Prediction at the Discourse Level in L2 English Speakers: An Eye-Tracking Study

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1. Introduction

Psycholinguistic research has shown that monolingual speakers use different types of information to formulate hypotheses about how a sentence is likely to continue. In particular, research on prediction has demonstrated that speakers and listeners build up expectations during sentence processing at the lexical, morphosyntactic and discourse levels (e.g., Altmann & Kamide, 1999). At the discourse level—the topic addressed in this paper—we know that native speakers formulate expectations about who will be mentioned in the upcoming discourse by using implicit causality information encoded in the verb (e.g., Cozjin, Commandeur, Vonk, & Noordman, 2010; Pyykkönen & Järvikivi, 2010). To our knowledge, there are no studies that have investigated whether second language (L2) speakers are similar to monolingual speakers in their use of implicit causality to generate expectations. This is the goal of the experiments reported here.

Implicit causality is a feature of certain psychological verbs in which the cause of events is implied and conveyed implicitly as part of the verb's meaning. Implicit causality verbs can be divided into *NP1 bias* and *NP2 bias*. To illustrate, in (1) below the interpretation of the pronoun *she* varies depending on the bias of the verb: *frighten* and *confuse* are NP1 bias, which leads to a subject resolution of the referentially-ambiguous pronoun *she* (i.e., *Sally* is the preferred referent for *she*). *Love* and *hate* are NP2 bias, which leads to an object resolution (i.e., *Mary* is the preferred referent for *she*).

(1) Sally VERBs Mary because *she*...

Various studies have shown that implicit causality information encoded in verbs has an impact on native speakers' referential expectations during reading (e.g., Caramazza, Grober, Garvey & Yates, 1977) and listening (e.g., Cozijn et al., 2011). Previous research that has analyzed the activation of implicit causality information during listening (Cozijn et al., 2011 for Dutch; Pyykkonen & Jarvikivi, 2010 for Finnish) has found that native listeners' expectations emerge before the target referent in the subordinate clause is even mentioned (in example (1) above, this would be at the causal connective *because*).

Studies that have investigated predictive processing abilities in L2 learners have demonstrated that this population shows limitations in building up expectations during language processing (e.g., Martin, Thierry, Kuipers,

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Boutonnet, Foucart, & Costa, 2013; Grüter, Lew-Williams, & Fernald, 2012; Dussias, Valdés Kroff, Guzzardo Tamargo, & Gerfen, 2013). In the present paper, we investigate prediction at the discourse level, a level at which predictive processing is known to occur in monolingual speakers, and which has not yet been extensively investigated in L2 speakers (see Grüter, Rohde, & Shafer, 2016; Cheng & Almor, 2016). For example, Cheng and Almor (2016) looked at the off-line preferences for interpreting pronouns in implicit causality contexts in a group of native speakers of Chinese who were intermediate/advanced learners of English. Participants were presented with two sentence completion tasks. In the sentences, implicit causality verbs were presented that were either NP1 or NP2 bias, as illustrated in (2) and (3) (only conditions relevant for the purpose of the present study are illustrated here):

(2) John frightened Henry because he….
(3) John feared Henry because he….

Completions provided by the Chinese learners of English suggested that they could not use implicit causality information encoded in the verbs as accurately as native English speakers. In particular, Cheng and Almor (2016) found that L2 learners used a first-mention bias for both NP1 and NP2 bias verbs. Because the authors tested intermediate/advanced L2 learners who did not live in an English immersion context, one question is whether the amount of L2 input that the speakers were exposed to could have influenced the leaners' performance. Additionally, NP2 bias verbs are less frequent in Chinese than in English because Chinese has alternative, more frequent, constructions that can express the same meaning. This cross-linguistic difference may have impacted the correct use of implicit causality information by the Chinese learners.

