Priming Effects at Clause Edge in the Processing of English as a Second Language

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The present study explores whether or not L2 learners' real time grammatical processing differs from adult L1 speakers'. According to the Shallow Structures Hypothesis (SSH; Clahsen & Felser, 2006a, b), nonnative speakers (NNS) access only shallow representations during processing. This study tests the prediction made by the SSH more concretely, by investigating antecedent priming effects at intermediate gap positions during the processing of long distance wh-dependencies in L2 English, using a semantic priming task. High level NNSs showed crucial asymmetries: They responded faster to clause edge probes related to antecedents than to subjects, but not otherwise. Low level NNSs' reaction times were flat. They produced no reading-time asymmetries suggestive of intermediate traces or priming effects at gap position, unlike NSs under the same stimuli. In contrast, antecedent-priming at clause edge was discovered, suggesting intermediate traces left by cyclic movement. Priming effects at clause edge are prima facie reflexes of intermediate traces in NNS processing, suggesting that it is grammatically based.

I. INTRODUCTION

There are an increasing number of researches that investigate native speakers' (NSs) and nonnative speakers' (NNSs) sentence processing in real time using on-line techniques such as self-paced reading and semantic/cross-modal priming. One area of sentence comprehension that has been under the spotlight is the processing of filler-gap dependencies in sentences such as [Which professor; did John say [t; [Mary had respected t]]], in which, from a generative perspective of grammar, the dislocated constituent which professor is syntactically linked to its original direct object position (t) via an intermediate trace in the embedded CP-Spec position (t). More specifically, most of generative grammarians assume
that some kind of intermediate linguistic structure is manifest at intervening clause edges for dependencies extending more than one clause. This intermediate structure mediates between the filler and its ultimate gap. Generative syntacticians also assume that long-distance filler-gap dependencies are mediated by empty categories at intervening clause edges. They further posit a storyline that intermediate traces of the filler are located in the specifier position of intervening complementizer phrases (CPs). An example of what is usually labeled as successive cyclic wh-movement is provided as in the following (Marinis et al. 2005, p.55):

(1) Who, do you think [CP t₁'' [(that) John says [CP t₁' [(that) Mary likes t₂]]]]?

I will refer to the positions marked t₁'' and t₁' in (1) as intermediate gaps.

Antecedent reactivation effects in reading-time studies and priming experiments provide a major source of evidence indicating that syntactic gaps form part of the processing of sentence structure, by showing that at the intermediate gap sites the moved constituent is mentally reactivated (Clashen & Featherston, 1999; Felser & Roberts, 2007; Love & Swinney, 1996; Marinis et al., 2005; Roberts et al., 2007). As far as real-time processing is concerned, the filler cannot be fully integrated in the original gap position until it meets the predicate that subcategorizes the filler. Before reaching full integration, the filler should be temporarily stored in a short-term working memory (WM) and then wait to be integrated.

It is well documented that filler-gap dependencies impose a particular burden or challenge for the parser. A filler must be temporarily stored in WM until it can be linked to its subcategorizer or other licensor. This is assumed to incur a processing cost that increases with distance. Once a gap has been identified, the filler must be retrieved from WM and ultimately integrated with its subcategorizer to ensure that the sentence can be assigned a coherent interpretation. There is strong evidence from the adult L1 processing literature that having encountered filler, the parser attempts integrate it at the earliest grammatically possible point during the parse. More specifically, in processing long-distance wh-movement chains, the frontal wh-constituent is associated with all potential gap positions. The parser’s preference for keeping filler-gap dependencies as short as possible is known as Active Filler Strategy (AFS; Clifton & Frazier, 1989).

