A Full Parse or a Shallow Structure in L2? An ERP Study of Anaphora in Successive-Cyclic *Wh*-movement in L1-Mandarin/L2-English

Kyle Swanson and Laurent Dekydtspotter

1. The Nature of L2 Knowledge and Processing

A central question in Generative Second Language Acquisition (GenSLA) has always been whether second languages that are learned in adulthood (L2s) are qualitatively similar to or different from native languages (L1s). As GenSLA research has advanced, it has sought to address this question at ever finer levels of granularity, making increasing use of empirical methods that can provide new types of evidence (DeLuca, Miller, Swanson & Rothman, to appear). In terms of L2 syntax, a critical mass of evidence indicates that L2 speakers can in principle acquire any grammatical property of natural language, whether or not it is instantiated in their L1; further, they can *only* acquire properties of natural language (White, 2003). However, speakers must also comprehend sentences that unfold incrementally during actual language use, so a further question has been to what extent L2 speakers can apply their L2 grammatical knowledge in real time. On the one hand, the Shallow Structure Hypothesis[1] (Clahsen & Felser, 2006) proposes that incremental sentence processing in L2 is limited to "argument structure representations of the input that capture thematic roles and other aspects of lexical-semantic structure, but which lack hierarchical detail and more abstract elements of syntactic structure" (p. 32). On the other hand, the Full Transfer/Full Access/Full Parse Hypothesis[2] (Dekydtspotter, Schwartz & Sprouse, 2006) states that L2 speakers reflexively (attempt to) compute complete syntactic representations. The Full Parse Hypothesis allows, however, that L2 speakers may fail to compute complete syntactic representations quickly or successfully, due to an increased upstream processing load. For example, L2 speakers must access

* Kyle Swanson, Purdue University, krswanso@purdue.edu; Laurent Dekydtspotter, Indiana University Bloomington, ldekydts@indiana.edu. This article comes from the first author's dissertation – see Swanson (2021) for full details on the study. We gratefully acknowledge the feedback received at BUCLD, as well as in the PoLaR Lab at UiT: The Arctic University of Norway and in the L2 Brain Lab and the Department of Second Language Studies at Indiana University Bloomington. All remaining errors are ours.

[1] See Clahsen and Felser (2018) for an updated iteration of the Shallow Structure Hypothesis, now about the relative order in which L2 speakers apply grammatical knowledge in comparison to knowledge about lexical semantics, pragmatics, and the like.

[2] Going forward, we call it only the Full Parse Hypothesis, to highlight the relevant aspect.

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lexis that is not as well entrenched as L1 lexis, and they need to manage the coactivation of their L1 grammatical knowledge.

Studies involving *wh*-dependencies have provided critical evidence about L2 sentence processing, because, in English and many other languages, *wh*-constituents do not appear in canonical position. For instance, consider (1a):

(1) a. What did the man read?

Direct objects typically must appear immediately after the thematic verb, but, in *wh*-questions about them, they instead appear in sentence-initial position. Research in generative syntax suggests that an unpronounced copy of the pronounced *wh*-phrase appears in the canonical position for direct objects (Chomsky, 1995), as the relevant syntactic representation for (1a) in (1b) shows:

(1) b. What did the man read *what*

In incremental parsing, computing unpronounced copies is argued to increase the activation of the *wh*-phrase itself in working memory (Fodor, 1978). Crucially, unpronounced copies are abstract, so the Shallow Structure Hypothesis predicts that L2 speakers should not be able to compute them in real time while the Full Parse Hypothesis predicts that they should. However, it is also possible that lexical representations and/or computations rather than syntactic ones could drive heightened activation of *what* at *read*, since *read* allows a direct object.

Several constructions avoid this confound. One influential test case has been islands – that is, syntactic environments that do not allow *wh*-dependencies to be established inside them (Ross, 1967). For example, consider (2):

(2) *What did [the man who read yesterday] arrive?

