.45 7
Set Size Span	0.35 5	-0.09 5	-0.86 5		1.00 7		0.35 7	-0.54 7	-0.09 7	0.58 7	1.00 7	0.55 7
Total Span	0.74 5	-0.09 5	0.55 7			1.00 7	0.42 7	-0.11 7	-.835* 7	0.45 7	0.55 7	1.00 7

500 to 700 ms	Outliers excluded						Outliers included					
	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span
PT1_Sim	1.00 6	-0.61 6	-0.15 6	-.862* 6	-0.47 6	-0.60 6	1.00 7	-0.06 7	0.14 7	-.819* 7	-0.10 7	-0.13 7
PT2_Sim	-0.61 6	1.00 6	-0.06 6	0.23 6	-0.40 6	0.09 6	-0.06 7	1.00 7	0.11 7	0.04 7	-0.18 7	0.26 7
PT3_Sim	-0.15 6	-0.06 6	1.00 6	0.32 6	0.43 6	-0.36 6	0.14 7	0.11 7	1.00 7	0.17 7	0.49 7	-0.17 7
MLAT	-.862* 6	0.23 6	0.32 6	1.00 6	0.76 6	0.66 6	-.819* 7	0.04 7	0.17 7	1.00 7	0.58 7	0.45 7
Set Size Span	-0.47 6	-0.40 6	0.43 6	0.76 6	1.00 6	0.49 6	-0.10 7	-0.18 7	0.49 7	0.58 7	1.00 7	0.55 7
Total Span	-0.60 6	0.09 6	-0.36 6	0.66 6	0.49 6	1.00 6	-0.13 7	0.26 7	-0.17 7	0.45 7	0.55 7	1.00 7

Table 8. Correlations for the Dissimilar Type in the Salience group.

300 to 500 ms	Outliers excluded						Outliers included					
	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span
PT1_Diss	1.00 5	-0.56 5	-0.14 5	-0.67 5	0.11 5	-0.17 5	1.00 7	-0.25 7	0.48 7	-0.15 7	-0.08 7	-0.12 7
PT2_Diss	-0.56 5	1.00 5	0.87 5	-0.01 5	-0.33 5	-0.06 5	-0.25 7	1.00 7	0.64 7	-0.25 7	-0.54 7	-0.17 7
PT3_Diss	-0.14 5	0.87 5	1.00 5	-0.49 5	-0.39 5	0.14 5	0.48 7	0.64 7	1.00 7	-0.24 7	-0.22 7	-0.15 7
MLAT	-0.67 5	-0.01 5	-0.49 5	1.00 7			-0.15 7	-0.25 7	-0.24 7	1.00 7	0.58 7	0.45 7
Set Size Span	0.11 5	-0.33 5	-0.39 5		1.00 7		-0.08 7	-0.54 7	-0.22 7	0.58 7	1.00 7	0.55 7
Total Span	-0.17 5	-0.06 5	0.14 5			1.00 7	-0.12 7	-0.17 7	-0.15 7	0.45 7	0.55 7	1.00 7

500 to 700 ms	Outliers excluded						Outliers included					
	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Span Size	Total Span	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Span Size	Total Span
PT1_Diss	1.00 7	0.30 7	0.50 7	0.16 7	0.65 6	-0.10 6	1.00 7	0.30 7	0.50 7	0.16 7	-0.20 7	0.41 7
PT2_Diss	0.30 7	1.00 7	-0.02 7	-0.13 7	-0.40 6	-0.67 6	0.30 7	1.00 7	-0.02 7	-0.13 7	-0.30 7	-0.07 7
PT3_Diss	0.50 7	-0.02 7	1.00 7	0.08 7	0.43 6	-0.22 6	0.50 7	-0.02 7	1.00 7	0.08 7	-0.05 7	0.14 7
MLAT	0.16 7	-0.13 7	0.08 7	1.00 7			0.16 7	-0.13 7	0.08 7	1.00 7	0.58 7	0.45 7
Span Size	0.65 6	-0.40 6	0.43 6		1.00 6		-0.20 7	-0.30 7	-0.05 7	0.58 7	1.00 7	0.55 7
Total Span	-0.10 6	-0.67 6	-0.22 6			1.00 6	0.41 7	-0.07 7	0.14 7	0.45 7	0.55 7	1.00 7

Table 9. Correlations for the Unique Type in the Salience group.

