Rethinking Nonnative Processing Constraints: Evidence from L2 French

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1. Introduction

An ongoing discussion in the field of second language (L2) acquisition is centered on what characterizes the fundamental nature of L2 processing. The basic question motivating this debate is whether adult L2 learners (L2ers) can make use of the same sources of information that native speakers (NSs) deploy to build representations and assign meaning to the input in real time. On the one hand, it has been argued that the same domain-specific mechanisms that underlie native language (L1) processing are also used in L2 processing (Frenck-Mestre, 2005; Frenck-Mestre & Pynte, 1997; Hoover & Dwivedi, 1998; Juffs, 1998, 2006; Juffs & Harrington, 1995; Williams, Möbius, & Kim, 2001). Within this framework, any observed differences in the behavior of NSs and L2ers in online comprehension tasks can be explained by divergent prosodic representations, variations in reading strategies, slowed or impaired lexical access, and so on (see, e.g., Dekydtspotter, Schwartz, & Sprouse, 2006), without the need to assume a fundamental difference between L1 and L2 processing. On the other hand, the sometimes divergent behavior of L2ers on certain online tasks has been interpreted by some researchers as evidence for a fundamental difference between L1 and L2 processing (Felser & Roberts, 2007; Felser, Roberts, Gross, & Marinis, 2003; Love, Maas, & Swinney, 2003; Marinis, Roberts, Felser & Clahsen, 2005; Papadopoulou & Clahsen, 2003).

Clahsen and Felser's (2006) shallow structure hypothesis (SSH) frames this fundamental difference in terms of the availability of processing routes. In the online interpretation of sentences, there are two potential processing routes available: syntactic parsing with fully specified representations, and shallow structures based on meaningful chunks of information and the possible relationships between them (Ferreira, Bailey & Ferraro, 2002; Sanford & Sturt, 2002; Townsend & Bever, 2001). For syntactically complex sentences, such as those that contain filler-gap dependencies, a parse with fully specified hierarchical structures will include abstract elements such as empty categories including traces left by moved constituents. A shallow structure, on the other hand, relies more heavily on semantic cues, contextual information, and real-world knowledge for interpretation.

In native speakers, when syntactic representations break down, shallow representations can be used to assign structure to the input (Ferreira et al., 2002). According to the SSH, the fundamental difference between L1 and L2 processing thus lies in the fact that even highly proficient L2ers are unable to access complex syntactic representations during online comprehension and are instead restricted to shallow processing. Thus, due to a purported deficiency in the L2 grammar (even at advanced proficiency levels), detailed syntactic information is unavailable or cannot be deployed in real time. As a result, L2ers must instead rely heavily on nonstructural cues and use contextual and semantic information to assign meaning to the input. Even when L2ers and NSs ultimately converge on their interpretations, they typically do so through distinct routes.

The current study reports on a priming experiment that tests for evidence of syntactic gaps in online processing among intermediate and advanced L2ers of French as well as among French NSs. Reaction time (RT) asymmetries in a picture classification during reading task are examined for evidence of gaps of relativized indirect objects during sentence processing. Such evidence would imply that processing is structurally driven and would thus provide motivation for reconsidering the L2 processing constraints that the SSH posits—namely, that processing moments associated with traces in

* I would like to thank Laurent Dekydtspotter as well as my audience at SLRF and two anonymous readers for their helpful and insightful comments.

the representations of long-distance filler-gap dependencies are absent from L2 sentence processing.

2. Motivating the SSH

Support for the SSH comes in part from studies that have looked for evidence of trace reactivation at the syntactic gap site. In a sentence as in (1), the relativized noun phrase (NP) *the boy* has moved up in the structure, but leaves behind a silent copy in its canonical object position.

1) *The policeman saw the boy who the crowd at the party accused* <who> *of the crime.*

The presence of traces as structural reflexes of language processing can be revealed through studies that use crossmodal priming. In these experiments, participants seated at a computer are asked to make simple categorization decisions about probes that are presented visually at specific moments while at the same time listening to an auditory stimulus. The probes may be images to be classified according to some binary distinction, such as ±edible, or they might be strings of letters to be identified as a word or nonword. Priming effects occur when the moved constituent is mentally reactivated at the hypothesized gap site, which facilitates responses to probes that are semantically related or identical to the antecedent of the trace: RTs to related targets at the gap position should be faster than those to unrelated targets appearing in the same position, and faster than those to related targets presented at other moments during processing.

Antecedent reactivation effects suggest that syntactic gaps are part of the sentence structure in online L1 processing. For example, Love (2007) investigated these effects of antecedent priming in L1 processing by English NS children (ages 4-6) and college-aged young adults, using sentences as in (2):

2) *The zebra that the* [#1] *hippo had kissed* [#2] *on the nose ran far away*.

