

# Clause-Edge Reactivations of Fillers in Processing English as a Second Language

Laurent Dekydtspotter, A. Katherine Miller, Vance Schaefer,  
Yufen Chang, and Ock-Hwan Kim  
Indiana University

## 1. The fundamental nature of second language processing: A debate<sup>1</sup>

A body of research in the generative paradigm argues that the same task- and domain-specific mechanisms underlie first language (L1) and second language (L2) processing, citing similarities with L1 sentence processing and L1 effects (Frenck-Mestre, 2005; Frenck-Mestre & Pynte, 1997; Juffs, 1998, 2006; Juffs & Harrington, 1995; Williams, Möbius, & Kim, 2001). Thus, L2 sentence processing has been found to display sensitivity to argument structure (Frenck-Mestre & Pynte, 1997; Juffs, 1998), as well as economy in filler-gap dependencies (Hoover & Dwivedi, 1998; Juffs & Harrington, 1995; Williams et al., 2001). Following this line of research pioneered by Juffs and Harrington (1995), nonnative processing is also said to differ in terms of the ability of nonnative speakers (NNSs) to revise representations. Dekydtspotter (2001) and Dekydtspotter and Sprouse (2003) note that slower computations in the course of L2 sentence processing explains failure to revise, as computations may time out in fixed memory resources. Differences in lexical access and in reading strategies, as well as target-deviant prosody and lexical representations including nontargetlike semantic fields induced by the L1 grammar, may yield misanalyses from which the parser must recover (Dekydtspotter, Schwartz, & Sprouse, 2006).

In stark contrast, another body of generative research argues that the mechanisms deployed in L2 sentence processing differ fundamentally from those used in L1 sentence processing (Felser & Roberts, 2007; Felser, Roberts, Marinis, & Gross, 2003; Marinis, Roberts, Felser, & Clahsen, 2005; Papadopoulou & Clahsen, 2003). On this basis, Clahsen and Felser (2006a, 2006b) formulate the shallow structure hypothesis, which maintains that, unlike native speakers (NSs), NNSs cannot deploy syntactic representations in the task of sentence processing and consequently rely instead on information related to meaning, such as thematic-relations, lexical information, and *crucially* pragmatic reasoning and contextual information to process input sentences. For instance, genitive constructions of the type N1 *of* N2 RC—in which the relative clause may attach to either of two noun phrases (NPs)—are associated with distinct attachment preferences across languages. Greek and Spanish NSs prefer high attachment to the top NP node, whereas English NSs typically select low attachment to the bottom NP node. Studies by Dussias (2001, 2003) for L2 Spanish, Papadopoulou and Clahsen (2003) for L2 Greek, and Felser et al. (2003) for L2 English, noted that, whereas NSs exhibited clear, statistically valid preferences (in judgments and reading times), NNSs did not. There was no evidence that the learners' L1 affected parsing (cf. Frenck-Mestre, 2002, for different results in English-French and Spanish-French comparisons). Clahsen and Felser (2006a, 2006b) surmised that this different style of processing stems from L2 representations that are not of a type that allows for online access.

NSs may resort to shallow representations as sentence processing breaks down (Ferreira, Bailey, & Ferraro, 2002), but they are not generally limited to shallow representations. If the shallow structure hypothesis is correct, the processing styles proposed for NNSs and NSs occupy opposite poles in Fodor's (1983, 2000) typology of mental processes. Fodor points to crucial properties of sentence processing that reveal signs of an input system that operates independently of other cognitive domains.

---

<sup>1</sup> Special thanks to our SLRF 2008 audience and two anonymous SLRF reviewers who helped us improve our argument.

In sentence processing, representations are built immediately as input is encountered—following certain designated routes even if these routes lead to dead ends (i.e., garden paths; e.g., Crocker, 1996; Fodor & Inoue, 1998, 2000; Frazier & Clifton, 1989; Frazier & Rayner, 1988). Furthermore, the processor is unable to learn from previous mistakes, falling into the same designated routes, although the manifestations of this vary with the specifics of the representations computed. Autonomy of sentence processing from context, speed, computational characteristics, and specific patterns of breakdown led Fodor (1983) to argue that humans are endowed with an innate, genetically determined language processing module that operates on the basis of the local structure of representations but crucially not on world knowledge such as the direction of conversational exchange. It is plausible that the modules of the parser are provided by Universal Grammar (UG; Fodor, 2000; Schwartz, 1999; see Schwartz, 1986, 1999, for a detailed discussion and a study of consequences for L2 acquisition). In contrast, L2 sentence processing on the shallow structure hypothesis must rely on a range of non-structural (meaning-based) information. Fodor (2000) notes that processing style is logically independent of the nature of representations: A certain representation might be attained on either processing mode. Thus, the general question of processing mode can be advanced (in relative independence of the representations) by examining the integration of various information sources in L2 sentence processing to determine allowable interactions. Focusing on the interaction of context and prosody with structural information, Dekydtspotter, Donaldson, Edmonds, Liljestrand-Fultz, and Petrush (2008) argue that L2 sentence processing also involves independent but interacting syntactic, prosodic, and semantic computations in a modular organization constraining interfaces in a classical way. These results, supporting informational encapsulation, do not fit with the shallow structure hypothesis.

We focus on a specific claim of the shallow structure hypothesis according to which processing moments associated with (intermediate) traces in the representations of long-distance dependencies are absent from L2 sentence processing (Felser & Roberts, 2007; Marinis et al., 2005). These processing moments are indicative of a task-specific processing reflex reliant on domain-specific constraints of UG. Their absence on stimuli found to be reliable for NSs is taken as evidence for shallow structures in L2 sentence processing. We challenge this argument noting the crucial consequences of slower lexical access for L2 sentence processing. We report on an experiment that tests for intermediate traces in the processing of both L1 and L2 English. We examine reaction times (RTs) in a picture classification task during reading for evidence of the postulation of intermediate traces at the embedded clause edge. We argue that, despite obvious differences between NSs and NNSs in our data, the nature of NNS patterns provide no evidence for the shallow structure hypothesis and are compatible with UG-constrained *wh*-dependencies. Our examination of the data charts new directions for research.

## 2. Traces in L2 sentence processing

Clahsen and Felser (2006a, 2006b) argue that, whereas the L1 processing of a long-distance dependency between a filler and a gap inside an embedded clause as in (1a) in fact seems to require cyclic movement crucially implicating traces, that is, copies of moved expressions, as in (1b), L2 sentence processing involves the direct association of the filler with the subcategorizing verb in the embedded clause as in (1c), where the indices reflect direct theta-grid association in the conceptual system without syntactic mediation. Their discussion highlights work by Marinis et al. (2005) for L2 processing following work reported in Gibson and Warren (2004) for L1 processing.

- (1) a. Who did the consultant claim that the proposal had pleased?
- b. [Who did the consultant claim [<who> that the proposal had pleased <who>]]
- c. [Who<sub>i</sub> did the consultant claim that the proposal had pleased<sub>i</sub>]

Intermediate traces at clause edge have the potential to provide significant information about L2 processing. This is because clause-edge intermediate traces are the presumed signatures of a processing mechanism highly specific to language design, which incorporates a grammatical apparatus that requires traces at the edge of phases as in standard generative theory. Not all grammatical models

make the same claims about the nature of these dependencies, and so the precise manner in which natural language grammars operate is an empirical matter. In fact, a body of processing evidence seems to point to the computation of traces in L1 processing of long-distance dependencies (Bever & McElree, 1988; Clifton & Frazier, 1989; Gibson & Warren, 2004; Love & Swinney, 1996; Nicol & Swinney, 1989).