In the study presented here, we investigate whether highly proficient L2 speakers engage in prediction while processing discourse information. In Experiment 1, monolingual English-speaking adults and L1 Spanish-L2 English speakers participated in an eye-tracking study, in which the stimuli were presented auditorily (e.g., Cozijn et al., 2011). In Experiment 2, we used a sentence completion task to assess participants' use of the implicit causality verbal information in an off-line task. Spanish and English were chosen because the two languages have comparable use of NP1 and NP2 bias verbs (Goikoetxea, Pascual, & Acha, 2008). By recruiting highly proficient L2 speakers of English and by eliminating cross-linguistic differences, the present study aims at investigating the retrieval of implicit causality information and its use to generate expectations about upcoming referents.

We expect that L2 participants will behave similarly to monolingual English-speaking controls in their ability to make off-line predictions about the referent of an ambiguous pronoun immediately following an implicit causality verb (Cheng & Almor, 2016). For the eye-tracking experiment, we expect that L2 speakers will be able to activate implicit causality information to predict the upcoming referent, although the exact time-course of their prediction is less

clear. One possibility is that the L2 participants will be comparable to monolingual English-speaking participants, with no differences found in how fast implicit causality information is activated and used to make predictions. Another one is that the L2 speakers will show delayed activation of implicit causality information, either due to general slowness in discourse processing, or due to a processing cost specifically associated with the activation of the lexical information of the verb.

There are several reasons to assume that L2 learners may be generally slower than monolingual speakers. For example, L2 speakers may have reduced processing resources at their disposal to formulate predictions because access and integration of lexical information is slower compared to monolinguals. According to Grüter et al. (2016), this disadvantage may affect the building of expectations. Differences between monolingual and L2 speakers, however, could also be the result of differences in the quality of the lexical representations for the verbs. This explanation is grounded on the observation that the quality of lexical representations in speakers of two languages is generally weaker in the less dominant language because L2 speakers have lower exposure to the L2 than monolingual speakers (e.g., Gollan, Montoya, Cera, & Sandoval, 2008; Gollan, Slattery, Goldenberg, Van Assche, & Duyck, Rayner, 2011).

2. Method

2.1. Participants

Twenty-one L1 English-speaking adults (12 females; mean age 20.5; SD= 2) and twenty-three Spanish-English bilingual speakers (14 females; mean age 21, SD= 3.5) were recruited at two large North-American universities. Both groups of participants completed a Language History Questionnaire (LHQ, Marian, Blumenfeld & Kaushanskaya, 2007) prior to testing. In addition, the L2 speakers completed the *Michigan English Language Institute College English Test* (MELICET) that served to assess proficiency in the L2. Monolinguals indicated little or no exposure to a second language in the LHQ. L2 participants were very proficient in English, as indicated by their mean score in the MELICET (see Table 1).

Table 1. Participant information: Mean (SD)

	Spanish - L1	English - L2
Age of exposure (age in years)	0 (0)	6 (4)
Length of residence in the USA (in years)	13(8)	14(8)
Speaking (1-10)	8(2)	8(2.5)
Listening (1-10)	9(1)	9(3)
Reading (1-10)	8(2)	8(2)
Average daily exposure (%)	56 (14)	44(14)
Language proficiency score (out of 50)	-	41.3(2.9)