Here, the [island] blocks *what* from serving as the direct object for *read*. Since *arrive* is intransitive, *what* has no grammatical role, so (2) is ungrammatical. Importantly, L1 speakers robustly apply knowledge of island constraints such that they do not even consider *what* as a possible direct object for *read* as the sentence unfolds word by word. Similarly, studies have found that L2 speakers also respect island constraints in their incremental sentence processing, both when the L1 and L2 work similarly with respect to islands (Omaki & Schulz, 2011) and when they do not (Aldwayan, Fiorentino & Gabriele, 2010; Covey, 2018; Johnson, Fiorentino & Gabriele, 2016). Admittedly, there have been mixed findings regarding when syntactic knowledge applies during L2 sentence processing of islands (Boxell & Felser, 2017; Felser, Cunnings, Batterham & Clahsen, 2012; Kim, Baek & Tremblay, 2015) - See also Clahsen and Felser (2018). However, as Omaki and Schulz (2011) note with regard to their own study, “What the island constraints do is restrict the domain in which the parser searches for a gap; hence, the choice of representation alternatives (i.e., traces or direct lexical association) should not affect the expected reading-time pattern” (p. 571). Island constraints, then, do not necessarily identify the type of knowledge and/or processing at work in incremental L2 sentence processing. However, ensuring that test cases necessarily tap domain-specificity is a key priority for questions in GenSLA about qualitative similarities and differences between L1s and L2s.

For this reason, a substantial amount of research has focused on *wh*-dependencies across multiple clauses. They are an ideal test case because they involve unpronounced copies in positions where only syntax is at work. For example, (3) shows that an additional unpronounced copy is argued to be present at the bridge between clauses in such sentences:

(3) What did the man say *what* the girl read *what*?

Evidence from self-paced reading times indeed suggests that L1 speakers compute unpronounced copies in real-time (Gibson & Warren, 2004), independently of the properties of the bridge verb (Keine, 2020). However, studies about L2 speakers have yielded indeterminate, mixed and contested results. One representative series of studies is notable for all using the same materials. Using self-paced reading, Marinis, Roberts, Felser and Clahsen (2007) argued that their L1-Chinese, L1-German, L2-Greek and L1-Japanese L2-English speakers with intermediate and advanced proficiency did not compute intermediate unpronounced copies, but Dekydtspotter, Schwartz and Sprouse (2006) re-analyzed the data and argued that the L1-German and L1-Japanese L2-English speakers had done so, just at a delay. Also using self-paced reading, Pliatsikas and Marinis (2013) concluded that their L1-Greek advanced L2-English speakers with substantial immersion experience computed complete syntactic representations, whereas comparable speakers without substantial immersion experience did not. Likewise, using pupillometry, Fernandez, Höhle, Brock and Nickels (2018) inferred that their L1-German proficient L2-English speakers with substantial daily use of English computed unpronounced copies at the bridge between clauses. In a rare application of neurolinguistic methods to the study of domain-specificity (DeLuca, Miller, Swanson & Rothman, to appear; Roberts, González Alonso, Pliatsikas & Rothman, 2018), Pliatsikas, Johnstone and Marinis (2017) found possible evidence from fMRI that their L1-Greek proficient L2-English speakers with substantial immersion experience successfully computed real-time syntactic representations containing unpronounced copies. As this review makes clear, the language pairings and types of evidence brought forth have not been varied in entirely systematic fashion in this series of studies, given the focus on different aspects of the across-the-board predictions of the Shallow Structure Hypothesis.

Crucially, *wh*-dependencies across multiple clauses can involve anaphora:

(4) Which picture of himself$_{1/2}$ did Ben$_1$ say that Mike$_2$ liked on Facebook?

As the indices indicate, either *Ben* or *Mike* can bind *himself*. There is substantial debate over the precise mechanics that gives rise to these possibilities, but Barss (1986) seminally argued that the syntax of the *wh*-dependency plays a key role.