300 to 500 ms	Outliers excluded						Outliers included					
	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span
PT1_Unq	1.00 6	-0.56 6	0.18 6	0.00 6	-0.23 6	0.33 6	1.00 7	-0.19 7	0.52 7	0.20 7	-0.26 7	0.32 7
PT2_Unq	-0.56 6	1.00 6	-0.62 6	-0.52 6	0.18 6	-0.37 6	-0.19 7	1.00 7	-0.15 7	-0.33 7	0.12 7	-0.30 7
PT3_Unq	0.18 6	-0.62 6	1.00 6	0.16 6	-0.23 6	0.45 6	0.52 7	-0.15 7	1.00 7	0.34 7	-0.25 7	0.40 7
MLAT	0.00 6	-0.52 6	0.16 6	1.00 6	0.66 6	0.44 6	0.20 7	-0.33 7	0.34 7	1.00 7	0.58 7	0.45 7
Set Size Span	-0.23 6	0.18 6	-0.23 6	0.66 6	1.00 6	0.57 6	-0.26 7	0.12 7	-0.25 7	0.58 7	1.00 7	0.55 7
Total Span	0.33 6	-0.37 6	0.45 6	0.44 6	0.57 6	1.00 6	0.32 7	-0.30 7	0.40 7	0.45 7	0.55 7	1.00 7

500 to 700 ms	Outliers excluded						Outliers included					
	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span
PT1_Unq	1.00 6	-0.48 6	-0.19 6	-0.59 6	-0.75 6	-.955* 5	1.00 7	-0.18 7	0.31 7	-0.31 7	-0.70 7	-0.13 7
PT2_Unq	-0.48 6	1.00 6	-0.23 6	-0.40 6	0.24 6	0.25 5	-0.18 7	1.00 7	0.19 7	-0.21 7	0.17 7	-0.19 7
PT3_Unq	-0.19 6	-0.23 6	1.00 6	0.23 6	-0.25 6	0.30 5	0.31 7	0.19 7	1.00 7	0.40 7	-0.24 7	0.20 7
MLAT	-0.59 6	-0.40 6	0.23 6	1.00 6	0.66 6		-0.31 7	-0.21 7	0.40 7	1.00 7	0.58 7	0.45 7
Set Size Span	-0.75 6	0.24 6	-0.25 6	0.66 6	1.00 6		-0.70 7	0.17 7	-0.24 7	0.58 7	1.00 7	0.55 7
Total Span	-.955* 5	0.25 5	0.30 5			1.00 5	-0.13 7	-0.19 7	0.20 7	0.45 7	0.55 7	1.00 7

Rule & Salience group

Table 10. Correlations for the Similar Type in the Rule & Salience group.

300 to 500 ms												
	Outliers excluded						Outliers included					
	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Set Size Span	Total Span
PT1_Sim	1.00 9	-0.50 9	-0.26 9	-0.02 8	0.18 9	-0.11 10	1.00 11	-0.11 11	-0.11 11	0.18 10	0.42 11	0.19 11
PT2_Sim	-0.50 9	1.00 9	-0.11 9	0.09 8	-0.11 9	0.02 10	-0.11 11	1.00 11	0.21 11	-0.22 10	0.09 11	0.14 11
PT3_Sim	-0.26 9	-0.11 9	1.00 9	0.23 8	0.05 9	0.18 10	-0.11 11	0.21 11	1.00 11	-0.13 10	0.02 11	0.21 11
MLAT	-0.02 8	0.09 8	0.23 8	1.00 10			0.18 10	-0.22 10	-0.13 10	1.00 10	-0.25 10	-0.47 10
Set Size Span	0.18 9	-0.11 9	0.05 9		1.00 11		0.42 11	0.09 11	0.02 11	-0.25 10	1.00 11	0.38 11
Total Span	-0.11 10	0.02 10	0.18 10			1.00 11	0.19 11	0.14 11	0.21 11	-0.47 10	0.38 11	1.00 11