Four conditions crossed probe position (gap position, indicated by #2, or control, #1) with probe type (matching the antecedent NP1, in this case, *the zebra*, or the embedded subject NP2, *the hippo*). Participants listened to the sentences for comprehension, which was periodically verified through simple auditory questions, and had the additional task of indicating, by pressing a button as quickly as possible, whether the images appearing on the computer screen depicted something that was edible or inedible. The main experimental items all featured pictures of animals, and the filler sentences involved images of common edible items as well as of nonedible inanimate objects. Participants were trained to a 100% accuracy level in the classification task before completing the crossmodal priming task. Both the adult and children NS participants produced faster RTs for probes matching the antecedent that occurred concurrently with the gap position.

Love's (2007) results are actually consistent with theories of either trace reactivation, indicating that the participants have used the structural gap to integrate the filler, or of direct association, whereby participants used their thematic knowledge of the verb for filler integration as soon as the verb occurred (see, e.g., Pickering & Barry, 1991; Sag & Fodor, 1995; Traxler & Pickering, 1996). In other words, it is not clear whether this effect is due to the presence of a trace or to encountering the verb (e.g., Nicol, 1993). The results could thus point to either syntactic processing or to shallow structures. In order to differentiate between these two possibilities, Roberts et al. (2007) tested adult and child English NSs on a similar crossmodal priming task using sentences such as that in (3), in which the structural trace is separated from the verb:

3) *Fred chased the squirrel to which the nice monkey explained the game's* [#1] *difficult rules* [#2] *in the class last Wednesday*.

At the gap position (#2) or in a control position approximately 500 ms earlier (#1), participants pressed a button to classify identical and unrelated target pictures as alive or not alive. The identical probes matched the antecedent of the trace, whereas the control probes depicted some unrelated inanimate object. Participants encountered periodic comprehension questions to hold them accountable for actively paying attention to the experimental items. In addition to the main experimental task, all participants also completed a memory span test. Roberts et al. found clear reactivation effects: RTs for the identical probes in the gap position were faster than those for unrelated probes at the same position and also faster than those for identical probes in the control position. However, only the children and adults with high working memory (WM) capacity demonstrated these priming effects.

There is thus clear evidence for syntactic gaps in L1 processing. However, the picture for L2 processing is less clear. Felser and Roberts (2007) tested 24 advanced Greek-speaking adult L2ers of English on the same stimuli used by Roberts et al. (2007), and compared these results against those of each of the four subgroups of NSs: low WM adults (n = 22), high WM adults (n = 19), low WM children (n = 32), and high WM children (n = 25). The L2ers' RTs were shorter for identical versus unrelated targets in both gap and control position, which Felser and Roberts interpreted as evidence for maintained activation of the antecedent throughout the sentence, as opposed to reactivation of the antecedent triggered by the presence of a trace at the gap position. Furthermore, no effect of WM capacity was found among these L2ers. Felser and Roberts point out that their L2ers behaved differently from all four subgroups of NSs in Roberts et al.: Both the high WM children and adults showed a position-specific advantage for identical targets at gap position only, whereas the L2ers show this advantage in both gap and control position; among the low WM adults, there were no significant differences between RTs to identical versus unrelated targets; finally, the low WM children showed inhibition rather than facilitation effects, with RTs to identical targets that were actually longer in both positions, and much more so at the gap position (147 ms faster for unrelated targets, versus a 36 ms difference at the control position). Because the L2ers behaved differently than all NS subgroups, Felser and Roberts took this to indicate of a fundamental difference. Given that the L2ers produced the same RT asymmetry regardless of position, which pointed to a lack of effect of structure, Felser and Roberts thus concluded in favor of the SSH.

However, other possible accounts for these data merit reconsideration and further discussion. In investigating L2 processing, researchers generally assume that if experimental instruments have shown the expected results among NS populations, they should also be able to capture the same effects among L2ers—if these effects are present. Divergent L2er results are thus interpreted as evidence for a fundamental difference in L2 processing. However, the crossmodal priming paradigm may not be ideal for testing L2ers. As Dekydtspotter, Miller, Schaefer, Chang, and Kim (in press) point out, listening to decontextualized speech without recourse to visual cues to aid in comprehension creates an extra computational burden on L2ers' processing resources, and among some respondents, could lead to increased levels of stress. This could, in turn, induce the development of a strategy for completing the task. In Felser and Roberts (2007), all of the identical/alive probes were participants in the sentences, whereas the unrelated/not alive targets appeared out of the blue and had little or nothing to do with the content of the sentences. The shorter RTs to identical probes found across the board in the L2er data could have simply been due to the fact that the identical targets had just been encountered (and lexically accessed), whereas the unrelated targets had not. The SSH and theories of direct association would predict that the thematic structure of the verb would be used to resolve the filler-gap dependency. However, in the sentences used by Felser and Roberts and by Roberts et al. (2007), both the gap and pregap control positions occurred after the verb had already been encountered and thus presumably after the antecedent would have been integrated into the structure with the verb. Therefore, the patterns of asymmetry in Felser and Roberts' results seem to be due to the fact that the identical probes depicted things that had just been encountered in the sentences, whereas the unrelated probes represented something new that had not been previously mentioned.