In particular, Binding Condition A requires a local antecedent for reflexives (Chomsky, 1995), so, extending the structure from (3b), *Ben* can bind *himself* locally at the intermediate unpronounced copy while *Mike* can bind it locally at the tail unpronounced copy. This construction has been used profitably to investigate various aspects L2 processing as, even beyond the abstract unpronounced copies, the Shallow Structure and Full Parse Hypotheses differ in their predictions about whether L2 speakers can compute in real time the hierarchical syntactic structures that binding relies on. For instance, Dekydtspotter and Gilbert (2019) argued on the basis of self-paced reading times that their L1-English advanced L2-French speakers computed anaphora at unpronounced *wh*-copies regardless of whether the task directed attention to syntax – i.e., through comprehension checks about anaphoric reference. In an extension, Dekydtspotter, Miller, Gilbert, Iverson, Swanson, Leal and Innis (2019) found ERPs consistent with computation of intermediate *wh*-copies (but not anaphora) in a similar group of speakers. Relatedly, manipulating whether pronouns inside the *wh*-phrases specified the gender of their antecedent, Dekydtspotter, Black, Frimu and Panwitz (2018) argued on the basis of cross-modal priming reaction times that L1-French speakers computed inferences that depended on anaphora for both types of pronouns, whereas L1-English advanced L2-French speakers only provided evidence for inferences that depended on computation of anaphora for gender-specified pronouns. Consonant with this claim, Dekydtspotter, Miller, Iverson, Xiong, Swanson and Gilbert (2021) found that, while L1-French and L1-English advanced L2-French speakers showed event-related spectral perturbations indicating attention to both domain-specific computations as well as inferences, L1 speakers showed greater power for the inferences in frequency bands where L2 speakers showed greater power for the syntactic computations. Importantly, English and French are similar in that they both require *wh*-phrases to be fronted and therefore allow anaphoric effects that depend on unpronounced *wh*-copies. It is important, then, to establish whether L2 speakers can compute anaphora in successive-cyclic *wh*-movement in real time when the L1 does not license it. Using self-paced reading tasks, Wang (2012) argued that her L1-English speakers and L1-Mandarin advanced L2-English speakers provided evidence for computation of anaphora at the sites of unpronounced copies. Given the lack of neurocognitive evidence, the current study takes shape. In particular, it uses ERPs to answer whether L2 speakers can compute real-time syntactic representations when the construction ensures domain specificity and no L1 analogue exists.

2. Study

2.1. Participants

25 L1-English speakers and 17 L1-Mandarin L2-English speakers took part in the study. L1-English speakers had an average age of 20.2 years, and L2-English speakers had an average age of 25.6 years. For L2 speakers, scores on Brown’s (1980) cloze ranged from 8-46 points out of a possible maximum of 49 points. Given this wide range and the lack of a natural break, L2 speakers were

divided into two groups based on the median score of 25 points. The scores from 9 participants fell below the median; the average score was 18.33 points, with a standard deviation of 4.42 points. Since this set of students had high enough proficiency to study in an American university, we refer to them as the Intermediate Proficiency Group. The scores from 8 participants fell above the median; the average score was 32.38 points, with a standard deviation of 8.16 points. We refer to this set of speakers as the Advanced Proficiency Group.

2.2. Design and Materials

The study used 128 critical items. They represented 32 quadruples on a 2x2 design that orthogonally crossed Pronominal (Reflexive | Pronoun) and Constituent (Singleton | Conjoint), as in Table 1:

Table 1. Conditions and Example Stimuli

Pronominal	Constituent	Example
Reflexive	Singleton	Which film of himself did Josh say that Sarah watched without anyone's permission?
Pronoun	Singleton	Which film of him did Ben say that Amy watched without anyone's permission?
Reflexive	Conjoint	Which film of both himself and Mary did Mike say that Rebecca watched without anyone's permission?
Pronoun	Conjoint	Which film of both him and Jessica did William say that Emily watched without anyone's permission?

Note: The names were rotated for each item to ensure that participants would attend to the sentences. During pre-piloting, 10 L1-Mandarin L2-English speakers were 100% accurate at identifying the gender for the 12 names used in the task.

In all cases, the matrix subject matched the pronominal in gender and the embedded subject mismatched it in gender. However, the pronominal and matrix subject were masculine in half of the quadruples and feminine in half.

Despite the four-way division in the table, syntactic theory proposes only a three-way division. Following Chomsky (1995), the singleton reflexive is subject to Binding Condition A, so *Ben* must bind it at the unpronounced copy at the bridge between clauses, because it is only there that *Ben* is sufficiently local. Binding Condition B requires that a singleton pronoun not be bound locally, so *Ben* can most naturally bind one at the tail unpronounced copy. The Singleton Reflexive and Singleton Pronoun conditions thus both require computation of binding domains, but not binding at the same position. In contrast, conjoined reflexives and conjoined pronouns are not subject to either Binding Condition and, though they are certainly bound semantically, syntax does not restrict whether binding takes place at the intermediate or tail unpronounced copy. In any case, the Conjoined Reflexive and Conjoined Pronoun conditions do not then involve the computation of a binding domain, so, no matter where they are bound, they will differ from the Singleton Reflexive and/or Singleton Pronoun condition.

2.3. Procedure

Participants were fitted with an EGI 64-sensor geodesic cap that had been soaked for 5 minutes in a solution of water, NaCl and baby shampoo. The cap was adjusted until impedances were <50kΩ. Participants were first given instructions for the task verbally and then again in writing. They were instructed to try to minimize their blinking during stimulus delivery, but to keep attention on reading. Participants completed 6 practice items.