Exactly how filler integration is accomplished is still controversial. There are at
least two competing processing models in the psycholinguistics literature: the Direct Association Hypothesis (DAH) and the Trace Reactivation Hypothesis (TRH). According to DAH, fillers are directly linked to their lexical subcategorizer as soon as the filler encounters the subcategorizer, and semantically integrated into the subcategorizer’s argument structure. On the other hand, TRH claims that filler integration is mediated by empty syntactic categories such as traces, which form part of the grammatical representations built during parsing. It further maintains that a filler is retrieved from WM, or reactivate, when the parser has identified a potential syntactic gap, and irrespective of the position of its lexical subcategorizer. Findings from studies on long-distance wh-dependencies in English (Clashen & Felser 2006, 2007; Gibson & Warren 2004; and Marinis et al. 2005, among many others) provide evidence that adult L1 postulates syntactically-defined gaps during parsing. Replicating Gibson and Warren’s 2004 findings, and comparing sentences with and without extraction across either VPs or NPs, Marinis et al. (2005) provide evidence that English native speakers propose intermediate gaps during the processing of long-distance wh-dependencies, in accordance with the subjacency constraint. Their findings are consistent with a successive-cyclic version of the AFS hypothesis, according to which a filler is retrieved from WM at every grammatically possible gap position and not just upon encountering the lexical subcategorizer.

Modeled after Gibson and Warren (2004), the study of Marinis et al. (2005) investigates the processing of long-distance wh-dependencies in complex sentences in both L1 speakers and advanced adult L2 learners of English form different langue background. The following is their experimental sentences (from Felser & Roberts, 2007: 11):

(2) a. The nurse [who the doctor argued [that the rude patient had angered e1] is refusing to work late.

b. The nurse [who the doctor’s argument about the rude patient had angered e1] is refusing to work late.

For the L1 speakers, filler integration was facilitated by the presence of an intermediate gap in sentences involving extraction across a clause boundary in (2a),
which can be evidence of intermediate gap effect. This can be compared to sentences of the same length that did not contain an intermediate gap such as (2b). For the L2 learners, however, there was no intermediate gap effect. Results of Marinis et al. (2005) show that L1 speakers assume trace positions when processing long-distance wh-dependencies in English, whereas L2 learners do not. That is, intermediate gaps do not form part of the mental representations constructed during L2 processing. This finding provides further support for the hypothesis that L2 learners’ sensitivity to syntactic information with respect to L2 processing is restricted relative to that of L1 speakers. Their reported discrepancy between L2 learners’ comprehension capacities and on line sentence processing shows that L2 learners do not use native like, phrase structure based processing mechanism. Put differently, the L2 learners seem to process long-distance wh-dependencies in accordance with the DAH but not the TRH. Their finding in turn supports the hypothesis that the grammatical representations constructed during L2 processing are shallower than those built during L1 comprehension and lack abstract elements such as empty syntactic categories (Clashen & Felser 2006, 2007).

Clashen and Felser (2006a) propose a novel account of L2 processing, the shallow structure hypothesis (SSH). They propose the SSH to explain the differences reported in sentence processing in real time, according to which the syntactic representations computed by L2 learners during comprehension are shallower and less detailed than those computed by L1 speakers and involve more direct form function mappings. The hypothesis argues that learners immediately interpret incoming words in minimal semantic representations by assigning thematic roles to argument expressions and associating modifiers to their hosts. They are not mapping detailed and complete syntactic representations onto semantic representations. Clashen & Felser (2006a) further the claim by saying that although L2 learners are successful in drawing on lexical, morphological, and pragmatic sources of information, they underuse syntactic structure, which results in shallower and less detailed processing than that of native speakers. They in turn show that adult L2 learners differed from L1 speakers with a relatively high reading/listening span in that they did not show any evidence of structurally based antecedent reactivation at the point of the indirect object gap. Felser and Robert (2007) argue that results from the Greek speaking learners support the hypothesis.
that the mental representations built during non-native language processing lack abstract linguistic structure such as movement traces. They argue that the SSH predicts that although learners may be able to keep a filler in short-term memory and semantically associate it with an appropriate lexical head further downstream, filler integration will not be mediated by any structurally defined gaps. In order to test the prediction of the SSH, Felser and Roberts (2007) investigate antecedent priming effects at structural gap positions during the processing of indirect object dependencies in L2 English, using a cross-modal priming task.