Applying a sort of trace-theoretic litmus test to L2 sentence processing, researchers have reported the absence of traces in NNSs' sentence processing, concluding that L2 sentence processing must indeed be fundamentally different. Thus, Marinis et al. (2005) devised an experiment, based on Gibson and Warren (2004), with four groups of Chinese, Japanese, Greek, and German speakers of English as a L2 and a group of English NSs. The learners were similar in age, had generally started learning English in their eleventh and twelfth year (apart from Greek learners, with a mean age of first exposure of 8.67 years), and seemed to be within the same general proficiency range. They were given a grammatical questionnaire with 20 items as in (2) in order to show that learners could indeed understand the type of sentences under study. All groups tested above 90%.

- (2) The captain who the officer decided that the young soldier had displeased will write a formal report next week.

Who made a decision?

*the captain*

*the officer*

*the soldier*

The respondents were tested on sentences such as (3a-d). (3a, b) involved the movement of a *wh*-expression *who*. (3c, d) did not involve movement. (3a, b) differed in the following way: (3a) involved cyclic movement with a trace, a silent copy of the moved item (<who>), at the edge of the embedded clause. (3b) did not.

- (3) a. The manager who/ the secretary claimed/ <who> that/ the new salesman/ had pleased <who>/ will raise company salaries.  
 b. The manager who/ the secretary's claim/ about/ the new salesman/ had pleased <who>/ will raise company salaries.  
 c. The manager thought/ the secretary claimed/ that/ the new salesman/ had pleased/ the boss in the meeting.  
 d. The manager thought/ the secretary's claim/ about/ the new salesman/ had pleased/ the boss in the meeting.

Marinis et al.'s NS results replicated the results obtained by Gibson and Warren. NSs produced longer reading times for *that* in (3a) versus (3c), but shorter reading times on the verb segment *had pleased* in (3a) versus (3b). In (3a), reading slowed down on the complementizer as a result of the need to accommodate the trace at the edge of the embedded clause, but this provided a processing advantage for later trace integration in thematic position. In stark contrast, learners did not show these effects. There was no general effect on the complementizer *that*. The processing of the verb segment induced significantly longer reading times in extraction contexts than in nonextraction contexts, with no effect of cyclic movement, unlike in NSs.

Roberts, Marinis, Felser, and Clahsen (2007) and Felser and Roberts (2007) focused on the documented ability of traces to prime their antecedents among NSs and Greek learners of English, respectively. At a computer monitor, respondents listened to sentences as in (4a-d). As respondents listened, a picture of the antecedent [SQUIRREL] (4a, b) or of an unrelated object [TOOTHBRUSH] (4c, d) appeared on a computer screen either in gap position (4a, c), where the silent trace of *to which* is expected, or in control position (4b, d) before this point. Respondents indicated with a button press whether the picture depicted something alive or not.

- (4) Fred chased the squirrel to which the nice monkey explained...
- a. the game's difficult rules [SQUIRREL] in class last Wednesday.
  - b. the game's [SQUIRREL] difficult rules in class last Wednesday.
  - c. the game's difficult rules [TOOTHBRUSH] in class last Wednesday.
  - d. the game's [TOOTHBRUSH] difficult rules in class last Wednesday.

NSs reacted significantly faster to pictures related to the antecedent than to pictures unrelated to it, although crucially not in pre-gap position. NNSs did not produce differences between gap and pre-gap positions, reacting more quickly overall to related than to unrelated probes.

Marinis et al. (2005) as well as Felser and Roberts (2007) did not uncover any psychometric evidence for traces in NNSs. Because the instrument revealed theoretically relevant asymmetries in NSs, the researchers assumed that the instrument was a reliable indicator of traces for all populations, so that if there had been any traces in NNSs' sentence processing, the task would have detected their presence. Failure of the task to register the presence of traces is, therefore, interpreted as evidence of absence motivated by a different manner of processing that is meaning-based rather than structural. Specifically, Marinis et al.'s conclusion that NNSs parse without reference to traces depends on the assumption that the processing of the complementizer *that* overlaps with the processing of the intermediate trace of cyclic movement. This assumes that the synchronicity of two levels of processing (reading and access to syntactic representations) is a necessary property of a task-specific algorithm. This assumption is very likely to be incorrect: If learners' processing lags or the representation is less persistent, this overlap between levels of processing may be lost. The question of synchronicity between the eye and the mind is not a concern unique to L2 processing. Ehrlich and Rayner (1983) and Rayner and Pollatsek (1981) present arguments that readers move to the next word as soon as the lexical item is acquired, so that computations may lag behind reading, leading to spillover (cf. Carpenter & Just, 1983, for an argument that fixation on a word lasts until all processes are completed). Similarly, the effect of the intermediate trace on final trace integration with the thematic verb is not uniquely a property of the syntactic structure, but also a property of the strength of the reactivations of the filler. That is to say, the trace integration effect on the thematic verb is due to the fact that in cyclic movement the referent of the filler is alive in memory at the time of its integration with the thematic verb, whereas the activation of a filler in a long movement dependency, without an intermediate reactivation is significantly decreased as a result of the activations of other referents introduced during the processing of the movement dependency (Gibson, 1998, 2000). Given that slower lexical access routines affect the strength of activation, the benefits due to cyclic movement would be much shorter-lived in L2 sentence processing, resulting in the elimination of the trace integration effect. The absence of asymmetries in L2 sentence processing on specific segments in this experiment does not necessarily indicate the absence of UG-constrained representations, since processing impacted by slower lexical access could naturally explain these differences. Thus, as NNSs and NSs read a given segment, there is no guarantee that their reading will reflect the very same abstract computational moments even if L1 and L2 sentence processing obey the same principles.

Likewise, Felser and Roberts' (2007) conclusion that NNSs parse without reference to traces crucially relies on the assumption of alignment between lexical retrieval of the word and the processing of abstract syntactic representations. Furthermore, listening to decontextualized speech without visual support could lead to higher stress levels in NNSs, engendering depressed performance. Not only does typical foreign language exposure rely heavily on the written medium, but speech recognition requires overcoming phonetic differences, voice, accent, speech rate, and so on, all of which accumulate and might contribute to depressed performance. Faced with the demands of attending to the speech signal, learners might scan for the live participants in the sentences. Because the related/unrelated dimension of probes matched the alive/not alive distinction, the general bias for (matching) animates could have resulted from such a strategy (cf. Clahsen & Featherston, 1999), masking other aspects of processing.

### 3. Activation and lexical access

Facilitations in the task of classifying antecedent-related probes in a critical position associated with traces in relation to a control position rely not only on movement representations in syntax but also on a specific process (i.e., activation spreading) in the lexicon that accompanies lexical access. Activation spreading primes semantic concepts, allowing a speeded classification of related pictures. Given a solid activation of a referent associated with robust lexical access of its corresponding NP, the activation spreads to related categories in the semantic network, following semantic relationships. We focus here on the superordinate categories of which the referent of the antecedent (an individual concept) is an instance such as *human*, and the categories composed thereof.