During the task, the 128 critical items were delivered alongside 128 distractors that also involved *wh*-dependencies across multiple clauses. These 256 items were divided into 8 blocks such that no two items from the same quadruple appeared in each block. EPrime randomly ordered the order of blocks and items inside each block for each participant. After the first, third, fifth and seventh blocks, participants were encouraged to take a 30s break. After the second, fourth and sixth blocks, the sensors on the cap were refreshed until the impedances were again <50kΩ. In general, participants spent about 13m on each block.

Each item consisted of two or three parts. First, a context sentence appeared so that participants could anticipate the structure of the stimulus. The context sentence was always a thetic version of the stimulus, such as *Josh said that Sarah watched a film of him – that is, Josh – without anyone's permission* for the item from the Singleton Reflexive condition in Table 1. Participants were told to imagine that one friend was updating another friend about the latest episode of a favorite TV series, and that the first friend was saying the under-informative context statement. Wanting more details, the second friend asked the question in the stimulus. Participants read the context sentence, then pressed the spacebar to continue to the second part of each item, the stimulus. Each word was presented for 250ms, with a 300ms ISI, as in Dekydtspotter et al. (2019). Finally, 50% of items were followed by a true-false comprehension check.

2.4. Data Treatment and Statistical Analysis

The EEG data were manually preprocessed using the EEGLAB plugin (Delorme & Makeig, 2004) for MATLAB. First, data were filtered from .1-100Hz. A delay introduced by the amplifier was corrected using a dedicated script (I. Innis, p.c.). Electrodes whose impedances were >50kΩ at checkpoints or with abnormal data in >13 (~10%) epochs were removed. If >7 (~10%) electrodes were removed, the whole dataset was discarded. Any line noise was reduced using Cleanline (Mullen, 2012). The data were epoched from the Matrix Subject through the second word after the Embedded Verb, a 3.75s period. Trials with irreparable artifacts were discarded; if >39 (~30%) of trials were removed, the whole dataset was discarded. Independent Component Analysis with a Principle Component Analysis for 32 components was run, and components corresponding to artifacts were removed. Rejected electrodes were interpolated using the average reference. The data were re-referenced to average mastoids. The data for each word were baselined using the first 50ms of the word's presentation, following Dekydtspotter et al. (2019). See Swanson (2021) for a more detailed description of the pipeline as well as for the quality metrics.

The length of the *wh*-dependency was analyzed, from the Matrix Subject through the Embedded Verb. For each word, linear mixed models were computed in R for six time windows over six regions. The windows were 1-50ms, 51-150ms, 151-250ms, 251-350ms, 351-450ms and 451-550ms; the first window is the baseline, and the remaining five are equal divisions of the remaining presentation of the word and ISI. The six regions of interest were the Left, Midline, and Right Anterior as well as the Left, Midline and Right Posterior, as Figure 1 shows:

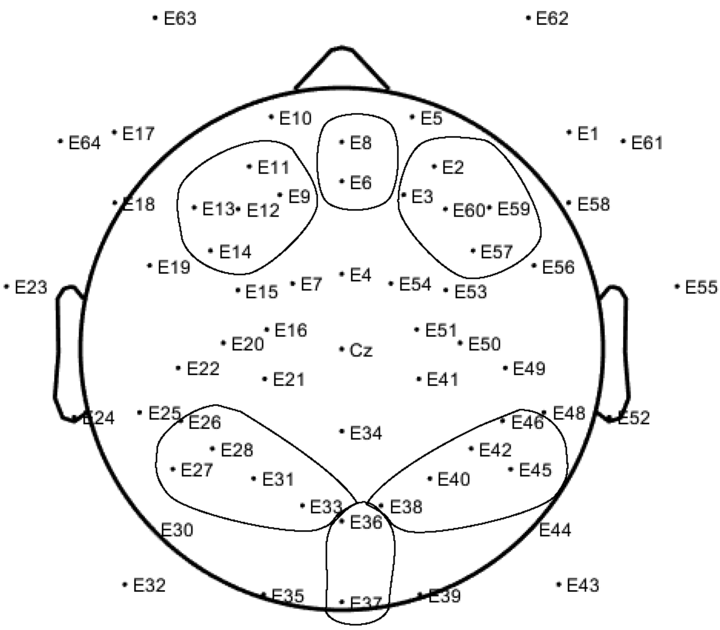

Figure 1. Regions of interest on EGI 64-sensor geodesic cap

For L1 speakers, fixed factors were PronominalType (Reflexive | Pronoun), ConstituentType (Singleton | Conjoint), and their interaction. For L2 speakers, fixed factors also included Proficiency (Intermediate | Advanced), as well as all interactions. Random intercepts were included for Participant using lmer; when models did not converge, Participant was removed and lm was used instead. Given the processing predictions that syntactic theory makes, only results relating to Pronominal*Constituent interactions and orthogonal contrasts are reported here. Pairwise comparisons for orthogonal contrasts were only conducted in the presence of such interactions. Interactions never existed in the presence of two overlapping main effects for Pronominal and Constituent. The α-level for all statistical tests was .05. If a significant effect appeared in the baseline and any later window, it is not reported here. Only significant tests are reported here; see Swanson (2021) for the full set of results.

