The Relationship between Sensitivity to Morphosyntactic Violations and Morphosyntactic Anticipation in L2 Comprehension

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1. Introduction to the Study

To comprehend spoken language in real time, a listener must establish relationships among multiple sentential constituents incrementally, and at a relatively fast speed. To accomplish this feat, listeners recruit both integrative (e.g., Phillips & Ehrenhofer, 2015) and anticipatory mechanisms (e.g. Borovsky et al., 2012). Previous studies have shown that these processes are employed by both native speakers and advanced second language (L2) learners (Marull, 2017a, 2017b), but the relationship between these processes is not clearly defined. Furthermore, there is limited understanding of how this relationship affects linguistic interpretation at different proficiency levels. Thus, the purpose of this study is to examine the relationship between L2 learners’ ability to detect morphosyntactic violations in reading (integration) with their ability to use morphosyntactic cues to predict upcoming input (anticipation) as a way of identifying the source of L2 learner divergence from native speaker performance. Teasing apart these two processes contributes significantly to understanding the numerous mechanisms and subcomponents of the L2 processor which, to date, has been largely approached in holistic terms. Additionally, this study aims to contribute to current debates on the locus of difficulty in L2 sentence processing and to advance knowledge and understanding of what non-native processing more precisely entails.

2. Background

Integration is a bottom-up reactive mechanism that assimilates incoming information with previously encountered information in a serial fashion (e.g., Frazier, 1999; Kazanina et al., 2007; Phillips & Ehrenhofer, 2015; Traxler & Pickering, 1996). In contrast, anticipation is a top-down mechanism that proactively generates expectations about upcoming material based on previously encountered cues. Such anticipation of linguistic content facilitates integration of bottom-up input further down in the processing pipeline (Borovsky et al., 2012; Elman, 1990; Federmeier, 2007; Misyak et al., 2010; Rodriguez et al., 1999).

According to the R.A.G.E. hypothesis (Grüter et al., 2014; 2016), learners can exhibit a native-like integration of morphosyntax, but their ability to generate expectations based on morphosyntactic cues appears impaired or non-existent in...
comparison to native speakers. For example, in previous L2 studies, learners have been successful in achieving native-like abilities on comprehension tasks involving (ungrammatical) gender-mismatch between nouns and post-nominal adjectives, case marking, and verb semantics (e.g. Dowens, Vergara, Barber, & Carreiras, 2009; Keating, 2009; Hopp 2010). However, preliminary evidence shows that L2 learners have had limited success in making use of predictive cues such as reliance on gender-predictive determiners (Grüter et al., 2012; Lew-Williams & Fernald, 2010), phonologically-predictive determiners (Martin et al., 2013), verbal aspect for coreference (Grüter et al., 2014; Grüter et al. 2016), extracted wh-phrases (Kaan, 2007), case markings (Hopp, 2015) and number markings on determiners (Marull 2017a, 2017b). The L2 ability to employ anticipatory mechanisms appears to be reliant on the availability of cognitive resources which are limited when the target constructions are dissimilar across languages or when proficiency is low. Thus, the saturation of cognitive resources is the most likely cause of this discrepancy between learners and natives. This is in line with findings that show that increased proficiency correlates with increased lexical automaticity, the speed and efficiency with which individuals can retrieve a lexical item (Hopp, 2014). Increased lexical automaticity frees up cognitive resources and makes more sophisticated top-down processing mechanisms, such as anticipation, available to the learner.

In Marull (2017a), a group of native Spanish-speakers, a group of intermediate learners of Spanish and a group of advanced English learners of Spanish completed a picture-selection task and a self-paced reading task. The former isolated predictive mechanisms by testing learners’ ability to utilize number cues to anticipate upcoming constituents and the latter measured learners’ sensitivity to number violations: a test of integration abilities. In the self-paced reading task, increased reading times corresponded with number-violation sensitivity and in the picture-selection task, shorter response times demonstrated anticipatory ability. The study’s results revealed that while all learners showed sensitivities to grammatical violations in the self-paced reading task, only the native speakers and advanced learners showed anticipation in the picture-selection task. The findings suggest that the L2 processor is not inherently different from the L1 processor, but that the two become more aligned with increasing proficiency in the L2.