In order to address this issue more specifically, we focus on a specific picture classification task in the context of *wh*-movement as in (5a-d), in which a picture probe depicts either a boy or a girl. The probe appears either in a target position in a structure mediating the processing of the trace of *who*, <who> in the silent copy notation, or in a control position protected from the postulation of a trace. In (5a, c), the boy probe is directly related to *Harry*, the antecedent of the *wh*-expression, since *Harry* refers to Harry and Harry is a boy. In (5b, d), the probes do not match in gender the antecedent of the *wh*-expression, but match the gender of the subject NP *Mary*, which intervenes on the movement dependency. We focus on (aspects of) the pattern of lexical activations that supervenes on the representations in (5) and the consequences that can be expected in RT patterns in a picture classification task.

- (5) a. Condition 1 (C1): trace-related position, probe related to *Harry*  
 Harry is [who Mary said on Monday [<who> that [probe: boy] [the headmaster congratulated <who> at the assembly]]].
- b. Condition 2 (C2): trace-related position, probe related to *Mary*  
 Harry is [who Mary said on Monday [<who> that [probe: girl] [the headmaster congratulated <who> at the assembly]]].
- c. Condition 3 (C3): non-trace-related position, probe related to *Harry*  
 Harry is [who Mary said on [probe: boy] Monday [<who> that [the headmaster congratulated <who> at the assembly]]].
- d. Condition 4 (C4): non-trace-related position, probe related to *Mary*  
 Harry is [who Mary said on [probe: girl] Monday [<who> that [the headmaster congratulated <who> at the assembly]]].

In the typical priming profile, classifications of probes semantically related to the referent of *Harry* are facilitated in conjunction with the processing of the trace (C1). Thus, such classifications should be faster than classifications of probes related to the non-antecedent *Mary* in the same position (C2), on the assumption that activation privileges the superordinate over sister categories in the semantic network. Likewise, classification of probes directly semantically related to antecedents in conjunction with the processing of a trace (C1) will also be facilitated with respect to pictures related to antecedents in the preceding control position, which is not associated with the processing of a trace (C3). Such a pattern in a group of respondents constitutes solid evidence for traces. From a trace-theoretic viewpoint and with all else being equal, RTs in C2 (unrelated probes), C3 and C4 (control position) should be essentially on par since probe classification is not conjoined with the processing of a trace. The typical facilitation profile thus obtained can be visualized in Figure 1.

This pattern assumes that the activation is significantly stronger on the superordinate category *boy* than on its sister category *girl*. The difference between C1 and C2 does not uniquely depend on the activation of a trace, but crucially on the strength of the activation spreading through the semantic network. In contrast, the asymmetry between C1 and C3 is uniquely dependent on the trace. If activation spreads efficiently from the individual concept *Harry* to the more distant *girl* concept in the semantic field, then the profile will be modified with both C1 and C2 showing trace facilitation. However, the trace-theoretic asymmetry in C1 versus C3 will remain. Crucially, all else being equal, it is expected that as time elapses, activation decays. The C1-C3 asymmetry is unexpected under linear distance, as the greater distance between the NP and matching probe yields the shorter RTs.

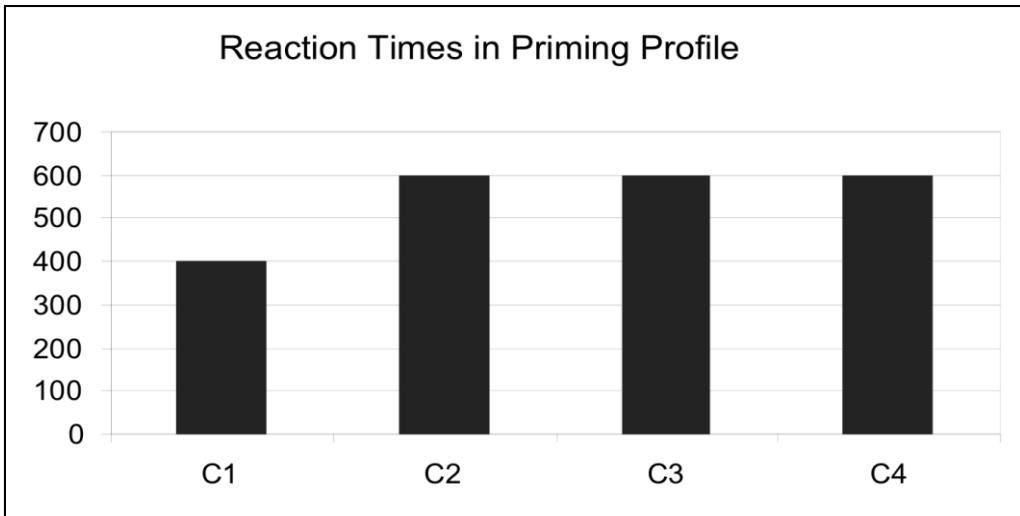


Figure 1. Facilitations on matching probes due to (re)activations in C1.

It has long been established that there are lexical access differences between NSs and NNSs (Favreau & Segalowitz, 1983; Segalowitz & Segalowitz, 1993). Since processing a chain requires repeated access to lexical items and activation of referents as well as maintaining activations in the face of new activations arising during the processing of the chain, the likely consequences of underlearned lexical access in L2 acquisition for the processing of *wh*-dependencies becomes a central processing question. Crucially, because activation spreading is not the only relevant mechanism supervening on access to lexical representations, this profile is not the only possible reflex of traces. In experiments with college-aged English NSs using newly acquired technical vocabulary (e.g., *accipiter*, the genus of goshawks and sparrow-hawks) as primes, inhibitions arose on related terms such as *eagle* in lieu of the usual facilitations (Dagenbach, Carr, & Barnhardt, 1990). This is explained by a center-surround mechanism whereby, to maintain the category *accipiter*, which is weakly activated due to under-routinized lexical access, related semantic categories of birds of prey are dampened to preserve a weak activation (Carr & Dagenbach, 1990). Likewise, under-routinized lexical access in (intermediate) L2 learners (Favreau & Segalowitz, 1983) and continued slow access in advanced learners (Segalowitz & Segalowitz, 1993) have repercussions for the processing of *wh*-dependencies. In the event of weak activation of the individual concept *Harry*, it becomes locally more strategic to dampen the associated superordinate categories *male* and *human* (and dependents) in order to focus resources on the weakly activated individual concept *Harry*. In other words, the local need to maintain the weak activation takes precedence over the benefits of spreading activation, since if the activation dies, all is lost. We refer to this as the weak activation hypothesis. Under the center-surround mechanism that puts resources on the weakly activated representation by dampening those concepts that are most closely related, an opposite inhibition profile as shown in Figure 2 is expected. Classification of boy probes in C1 associated with trace processing is inhibited by the dampening of its most closely related concept *boy* of which it is an instance to maintain the activation of the individual concept *Harry*.