3. Results

Table 2 shows the pattern of ERPs for L1 and L2 speakers:

Table 2. Overview of ERPs

Word	L1	L2	
	2-way	2-way	3-way
Matrix Subject	✗	✗	✓
Bridge Verb	✓	✓	✗
Complementizer	✗	✗	✗
Embedded Subject	✗	✓	✗
Embedded Verb	✓	✓	✓

Note. 2-way is Pronominal*Constituent; 3-way also includes Proficiency.

As Table 2 shows, the patterns of ERPs differed for L1 and L2 speakers.

As Table 2 shows, L1 speakers only yielded the predicted interactions at the predicted segments. At the Bridge Verb, only one effect appeared: a significant positivity over the Right Anterior from 351-450ms for the Singleton Pronoun condition in comparison to the Singleton Reflexive condition. It corresponds to the fact that Binding Condition A constrains singleton reflexive such that they must be bound here, whereas Binding Condition B constrains singleton pronouns so that they are not naturally bound here. The effect appears in Figure 2 on the next page.

At the Embedded Verb, two effects appeared. First, there was again a significant positivity for the Singleton Pronoun condition in comparison to the Singleton Reflection condition, this time from 51-150ms over the Midline Posterior and then from 151-250ms over the Left Anterior and Left Posterior. This contrast reflects the fact that Binding Condition A applies to singleton reflexives, so that they cannot be bound here, whereas Binding Condition B most naturally allows singleton pronouns to be bound in this position. Second, there was a significant positivity for the Conjoined Reflexive condition in comparison to the Singleton Reflexive condition, over the Left Anterior from 151-350ms and 451-550ms, as well as over the Left Posterior from 151-250ms. It minimally corresponds to the fact that Binding Condition A constraints singleton reflexives such that they cannot be bound here, whereas conjoined reflexives are not subject to Binding Condition A. Representative plots for the first and second effects appear in Figures 3 and 4, respectively.