The preliminary picture that has emerged thus far suggests that in processing syntactic dependencies, native speakers demonstrate lexical as well as structure-based effects. Of these, only the former were seen in L2 learners. To account for the observed L1 vs. L2 differences in processing, Clashen and Felser proposed the SSH, which claims that during L2 processing learners compute grammatical representations that lack complex hierarchical structure and abstract, configurationally determined elements such as movement traces, and that native-like grammatical processing is restricted to local domains such as word segmentation or morphosyntactic agreement between closely adjacent constituents. The purpose of the present study is to explain whether or not real-time grammatical processing in L2 learners differs from that of adult L1 speakers. More specifically, the current research tests the prediction made by the SSH more directly, by investigating antecedent priming effects at intermediate gap positions during the processing of long-distance wh-dependencies in L2 English, using a semantic priming task.

II. ANTECEDENT PRIMING IN SENTENCE PROCESSING

The semantic priming effect can be used to track activation of the words in a sentence. The semantic priming technique provides a useful tool for examining whether or not dislocated constituents are mentally reactivated at particular structural positions. It is critical to our interests that this technique can be used to examine when and where the traces related to an antecedent/subject are activated. If dislocated constituents are reactivated at (intermediate) gap positions, then participants’ response to targets semantically related or identical to the antecedent should be facilitated at the point of a gap, relative to non-gap (control) positions.
The antecedent priming effect observed at the point of the intermediate gap position indicates that the antecedent was retrieved from short memory, or reactivated, at its grammatically based position. In L1 sentence processing, antecedent reactivation at gap positions is known to be influenced by individual WM differences. In L2 sentence processing, on the contrary, successful comprehesion does not necessarily depend on participants’ constructing representations that include abstract linguistic structure such as movement traces.

In a cross-modal priming study examining long-distance scrambling constructions in Japanese, Nakano, Felser, and Clahsen (2002) provide evidence for the TRH by finding filler reactivation effects at the intermediate gap position—before the subcategorizing predicate had been encountered—of a scrambled direct object, but only for participants with a relatively high WM span. The low span participants appeared to be unable to hold the filler in WM for long enough, i.e., across three intervening NPs, before encountering the gap site.

Studies depending on the cross-modal technique have found that adult NSs mentally reactivate a dislocated constituent at structural position where generative syntactic theory would posit a trace of that constituent. Love and Swinney (1996) put forth a study based on English sentences that contain objective relative clauses as follows:

(3) Jimmy used the new pen that his mother-in-law recently #1 purchased #2.

In (3), the object the new pen is dislocated to the left of the verb purchased that subcategorizes the object. They found that lexical decision times at the position indicated by #2 in (3) were significantly shorter for visual targets that were semantically related to the object of the embedded verb than for unrelated ones. They also found that, on the contrary, at the pre-gap (control) position marked as #1 that precedes the predicate purchased, there was no such difference. These findings are consistent with the TRH, according to which the parser reactivates the grammatical features of the dislocated constituent at a potential gap site by creating a silent syntactic copy/trace of the antecedent.

Antecedent priming in (4-6 years old) children has been studied by Love and Swinney (2007). They adopted the cross-modal picture priming (CMPP) task to investigate object relative clauses such as the following:

(3) Jimmy used the new pen that his mother-in-law recently #1 purchased #2.
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(4) The zebra1 that the #1 hippo had kissed #2 on the nose ran far away.

In the study, participants were given pictures at the two positions indicated in (4), a picture of the dislocated direct object NP (i.e. zebra, the related target), a picture of an unrelated animal (e.g. a camel, the filler target). On the appearance of the target, participants were required to make a decision as to whether or not the item in the picture was edible. The results obtained for children were similar to those of an adult control group. An antecedent priming effect was found at the position indicated by #2 in (4) in that the participants’ decision times for related targets (e.g. for zebra in (4)) were significantly shorter than for unrelated ones, whereas at the control position (#1) there was no such difference. This finding provides prima facie evidence for antecedent reactivation of dislocated constituents.