500 to 700 ms												
	Outliers excluded						Outliers included					
	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Span Size	Total Span	PT1_Sim	PT2_Sim	PT3_Sim	MLAT	Span Size	Total Span
PT1_Sim	1.00 10	-0.26 10	-0.13 10	0.47 9	0.29 9	0.00 10	1.00 11	-0.19 11	0.31 11	0.32 10	0.29 11	0.18 11
PT2_Sim	-0.26 10	1.00 10	-.687* 10	-0.11 9	0.38 9	0.28 10	-0.19 11	1.00 11	-0.60 11	-0.11 10	0.20 11	0.27 11
PT3_Sim	-0.13 10	-.687* 10	1.00 10	-0.40 9	-0.07 9	0.26 10	0.31 11	-0.60 11	1.00 11	-0.34 10	-0.10 11	0.35 11
MLAT	0.47 9	-0.11 9	-0.40 9	1.00 9			0.32 10	-0.11 10	-0.34 10	1.00 10	-0.25 10	-0.47 10
Span Size	0.29 9	0.38 9	-0.07 9		1.00 9		0.29 11	0.20 11	-0.10 11	-0.25 10	1.00 11	0.38 11
Total Span	0.00 10	0.28 10	0.26 10			1.00 10	0.18 11	0.27 11	0.35 11	-0.47 10	0.38 11	1.00 11

Table 11. Correlations for the Dissimilar Type in the Rule & Salience group.

300 to 500 ms												
	Outliers excluded						Outliers included					
	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span
PT1_Diss	1.00 11	0.56 11	0.22 11	-0.11 8	-0.10 11	-0.43 9	1.00 11	0.56 11	0.22 11	-0.08 10	-0.10 11	-0.27 11
PT2_Diss	0.56 .071 11	1.00 11	0.25 .453 11	-0.20 .631 8	0.51 .111 11	-0.21 .586 9	0.56 .071 11	1.00 11	0.25 .453 11	-0.27 .454 10	0.51 .111 11	0.11 .737 11
PT3_Diss	0.22 11	0.25 11	1.00 11	0.49 8	-0.36 11	0.21 9	0.22 11	0.25 11	1.00 11	0.33 10	-0.36 11	0.22 11
MLAT	-0.11 8	-0.20 8	0.49 8	1.00 8			-0.08 10	-0.27 10	0.33 10	1.00 10	-0.25 10	-0.47 10
Set Size Span	-0.10 11	0.51 11	-0.36 11		1.00 11		-0.10 11	0.51 11	-0.36 11	-0.25 10	1.00 11	0.38 11
Total Span	-0.43 9	-0.21 9	0.21 9			1.00 9	-0.27 11	0.11 11	0.22 11	-0.47 10	0.38 11	1.00 11

500 to 700 ms												
	Outliers excluded						Outliers included					
	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span	PT1_Diss	PT2_Diss	PT3_Diss	MLAT	Set Size Span	Total Span
PT1_Diss	1.00 11	0.29 11	-0.21 11	0.05 10	-0.12 11	-0.37 11	1.00 11	0.29 11	-0.21 11	0.05 10	-0.12 11	-0.37 11
PT2_Diss	0.29 .379 11	1.00 11	-0.51 .108 11	-0.24 .505 10	.700* .016 11	-0.12 .729 11	0.29 .379 11	1.00 11	-0.51 .108 11	-0.24 .505 10	.700* .016 11	-0.12 .729 11
PT3_Diss	-0.21 11	-0.51 11	1.00 11	0.42 10	-0.16 11	0.35 11	-0.21 11	-0.51 11	1.00 11	0.42 10	-0.16 11	0.35 11
MLAT	0.05 10	-0.24 10	0.42 10	1.00 10	-0.25 10	-0.47 10	0.05 10	-0.24 10	0.42 10	1.00 10	-0.25 10	-0.47 10
Set Size Span	-0.12 11	.700* 11	-0.16 11	-0.25 10	1.00 11	0.38 11	-0.12 11	.700* 11	-0.16 11	-0.25 10	1.00 11	0.38 11
Total Span	-0.37 11	-0.12 11	0.35 11	-0.47 10	0.38 11	1.00 11	-0.37 11	-0.12 11	0.35 11	-0.47 10	0.38 11	1.00 11

Table 12. Correlations for the Unique Type in the Rule & Salience group.