Thus, an inhibition pattern follows from the center-surround mechanism: As the individual concept *Harry* is reactivated at clause edge, the superordinate category *boy* is dampened by the center-surround mechanism (C1), classifications of boy pictures will be inhibited with respect to girl pictures (C2). This is because inhibitions will presumably have a greater effect on the categories in the superordinate relations (direct semantic line) than on categories in sister lines, although a weaker neighborhood effect is possible. Classification of male pictures related to male antecedents reactivated at clause edge (C1) will be inhibited with respect to male pictures in control position (C3). This is because inhibitions of the superordinate categories will be increased at reactivation points. Such a pattern in a group of respondents also points to traces, pace the dampening of semantic neighbors. It is expected that RTs in C2 (unrelated probes) and in C3 and C4 (control position) should be essentially on par since none of these conditions involve classification conjoined with the processing of a trace.

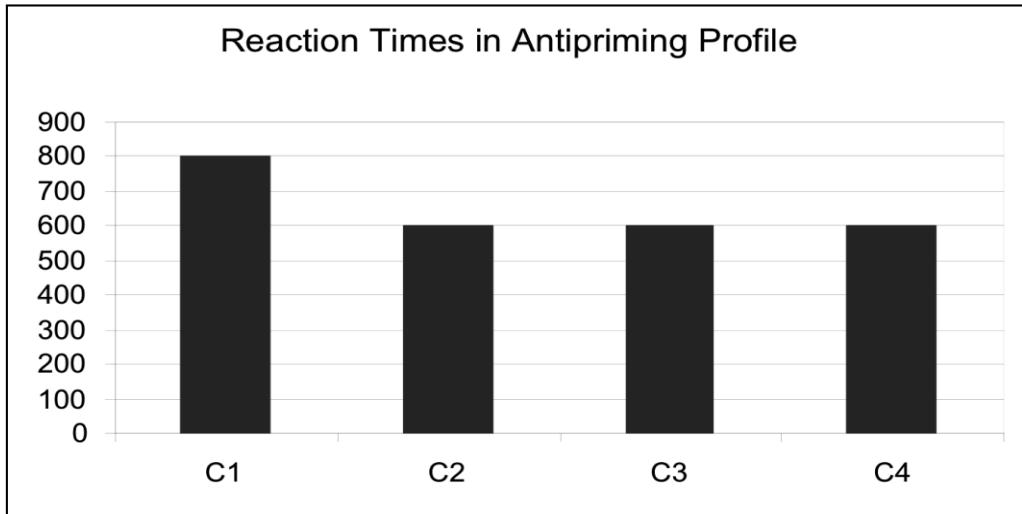


Figure 2. Inhibitions on matching probes due to (re)activations in C1.

A specific interaction of probe type and position obtains in the inhibition pattern in Figure 2, which is not readily explained by means other than the dampening in the semantic field accompanying weak activation during lexical access. Thus, if the referent of the first name were less salient than the second a C1-C2 difference would be accounted for; however, a similar asymmetry should also arise in the control position (C3-C4). Likewise, a computational load associated with linear distance should be found in both critical and control positions. Thus, the asymmetry between C1-C2 and C1-C3, when other conditions are stable, seems highly suggestive of effects of reactivation due to a trace. Such a pattern seems to be the specific hallmark of weak activation associated with underautomatized lexical access in conjunction with syntactically induced (re)activation of referents.

In short, opposite patterns are suggestive of trace-theoretic (re)activations of referents. Their origin lies in the strength of the activation of referents as lexical forms are accessed during sentence processing. According to the weak activation hypothesis, our working hypothesis, NNSs will often exhibit an inhibitory pattern by virtue of weaker activations. The central research question is the degree to which L2 processing of *wh*-dependencies can be captured in terms of these profiles, which we take to be indicative of traces. Finding an inhibitory pattern as in Figure 2 would suggest that the investigation of *wh*-dependencies in L2 acquisition should be investigated in a much greater context than has been considered so far.

#### 4. The study: Picture classification during reading

This experiment was conceived of on the undisputed assumption that L2 processing is typically slower, especially in the area of lexical access, which can lead to spill over/delay of effects in sentence processing, given that readers typically continue reading as soon as a word is acquired from the lexicon. Thus, a stimulus may adequately capture the processing of NSs, who have speedy access to vocabulary and structures of their native language during processing, but may carry a significant difficulty for learners, so that factors that were negligible in NSs may become significant. We note, however, that a stimulus well-gauged for NNSs given a certain speed of activations and deployment of structure may in return lack sensitivity to capture effects in NSs. L2 sentence processing is best investigated in the light of known mental processes by examining its contours, since these types of reflexes are most revealing of mental constitution.

Since typical instructed learners receive input through the written medium, reading might provide NNSs with greater support than listening and would therefore allow for the testing of respondents at lower levels of proficiency. In silent reading or listening, comprehension checks verify that the respondents are paying attention to the stimulus. In the case of a classification task during listening comprehension, two decision points are required per item, which unquestionably adds to the complexity of the task and to test-taking stress. Reading aloud in a low voice provides an attractive

testing modality, especially in learners of intermediate proficiency, because respondents produce the stimulus sentences on the basis of the written stimulus—ensuring that they are processing the sentences linguistically since they are audibly producing it. Thus, our task required respondents to classify a probe while reading a sentence presented word by word on a computer screen in a low voice. At given moments, pictures appeared at the center of the screen for 650 milliseconds. Respondents classified these pictures as human or nonhuman as quickly as possible. RTs were recorded. Reading speed was controlled using DMDX (Forster & Forster, 2003) and calibrated so that reading was fluent, leaving no opportunity for respondents to reflect on the structure or employ other strategies. In contrast, the self-paced methodology could have encouraged respondents to pause and deploy task-taking strategies. Twenty graduate student NS and NNS volunteers, who helped us pilot the instrument, remained naïve after completing the task. Nonnative presentation was slightly slower than that for NSs: word segments appeared for 30 ms longer, and had an increased inter-item duration of 100 ms. Respondents were debriefed after the task and reported that the speed of presentation was both comfortable and appropriate. The instrument included 40 items involving cyclic movement across a clause as in (6).

(6) Harry is who<sub>i</sub> Mary said on Monday  $t_i$  that the headmaster congratulated  $t_i$  at the assembly.

These sentences were given a context that rendered them felicitous. Respondents were told that they were to read a classroom log written by a substitute teacher. As a prank, the children in the class had systematically switched names. The substitute teacher recorded a series of events to help the regular teacher sort things out. The respondents were to read the log and classify pictures as human or not.

Critical sentences were organized in a Latin square: Four conditions crossed (target/control) positions with (filler-related/non-filler-related) probes as illustrated in (7a-d). The sentences included 10 girl-boy pairs and 10 boy-girl pairs as well as 10 pictures of boys and girls equally divided among them. There were 20 distracter items involving animals (nine primates and 11 others). The control position was located 600 ms before target positions, occurring within a prepositional phrase that offered a protective zone from any trace temporarily associated with the complement position of the verb.