However, Love and Swinney’s (1996, 2007) results could also be subject to an alternative explanation in terms of the DAH, according to which as soon as the subcategorizer is processed, a displaced argument will be linked to it directly. According to this view, reactivation effects for dislocated objects are the result of lexically processing the subcategorization frame of a transitive verb such as purchase in (3) and kiss in (4) and do not require the postulation of movement traces or syntactic gaps. To wrap up, the problem with Love and Swinney type researches is that it is not straightforward to decide whether this effect was due to trace reactivation or direct association of the dislocated antecedent with the subcategorizing verb. Clearly, more research is needed to determine whether NNSs truly activate antecedent at gap positions.

III. THE CURRENT STUDY

The purpose of the present study is to examine whether adult NNSs show trace reactivation effects, that is, antecedent priming at intermediate gap sites that are not adjacent to the subcategorizing verb. This is summarized as follows:

(5) Research question:
Do NNSs reactivate the antecedent at the intermediate gap position?

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The research question is accompanied by a couple of hypotheses in the following:

(6) **Hypotheses:**

a. Reaction times (RTs) to priming effects at the intermediate gap position are faster for antecedent condition than those for subject condition.

b. RTs to priming effects at the intermediate gap position with antecedent condition are faster than those at pre-gap position.

The logic of the current study is that if dislocated constituents are reactivated at the gap position, then participants' response to targets semantically related to the antecedent should be facilitated at the point of a gap, relative to non-gap (control) positions. More specifically, participants' RTs to probes (e.g., BOY or GIRL) related to the antecedent should be shorter than RTs to unrelated ones at the test position immediately following gap position—for example, the immediate post-complementizer *that* position—but not at an earlier control position—for example, within a PP that precedes the embedded clause(s).

**IV. METHOD**

1. **Participants**

40 NNSs of English participated in the current research, who were recruited from English language support courses at a major university in the United States. The NNSs' L1 background varied from Arabic (n=3), Burmese (n=1), Cantonese (n=3), Hindi (n=3), Japanese (n=2), Korean (n=24), Mandarin Chinese (n=2), Pashto (n=1) to Vietnamese (n=1). Their mean age was 22.24 ranging from 17 to 28. They had been resident in the English speaking communities for an average of 1.7 years ranging from 3 months to 7 years. In addition, as a control group, a group of 12 native speakers of English were recruited from undergraduate courses from a major University in the United States. The NS participants' mean age was 19 ranging from 18 to 24. All NS and NNS participants had normal vision and were not informed what the purpose of the current research would be. They received a small amount of extra credit toward the courses that they were enrolled in. The NNS mean score of the two C-tests was 69, ranging from 45/100 to 100/100.
did not adopt the C score, though, because I decided that accuracy was not reliable enough to use as a criterion of dividing the participation population in two proficiency groups: lower group vs. higher group. The NNS mean WM scores was 34, ranging from 42/17 to 42/44.

2. Materials

To determine the learners' general proficiency in English at the time of testing, all L2 and L1 participants completed two C tests. The materials for the test comprised a total of 100 blanks, 25 blanks per a paragraph. One of the two processing tasks was a WM task. The WM task consisted of 12 sets of a total of 42 sentences, each set of which increases with respect to number of sentences. Sets 1 to 3 contains two sentences, Sets 4-6 three sentences, Sets 7-9 four sentences, and Sets 10-12 five sentences, respectively. Half of the entire sets—Sets 2, 6, 7, 8, 9, and 11—included sentence(s) with grammatical errors: one ungrammatical sentence for sets 2 and 6, two ungrammatical sentences for sets 7, 8, 9, and 11, respectively.

The materials for the online semantic priming task comprised a total of 46 sentences, including 6 practice sentences, 20 experimental sentences, and 20 fillers. The reason for including the same number of fillers as experimental ones was to distract participants from recognizing the purpose of the current research, thus preventing the participants from developing any kinds of response strategies. Each of the experimental sentences came in a quadruple design as (7). The full set of experimental sentences is provided in Appendix A.