300 to 500 ms												
	Outliers excluded						Outliers included					
	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span
PT1_Unq	1.00 11	0.26 11	0.44 11	0.31 10	.731* 10	0.24 10	1.00 11	0.26 11	0.44 11	0.31 10	0.54 11	0.11 11
PT2_Unq	0.26 .435 11	1.00 11	0.01 .971 11	0.18 .628 10	0.63 .050 10	0.11 .765 10	0.26 .435 11	1.00 11	0.01 .971 11	0.18 .628 10	0.56 .074 11	-0.21 .542 11
PT3_Unq	0.44 11	0.01 11	1.00 11	-0.04 10	0.34 10	0.22 10	0.44 11	0.01 11	1.00 11	-0.04 10	0.28 11	0.16 11
MLAT	0.31 10	0.18 10	-0.04 10	1.00 10			0.31 10	0.18 10	-0.04 10	1.00 10	-0.25 10	-0.47 10
Set Size Span	.731* 10	0.63 10	0.34 10		1.00 10		0.54 11	0.56 11	0.28 11	-0.25 10	1.00 11	0.38 11
Total Span	0.24 10	0.11 10	0.22 10			1.00 10	0.11 11	-0.21 11	0.16 11	-0.47 10	0.38 11	1.00 11

500 to 700 ms												
	Outliers excluded						Outliers included					
	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span	PT1_Unq	PT2_Unq	PT3_Unq	MLAT	Set Size Span	Total Span
PT1_Unq	1.00 11	0.24 11	0.34 11	.780* 9	0.25 11	-0.18 11	1.00 11	0.24 11	0.34 11	.636* 10	0.25 11	-0.18 11
PT2_Unq	0.24 .480 11	1.00 11	-0.23 .491 11	0.17 .667 9	0.32 .334 11	-0.39 .235 11	0.24 .480 11	1.00 11	-0.23 .491 11	0.13 .726 10	0.32 .334 11	-0.39 .235 11
PT3_Unq	0.34 11	-0.23 11	1.00 11	0.27 9	-0.28 11	0.27 11	0.34 11	-0.23 11	1.00 11	0.03 10	-0.28 11	0.27 11
MLAT	.780* 9	0.17 9	0.27 9	1.00 9			.636* 10	0.13 10	0.03 10	1.00 10	-0.25 10	-0.47 10
Set Size Span	0.25 11	0.32 11	-0.28 11		1.00 11		0.25 11	0.32 11	-0.28 11	-0.25 10	1.00 11	0.38 11
Total Span	-0.18 11	-0.39 11	0.27 11			1.00 11	-0.18 11	-0.39 11	0.27 11	-0.47 10	0.38 11	1.00 11

BIBLIOGRAPHY

Allen, M., Badecker, W., & Osterhout, L. (2003). Morphological analysis in sentence processing: An ERP study. *Language and Cognitive Processes, 18,* 405-430.

Andersson, A-B. (1992). *Second language learners' acquisition of grammatical gender in Swedish.* Gothenburg Monographs in Linguistics 10. University of Göteborg: Department of Linguistics.

Andersson, A-B. (1994). On the acquisition of gender in Swedish. *Proceedings of the XIVth Scandinavian conference of linguistics, 74,* 27-38. University of Göteborg, Sweden.

Benati, A. (2004). The effects of processing instruction and its components on the acquisition of gender agreement in Italian. *Language Awareness, 13,* 67-80.

Birdsong, D. (2005). Interpreting age effects in second language acquisition. In J. F. Kroll & de Groot (Eds.). *Handbook of Bilingualism: Psycholinguistic Approaches*. New York, NY: A. Oxford University Press.

Chen, L., Shu, H., Liu, Y., Zhao, J., & Li, P. (2007). ERP signatures of subject-verb agreement in L2 learning. *Bilingualism: Language and Cognition*, *10*, 161-174.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences,* 3rd edition, Lawrence Erlbaum Associates, Inc.: New Jersey.

Coren, S. (1992). *The left-hander syndrome: The causes and consequences of left-handedness*, Free Press: New York.

Coulson, S., King, J. W., & Kutas, M. (1998). Expect the unexpected: Event-related brain response to morphosyntactic violations. *Language and Cognitive Processes*, *13*, 21-58.

DeKeyser, R., & Larson-Hall, J. (2005). What does the critical period really mean? In J. Kroll & A. de Groot (Eds.). *Handbook of Bilingualism: Psycholinguistic approaches*. New York, NY: Oxford University Press.

Doughty, C. (1991). Second language instruction does make a difference: Evidence from an empirical study of SL relativization. Studies in Second Language Acquisition 13, 431-469.