In light of these issues, Dekydtspotter et al. (in press) created a forced-paced reading task combined with picture classification; this methodology was argued to eliminate some of the stress created by crossmodal priming tasks and furthermore allowed for testing at the intermediate level. With this probe classification during reading task, Dekydtspotter et al. tested for evidence of antecedent reactivation at clause edge (i.e., of intermediate traces) in 61 high intermediate English L2ers of various L1 backgrounds (mostly Korean and Chinese) on sentences such as (4):

4) *Harry / is / who / Mary / said / on /* [#1] */ Monday / that /* [#2] */ the headmaster / congratulated / at the assembly.*

Participants were told that the sentences belonged to a log kept by a substitute teacher who was the not so unsuspecting victim of a name-switching prank. Participants read the sentences aloud to themselves as each segment appeared on the screen and classified intervening images as human or nonhuman. Picture probes appeared at clause edge or in an earlier control position inside a prepositional phrase and depicted either a boy, thus matching the antecedent *Harry*, or a girl, matching the embedded subject *Mary*. The filler items were sentences of the same structure and incorporated pictures of animals. The results grouped according to scores on a WM reading span test revealed only partial priming effects among NS controls (n = 45) and mirror-image asymmetries among the L2ers. However, a closer examination of the data revealed that about one-half of the participants in each of the populations actually did show the expected facilitatory priming effects at clause edge, whereas the other half, again of both groups, seemed to show inhibitory priming effects, with longer RTs for nonmatching probes at clause edge. Dekydtspotter et al. argue that these results highlight an additional factor involved in online processing, which has not received sufficient attention in studies of this type: the role of lexical access and patterns of antecedent activation.

3. Rethinking the SSH: The current study

The current study tests for evidence of structurally based processing among intermediate and advanced American L2ers of French, using the methodology developed in Dekydtspotter et al. (in press)—namely, the probe classification during reading task. The main goals of this experiment were to further explore patterns of antecedent activation and to determine whether a using more appropriately designed task would reveal priming effects among L2ers.

3.1. Methodology

The 20 experimental items involved indirect object relative clauses and were inspired by the sentences used in Roberts et al. (2007) and Felser and Roberts (2007). Direct translation from English to French would have been possible in most cases, however, the vocabulary used in the current experiment was simplified, as it is reasonable to assume that even advanced L2ers would probably not have much occasion to use the names of some of the more exotic animals (e.g., *ostrich*, *beetle*, *peacock*), thus inducing additional difficulties in lexical access. All of the animals that appeared in the experimental items of the current study were either common animals whose names L2ers would have seen from the very beginning levels (e.g., *chien* “dog,” *poisson* “fish”), or animals with cognate names in French (e.g., *hippopotame*, *zèbre*).

The picture probes used in the 20 experimental items were of animals and matched either the antecedent or the embedded subject. As in crossmodal priming studies, a 2×2 design crossed type of probe (antecedent matching or nonmatching) with position of probe (gap or control) to create four versions of each experimental item as in (5). Each participant encountered only one version of each sentence, but equal numbers of sentences in all four conditions as shown in (5).

5) a. Condition 1: antecedent matching, gap position
Christophe admire le tigre à qui le petit rat a donné le beau chapeau [picture probe: TIGER] *dans le jardin lundi matin*.

b. Condition 2: nonmatching, gap position
Christophe admire le tigre à qui le petit rat a donné le beau chapeau [picture probe: RAT] *dans le jardin lundi matin*.

c. Condition 3: antecedent matching, control position
Christophe admire le tigre à qui le petit rat a donné le beau [picture probe: TIGER] *chapeau dans le jardin lundi matin*.

d. Condition 4: nonmatching, control position
Christophe admire le tigre à qui le petit rat a donné le beau [picture probe: RAT] *chapeau dans le jardin lundi matin*.

“Christopher admires the tiger to whom the little rat gave the nice hat in the garden Monday morning.”

An additional 30 sentences with a similar structure were created as fillers. These included pictures of animals and of inanimate objects. Examples of the picture probes are shown in Figure 1.