(7) a. Harry is who Mary said / on / Monday / that / BOY / the headmaster congratulated at the assembly.
b. Harry is who Mary said / on / Monday / that / GIRL / the headmaster congratulated at the assembly.
c. Harry is who Mary said / on / BOY / Monday / that / the headmaster congratulated at the assembly.
d. Harry is who Mary said / on / GIRL / Monday / that / the headmaster congratulated at the assembly.
Each sentence was dissected into six segments and each segment in turn was fed on the computer monitor bit by bit, during which one of two probes (BOY and GIRL) appeared. The rationale is that the BOY/GIRL property of the antecedent of the trace should be more prominent at trace position as the filler is integrated into the representation at that level. The probes were counterbalanced by designing four different types of tasks: Data collections A, B, C, and D. The purpose of the counterbalancing was to eliminate any effect of better known versus lesser known names. All experimental sentences and fillers were followed by a brief Yes No comprehension questions, the purpose of which was to make ascertain that the participants sure actively read the sentence.

3. Procedures

Each participant was tested individually at a laboratory in the same university. The two C tests on the one hand and the WM task and the online semantic priming task on the other were administered in two separate sessions with a week interval. In the first session of the C test, the participants were required to fill in four short paragraphs within a total of 20 minutes. In the paper and pencil task, the participants were asked to fill out as many words as possible in the limits of five minutes per paragraph.

In the second session, participants were asked to do two tasks. In the first ten minutes, each participant was seated in front of a 17" PC monitor and was asked to read 12 sets of a total of 42 sentences as a WM task. The participants were asked to read each sentence aloud and remember the last word of each sentence. At the end of each set, they were required to write down the last word of each sentence in the set in order presented and to indicate whether or not there were any grammatical errors in the set.

In the last ten minutes, they were assigned to do another reading exercise. They were asked to read 40 sentences on the 12" computer monitor for comprehension. Each sentence is preceded by a diamond symbol, where participants may pause if they need to. Otherwise, they were instructed to push the yellow button to start reading the sentence. Although they controlled their own reading, they were asked to read as quickly as possible and not stop until the next diamond. During at the end of each sentence, there followed a comprehension check. First, encountering a
Prompt either BOY or GIRL in large font, if BOY appeared, they were supposed to indicate whether a school boy had been mentioned. Likewise, if GIRL appeared, they were also supposed to indicate whether a school girl had been mentioned. They should use the green button for yes and the red one for no. The computer would measure time elapsing between button processes.

They were required to press the relevant button as soon as possible because the computer measured their reaction time. Their reading would be interrupted with a prompt to which they would react quickly by indicating whether the prompt matched a name in the sentence or not. At the end of each experimental sentence, a brief statement was offered as a summary of the facts ascribed in the sentence. They were required to either push the green button if the statement was correct or push the red button if the statement was wrong.

V. RESULTS

1. Accuracy

For analyzing the RT data, I followed common practice and included only those trials that were responded to correctly, removing trials for which BOY/GIRL probe was incorrect. For the experimental 20 items (excluding 20 fillers), the answer was always ‘yes’. If the participants responded six or more ‘no’ responses (i.e. below 75 % of accuracy rate), we eliminated them. 22 out the original 40 NNSs fulfilled this requirement, and our statistics is based on these 22 participants. In addition, they were 80 % accurate on comprehension checks.

Following Harrington and Sawyer (1992), I administered a working memory test, including the detection of ungrammaticality. The mean grammar score was nine out of 12. The higher proficiency group is made up of those who scored more than 9 (n=10), and the lower proficiency group less than 9 (n=12). Native speakers (n=12) were tested to show maximal expected means 11/12 for grammaticality score, 91 % accuracy on probes and 87 % on final judgments.

2. Reaction Times

RTs for experimental items were recorded in a spread sheet. As mentioned
above, I included only those 22 NNS trials that were responded correctly more than 75%, discarding trials for which the BOY/GIRL decision was incorrect more than 25%. I also excluded, for each of the four conditions, extreme RTs of means + 2 x SDs (for each condition: 2712, 2638, 2955, and 2942 ms, respectively). Missing values were replaced by the mean of each condition. Finally, outliers, i.e., RTs that were more than 2 SDs above or below the participant group’s mean per condition were removed from the dataset. Statistical analyses were performed on the remaining RT data from 22 NNSs.