Ellis, N. (1993). Rules and instances in foreign language learning: Interactions of explicit and implicit knowledge. *European Journal of Cognitive Psychology, 5*, 289 – 318.

Ellis, N. (2005). At the interface: dynamic interactions of explicit and implicit language knowledge. *SSLA*, *27*, 305-352.

Ellis, N. (2006). Selective attention and transfer phenomena in L2 acquisition : Contingency, cue competition, salience, interference, overshadowing, blocking, and perceptual learning. *Applied Linguistics*, *27*, 164-194.

Ellis, N., & Sagarra, N. (2010). Learned attention effects in L2 temporal reference: The first hour and the next eight semesters. *Language Learning 60*, 85–108.

Engle, R.W., Laughlin, J.E., Tuholski, S. W., & Conway, A. R. A. (1999). Working memory, short-term memory, and general fluid intelligence: A latent-variable approach. *Journal of Experimental Psychology, General*, *128*, 309-331.

Fender, M. (2003). English word recognition and word integration skills of native Arabic- and Japanese-speaking learners of English as a second language. *Applied Psycholinguistics, 24*, 289-315.

Frenck-Mestre, C., Osterhout, L., & McLaughlin, J. (2008). The effect of phonological realization of inflectional morphology on verbal agreement in French: Evidence from ERPs. *Acta Psychologica,* 128, 528-536.

Goldschneider, J. M. & DeKeyser, R. M. (2005). Explaining the "natural order of L2 morpheme acquisition" in English: A meta-analysis of multiple determinants. *Language Learning*, *51*, 1-50.

Green, D.M. & Swets, J.A. (1974). *Signal Detection Theory and Psychophysics.* New York: Wiley.

Greenhouse, S. W. & Geisser, S. (1959). On methods in the analysis of profile data. *Psychometrica*, 24, 95-112.

Hahne, A., Mueller, J.L., & Clahsen, H. (2006). Morphological processing in a second language: Behavioral and event-related brain potential evidence for storage and decomposition. *Journal of Cognitive Neuroscience, 18*, 121-34.

Han, Z.-H., Park, E. S., & Combs, C. (2008). Textual enhancement of input: Issues and possibilities. *Applied Linguistics*, *29*, 597–618.

Holcomb, P. J., Kounios, J., Anderson, J. E., & West, W. C. (1999). Dual-coding, context-availability, and concreteness effects in sentence comprehension : An electrophysiological investigation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *25*, 721-742.

Jasper, H.H. (1958). The ten twenty electrode system of the International Federation. *Clinical Neurophysiology, 10*, 371-375.

Johnson, J. S. & Newport, E. L. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology, 21*, 60-99.

Jourdenais, R. M., Ota, M., Stauffer, S., Boyson, B., & Doughty, C. (1995). Does textual enhancement promote noticing? A think-aloud protocol analysis. In R. Schmidt (ed): *Attention and Awareness in Foreign Language Learning*. Honolulu: University of Hawaii Press, pp. 182-209.

Juffs, A. (2006). Processing reduced relative versus main verb ambiguity in English as a Second Language: A replication study with working memory. In R. Slabakova, S. Montrul & P. Prevost (Eds.), *Inquiries in Linguistic Development in Honor of Lydia White* (pp. 213-232). Amsterdam: John Benjamins.

Kaan, E. & Swaab, T.Y. (2003). Repair, revision, and complexity in syntactic analysis: An electrophysiological differentiation. *Journal of Cognitive Neuroscience, 15*, 98-110.

Keating, G. D. (2009). Sensitivity to violations of gender agreement in native and nonnative Spanish: An eye-movement investigation. *Language Learning, 59,* 503-535.

Kim, A., & Osterhout, L. (2005). The independence of combinatory semantic processing: Evidence from event-related potentials*. Journal of Memory and Language, 52*, 205-225.

Kupferberg, I. (1999). The cognitive turn of contrastive analysis: Empirical evidence. *Language Awareness, 8,* 210-22.

Kupferberg, I., & Olshtain, E. (1996). Explicit contrastive instruction facilitates the acquisition of difficult L2 forms. *Language Awareness, 5,* 149-165.

Kutas, M. & Hillyard, S. A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science, 207*, 203-205.

Kotz, S. A., Holcomb, P. J., & Osterhout, L. (2008). ERPs reveal comparable syntactic sentence processing in native and non-native readers of English. *Acta Psychologica, 128*, 514-527.