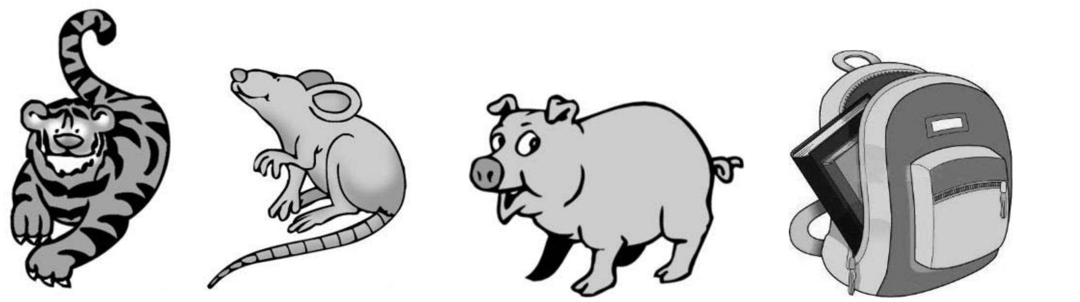


Figure 1. Examples of alive and not alive picture probes

It should be noted that previous research (McKoon & Ratcliff, 1994; Nicol, Swinney, Love, & Hald, 2007) has suggested that an all-visual presentation, in which the sentence is interrupted by the appearance of the probe, may be more susceptible to congruency effects than the crossmodal priming paradigm. In other words, the parser may attempt to integrate the intervening probe as part of the structure of the interrupted sentence. This is potentially problematic as it could conceivably create an illusion of priming. However, the two studies mentioned paired forced-paced reading with a lexical decision task. Participants were asked to identify strings of letters that intervened during reading as words or nonwords. The probes were presented slightly offset from the center and in all capital letters to differentiate them from the sentence. Nonetheless, participants exhibited faster RTs when the probe word could be easily integrated into the structure. The current study used pictures instead of words as probes in an attempt to minimize this type of effect, as visual processing is separate from language processing (e.g., Jackendoff, 1987; Marr, 1982). Furthermore, because both the matching and nonmatching probes were always animals, there is little reason to believe that one probe would be significantly more compatible with the sentence structure than the other. This methodology is thus expected to elicit priming effects similarly to studies in the crossmodal priming paradigm.

3.2. Procedure

A masked priming task was included as an independent measure of priming behavior. Masked priming presents a prime word that appears for only around 40-60 ms and that is both forward and backward masked, making it imperceptible to most participants. The forward mask is usually a series of hatch marks and the backward mask is a target word presented in all caps. Participants make simple decisions about the target words. Because the participant is not consciously aware of the presence of the prime, masked priming is thought to be very revealing of priming effects (see Forster, 1998, for a review of this paradigm). In the current study, the masked priming task was a simple picture classification task, and participants were told that it was a part of a training phase before the main task. The same pictures that would later appear in the probe classification during reading task were classified as alive or not alive. The forward mask ##### appeared on the screen for 500 ms, followed by the prime word for 40 ms, and then the picture target for 650 ms. The task paired French animal name primes with images in three conditions: the match condition, where the picture matched the prime, such as a picture of a zebra following the masked prime word *zèbre*; the mismatch condition, where a picture of a different animal followed the prime, such as a picture of a rabbit after the masked prime *zèbre*; and the object condition, where a picture of an inanimate object appeared after the prime. When debriefed afterwards, one participant reported seeing a flicker between the mask and the picture, but was not aware of having seen a word. The rest of the participants were unaware of anything appearing between the mask and the prime. The results of this task provided an independent measure of priming behavior, with which to compare the results from the probe classification during reading task.

Participants also completed a WM test, which was modeled on Harrington and Sawyer's (1992) reading span test, an L2 English version of Daneman & Carpenter's (1980) test. Forty-two sentences, approximately 11-13 words in length, were presented in sets of two, three, four, and five in a forced-paced PowerPoint presentation. To prevent ceiling effects, a NS version of the task was created with sentences that were longer by 4-5 words. Participants were asked to read each sentences aloud, to indicate on their answer sheet whether it was grammatically correct, and, at the same time, to remember the last word of each sentence per set. When prompted at the end of each set, participants turned the answer sheet over to write down the last words of each of the sentences in order. Final words were common, monosyllabic words. The grammatical errors consisted of subject-verb mismatches, preposition mistakes and other simple but fairly obvious errors. There are two scores for this test: the total number of words remembered out of 42 and the number of complete sets in which all words were remembered out of 12.