High scoring NNSs showed crucial asymmetries: For high-span NNSs, RTs to the antecedent related probe were faster than those to the antecedent unrelated probe at the gap position. They were 1130 ms (7a) 1288 ms (7b). On the contrary, there was no advantage at all for the antecedent related probe at the earlier pre-gap (control) position: 1239 ms (7c) vs. 1243 ms (7d). A planned (one-tailed) t test revealed the difference at clause edge to be significant: t(9) = 1.993, p = .039. Lower scorers’ RTs were flat: 1110 (7a) vs. 1105 (7b) and 1216 (7c) vs. 1245 (7d) respectively.

I cannot provide any significant account for NSs’ performance because they displayed no crucial contrast at clause edge. If NSs deploy devices faster than NNSs, my stimulus that helped adequately measure NNSs is inadequate for NSs and vice versa. I will be collecting more NNS data and modifying the instrument in order to capture effects in NSs.

Table 1. Mean RTs (ms) for Trace/Non-trace by Proficiency Group Level

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<tr>
<th></th>
<th>Lower proficiency group (n = 12)</th>
<th>Higher proficiency group (n = 10)</th>
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<tbody>
<tr>
<td></td>
<td>+antecedent</td>
<td>-antecedent</td>
</tr>
<tr>
<td>Trace</td>
<td>1110 (379)</td>
<td>1105 (245)</td>
</tr>
<tr>
<td>Non-trace</td>
<td>1216 (321)</td>
<td>1245 (323)</td>
</tr>
</tbody>
</table>

*Standard deviations are in parentheses
Table 2. Task: Test of Research Questions: Planned T-tests

<table>
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<tr>
<th></th>
<th>Lower proficiency group (n = 12)</th>
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<tbody>
<tr>
<td>Research question 1</td>
<td>1110 vs 1105, p = .481 (one tailed)</td>
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<tr>
<td>Research question 2</td>
<td>1110 vs 1216, p = .096 (one tailed)</td>
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<th>Higher proficiency group (n = 10)</th>
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<tr>
<td>Research question 1</td>
<td>1130 vs 1288, t(9) = 1.993, p = .039 (one tailed)</td>
</tr>
<tr>
<td>Research question 2</td>
<td>1130 vs 1239, t(9) = 1.980, p = .101 (one tailed)</td>
</tr>
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VI. DISCUSSION

The most interesting result of this study is the priming effect obtained at intermediate gap positions in the NNS groups of high span participants. This finding receives a straightforward explanation from the TRH, according to which empty categories form part of the mental representations constructed during the processing of filler-gap dependencies. In my experimental sentences, the parser predicts an intermediate gap which reactivates the antecedent at the gap site and produces the observed priming effect. Note that the DAH, according to which a dislocated argument is directly linked to its subcategorizer, cannot explain the priming effect we found, as it occurred at a position that was not immediately adjacent to the subcategorizing verb. Only the TRH—but not the DAH—predicts such an effect at the later test point. That is, upon identifying a syntactic gap, the parser reconstructs the antecedent at this position even if it is not adjacent to the antecedent's lexical subcategorizer, and at a greater distance from the point at which the antecedent was first mentioned than the pre-gap control position.

This finding is AGAINST the results of previous studies on NNSs long-distance wh-dependencies (Felser & Roberts, 2007; Marinis et al., 2005). Clashen and Felser (2006) suggested that L2 learners typically perform partial or shallow parses only, that is, they construct syntactic representations that lack deep hierarchical structure, and abstract elements of phrase structure such as movement traces.

That antecedent priming effects were found in adult high span NNSs at the intermediate position not only supports a trace-based account of the processing of wh-dependencies. This finding also strongly challenges the SSH, which claims that during L2 processing learners compute grammatical representations that lack
complex hierarchical structure and abstract, configurationally determined elements such as movement traces (Clashen & Felser, 2006a, b). Because, in the current study, high-span NNSs showed a structurally determined antecedent priming effect of the kind that was observed in the high-span NSs, Felser and Roberts’ (2007) proposal should be given a second thought that that non-native comprehenders are unable to apply some of the parsing routines that are used in L1 comprehension.