Lado, R. (1957). *Linguistics across Cultures: Applied Linguistics for Language Teachers*. Ann Harbor: University of Michigan Press.

LaPointe, L. B., & Engle, R. W. (1990). Simple and complex word spans as measures of working memory capacity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 1118–33.

Lee, S. (2007). Effects of textual enhancement and topic familiarity on Korean EFL students' reading comprehension and learning of passive form. *Language Learning*, *57*, 87-118.

Lee, S.-K., & Huang, H.-T. (2008). Visual input enhancement and grammar learning: A meta-analytic review. *Studies in Second Language Acquisition, 30,* 307–331.

Lenneberg, E. (1967). *Biological foundations of language*. New York: Wiley & Sons.

MacWhinney, B. (2005). A unified model of language acquisition. In J. Kroll & A. de Groot (Eds.). *Handbook of Bilingualism: Psycholinguistic approaches*. New York, NY: Oxford University Press.

Martín-Loeches, M., Muñoz, F., Casado, P., Melcón, A., & Fernández-Frías, C. (2005). Are the anterior negativities to grammatical violations indexing working memory? *Psychophysiology, 42*, 508-519.

McDonald, J. L. (1987). Sentence interpretation in bilingual speakers of English and Dutch. *Applied Psycholinguistics, 8,* 379-413.

McLaughlin, J., Osterhout, L., & Kim, A. (2004). Neural correlates of second-language word learning: minimal instruction produces rapid change. *Nature Neuroscience 7,* 703-704.

McLaughlin, J., Tanner, D., Pitkänen, I., Frenck-Mestre, C., Inoue, K., Valentine, G., & Osterhout, L. (2010). Brain potentials reveal discrete stages of L2 grammatical learning. *Language Learning, 60,* 123–150.

Michael, E. B., & Gollan, T. H. (2005). Being and becoming bilingual: Individual differences and consequences for language production. *Handbook of Bilingualism: Psycholinguistic approaches*. New York, NY: Oxford University Press.

Morgan-Short, Sanz, Steinhauer, & Ullman (2010). Second language acquisition of gender

agreement in explicit and implicit training conditions: An event-related potential study. *Language Learning 60*, 154–193.

Norris, J. M., & Ortega, L. (2000). Effectiveness of L2 instruction: A research synthesis and quantitative meta-analysis. *Language Learning, 50,* 417-528.

Ojima, S., Nakata, H., & Kakigi, R. (2005). An ERP study of second language learning after childhood: Effects of proficiency. *Journal of Cognitive Neuroscience, 17,* 1212-1228.

Osterhout, L., & Holcomb, P.J. (1992). Event-related potentials elicited by syntactic anomaly. *Journal of Memory and Language, 31*, 785-806.

Osterhout, L., McLaughlin, J., Pitkänen, I., Frenck-Mestre, C., & Molinaro, N. (2006). Novice learners, longitudinal designs, and event-related potentials: A paradigm for exploring the neurocognition of second-language processing. *Language Learning, 56,* 199-230.

Overstreet, M. (1998). Text enhancement and content familiarity: The focus of learner attention. *Spanish Applied Linguistics, 2*, 229-258.

Parodi, T., Schwartz, B. D., & Clahsen, H. (2004). On the L2 acquisition of the morphosyntax of German nominals. *Linguistics, 42,* 669-705.

Picton, T. W., Bentin, S., Berg, P., Donchin, E., Hillyard, S. A., Johnson, Jr., R., Miller, G. A., Ritter, W., Ruchkin, D. S., Rugg, M. D., & Taylor, M. J. (2000). Guidelines for using human event-related potentials to study cognition: Recording standards and publication criteria. *Psychophysiology, 37*,127–152.

Pienemann, M., & Håkansson, G. (1999). A unified approach toward the development of Swedish as L2: A processability account. *Studies in Second Language Acquisition, 21*, 383-420.

Portin, M., Lehtonen, M., Harrer, G., Wande, E., Niemi, J., & Laine, M. (2008). L1 effects on the processing of inflected nouns in L2. *Acta Psychologica*, *128,* 452-465.

Robinson, P. (1995). Attention, memory, and the "noticing" hypothesis. *Language Learning, 45,* 283-331.

Robinson, P. (1997). Generalizability and automaticity of second language learning under implicit, incidental, enhanced, and instructed conditions. *Studies in Second Language Acquisition*, *19*, 223-47.