2.2. Materials

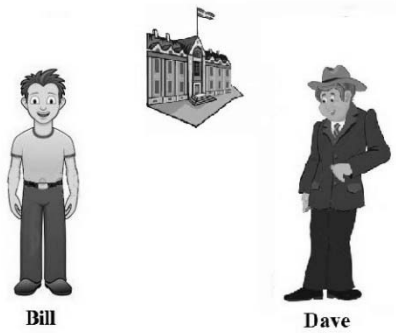
Eye-tracking Task

Monolingual and L2 speakers participated in an eye-tracking study using the visual word paradigm technique. Participants were presented with a picture depicting two male referents and they listened to a sentence while their eye movements were recorded. The auditory stimuli consisted of twenty-four sentences containing a main *clause* in which two referents (e.g., Kevin and Dave) were introduced, separated by an implicit causality verb. The main clause contained either an NP1-bias verb (12 sentences) or an NP2-bias verb (12 sentences), and was followed by a prepositional phrase (PP, e.g., in the evening) and two subordinate clauses introduced by *because he* (e.g., "because he was scared and because he had insulted him."). The first subordinate clause was neutral, and did not provide information about how to interpret the ambiguous pronoun *he*. The second subordinate clause did provide disambiguating information that could either be congruent or incongruent with the implicit causality bias of the verb, as illustrated in the examples (4)-(7). Neutrality, congruency and incongruency of the subordinate clauses was assessed through a separate norming study. In the norming study, native English speakers chose the referent of an ambiguous pronoun *he*, in a sentence where only the main clause and the first subordinate clause was present (e.g., Kevin apologized to Dave in the evening because he was scared). For the congruent subordinate clauses, participants chose the referent congruent with the bias of the verb in the majority of the cases (NP1 verbs: 92%; NP2 verbs: 96%). For neutral subordinate clauses, participants choices were close to chance (NP1 verbs: 62%; NP2 verbs: 52%). Finally, for incongruent subordinate clauses, the referent was incongruent with the verb's bias in the majority of the cases (NP1 verbs: 89%; NP2 verbs: 94%).

In the preparation of the sentences for the eye-tracking study, a 400ms pause was spliced in after the PP (Kevin apologized to Dave in the evening

PAUSE because he was scared). Because participants' anticipatory looks are expected to emerge before the connective *because*, the pause allows us to measure early predictive looks to the referent that is congruent with the implicit causality bias of the verb.

Figure 1. Sample of picture materials



(4) NP1 Verb-Congruent: Kevin apologized to Dave in the evening because he was scared and because he had insulted him.

(5) NP1 Verb-Incongruent: Kevin apologized to Dave in the evening because he was scared and because he was insulted.

(6) NP2 Verb-Congruent: Kevin believed Dave yesterday because he was kind and because he showed him the photograph of the crime.

(7) NP2 Verb-Incongruent: Kevin believed Dave yesterday because he was kind and because he had seen a photograph of the crime.

The eye-tracking task was always administered at the beginning of the experimental session. Eye movements were time-locked to the onset of the 400ms pause inserted between the main clause and the subordinate clause. The eye-movement data were analyzed starting from 200ms after the onset of the pause to account for the time it takes to program a saccadic eye movement (Matin, Shao, & Boff, 1993), and ending 1500ms after the onset of the pause. Trials with combined total looking times to the competitor and target of less than 30% of the trial duration (i.e. the 200-1800ms following the auxiliary) were discarded, amounting to 3% of the data.

Sentence Completion Task

The sentence-continuation task included sentence fragments that contained an NP1 or an NP2 bias verb. The 24 implicit causality verbs used in the eye-tracking experiment (12 NP1 and 12 NP2) were used in the sentence completion task. An example of a sentence fragment is shown in (8).

(8) Mike despised Brian because he

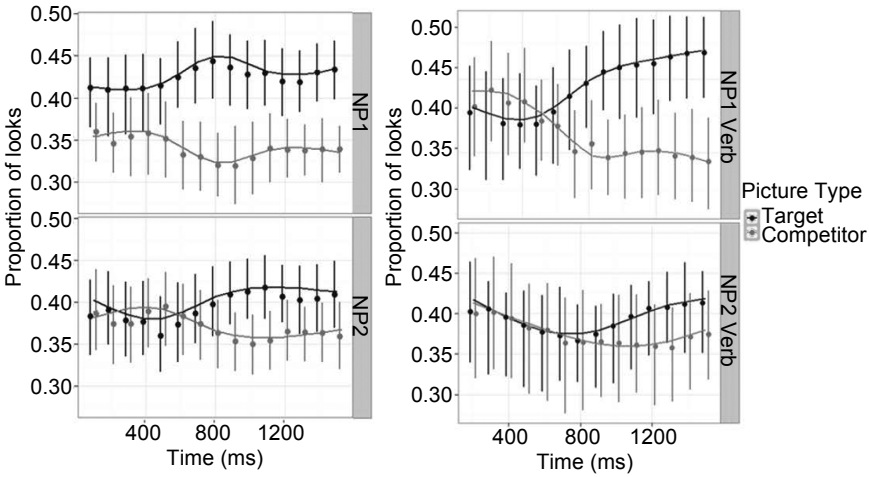
Forty-eight filler sentences were included that had similar structure as the experimental items, but that did not contain implicit causality verbs. Participants were instructed to complete the sentence with a continuation that sounded natural to them and avoid humor. Two judges scored the continuations as either congruent with an NP1 or NP2 interpretation. Thirteen percent of the total responses for monolinguals and 15% of total responses for L2 speakers were labeled as unclear, and were discarded from further analysis. Additionally, one trial was discarded from the analysis (the verb *punish*) due to an error in the design of the task. The sentence-completion task was administered at the end of the testing session, after the eye-tracking task, the language proficiency test, and the language background questionnaire.