The results from the present study are not consistent with Marinis et al’s (2005) finding that proficient learners of L2 English do not postulate any intermediate traces when processing long-distance wh-dependencies in their L2. Recall that, in their study, native speakers have been found to reconstruct the filler at structurally defined gap sites when processing filler-gap dependencies, in accordance with the TRH and that existing L2 processing studies, however, have thus far failed to find any evidence for trace-based gap-filling in non-native sentence processing. Their argument is that although NNSs are able to interpret sentences containing filler gap dependencies correctly, NNS comprehension does not involve any structure-driven gap-filling of the kind that has been observed in NSs.

VII. CONCLUSION

Contra Marinis et al (2005) and Felser and Roberts (2007) on the one hand and the SSH proposed by Clashen and Felser (2006a, b) on the other, my results challenge the hypothesis that the representations constructed during L2 processing lack such abstract grammatical devices as movement traces. Priming effects at clause edge are prima facie reflexes of intermediate traces in NNS processing, suggesting that it is grammatically based. The high-span NNSs in the present research showed evidence of structurally determined reactivation. My findings indicate that these data are problematic for the SSH and suggest that the data offered in its support require a different interpretation. This novel observation can be accounted for by assuming against the SSH that even NNSs are able to exploit finely-grained structural cues to interpretation. Needless to say, the hypothesis that NNS sentence processing involves intermediate traces must be supported by a range of studies consistent with their presence in various structures including long-distance wh-dependencies.
REFERENCES


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APPENDIX

LIST OF EXPERIMENTAL SENTENCES AND ACCOMPANYING COMPREHENSION CHECKS

1. Harry is who Mary said that the headmaster congratulated at the assembly.
   One student said that the headmaster congratulated someone.
   One student said that the headmaster warned someone.
2. Adam is who Amy learned that the drama teacher chose at the rehearsal.
   One student learned that the drama teacher chose someone.
   One student learned that the principal chose someone.
3. John is who Jane thought that the rabbit licked on the face.
   One student thought that the rabbit licked someone on the face.
   One student thought that the rabbit licked someone on the neck.
4. Matt is who Beth thought that the cheerleader admired at practice.
   One student thought that the cheerleader admired someone at practice.
   One student thought that the cheerleader admired someone in drama class.
5. Sam is who Sue reported that the bully kicked during recess.
   One student reported that the bully kicked someone during recess.
   One student reported that the bully kicked someone in class.
6. Kevin is who Karen noted that the bus driver forgot on Wednesday.
   One student noted that the bus driver forgot someone.
   One student noted that the bus driver remembered someone.
7. Jason is who Julie agreed that the principal scared on Monday.
   One student agreed that the principal scared someone.
   One student agreed that someone scared the principal.
8. Bill is who Jill concluded that the math teacher criticized in class.
   One student concluded that the math teacher criticized someone in class.
   One student concluded that the math teacher criticized someone during lunch break.
9. Tom is who Ann supposed that the student hit with his backpack.
   One student supposed that the student hit someone with his backpack.
   One student supposed that the student hit someone with his book.
10. Dave is who Kate declared that the track team outran on Friday.
    One student declared that the track team outran someone.
    One student declared that someone outran the track team.
11. Mary is who Harry explained that the hamster bit on the finger.
   One student explained that the hamster bit someone.
   One student explained that the snake bit someone.
12. Amy is who Adam stated that the hall monitor scolded one afternoon.
   One student stated that the hall monitor scolded someone.
   One student stated that the hall monitor helped someone.
13. Jane is who John said that the lunch lady ignored on pizza day.
   One student said that the lunch lady ignored someone.
   One student said that the lunch lady liked someone.
14. Beth is who Matt argued that the nurse examined in the office.
   One student argued that the nurse examined someone.
   One student argued that the nurse scolded someone.
15. Sue is who Sam insisted that the coach praised in the gym.
   One student insisted that the coach praised someone in the gym.
   One student insisted that the coach praised someone in the classroom.
16. Karen is who Kevin regretted that the students teased in class.
   One student regretted that the students teased someone in class.
   One student regretted that the students encouraged someone in class.
17. Julie is who Jason realized that the monitor helped at recess.
   One student realized that the monitor helped someone.
   One student realized that the monitor punished someone.
18. Jill is who Bill insisted that the counselor advised in his office.
   One student insisted that the counselor advised someone.
   One student insisted that the principal advised someone.
19. Ann is who Tom swore that the janitor discovered in the classroom.
   One student swore that the janitor discovered someone in the classroom.
   One student swore that the janitor discovered someone in the computer lab.
20. Kate is who Dave argued that the librarian disliked at first.
   One student argued that the librarian disliked someone.
   One student argued that the librarian liked someone.
21. Amy is who Mary implied that the exchange student went out on a date with.
   One student implied that the exchange student dated someone.
   One student implied that the exchange student blamed someone.
22. Mary is who Amy supposed that the glee club invited to the concert.
   One student supposed that the glee club invited someone to the concert.
One student supposed that the glee club invited someone to the movie.