Knowing that at advanced levels L2 speakers can employ anticipatory mechanisms to generate linguistic expectations based specifically on morphosyntactic features, the broader question becomes, not if, but rather how this ability develops in relation to other parsing strategies. In this current study, the terms “prediction,” “anticipation,” and “expectation” are used interchangeably. Furthermore, we adopt Kuperberg and Jaeger’s (2016) definition that these terms minimally refer to the notion that contextual information (from multiple sources) is used to change the state of the language processing system before new bottom-up input becomes available, thereby facilitating processing of this new input. What remains unknown is the scope and nature of these two mechanisms. Thus, in this study we build upon the findings of Marull (2017a) to further investigate how integration and anticipation interact in L2 comprehension.
3. The study

This study utilizes data from Marull (2017a) to answer our research question which aims to understand the relationship between sensitivity to morphosyntactic violations and morphosyntactic anticipation. We took the results from the group of Spanish native speakers (32 recruited in Argentina) and advanced English learners of L2 Spanish (19 recruited at a large public institution in the United States). All participants were between 18 to 45-years-old and, minimally, had completed high school. The participants completed a language background questionnaire and a Spanish proficiency test - a modified version of the Diploma de Español como Lengua Extranjera (DELE) (Diploma of Spanish as a Foreign Language) - prior to taking part in the experimental tasks which were a self-paced reading and a picture-selection task. All materials were administered via digital presentation on a computer screen and required participants to read, listen, speak, and click to answer. The presentational order of the experimental tasks was counterbalanced.

3.1. Materials and Procedure
3.1.1. Self-paced reading procedure

In the noncumulative self-paced moving window task (Just, Carpenter, & Woolley, 1982), participants read sentences one at a time in the center of a computer screen with a series of dashes replacing all characters except for spaces. At the start of each sentence, the participants saw a fixation cross (+) which upon pressing the space bar disappeared to reveal the first word in the sentence. With each consecutive press of the space bar the next word in the sentence appeared and the prior word was replaced with dashes until the end of the sentence. Time between button presses was recorded and reading times were calculated for each word region. Participants completed six practice trials that were not included in analyses nor repeated as part of the experimental stimuli.

After each sentence the participants answered a comprehension question that addressed the semantic content of the sentence by pressing a “yes” button on the keyboard to respond if the question was correct (i.e., matched with the content of the previous sentence) or a “no” button to indicate if it was incorrect.

3.1.2. Picture-selection task procedure

The picture-selection task was adapted from Morett and MacWhinney’s (2013) picture-selection task and Fernald et al.’s (2008) looking-while-listening procedure. This task was designed to measure linguistic predictive mechanisms. At the start of each trial, the participants saw a 500 ms fixation cross (+), which was replaced by a pair of images, one on the left and one on the right side of the screen. The image presentations, respective to the screen, were vertically centered and counterbalanced. Once the participant was familiar with the images, they pressed the spacebar to start the presentation of the auditory stimulus sentence.
delivered through individual headphones. The aural stimulus matched only one of the picture’s semantic content. The pictures remained on the screen until the participant selected one by pressing a specified key that corresponded to the side of the screen on which it appeared. Participants were instructed that they would see two images and needed to select “the picture that best matches the sentence they hear as quickly as possible” (see Figure 1). They were explicitly told that they did not need to wait until the end of the sentence to choose an image. In the experimental trials, the images either matched or mismatched in number of the critical noun. The participant’s button press was time-locked to the offset of the critical determiner in the auditory stimuli. Participants performed a short practice block of four sentences and data from the practice trials were not included in the analyses. Sentence comprehension was measured by participants’ picture selection accuracy.

Figure 1. Picture Selection task

Uninformative Condition

![Uninformative Condition Image]

Informative Condition

![Informative Condition Image]

3.2. Analyses

To address how sensitivity to number marking (longer reading times) in the self-paced reading task and predictive strategies (faster response times) in the picture selection task are related, the following correlational analyses were conducted to determine the relationship between integration and prediction. First, to determine the effect size of violation in the self-paced reading task, construction types were collapsed together (due to a lack of interaction between construction type and agreement) in the critical regions. Then, in both the N and N+1 region
the difference scores between the grammatical and ungrammatical conditions were computed for each participant by subtracting the agreement reading times from the violation reading times. To calculate the size of the prediction effect in the picture selection task, the response times of the informative condition were subtracted from the response times in the uninformative condition.