3. Results

Eye-tracking Task

Figure 2 shows the proportion of looks to the target and competitor pictures in the two implicit causality verb conditions. The target picture is always the picture congruent with the bias of the verb (i.e., NP1 for the NP1-bias verbs, and NP2 for the NP2-bias verbs). The figure on the left depicts the results for the monolingual participants; the figure on the right shows the results for the L2 speakers. Eye-movements were analyzed using growth curve analysis, which allows the modeling of the dependent variable as a function of Time (e.g., Mirman, Dixon & Magnuson, 2008). The dependent variable is the empirical logit of the proportion of looks within each 100ms time-window. The independent variables are Verb Bias (NP1 bias verbs vs. NP2 bias verbs) and Picture Type (Target picture vs. Competitor picture).

Figure 2. Proportion of looks to the Target by Verb Bias and Picture Type in monolingual and bilingual participants. Points and range bars show empirical means and 95% confidence intervals. Lines show model estimates.



To ensure that the comparison between looks to Target and Competitor pictures did not violate the assumption of independence, we visually checked for independence and performed a correlation analysis for monolinguals and L2 speakers separately, comparing the overall amount of looks to targets and competitors. The results did not reveal a significant correlation between looks to the two pictures (monolinguals: $p<0.09$; L2 speakers: $p<0.1$). Time was coded using a restricted quartic (4 knots) spline with five knots (Harrell, 2001). Random by-Participant intercepts were included in the model, together with random slopes and interactions. By-Item random effects were not included because the proportions of looks were aggregated by participants across conditions. Group comparisons were not performed in this model because we were mostly interested in the underlying predictive processes during discourse processing, which are better represented by comparing the looks to target and competitor picture in each group separately. The full model for monolinguals is presented in Table 2; the full model for the L2 speakers is presented in Table 3.

The two models reveal very similar effects in the monolinguals' and L2 speakers' looking patters. We will focus here only on the three-way interaction between Time, Verb bias and Picture that emerges in both groups. The interaction indicates a significant difference between looks to the target and looks to the competitor only in the NP1 bias verb condition. The effect has a different time-course in the two groups, as shown by the model estimates in Figure 2. In the monolinguals, the significant difference between the looks to the target and the competitor starts 500-600ms in the NP-bias condition. In the L2

speakers, the same effect emerges in the NP1-bias condition much later, between 900-1000ms after the onset of the pronoun. In the NP2 bias condition, we did not observe the same clear divergence between looks to the target and looks to the competitor in either group.

Table 2. Fixed effects for models of looks in monolinguals.

Monolinguals	β	SE	χ^2	p
Intercept	-4.62738	0.006532		
Time_1	-0.00016	0.002908	0.333	0.98
Time_2	0.004002	0.011229		
Time_3	-0.00542	0.053623		
Time_4	-0.00701	0.337868		
Verb Bias	-0.00807	0.011286	84.064	0.0001
Picture	0.104559	0.011282	0.7093	0.7
Time_1 x Verb Bias	-0.0006	0.005819	0.3301	0.9
Time_2 x Verb Bias	-0.00408	0.022468		
Time_3 x Verb Bias	0.029334	0.107295		
Time_4 x Verb Bias	-0.11341	0.676039		
Time_1 x Picture	0.014313	0.005819	20.013	0.0004
Time_2 x Picture	-0.06653	0.022465		
Time_3 x Picture	-0.02927	0.107254		
Time_4 x Picture	1.475512	0.675806		
Verb Bias x Picture	0.118742	0.022543	27.987	0.0001
Time_1 x Verb Bias x Picture	-0.00946	0.011641	30.2	0.005
Time_2 x Verb Bias x Picture	-0.01273	0.044942		
Time_3 x Verb Bias x Picture	0.341175	0.214616		
Time_4 x Verb Bias x Picture	0.460885	0.352168		

Table 3. Fixed effects for models of looks in L2 speakers.