For the main experimental task, a context was provided in which a French elementary school teacher is looking at story books she has read to her class, remembering what the children have said about the animal characters. The cartoon-style pictures used as probes were meant to be illustrations from the books. Participants were asked to pay careful attention to the sentences, reading aloud to themselves in a low voice, and to indicate, as quickly as possible, whether an interrupting image depicted something alive or not alive by pressing a button. The 20 experimental items included animal pictures, matching either the antecedent or the other animal appearing in the same sentence as the embedded subject. Twenty of the filler sentences contained direct object relative clauses and pictures of inanimate objects, with five more direct object relative sentences with animal probes, and five more indirect object relative structures with inanimate object targets. Images appeared on the screen for 650 ms. DMDX software (Forster & Forster, 2003) was used to measure response times, and to control reading speed in the probe classification during reading task. Reading speed was calibrated through trial and error and piloting with native and nonnative volunteers. Nonnative presentation was slowed by 20 ms per segment.

3.3. Participants

Eighteen advanced and 17 intermediate L2ers of French participated in the current study, as well as 12 NS controls. The intermediate L2ers were undergraduate students at a large Midwestern university, enrolled in a 300-level advanced grammar course at the time of testing. The advanced L2ers and NSs were graduate students pursuing advanced degrees in French studies at the same university. The L2ers were all NSs of American English. Participant characteristics are shown in Table 1.

Table 1. Participant Characteristics

Group	Age	Years of study	Months abroad	WM words	WM sets
Intermediate	19.3	6.5	0.5	26	4
(*N* = 17)	(1.0)	(2.5)	(.8)	(5.4)	(1.8)
Advanced	26.4	10.6	14.8	32	6
(*N* = 18)	(3.5)	(3.6)	(11.3)	(6.4)	(3.1)
Native	30			36	8
(*N* = 12)	(6.4)	*n.a.*	*n.a.*	(4.3)	(2.2)

Note: Standard deviations are in parentheses.

3.4. Analysis and predictions

Participants were divided into high and low WM groups based on the mean WM score for each group (as shown in Table 1). For both the masked priming and the probe classification during reading tasks, only RTs for which an image was identified correctly as alive or not alive were included for analysis. All participants were highly accurate in their classification of images, with only 1.25% of the data excluded due to incorrect classifications. Within each participant group, any RT that fell outside two standard deviations from the mean was removed and replaced by the mean. This pruning procedure affected an additional 5.4% of the data. A repeated measures ANOVA investigated the effects and interactions of probe position and probe type. Planned paired-samples *t* tests were used to determine whether any asymmetries in the mean RTs across the conditions were statistically significant. Thus, if processing is structurally based, and if L2ers use syntactic gaps to resolve filler-gap dependencies, RTs are expected to be shorter in condition 1, where the picture probe appearing at the moment the gap is encountered matches the antecedent, than in condition 2, where the image does not match. Additionally, RTs in condition 1 are also predicted to be shorter than in condition 3, where the matching picture appears before the gap position. No differences in RTs are expected across the other conditions. The predicted asymmetries for the main experimental task are shown in Figure 2.

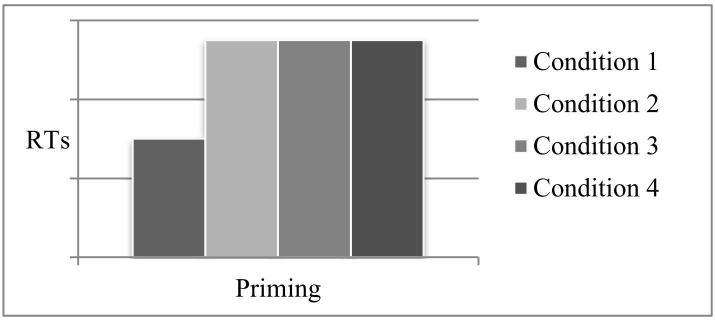
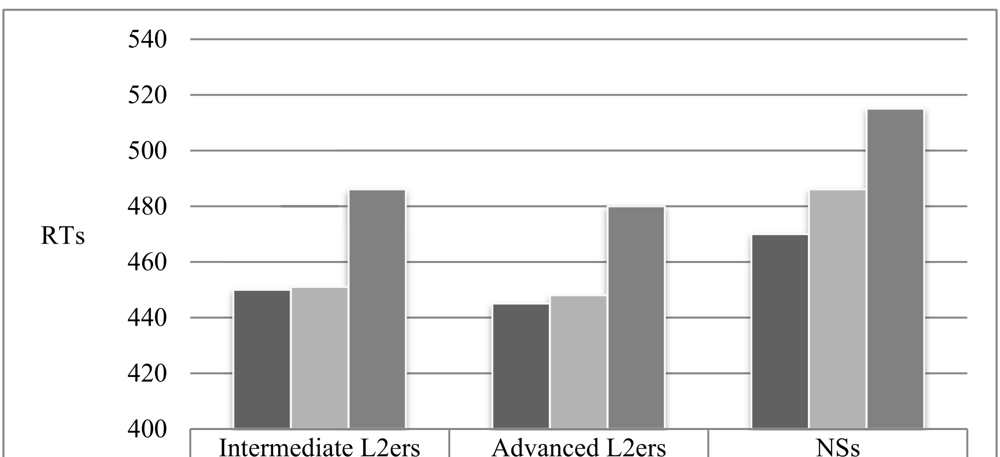