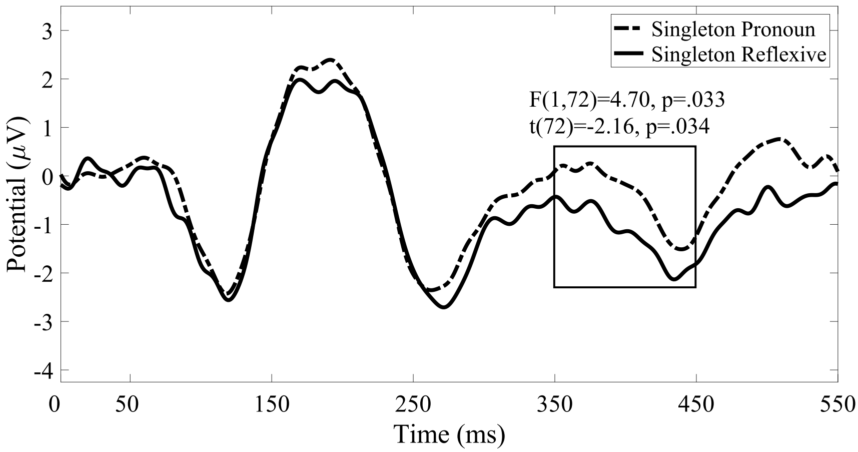

Figure 2. Bridge Verb - L1 Speakers, Right Anterior cluster

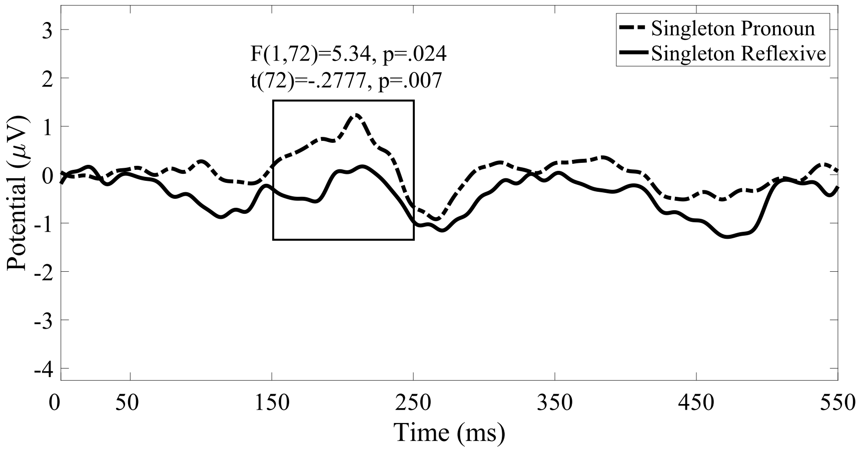

Figure 3. Embedded Verb - L1 Speakers, Left Posterior cluster

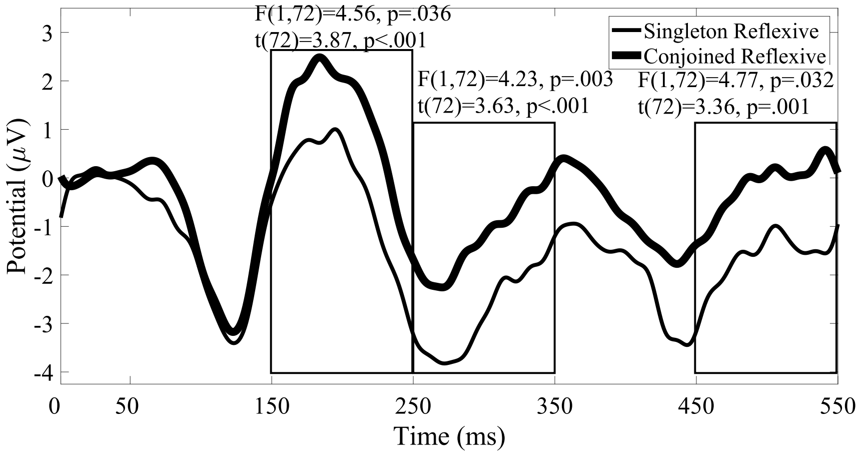

Figure 4. Embedded Verb – L1 Speakers, Left Anterior cluster

Turning to L2 speakers, Table 2 shows that they produced a more complex pattern of ERPs. However, to anticipate our interpretation, we will argue that it *does* suggest computation of anaphora on the basis of unpronounced copies.

At the Matrix Subject, advanced L2 speakers showed a positivity for the Singleton Reflexive condition in comparison to the Singleton Conjoint condition over the Right Posterior from 351-450ms. This effect must be interpreted with caution, for two reasons. First, no syntactic computation involving anaphora is argued to take place at this position. Second, each proficiency group contained only a small number of participants.

At the Bridge Verb, there was an explosion in the number of ERPs. All of these effects are, crucially, new – that is, they are not continuations or replications of effects from the Matrix Subject. As such, the processing of the Bridge Verb must have caused them. First, all L2 speakers yielded a positivity for the Singleton Pronoun condition in comparison to the Singleton Reflexive condition. As for the L1 speakers, it reflects the fact that singleton reflexives must be bound at this position whereas singleton pronouns are not naturally bound here. The effect ran from 51-550ms over the Left Posterior, with echoes over the Left Anterior from 251-350ms and over the Midline Posterior from 251-350ms. Figure 5 on the next page shows the effect over the Left Posterior.

Next, all L2 speakers produced a positivity for the Conjoined Reflexive condition in comparison to the Singleton Reflexive condition. It minimally reflects the fact that singleton reflexives require the computation of a binding domain, whereas conjoined reflexives do not. The effect was identical in timing and topographical distribution to the first effect. Figure 6 on the next page shows the effect over the Left Posterior.

Third, still among all L2 speakers, there was a positivity for the Singleton Pronoun condition in comparison to the Conjoined Pronoun condition. It is like the second effect in that, at a minimum, it corresponds to the fact that singleton pronouns, but not conjoined pronouns, require the computation of a binding domain. It surfaced over the Left Posterior from 251-350ms, then ran from 351-550ms over the Left Anterior, with a further echo over the Left Posterior from 451-550ms. Figure 7 on the next page shows the effect over the Left Anterior.

Finally, all L2 speakers yielded a positivity for the Conjoined Reflexive condition in comparison to the Conjoined Pronoun condition. Syntactic theory does not straightforwardly predict this effect. It ran from 251-550ms over the Left Posterior, with an echo over the Left Anterior from 451-550ms.