23. Jane is who Beth insisted that the lunch lady tried to give an ice cream cone to.
    One student insisted that the lunch lady tried to give an ice cream cone to someone.
    One student insisted that the lunch lady tried to give a hamburger to someone.

24. Beth is who Jane thought that the singer sang a song for at the party.
    One student thought that the singer sang a song to someone at the party.
    One student thought that the singer sang a song to someone in music class.

25. Karen is who Julie implied that the counselor asked to see yesterday.
    One student implied that the counselor asked to see someone.
    One student implied that the nurse asked to see someone.

26. Julie is who Karen learned that the coach wanted to speak with.
    One student learned that the coach wanted to speak with someone.
    One student learned that someone wanted to speak with the coach.

27. Kate is who Ann noted that the French teacher gave a good grade to.
    One student noted that the French teacher gave a good grade to someone.
    One student noted that the French teacher failed someone.

28. Ann is who Kate declared that the students laughed at in the lunchroom.
    One student declared that the students laughed at someone in the lunchroom.
    One student declared that the students laughed at someone in the classroom.

29. Jill is who Sue explained that the bus driver drove to the museum.
    One student explained that the bus driver drove someone to the museum.
    One student explained that the bus driver drove someone to the mall.

30. Sue is who Jill realized that the librarian lent the book to.
    One student realized that the librarian lent the book to someone.
    One student realized that the librarian returned the book to someone.

31. Adam is who Jason declared that the art teacher kicked out of class.
    One student declared that the art teacher kicked someone out of class.
    One student declared that the history teacher kicked someone out of class.

32. Jason is who Adam hinted that the marching band wanted to join them.
    One student hinted that the marching band wanted someone to join them.
    One student hinted that someone wanted to join the marching band.

33. Dave is who Matt stated that the school cheered for at the pep rally.
    One student stated that the school cheered for someone at the pep rally.
    One student stated that the school cheered for someone at the game.

    Priming Effects at Clause Edge in the Processing of English as a Second Language
34. Matt is who Dave swore that the bully picked a fight with after school.
   One student swore that the bully picked a fight with someone.
   One student swore that someone picked a fight with the bully.
35. Sam is who Bill supposed that the hall monitor accused of vandalism.
   One student supposed that the hall monitor accused someone of vandalism.
   One student supposed that the bus driver accused someone of vandalism.
36. Bill is who Sam argued that the cheerleader flirted with in math class.
   One student argued that the cheerleader flirted with someone.
   One student argued that the cheerleader was angry with someone.
37. Harry is who Kevin reported that the students elected as class president.
   One student reported that the students selected someone as class president.
   One student reported that the headmaster selected someone as class president.
38. Kevin is who Harry stated that the principal called early this morning.
   One student stated that the principal called someone.
   One student stated that the principal visited someone.
39. Tom is who John said that the janitor caught smoking in the restroom.
   One student said that the janitor caught someone smoking.
   One student said that someone caught the janitor smoking.
40. John is who Tom concluded that the school nurse excused from class.
   One student concluded that the school nurse excused someone from class.
   One student concluded that the counselor excused someone from class.

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