Figure 2. Expected RT asymmetries showing facilitative priming effects

4. Results

The mean RTs for the masked priming task are shown in Figure 3. Paired-samples *t* tests revealed strong priming effects: For the intermediate L2er data, there was a significant difference between the match and object conditions, $t(16) = 4.79$, $p < .005$, as well as between the mismatch and object conditions, $t(16) = 6.189$, $p < .005$, with no significant difference between the match and mismatch conditions, $t(16) = 0.684$, $p = .504$. The same pattern of asymmetries is found in the advanced L2er data, for match-object, $t(17) = 6.552$, $p < .001$, for mismatch-object, $t(17) = 4.482$, $p < .001$, for match-mismatch, $t(17) = 0.579$, $p = .558$. The NS data reveal a more gradient asymmetry: Their RTs are marginally longer in the mismatch condition than in the match condition, $t(10) = 2.295$, $p = .064$.[1] Their RTs are significantly longer in the object condition than in both of the other conditions, match-object, $t(10) = 6.366$, $p < .001$, mismatch-object, $t(17) = 4.636$, $p < .005$.



	Intermediate L2ers	Advanced L2ers	NSs
Match	450	445	470
Mismatch	451	448	486
Object	486	480	515

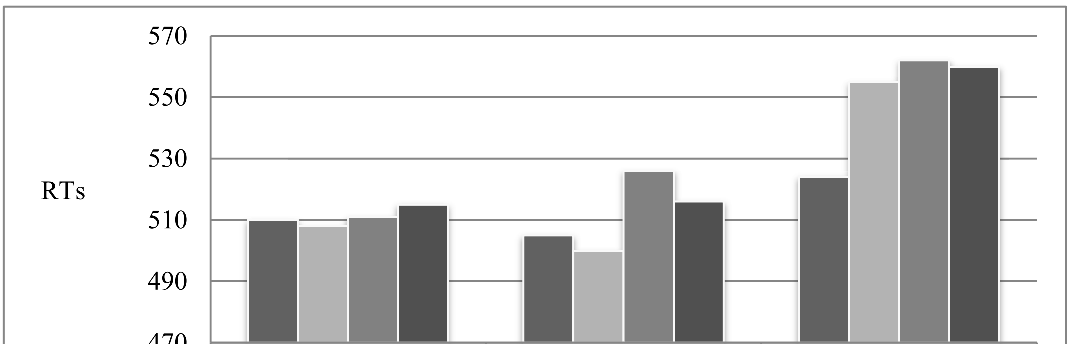
Figure 3. RTs in ms to pictures in masked priming task

[1] Given one-tailed expectations of facilitation due to priming, this difference reaches significance at $\alpha = .05$

Thus, two distinctive patterns of facilitation were found: For the NSs, a masked animal name prime facilitated the classification of matching animal pictures and pictures of other animals to different extents. The facilitation was greater with an exact match. Among the learners, however, a masked animal name prime facilitated the classification of any animal picture, regardless of whether the picture matched the prime exactly.

Turning now to the main experimental task, a repeated measures ANOVA, with position and probe as within-subject factors and participant group and WM group as between-subject factors, revealed a main effect of position, $F(1, 42) = 8.986$, $p < .005$, and a significant interaction between probe type and group, $F(1, 42) = 3.787$, $p < .05$. There was no significant effect of either of the WM scores, which is similar to the findings of previous studies (e.g., Felser & Roberts, 2007). Each participant group will thus be considered as a whole, without any further division according to WM capacity. Additionally, it should be noted that item analyses did not produce any relevant effects or interactions, most likely due to large differences among subjects on this task. The results reported here are thus based only on subject analyses.

The mean RTs for the probe classification during reading task are shown in Figure 4. The intermediate L2ers produced flat RTs across all conditions. The advanced L2er data, however, presents a different picture. These L2ers did not produce the predicted RT asymmetry between conditions 1 and 2 but instead exhibited similar mean RTs for both antecedent matching and nonmatching pictures in the gap position, $t(17) = 0.594$, $p = .560$. However, significant priming effects are clearly found in condition 1 as compared with condition 3, $t(17) = 3.475$, $p < .005$. These advanced L2ers thus show an effect of structure, classifying antecedent matching pictures more quickly in the gap position than in the control position. The NSs, despite exhibiting longer RTs overall, produced the expected asymmetries, condition 1-condition 2, $t(11) = 2.504$, $p < .05$, condition 1-condition 3, $t(11) = 2.481$, $p < .05$. The NSs thus responded most quickly to antecedent matching probes in gap position, with flat RTs across all other conditions.