4. Results

Having created an effect size of violation and an effect size of prediction, we present our findings for each group separately.

4.1. Native Speaker Results

In the N region there was no correlation \((r = -.06, p = .746)\), but in the N+1 region, there was a negative correlation between the effect of violation sensitivity and predictive sensitivity \((r = -.415, p = .018)\). However, when the two regions were collapsed together only a trend towards correlation was revealed \((r = -.342, p = .056)\) (see Figures 2, 3, and 4).

Figure 2. The relationship between the effect of violation sensitivity and prediction effect for natives at N region

\[ y = -44.45 + 0.03x \]

\( R^2 \) Linear = 0.004
Figure 3. The relationship between the effect of violation sensitivity and prediction effect for natives at N+1 region

$$y = 1.25 \times 10^2 + 0.28 \times x$$

Figure 4. The relationship between the effect of violation sensitivity and prediction effect for native at collapsed N and N+1 regions

$$y = 1.69 \times 10^2 + 0.31 \times x$$
4.2. Advanced Learner Results

In the N and N+1 region there was no correlation (N: $r = -0.335$, $p = .161$; N+1: $r = -0.166$, $p = .496$) between the effect of violation sensitivity and predictive sensitivity. However, when the N and N+1 region were collapsed together, there was a negative correlation between the effect of violation sensitivity and predictive sensitivity ($r = -0.489$, $p = .036$) (see Figures 5, 6, and 7).

Figure 5. The relationship between the effect of violation sensitivity and prediction effect for advanced learners at N region
Figure 6. The relationship between the effect of violation sensitivity and prediction effect for advanced learners at N+1 region

Figure 7. The relationship between the effect of violation sensitivity and prediction effect for advanced learners at collapsed N and N+1 regions
The above findings suggest that there is a correlation in performance between the prediction task (picture-selection task) and the integration task (self-paced reading task). Although qualitatively the slopes of the regression lines are very similar between the natives and the advanced learners, this relationship was identified in different regions (natives: in the N+1 region; advanced learners: in the collapsed region N and N+1).

5. Discussion

To address the relationship between anticipatory and integrative mechanisms during processing of sentence comprehension, a prediction effect size from the picture-selection task and a violation effect size from the self-paced reading task used in Marull (2017a) were calculated for each participant, and correlation analyses were run. The findings revealed a weak negative correlation for both native speakers and advanced learners. The greater the predictive effect size, the smaller the violation effect size. These findings establish that an individual’s capacity for predictive abilities ties in with their integration abilities and are the first findings of this kind in L2 processing studies.

Interestingly, the correlation between the predictive effect size and the violation effect size had a negative relationship. This counterintuitive finding may indicate that when both integrative and predictive processes are efficiently employed, recovery from an unexpected violation is faster than when predictive mechanisms are less efficient. We speculate that the combined effect of efficient integration and anticipation provides a participant with clear expectations regarding forthcoming linguistic information and when such expectations are not borne out he or she can easily recognize the cause of the processing disruption. Having such clear expectations can make it easier and faster to overcome a violation (shorter reading time delays). When the expectation is not as clear, there is an overreliance on backward-looking agreement checking. In this case, the combined effect of the detection of the violation and the identification of the source of the violation are costly with regard to temporal processing and thus, could explain the cause of the negative correlation. However, this is speculative and other explanations for the negative correlation need to be explored.

This pivotal finding allows us to begin to identify the individual contributions of the underlying processes responsible for sentence comprehension. It also furthers our understanding of the scope and limitations of different psycholinguistic methodologies and the interpretation of the findings. Future researchers will have to be very specific regarding the underlying language process that they are trying to measure. They must also be careful not to overgeneralize their findings to global language processes if the tasks of their studies confound the bottom-up and top-down processes, among the many other processes that are surely to be disentangled in future studies.
References