- (7) a. Condition 1 (C1): target position, filler-related probe  
Harry / is / who / Mary / said / on / Monday / that / [probe: boy] / the headmaster / congratulated / at the assembly.
- b. Condition 2 (C2): target position, non-filler-related probe  
Harry / is / who / Mary / said / on / Monday / that / [probe: girl] / the headmaster / congratulated / at the assembly.
- c. Condition 3 (C3): control position, filler-related probe  
Harry / is / who / Mary / said / on / [probe: boy] / Monday / that / the headmaster / congratulated / at the assembly.
- d. Condition 4 (C4): control position, non-filler-related probe  
Harry / is / who / Mary / said / on / [probe: girl] / Monday / that / the headmaster / congratulated / at the assembly.

Finding shorter RTs for pictures related to antecedents at clause edge (C1) than for pictures related to non-antecedents at clause edge (C2) in (7a) versus (7b), and shorter RTs for pictures related to antecedents at clause edge (C1) than for pictures related to antecedents in control position (C3) in (7a) versus (7b) constitutes *classical* evidence for the postulation of traces. However, in the case of intermediate L2 learners, inhibitory effects in C1 can also be expected as by-products of reactivations induced by non-automatic lexical access.

The 20 probes used for the critical sentences were pictures of boys and girls obtained from Microsoft Office Clipart and adjusted to similar size using Photoshop. They appeared uniformly at the center of the screen. There were four versions of the task so that the pictures of boys and girls cycled through the four conditions across the experiment. The probe in control position after the preposition

*on* appeared in a position where a common noun is disfavored but otherwise not excluded, as *on girls'/boys' night out*.



Figure 3. Examples of probes.

The names used in the experiment were common and unambiguously male or female: Harry, Adam, Matt, Kevin, Jason, Mark, Bill, Tom, Dave, and John for the boys, and Mary, Beth, Amy, Sue, Karen, Julie, Jill, Ann, Kate, and Jane for the girls. Respondents were tested to make certain that they knew the gender associated with each name. Results suggest that the gender of the names were known to nonnative participants.

After filling out a background questionnaire providing biographical information, respondents did a short picture classification task as a pretest, during which the pictures that appeared in the main experimental task were classified as human or non-human. This pretest provided an individual baseline. For each respondent, we kept track of which (sets of) pictures would appear in which conditions in the main experiment, so that comparisons could be made between picture classification alone and picture classification during language processing.

Respondents also did a version of Harrington and Sawyer's (1992) working memory (WM) reading span test modeled for L2 learners of English after Daneman and Carpenter (1980). Respondents read aloud 42 sentences organized in 12 sets increasing in size from two to five sentences per set by groups of three. They needed to indicate whether they had detected ungrammaticalities and recall the last word of each sentence. After each set, respondents recorded the last word of each sentence in order on an answer sheet. WM scores are the total number of recalled words out of 42, and the number of completely correct sets out of 12. For NSs, the sentences were longer by 5 to 7 words, making them comparable in length to those used in Daneman and Carpenter's (1980) task. After completing the WM reading span test, respondents did the main experimental task: a picture classification task during reading. Afterwards, an investigator verified their knowledge of the gender associated with each name and verified whether speed was appropriate. Brown's (1980) cloze-test was administered as an external proficiency measure. However, some subjects did not come back for the second session to do this test. These results, nevertheless, confirmed the intermediate proficiency level of the subject pool. Finally, we collected the results of an in-house placement test that measures listening and reading comprehension, supplemented with a short essay.

NS and NNS respondents received class credit for their participation. The NNS respondents we report on were 61 undergraduate students in their early twenties, enrolled in English language support courses for matriculated students: Korean ( $n = 38$ ), Mandarin (13), Cantonese (4), Indonesian (2), Japanese (2), Hindi (1), and Arabic (1). They were of intermediate proficiency with an average placement score of 60/80, with a range of 41-72, on a battery of tests. The mean cloze-test score for 42 NNSs was 22/50, remarkably different from NSs' ( $n = 35$ ) mean score of 42/50. The average NNS WM score per word was 34/42, with a range from 18 to 42. The average WM score per set was 7/12, with a range of 2-12. These NNSs are developing English proficiency, and a goal is in part to determine the type of processing that learners bring to the learning task. A control group of 45 undergraduate university students of similar age provided a validation group for our instrument. They were enrolled in introductory linguistics courses and had no knowledge of the structure of clauses of the type that we investigated. Their average WM word score was 36/42, with range from 24 to 42. Their average WM set score was 8/12, with range from 2 to 12. Respondents were split into a lower WM group and a higher WM group with above average scores. We grouped respondents based on set

scores since the distribution in the two groups aligns closely. Word scores and set scores yielded statistically similar results.

The following analytical procedures were followed. The pretest was used to examine RTs for picture classification alone. RTs for pictures appearing in all four conditions were extremely flat and similar for NSs and NNSs. For each respondent, we obtained a mean value for the pictures used in each of the four conditions and can therefore examine the difference between pretest means and means in the main task, obtaining values corrected for effects due to the pictures themselves. Only correct classifications were considered. For each group and each condition, measures two standard deviations beyond the mean in either direction were discarded. Missing values were replaced by means. For each respondent, mean RTs per condition were then obtained.

We performed mixed-design repeated measures ANOVAs on RTs with WM group and nativeness as between-subject factors and (target/control) position and (related/non-related) probe as within-subject factors. To confirm the hypotheses that RTs would be shorter for antecedent-related probes at clause edge than for non-antecedent related probes at clause edge and for antecedent-related probes in control position, we planned two *t*-tests with  $\alpha$  set at .05. We also examined individual patterns of distribution, seeking to determine whether a significant proportion of learners exhibited evidence of clause-edge priming, the presumed effects of intermediate traces. We partitioned those respondents who were faster in C1 than in C2 from those who were not to find out whether they were also faster in C1 than in C3, with no similar effect of position in C2 and C4. If this is so, picture classification is facilitated at the embedded clause edge in a group of learners, providing strong evidence of traces at the edge of embedded clauses in L2 sentence processing—even if other aspects of processing masked this in the aggregate data.

## 5. Results

The experimental results are provided in Table 1. An ANOVA revealed an interaction of position, probe and nativeness,  $F(1, 102) = 5.048, p = .027$ , which was qualified by WM,  $F(1, 102) = 3.190, p = .027$ . A main effect of nativeness was observed:  $F(1, 102) = 12.455, p = .001$ . Specific expectations were examined via *t*-tests.

Table 1. *RTs (in ms) in the Task of Picture Classification during Reading*

Condition	NSs		NNSs	
	Lower WM ( <i>n</i> = 26)	Higher WM ( <i>n</i> = 19)	Lower WM ( <i>n</i> = 35)	Higher WM ( <i>n</i> = 26)
C1: filler-related, target	542 (58)	533 (47)	579 (54)	585 (55)
C2: non-filler-related, target	538 (51)	535 (57)	578 (61)	562 (48)
C3: filler-related, control	558 (64)	560 (49)	586 (53)	571 (57)
C4: non-filler-related, control	550 (45)	544 (44)	587 (58)	583 (57)

*Note.* Standard deviations in parentheses.