Rosa, E.M. & Leow, R. P. (2004). Computerized task-based exposure, explicitness, type of feedback, and Spanish L2 development. *The Modern Language Journal*, *88*, 192-216.

Rossi, S., Gugler, M.F., Friederici, A.D., & Hahne, A. (2006). The impact of proficiency on syntactic second-language processing of German and Italian: Evidence from event-related potentials. *Journal of Cognitive Neuroscience,18,* 2030-2048.

Sabourin, L., & Stowe, L. A. (2008). Second language processing: When are first and second languages processed similarly? *Second Language Research, 24,* 397-430.

Sabourin, L., Stowe, L. A, & Haan, G. J. (2006). Transfer effects in learning a second language grammatical gender system. *Second Language Research*, *22*, 1-29.

Sanz, C. & Morgan-Short, K. (2004). Positive evidence versus explicit rule presentation and explicit negative feedback: A computer-assisted study. *Language Learning*, *54*, 35-78.

Schachter, J. (1974). *An error in error analysis.* Paper presented at the Linguistic Society of America, Amherst Massachusetts, July 1974.

Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics, 11*, 129-158.

Sharwood Smith, M. (1993). Input enhancement in instructed SLA: Theoretical bases. *Studies in Second Language Acquisition, 15,* 165-79.

Spada, N., & Tomita, Y. (2010). Interactions between type of instruction and type of language feature: a meta-analysis. *Language Learning, 60*, 263-308.

Tan, L.H., Spinks, J.A., Feng, C., Siok, W.T., Perfetti, C.A., Xiong, J., Fox, P., & Gao, J. (2003). Neural systems of second language reading are shaped by native language. *Human Brain Mapping*, *18*, 158-166.

Thierry, G., & Wu, Y. J. (2007). Brain potentials reveal unconscious translation during foreign-language comprehension. *Proceedings of the National Academy of Sciences, 104,* 12530-12535.

Tokowicz, N., & MacWhinney, B. (2005). Implicit and explicit measures of sensitivity to violations in second language grammar. *Studies in Second Language Acquisition*, *27*, 173-204.

Tokowicz, N., Michael, E., & Kroll, J. F. (2004). The roles of study-abroad experience and working-memory capacity in the types of errors made during translation. *Bilingualism: Language and Cognition, 7,* 255-272.

Tokowicz, N., & Warren, T. (2010). Beginning adult learners' sensitivity to morphosyntactic violations: A self-paced reading study. *European Journal of Cognitive Psychology*. *22*, 1092-1106.

Tolentino, L.C., & Tokowicz, N. (2009). Are pumpkins better than heaven? An ERP investigation of order effects in the concrete-word advantage. *Brain & Language*, *110*, 12-22.

Tolentino, L.C., & Tokowicz, N. (2010). *The relationship between ERP and behavioral measures of second-language processing: The role of cross-language similarity*. Manuscript under review.

Tolentino, L.C., & Tokowicz, N. (2011). Across languages, space, and time: A review of the role of cross-language similarity in L2 (morpho)syntactic processing as revealed by fMRI and ERP. *Studies in Second Language Acquisition*, *33*, 1-34.

Ullman, M. T. (2001). The neural basis of lexicon and grammar in first and second language: the declarative/procedural model. *Bilingualism: Language and Cognition, 4,* 105-122.

VanPatten, B. & Cadierno, T. (1993). Explicit Instruction and Input Processing. *Studies in Second Language Acquisition, 15,* 225-43.

van Schie, H. T., Wijers, A. A., Mars, R. B., Benjamins, J. S., & Stowe, L. (2005). Processing of visual semantic information to concrete words: Temporal dynamics and neural mechanisms indicated by event-related brain potentials. *Cognitive Neuropsychology, 22*, 364-386.

Wardhaugh, R. (1970). The contrastive analysis hypothesis. *TESOL, 4,* 123-130.

Weber, K. & and Lavric, A. (2008). Syntactic anomaly elicits a lexico-semantic (N400) ERP effect in the second language but not the first. *Psychophysiology, 25*, 1-6.

Weber-Fox, C.M., & Neville, H.J. (1996). Maturational constraints on functional specializations for language processing: ERP and behavioral evidence in bilingual speakers. *Journal of Cognitive Neuroscience*, *8*, 231-256.