	β	SE	χ^2	p
Intercept	-4.63893	0.005222		
Time_1	0.00262	0.002696	2.9	0.4
Time_2	0.004235	0.010414		
Time_3	-0.02722	0.049838		
Time_4	-0.12109	0.313825		
Verb Bias	-0.0016	0.010443	1.57	0.2
Picture	-0.00699	0.010443	2.00	0.15
Time_1 x Verb Bias	0.000231	0.005391	1.8	0.7
Time_2 x Verb Bias	-0.00481	0.020828		
Time_3 x Verb Bias	-0.0411	0.099676		
Time_4 x Verb Bias	-0.0696	0.627649		
Time_1 x Picture	0.014329	0.005391	11.42	0.02
Time_2 x Picture	-0.02855	0.020828		
Time_3 x Picture	-0.05373	0.099676		
Time_4 x Picture	0.465076	0.627649		
Verb Bias x Picture	-0.03856	0.020887	5.02	0.02
Time_1 x Verb Bias x Picture	0.003214	0.010782	10.53	0.03
Time_2 x Verb Bias x Picture	-0.06764	0.041656		
Time_3 x Verb Bias x Picture	0.429415	0.199353		
Time_4 x Verb Bias x Picture	2.151696	1.255299		

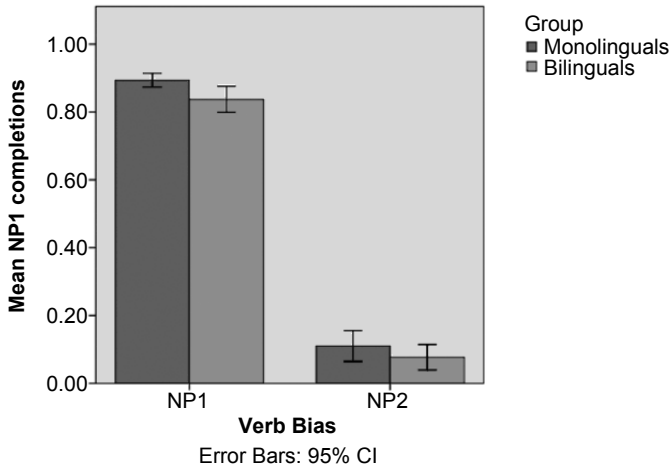
A second model was used to assess the differences between the two groups. Eye-movements were analyzed using growth curve analysis. The dependent variable is the empirical logit of the proportion of looks to the target picture only. The independent variables are Verb Bias (NP1 bias verb vs. NP2 bias verb) and Group (L2 speakers vs. monolinguals). Time was coded using a restricted quartic (4 knots) spline with five knots (Harrell, 2001). In this model,

no differences emerged in the amount of looks to the target picture over time in the two groups, showing that both monolinguals and L2 speakers orient to the target picture at a similar rate.

Sentence Continuation Task

Figure 3 shows the proportion of NP1 continuations out of the number of NP1 and NP2 responses given by the participants. The results are presented by verb bias condition.

Figure 3. Proportion of NP1 completions in the two verb bias conditions. 95% CI error bars.



We used mixed-effects logistic regression (Jaeger, 2008) with Verb Bias (NP-bias vs. NP2 bias) as a fixed effect. The model included random intercepts for participant and item, and participant and item random slope for Verb Bias. The analysis revealed only a main effect of Verb Type (ß= 0.38, SE= 0.04, t= -7.926, p<.0001), indicating more NP1 answers for NP1 verbs compared to NP2 verbs. No main effect of Group and no Group by Verb Bias interaction was found.