We first consider the NS data. There were no significant effects between RTs in C1 (filler-related probes in target position) and C2 (non-filler-related probes in target position). However, theoretically relevant asymmetries arose in RTs between C1 and C3 (filler-related probes in control position): For lower WM NSs (*n* = 26, WM = 33/42),  $t(25) = 2.061, p = .05$ . This effect was amplified in higher WM NSs (*n* = 19, WM = 39/42),  $t(18) = 3.580, p = .002$ . RTs in C2 and C4 were statistically non-distinct, so that the effect cannot simply be attributed to position. The pattern of a facilitation produced by higher WM NSs is suggestive of trace theoretic processing in real time. First, the asymmetry between C1 and C3, when C2-C4 is statistically non-distinct, is unexpected on the basis of general effects such as linear distance or salience. Salience appears to have no role in the data. Linear distance can only be given a counterintuitive role. The shorter RTs are associated with the greater distance. The pattern, therefore, does not appear to receive an explanation in domain-general terms. Second, we note that there is a trace-theoretic account of the pattern, in conjunction with the amplitude of activation

spreading in the semantic network. Thus, trace theory provides a ready explanation for facilitations in C1 and C2. The observed NS pattern follows if the activation carries over to sister lines, priming a semantic sister category, which levels the asymmetry between C1 and C2. This is a (partial) verification of the predictions associated with the postulation of a trace. This effect, therefore, suggests that the instrument achieved results compatible with the cross-modal priming paradigm.

For the NNSs, however, the aggregate results yielded similar asymmetries. For Lower WM NNSs ( $n = 35$ , WM = 29/42), no contrast approached significance. For higher WM NNSs ( $n = 26$ , WM = 40/42), an asymmetry was obtained in the opposite direction for the C1-C2 contrast,  $t(25) = 2.663$ ,  $p = .013$ , and the C1-C3 contrast was statistically marginal,  $t(25) = 1.816$ ,  $p = .081$ . It is, however, significant given expectations of inhibitions induced by non-automatic lexical access, which is well-documented in intermediate proficiency learners. Crucially, general considerations unrelated to syntax do not provide a very satisfying analysis. Greater salience of the second referent could account for the C1-C2 difference; but a similar asymmetry would be expected earlier (C3-C4), which does not happen. Costs associated with linear distance should apply equally to filler-related and non-filler-related probe classifications. The pattern, therefore, seems to be the hallmark of weak activation associated with under-automatized lexical access in conjunction with trace-induced (re)activation of referents.

The corrected measures are in Table 2. An ANOVA revealed an interaction of position, probe and nativeness,  $F(1, 102) = 7.763$ ,  $p = .006$ . There was also a main effect of nativeness,  $F(1, 102) = 11.934$ ,  $p = .001$ . WM produced no significant main effect or interaction.

Table 2. Corrected RTs (in ms) in the Task of Picture Classification during Reading

Condition	NSs		NNSs	
	Lower WM ( $n = 26$ )	Higher WM ( $n = 19$ )	Lower WM ( $n = 35$ )	Higher WM ( $n = 26$ )
C1: filler-related, target	33 (60)	37 (50)	72 (68)	95 (64)
C2: non-filler-related, target	26 (60)	51 (55)	75 (56)	78 (54)
C3: filler-related, control	65 (66)	79 (66)	87 (55)	74 (69)
C4: non-filler-related, control	44 (53)	64 (48)	93 (60)	96 (57)

Note. Standard deviations in parentheses.

A post hoc ANOVA on the NS data revealed an interaction of position and probe,  $F(1, 43) = 3.828$ ,  $p = .057$ , at the statistical margin, and a main effect of position,  $F(1, 43) = 26.722$ ,  $p < .0005$ . A post hoc ANOVA on the NNS data revealed an interaction of position and probe,  $F(1, 59) = 4.198$ ,  $p = .045$ . In NSs, facilitations were produced in target position. In contrast, the NNSs displayed a pattern in which measures for C2 (76,  $SD = 55$ ) contrasted with C4 (94,  $SD = 59$ ),  $t(60) = 2.437$ ,  $p = .018$ , while C1 (82,  $SD = 67$ ) and C3 (81,  $SD = 61$ ) were non-distinct. This pattern in which a picture classification induces longer RTs shortly after the introduction of a referent matched in gender than in a later position seems to point to inhibitions triggered by a center-surround mechanism supporting the maintenance of weakly activated referents as a result of non-automatic lexical access.

In a more exploratory move, which however follows from the apparent 'signatures' of trace-theoretic computations associated with effects of activation levels, we examined the (theory-internal) prediction that individuals who produced facilitations due to probe type in target position, shown by negative values in subtracting RTs in C2 from RTs in C1 (Group A) should produce facilitations in trace position versus control position. Thus, those Group A NS respondents ( $n = 24$ ), producing facilitations in C1 versus C2, exhibited facilitations in C1 versus C3,  $t(23) = 4.412$ ,  $p < .0005$ , which could not be due to a general effect of position: RTs in C2 versus C4 were virtually flat,  $t(23) = .342$ ,  $p = .736$ . Likewise, those Group A NNS respondents ( $n = 30$ ) exhibiting facilitations in C1 versus C2, produced facilitations C1 versus C3,  $t(29) = 3.377$ ,  $p = .002$ , which were not due to a broad effect of position as RTs in C2 versus C4 were flat,  $t(29) = 1.522$ ,  $p = .139$ .

Table 3. *Examination of Distribution of Individual RTs*

Condition	NSs		NNSs	
	Group A ( <i>n</i> = 24)	Group B ( <i>n</i> = 21)	Group A ( <i>n</i> = 30)	Group B ( <i>n</i> = 31)
C1: filler-related, target	523 (44)	555 (58)	566 (55)	597 (49)
C2: non-filler-related, target	551 (42)	521 (60)	592 (55)	552 (52)
C3: filler-related, control	554 (55)	564 (60)	588 (57)	572 (52)
C4: non-filler-related, control	548 (41)	547 (49)	581 (62)	590 (53)

*Note.* Standard deviations in parentheses.

We now turn to the rest of the respondents (Group B). Group B NSs revealed no useful information. Group B NNSs, however, produced RT spikes in C1 (C1 vs. C2,  $t(30) = 7.878$ ,  $p < .0005$ ) and C4 (C3 vs. C4,  $t(30) = 2.922$ ,  $p = .007$ ). Such spikes were also in evidence in the RTs of higher WM NNSs. Perusal of individual patterns, therefore, revealed asymmetries suggestive of trace-induced facilitations (and not mere effects of position) in one half of NSs and NNSs alike, who showed facilitations on matching probes in critical positions. NNSs otherwise produced RTs revealing inhibitions in the classification of probes matching recently (re)activated fillers. The data seem to speak loudly to an effect of recency of (re)activation in NNSs, a presumed effect of level of activation related to non-automatic lexical access in a L2. As Table 4 shows, this central issue revealed in these data seems orthogonal to the question of WM.

Table 4. *Descriptives of WM Scores for Groups A & B*

Condition	NSs		NNSs	
	Group A ( <i>n</i> = 24)	Group B ( <i>n</i> = 21)	Group A ( <i>n</i> = 30)	Group B ( <i>n</i> = 31)
WM/42	35 (5)	36 (3)	36 (5)	31 (7)
WM/12	7 (3)	8 (2)	8 (3)	6 (3)

*Note.* Standard deviations in parentheses.