	Intermediate L2ers	Advanced L2ers	NSs
■ Condition 1	510	505	524
■ Condition 2	508	500	555
■ Condition 3	511	526	562
■ Condition 4	515	516	560

Figure 4. RTs in ms to picture probes in probe classification during reading task.

The probe classification during reading task thus revealed three distinct patterns: The intermediate L2ers produced flat RTs across all four conditions, the advanced L2ers responded more quickly to both matching and nonmatching probes in gap versus control position, and the NSs produced the expected RT asymmetries, classifying antecedent matching probes in gap position most quickly with respect to the other conditions.

5. Discussion

The lack of RT asymmetries among the intermediate L2ers on the probe classification during reading task could be advanced as an argument for shallow processing. If these L2ers use the thematic structure of the verb to resolve the filler-gap dependency, the integration of the filler would have already taken place when the verb was encountered, before both of the test positions. Given that, in contrast to Felser and Roberts (2007), both matching and nonmatching probes depicted animals that appeared in the sentence, there should thus have been no significant differences between the RTs across all conditions.

That these intermediate L2ers would rely on shallow processing as processing breaks down is not entirely surprising at this proficiency level: These learners' processing system may have simply been overwhelmed. However, such break down does not provide evidence for the SSH. Indeed, the SSH is rooted in the idea that the L2 grammar is insufficient and incapable of sustaining a syntactic parse of the input. On Clahsen and Felser's (2006) model, the L2 grammar will never be sufficient, and shallow processing will persist even at the highest proficiency levels. The advanced L2er data suggests otherwise. These participants clearly showed sensitivity to the structure, reacting more quickly to picture probes at the gap position versus the control position. The advanced L2er results of the current study also contrast sharply with Felser and Roberts' (2007) results. The advanced L2er participants in that study responded more quickly to identical probes in both gap and control position, with no apparent effect of structure. A side-by-side comparison of the results of the two studies is shown in Figure 5.

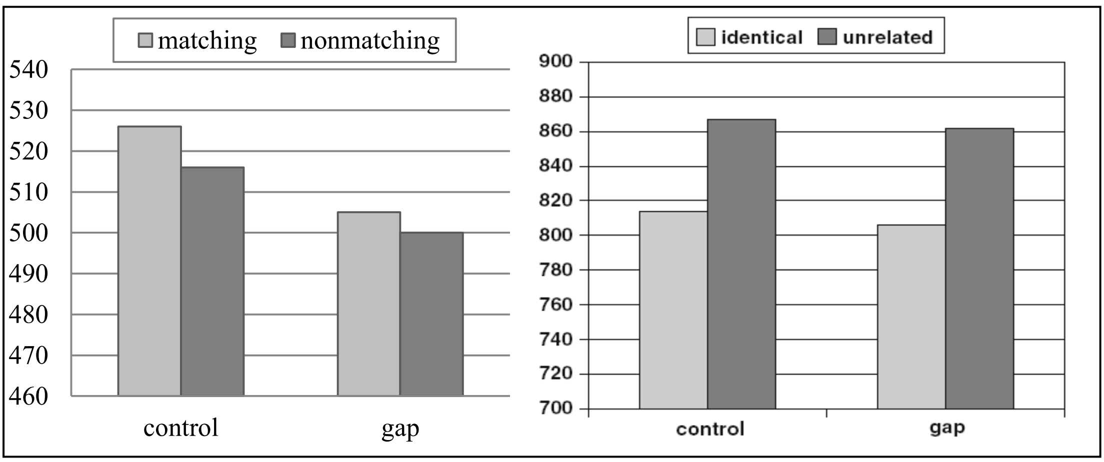


Figure 5. Advanced L2er results of the current study (left) compared with those of Felser and Roberts (2007; right; From Felser and Clahsen, 2009, p. 315, Figure 3)

Felser and Roberts (2007) argued that their L2er results showed evidence of maintained activation: The asymmetrical RTs in both positions, regardless of the structure, seem to suggest that the antecedent remained activated throughout processing, irrespective of *any* structure, including thematic representations. The advanced L2er results of the current study are manifestly inconsistent with this analysis. Although the advanced L2er RTs in the current study do not show significant asymmetries between probe types in either position, they crucially show an asymmetry between the two positions, with shorter RTs in the gap position. Because the gap position appeared further downstream than the control position and thus at a greater distance from both the antecedent and the embedded subject, a position-related asymmetry in the opposite direction might be expected within the framework of the SSH: The maintained activation of the filler might weaken gradually as the sentence continues and more referents are introduced. This is not the case for the results of the current study, which are more compatible with structurally-based L2 sentence processing.