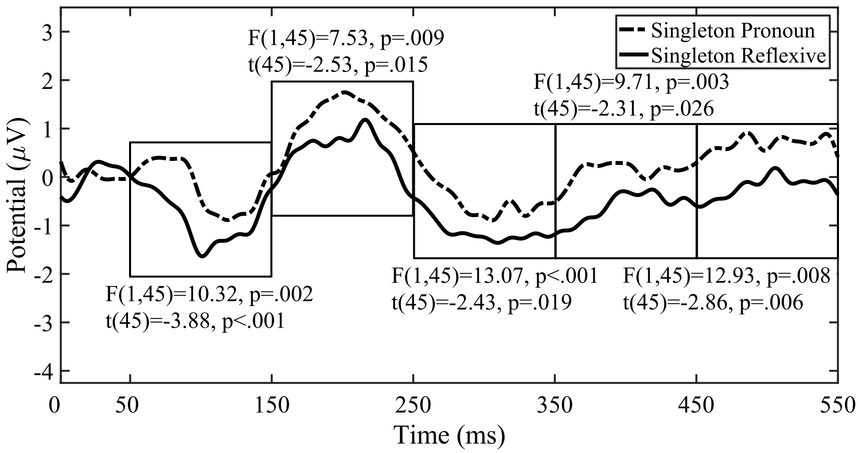

Figure 5. Bridge Verb – L2 Speakers, Left Posterior cluster

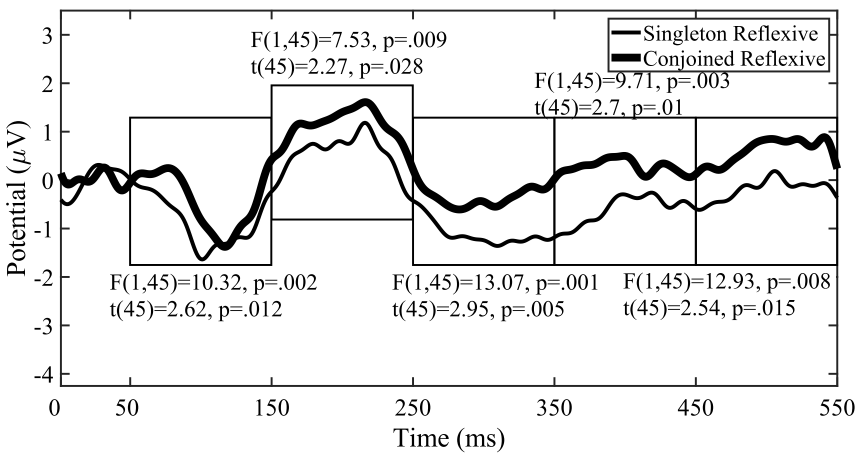

Figure 6. Bridge Verb – L2 Speakers, Left Posterior cluster

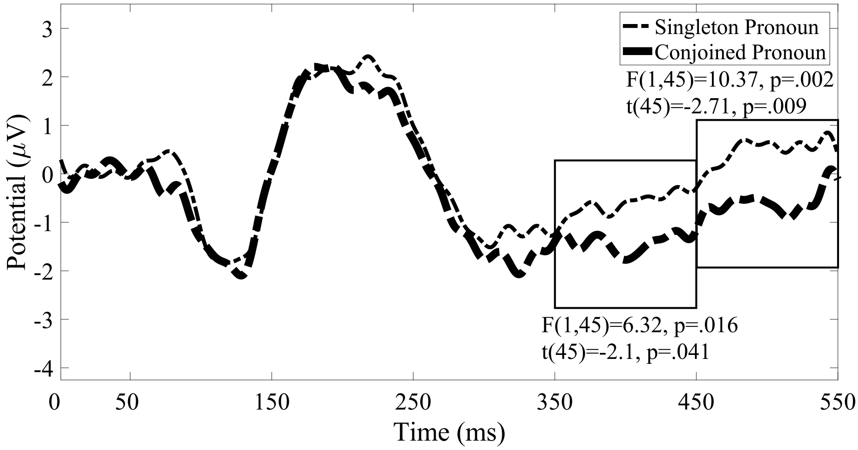

Figure 7. Bridge Verb – L2 Speakers, Left Anterior cluster

At the Embedded Subject, two effects surfaced for all L2 speakers over the Left Posterior from 151-250ms - first, a positivity for the Conjoined Reflexive condition in comparison to the Singleton Reflexive condition, and, second, a positivity for the Conjoined Reflexive condition in comparison to the Conjoined Pronoun condition. These ERPs must be interpreted cautiously, because anaphoric computations are not argued to occur here.