## 6. Discussion

The contours of NNSs' raw RTs closely match the predictions of our working hypothesis according to which weak activation of referents crucially interacts with the processing of movement chains. In the corrected values, an additional effect compatible with our hypothesis could be seen: Inhibitions affected the classifications of pictures presented shortly after the (re)activations of gender-matched referents. This motivated our examination of individual responses for evidence of a facilitation priming pattern hidden in the aggregate data. Indeed, perusal of the distribution of individual responses revealed that one half of respondents produced facilitations due to probe type in target position. This priming pattern is *prima facie* the hallmark of a domain-specific representation involving an intermediate trace at the edge of the embedded clause. Should this pattern be entirely ignored, since the discovery is *post hoc*? We do not think so. First, a trace-theoretic effect of a kind is found in the data, motivating an exploration of patterns capable of illuminating the issue. Second, the computational factors of the relative closeness of probes to matching expressions and of relative prominence of referents affecting domain-general name-picture matches completely rules out this attested pattern. That is to say, domain-general computational factors of distance and prominence should yield shortest RTs for shortest distance to the NP with the most prominent referent. Prominence might vary from individual to individual and even from sentence to sentence as a function of the perspective imposed by respondents. These expectations do not align with the (trace-theoretic) priming behavior of substantial groups of NSs and NNSs according to which closer position was associated with longer RTs, and greatest distance with shortest RTs. The very strength of the task design resides

in the fact that such results are unexpected on domain-general name-picture matches, yet natural under the theory of traces. The logic of the psycholinguistic evidence for traces in NSs also applies to telltale patterns of asymmetries in Group A NNSs. Additionally, the rest of the NNSs produced inhibitions supporting the weak activation hypothesis.

These findings threaten the shallow structure hypothesis, which rules out a syntactic reflex. The hypothesis that significant departures from NS processing arise from differences in activation and maintenance of referents reflecting differences in automaticity and speed of lexical access, in contrast, fares better in the light of the full data.

## 7. Perspectives

Marinis et al. (2005) and Felser and Roberts (2007) argue that NNSs must process sentences without computing abstract syntactic representations. Hitherto, the arguments against the postulation of traces in L2 sentence processing have given relatively little consideration to the full implications of slower, non-automatic lexical access routines. However, upon closer perusal, we hypothesized that the effects of non-automatic lexical access might be much more significant: weakly activated referents would require special treatment (i.e., dampening by the center-surround mechanism) to preserve the activations. Thus, the effect of trace-induced reactivations on weakly activated referents could be shorter-lived so that the processing advantage of cyclic over long movement found by Gibson and Warren (2004) might not be detectable in L2 sentence processing. The issue of strength of activations seems to confound previous conclusions. Indeed, the priming patterns that we uncovered in our experiment closely mirrored the predictions based on the dampening of activation of superordinate categories induced by weak activations. Close attention to distribution of individual patterns provided confirming evidence of trace-induced reactivations. This suggests that lexical access, activation spreading and dampening indeed play a significant, but hitherto largely undiscussed, role in explaining the processing of *wh*-dependencies in a second language.

## References

- Bever, Thomas G. & McElree, Brian (1988). Empty categories access their antecedents during comprehension. *Linguistic Inquiry*, 19, 35–43.
- Brown, James Dean (1980). Relative merits of four methods for scoring cloze tests. *Modern Language Journal*, 64, 311–317.
- Carpenter, Patricia A. & Just, Marcel A. (1983). What your eyes do while your mind is reading. In Keith Rayner (Ed.), *Eye movements in reading: Perceptual and language processes*. New York: Academic Press.
- Carr, Thomas H. & Dagenbach, Dale (1990). Semantic priming and repetition priming from masked words: Evidence for a center-surround attentional mechanism in perceptual recognition. *Journal of Experimental Psychology*, 16, 341–50.
- Clahsen, Harald & Featherston, Sam (1999). Antecedent-priming at trace positions: Evidence from German scrambling. *Journal of Psycholinguistic Research*, 28, 415–37.
- Clahsen, Harald & Felser, Claudia (2006a). Continuity and shallow structures in language processing. *Applied Psycholinguistics*, 27, 107–26.
- Clahsen, Harald & Felser, Claudia (2006b). Grammatical processing in language learning. *Applied Psycholinguistics*, 27, 3–42.
- Clifton, Charles & Frazier, Lyn (1989). Comprehending sentences with long distance dependencies. In Gregory N. Carlson & Michael K. Tanenhaus (Eds.), *Linguistic structure in language processing* (pp. 273–317). Dordrecht, The Netherlands: Kluwer.
- Crocker, Matthew W. (1996). *Computational psycholinguistics: An interdisciplinary approach to the study of language*. New York: Kluwer.
- Dagenbach, Dale, Carr, Thomas H., & Barnhardt, Terry M. (1990). Inhibitory semantic priming of lexical decisions due to failure to retrieve weakly activated codes. *Journal of Experimental Psychology*, 16, 328–40.
- Daneman, Meredyth & Carpenter, Patricia (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, 19, 450–66.
- Dekydtspotter, Laurent (2001). The Universal Parser and interlanguage: Domain-specific mental organization in the comprehension of combien interrogatives in English-French interlanguage. *Second Language Research*, 17, 91–143.
- Dekydtspotter, Laurent & Sprouse, Rex A. (2003). L2 performance: Interlanguage representations, computations, and intuitions. In Juana M. Liceras, Helmut Zobl, & Helen Goodluck (Eds.), *Proceedings of the 6th*

*Generative Approaches to Second Language Acquisition Conference (GASLA 2002): L2 Links* (pp. 45–54). Somerville, MA: Cascadilla Press.