The question remains, however, as to how to account for the lack of asymmetry between RTs to matching and nonmatching probes in the gap position that is found in the advanced L2er data. This contrasts with the NS data, which exhibits the relevant asymmetries consistent with facilitatory priming predicted by structurally driven processing. The advanced L2er RT pattern could be due to a sort of wrap-up effect: The gap position coincides with the point at which all arguments of the embedded clause verb have been encountered and integrated into the structure. That the so-called nonmatching probes actually matched the embedded subject could have thus induced the faster RTs for these probes in the gap position.

However, if the results of the probe classification during reading task are compared with those of the masked priming task, it is clear that two distinct profiles characterize the advanced L2er and NS results in both tasks. In the masked priming task, there was no difference between the match and mismatch conditions in the L2er data—that is, an animal word prime facilitated the classification of pictures of animals, regardless of whether there was an exact match. Similarly, in the probe classification during reading task, there was no difference between conditions 1 and 2—that is, between matching and nonmatching probes in gap position. In the NS data, these differences between RTs to matching and nomatching animal probes are present in both tasks. The results of the two tasks are compared in Figure 6.

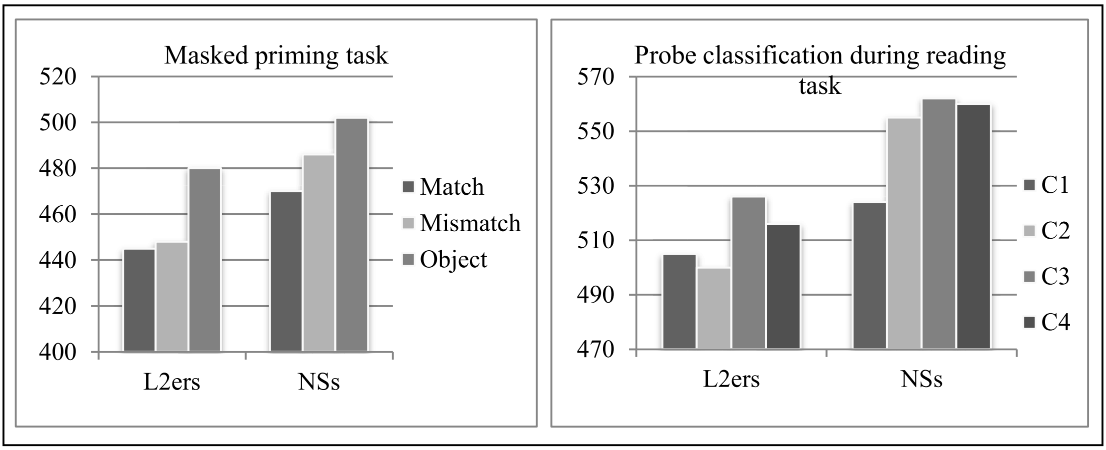


Figure 6. Advanced L2er and NS results of the masked priming and probe classification during reading tasks compared.

The difference between the RT patterns produced by the NSs and advanced L2ers on the probe classification during reading task can thus be accounted for when considered alongside the results of the masked priming task. These L2ers showed sensitivity to the sentence structure; the shorter RTs in the gap position seem to indicate reactivation of the antecedent. However, there was no difference in the RTs for matching and nonmatching probes in this position, analogous to the lack of difference between RTs to match and mismatch animal pictures in the masked priming task. This would seem to suggest that the activation of an animal referent seems to light up the entire category *animal*, or that activation spreads more quickly across semantic networks, yielding the robust facilitation effects for the classification of pictures of other animals, as compared to the differing levels of facilitation found in the NS data for matches and mismatches. This large degree of semantic overlap should be controlled for in future studies in which the matching and nonmatching probes would belong to different semantic categories.

The results of the masked priming task revealed differences between the priming patterns produced by L2ers and NSs, which had important implications for the main experimental task. Moreover, the patterns revealed in the current study have larger implications for processing research in general—namely, that differing patterns of activation play a significant role in the online processing of structurally complex sentences and that this aspect of L2 processing should be further explored.

6. Conclusion

Previous research in the crossmodal priming paradigm has concluded that the absence of the relevant asymmetries in the L2er data points to fundamental differences between L1 and L2 processing. In the current study, with a task designed to reduce the pressure and stress created by crossmodal priming tasks, advanced L2ers were found to show facilitative priming effects, following expectations for structurally driven processing. The advanced L2er results indicate that L2 processing is not necessarily limited to shallow structures but instead that highly proficient L2ers may indeed be able to construct fully specified syntactic representations during online processing. The results of the masked priming task revealed differences in priming patterns between L2ers and NSs that mirrored those found in the probe classification during reading task. The different patterns of priming effects found in the main experimental task, when compared with the results of the masked priming task indicate that modes of lexical access and patterns of activation also play a role in language processing, which is an aspect that future research should explore further.

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