Finally, at the Embedded Verb, all L2 speakers yielded a positivity from 151-250ms over the Left Posterior for the Conjoined Pronoun condition in comparison to the Conjoined Reflexive condition. Like at the Bridge Verb, grammatical theory does not predict this difference. In any case, intermediate L2 speakers yielded two additional effects over the Right Posterior from 151-250ms. First, they produced a positivity for the Singleton Reflexive condition in comparison to the Singleton Pronoun condition. Like in previous positions, it corresponds to a difference in the application of Binding Conditions A and B to singleton reflexives and singleton pronouns, respectively. Furthermore, singleton reflexives cannot be bound at this position, whereas singleton pronouns most naturally are. Second, they produced a positivity for the Singleton Reflexive in comparison to the Conjoined Reflexive condition. At a minimum, it corresponds to the fact that Binding Condition A requires computation of a binding domain for the singleton reflexive, whereas conjunction obviates this computation.

4. Discussion

L1-English speakers yielded ERPs corresponding to contrasts in the computation of anaphora at positions that are coextensive with unpronounced copies, i.e. the Bridge and Embedded Verbs. These ERPs did not run across the length of the full dependency, so they cannot reflect a just difference in the burden on working memory for carrying *wh*-phrases of different sizes across a dependency. Relatedly, they also cannot reflect a difference in the burden on working memory for just computing unpronounced copies of different sizes. For example, at the Embedded Verb, the shorter condition yielded a positivity in comparison to the longer condition in the case of the Singleton Pronoun condition vs the Singleton Reflexive condition, whereas, in the case of Conjoined Reflexive condition vs the Singleton Reflexive condition, the longer condition yielded a positivity in comparison to the shorter condition. These ERPs from L1 speakers, then, straightforwardly conform to predictions for the real-time computation of syntactic representations for anaphora in successive-cyclic *wh*-movement.

For L2 speakers, the pattern of ERPs was more complex. In particular, it included interactions at the Matrix and Embedded Subjects, where no relevant computations are argued to take place. More importantly, L2 speakers produced an explosion of ERPs corresponding to contrasts in the computation of anaphora at the sites of unpronounced copies – again, the Bridge and Embedded Verbs. Crucially, these explosions included *new* contrasts; that is, they cannot represent continuations of previous effects. The Bridge Verb offers the strongest evidence, because advanced L2 speakers showed a single contrast at the Matrix Subject, whereas all L2 speakers showed all orthogonal contrasts at the Bridge Verb. In contrast, all L2 speakers showed two contrasts at the Embedded Subject, and the contrast that all L2 speakers showed at the Embedded Verb was one of them. Additionally, while the polarity reversed, the timing and topographical distribution were the same at the Embedded Subject and Verb. While intermediate L2 speakers showed two additional contrasts at the Embedded Verb, the small number of participants in each proficiency group limits the inferences that can be made. Like for L1 speakers, the emergence of new contrasts at the Bridge and Embedded Verbs rules out the possibility that these ERPs reflect ongoing working memory burdens. Likewise, the inconsistent polarity for longer vs. shorter *wh*-phrases suggests that the ERPs do not reflect only computation of unpronounced copies.

In sum, these L1-Mandarin L2-English speakers provide evidence for the real-time computation of anaphora in successive-cyclic *wh*-movement. Crucially, these representations must include abstract elements (unpronounced copies) and be hierarchical (for binding). The results thus align with predictions from the Full Parse Hypothesis (Dekydtspotter, Schwartz & Sprouse, 2006) and provide counterevidence to the Shallow Structure Hypothesis (Clahsen & Felser, 2006). Importantly, the construction used here ensures that domain-specific knowledge and computations are necessarily being tapped, unlike, for example, in studies about island constraints. Furthermore, these ERPs suggest that such representations are computed even when the L1 does not license the construction, extending the line of inquiry in Dekydtspotter et al. (2019) and Dekydtspotter et al. (2021) by excluding transfer and L1 co-activation. Finally, the study provides neurocognitive evidence, extending the line of inquiry in Wang (2012). While important aspects of L2 knowledge and use require further study, as the different ERP patterns, timing and topographies here suggest, the results more generally suggest that, even as the granularity of the question and the multidimensionality of the data increase, L1s and L2 are indeed qualitatively similar.

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