- Dekydtspotter, Laurent, Donaldson, Brian, Edmonds, Amanda C., Liljestrang-Fultz, Audrey, & Petrush, Rebecca A. (2008). Syntactic and prosodic computations in the resolution of relative clause attachment ambiguity by English-French learners. *Studies in Second Language Acquisition*, 30, 453–80.
- Dekydtspotter, Laurent, Schwartz, Bonnie D., & Sprouse, Rex A. (2006). The comparative fallacy in L2 processing research. In Mary Grantham O'Brien, Christine Shea, & John Archibald (Eds.), *Proceedings of the 8th Generative Approaches to Second Language Acquisition Conference (GASLA 2006): The Banff Conference* (pp. 33–40). Somerville, MA: Cascadilla Press.
- Dussias, Paola (2001). Sentence parsing in fluent Spanish-English bilinguals. In Janet Nicol (Ed.), *One Mind, Two Languages: Bilingual Language Processing* (pp. 159–76). Malden, MA: Blackwell.
- Dussias, Paola (2003). The effect of bilinguality on L1 and L2 processing strategies. *Studies in Second Language Acquisition*, 25, 529–57.
- Ehrlich, Kate & Rayner, Keith (1983). Pronoun assignment and semantic integration during reading: Eye movements and immediacy of processing. *Journal of Verbal Learning & Verbal Behavior*, 22, 75–87.
- Favreau, Micheline & Segalowitz, Norman (1983). Automatic and controlled processes in the first- and second-language reading of fluent bilinguals. *Memory and Cognition*, 11, 565–74.
- Felser, Claudia & Roberts, Leah (2007). Processing *wh*-dependencies in a second language: A cross-modal priming study. *Second Language Research*, 31, 9–36.
- Felser, Claudia, Roberts, Leah, Marinis, Theodore, & Gross, Rebecca (2003). The processing of ambiguous sentences by first and second language learners of English. *Applied Psycholinguistics*, 24, 453–89.
- Ferreira, Fernanda, Bailey, Karl, & Ferraro, Vic (2002). Good enough representations in language comprehension. *Current Directions in Psychological Science*, 11, 11–15.
- Fodor, Jerry A. (1983). Phrase structure parsing and the island constraints. *Linguistics and Philosophy*, 6, 163–223
- Fodor, Jerry A. (2000). *The mind does not work this way*. Cambridge, MA: MIT Press.
- Fodor, Janet D. & Inoue, Atushi (1998). Attach anyway. In Janet D. Fodor & Fernanda Ferreira (Eds.), *Reanalysis in sentence processing* (pp. 101–141). New York: Kluwer.
- Fodor, Janet D. & Inoue, Atushi (2000). Syntactic features in reanalysis: Positive and negative symptoms. *Journal of Psycholinguistic Research*, 29, 25–36.
- Forster, Kenneth I. & Forster, Jonathan C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments and Computers*, 35, 116–24.
- Frazier, Lyn & Clifton, Charles (1989). Successive cyclicity in the grammar and the parser. *Language and Cognitive Processes*, 4, 93–126.
- Frazier, Lyn & Rayner, Keith (1988). Parameterizing the language system: Left- vs. rightbranching within and across languages. In John A. Hawkins (Ed.), *Explaining language universals* (pp. 247–279). Oxford, UK: Blackwell.
- Frenck-Mestre, Cheryl (2002). An on-line look at sentence processing in the second language. In Roberto R. Heredia & Jeanette Altarriba (Eds.), *Bilingual sentence processing* (pp. 217–35). Amsterdam: Benjamins.
- Frenck-Mestre, Cheryl (2005). Eye-movement recording as a tool for studying syntactic processing in a second language: A review of methodologies and experimental findings. *Second Language Research*, 21, 175–98.
- Frenck-Mestre, Cheryl & Pynte, Joël (1997). Syntactic ambiguity resolution while reading in second and native languages. *Quarterly Journal of Experimental Psychology*, 50A, 119–48.
- Gibson, Edward (1998). Linguistic complexity: Locality and syntactic dependencies. *Cognition*, 68, 1–76.
- Gibson, Edward (2000). The dependency locality theory: A distance-based theory of linguistic complexity. In Yasushi Miyashita, Alec Marantz, & Wayne O'Neil (Eds.), *Image, Language, Brain* (pp. 95–126). Cambridge, MA: MIT Press.
- Gibson, Edward & Warren, Tessa (2004). Reading-time evidence for intermediate linguistic structure in long-distance dependencies. *Syntax*, 7, 55–78.
- Harrington, Michael & Sawyer, Michael (1992). L2 working memory capacity and L2 reading skill. *Studies in Second Language Acquisition*, 14, 25–38.
- Hoover, Michael & Dwivedi, Veena D. (1998). Syntactic processing by skilled bilinguals. *Language Learning*, 48, 1–29.
- Juffs, Alan (1998). Main verb vs. reduced relative clause ambiguity resolution in second language sentence processing. *Language Learning*, 48, 107–147.
- Juffs, Alan (2006). Grammar and parsing and a transition theory. *Applied Psycholinguistics*, 27, 66–69.
- Juffs, Alan & Harrington, Michael (1995). Parsing effects in second language sentence processing: Subject and object asymmetries in *wh*-extraction. *Studies in Second Language Acquisition*, 17, 483–516.
- Love, Tracy & Swinney, David (1996). Coreference processing and levels of analysis in object-relative constructions: Demonstration of antecedent reactivation in the cross-modal priming paradigm. *Journal of Psycholinguistic Research*, 25, 5–24.

- Marinis, Theo, Roberts, Leah, Felser, Claudia, & Clahsen, Harald (2005). Gaps in second language sentence processing. *Studies in Second Language Acquisition*, 27, 53–78.
- Nicol, Janet & Swinney, David (1989). The role of structure in coreference assignment during sentence comprehension. *Journal of Psycholinguistic Research*, 18, 5–20.
- Papadopoulou, Despina & Clahsen, Harald (2003). Parsing strategies in L2 and L2 sentence processing: A study of relative clause attachment in Greek. *Studies in Second Language Acquisition*, 25, 501–528.
- Rayner, Keith & Pollatsek, Alexander (1981). Eye movement control in reading: Evidence for direct control. *Quarterly Journal of Experimental Psychology*, 33A, 351–373.
- Schwartz, Bonnie D. (1986). The epistemological status of second language acquisition. *Second Language Research*, 2, 120–159.
- Schwartz, Bonnie D. (1999). Let's make up your mind: "Special nativist" perspectives on language, modality of mind, and nonnative language acquisition. *Studies in Second Language Acquisition*, 21, 635–655.
- Segalowitz, Norman & Segalowitz, Sidney J. (1993). Skilled performance, practice, and the differentiation of speed-up from automatization effects: Evidence from second language word recognition. *Applied Psycholinguistics*, 14, 369–385.
- Williams, John, Möbius, Peter, & Kim, Choonkyong (2001). Native and non-native processing of English *wh*-questions: Parsing strategies and plausibility constraints. *Applied Psycholinguistics*, 22, 509–540.

# Selected Proceedings of the 2008 Second Language Research Forum: Exploring SLA Perspectives, Positions, and Practices

edited by Matthew T. Prior,  
Yukiko Watanabe, and Sang-Ki Lee

Cascadilla Proceedings Project Somerville, MA 2010

## Copyright information

Selected Proceedings of the 2008 Second Language Research Forum:  
Exploring SLA Perspectives, Positions, and Practices  
© 2010 Cascadilla Proceedings Project, Somerville, MA. All rights reserved

ISBN 978-1-57473-439-3 library binding

A copyright notice for each paper is located at the bottom of the first page of the paper.  
Reprints for course packs can be authorized by Cascadilla Proceedings Project.

## Ordering information

Orders for the library binding edition are handled by Cascadilla Press.  
To place an order, go to [www.lingref.com](http://www.lingref.com) or contact:

Cascadilla Press, P.O. Box 440355, Somerville, MA 02144, USA  
phone: 1-617-776-2370, fax: 1-617-776-2271, e-mail: [sales@cascadilla.com](mailto:sales@cascadilla.com)

## Web access and citation information

This entire proceedings can also be viewed on the web at [www.lingref.com](http://www.lingref.com). Each paper has a unique document # which can be added to citations to facilitate access. The document # should not replace the full citation.

This paper can be cited as:

Dekydspotter, Laurent, A. Katherine Miller, Vance Schaefer, Yufen Chang, and Ock-Hwan Kim. 2010. Clause-Edge Reactivations of Fillers in Processing English as a Second Language. In *Selected Proceedings of the 2008 Second Language Research Forum*, ed. Matthew T. Prior et al., 108-122. Somerville, MA: Cascadilla Proceedings Project. [www.lingref.com](http://www.lingref.com), document #2388.