4. Discussion

In the eye-tracking results, the first model revealed that monolingual English speakers generated expectations about the upcoming referent when an NP1-bias verb was present. The effect emerged starting 500-600ms after the onset of the pause, when the ambiguous pronoun had not yet been presented (we note that the eye-movements were time-locked to the 400ms pause, and that the length of the word *because* amounts to 200 ms on average). This result is in line with previous studies investigating the online processing of implicit causality

information (e.g., Cozjin et al., 2011), which shows early emergence of participants' expectations based on the verb's implicit causality. Similar to the findings in Cozjin et al. (2011), the activation of the NP2 bias is less clear-cut in comparison to the NP1 bias condition, and no effect emerged in the analysis. For the L2 group, the divergence of looks to target and competitor pictures emerges later than in monolinguals—at about 900-1000ms after the onset of the pause. This result shows that while the monolingual participants have already engaged in predictive processing, the L2 participants do not show a clear referential anticipatory pattern. However, a second model directly comparing looks to the target picture in the two groups did not show any difference between L2 speakers and monolinguals in the speed of processing of the implicit causality information. From the L2 speakers, it is unclear if the delayed increase in looks to the target in the NP1 condition is the result of delayed predictive processing based on the verb semantics, or an effect of the first mention-bias (with no predictive processing being involved). The results from the sentence continuation task showed that both groups produced similar continuations in the two verb bias conditions; that is, there was a preference for NP1 continuations for NP1-bias verbs, and for NP2 continuations for NP2-bias verbs. These results suggest that L2 speakers can successfully use the semantic information encoded in the verb to make predictions about upcoming referents in an off-line task. In Cheng and Almor (2016), intermediate/advanced Chinese-English L2 speakers could not use the verb's implicit causality as consistently as native English-speakers; instead, they employed a general first mention bias. Our results show that when a bilingual's first and second language converge in the use of implicit causality verbs, speakers who are highly proficient in the L2 resemble native speakers of the target language in their deployment of implicit causality information to generate predictions off-line. Given this, we can tentatively suggest that the effect found in the eye-tracking results for the NP1-bias condition is the result of predictive processing, both for the monolingual and the L2 group. An open question is how to account for the delay observed by the L2 speakers in the emergence of the predictive processing. Previous research has demonstrated that intermediate/proficient L2 learners of English may have reduced ability to generate expectations based on morpho-syntactic, semantic or discourse information (e.g., Grüter et al., 2012; Martin et al., 2013). Furthermore, it has been demonstrated that prediction abilities may be determined by the participants' proficiency and the typological relatedness of the L1 and L2 (Dussias et al., 2013). We also know that discourse processing can be a challenging domain for L2 speakers, even at the highest levels of proficiency both in comprehension (e.g., Roberts et al., 2008) and in production (e.g., Contemori & Dussias, 2016). Previous studies have proposed that a consequence of the difficulty associated with discourse processing is that L2 speakers may show reduced predictive abilities in comparison to monolinguals. From our results, we cannot rule out this hypothesis to explain the delay observed in the L2 speakers' eye-tracking data. However, our L2 participants were very proficient in the L2 and had lived in an L2 immersion context.

Additionally, as shown by the results of the second statistical model, they did not differ from monolinguals when only looks to the target picture were compared. Therefore, it seems unlikely that the delay in use of the implicit causality information could be attributed to demands associated with discourse processing. Based on our online and offline results, we speculate that the delay observed in the first statistical model may be associated to the quality of the lexical representations of the implicit causality verbs in English. Our participants are predominantly Spanish-dominant, and as a result of less exposure to English, words may have weaker associative connections in the L2 compared to monolinguals (e.g., Gollan et al., 2008; Gollan, et al., 2011). In the case of implicit causality verbs, we hypothesize that L2 speakers have had less exposure to the verbs used in the experiment, and therefore less experience with the bias associated with them. As a result, L2 speakers may activate the implicit causality information later than monolingual English-speakers.

To summarize, our study shows that English monolingual speakers and Spanish-English L2 speakers can use implicit causality discourse processing both online and offline. However, the L2 speakers show a significant delay in the online activation of the implicit causality bias associated with the verbs, as shown when looks to the target and to competitor pictures are compared. We proposed that the Spanish-English L2 speakers tested in the present study experience a processing cost associated with activating the verb implicit causality information, which is related to the quality of the lexical representations of these verbs.

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