L2 Speakers' Reference Resolution in Processing and Production

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Abstract

This study reports one eye-tracking and one sentence completion study investigating the antecedent biases of Turkish-speaking L2 speakers of English, for anaphor *it* and deixis *this*. Our results show L2 speakers displayed native-like sensitivity to the type of antecedents while using *it* and *this* in sentence completion, but this sensitivity was not replicated in our online reading experiment. This shows limitations in L2 speakers' use of information in online reading, and poor performance in making use of pragmatic changes in context to track the antecedents of *it* and *this*.

Keywords: anaphora; demonstratives; processing; reading; non-native

Referential Expressions: *It* vs. *This*

An addresser's choice of anaphor *it* and deixis *this* is not arbitrary (Çokal, Sturt & Ferreira, 2016; Çokal & Sturt, 2017; Kaiser & Trueswell, 2008; Webber 1991). When an addresser utters, "It was a fearsome fortress…" in [1a] or "This was a fearsome endeavour…" in [1b], the types of referent(s) to which the addresser refers play a role in his/her choice of referring expression, since they are encoded with different procedural instructions and direct an addresser's attention to different aspect(s)/part(s) of discourse (Çokal et al., 2016; Çokal & Sturt 2017; Cornish, 2008; Fossard, Garnham, & Cowles. 2012; Kaiser & Tueswell, 2008; Webber, 1990).

(1a) The Emperor built a huge castle. *It* was a fearsome fortress and won the emperor great fame

(1b) The Emperor built a huge castle. *This* was a fearsome endeavour and won the emperor great fame.

While *this* in [1b] refers to a proposition/predication or event (i.e., a non-NP referent) in the previous clause/sentence, *it* refers to a concrete entity (i.e., a noun phrase (NP) referent) (Webber, 1990; 1988): *It* refers to a huge castle built by the Emperor in [1a]), in [1b] *this* refers to a proposition (i.e., The Emperor's building a huge castle).

According to some authors, the selection of referential expressions also depends on the cognitive effort the addresser urges the addressee to devote to disambiguate *it* and *this* (Maes, 1997; Webber 1988). Compared with *it* in [1a], *this* is preferred for extra cognitive processing: '*This* – The Emperor's building a huge castle – was a fearsome endeavour.' The inserted part is a proposition formed by combining a subject (i.e., *the Emperor*) with the following predicate. This reconstructive process of binding a subject and predicate, arguably involves extra processing complexity (Çokal et al., 2016; Çokal & Sturt, 2017).

Our previous research (Çokal et al., 2016) tested (1) whether *it* and *this* are preferred as referents for different types of antecedents (i.e., a non-NP/proposition vs. concrete entity/NP), (2) whether this information is used on-line in the reference resolution process, and (3) whether an addresser has the same referent choices in the production of these anaphoric expressions. In the eye-tracking experiment, Çokal et al. (2016) demonstrated that native speakers of English showed more processing difficulty (reflected in longer reading times) when *it* referred to a proposition than when *this* referred to a proposition, with a reverse effect when *it* or *this* referred to a concrete entity. Similarly, in the sentence completion experiment, native speakers of English used *it* or *this* depending on the type of referent, with *this* being more likely to refer to a proposition and *it* to a concrete entity (NP). Overall, our results show that the processing and use of anaphoric expressions is affected by the interaction between the lexical characteristics of referential forms and different types of referent, possibly reflecting referent complexity.

L2 Speakers' Anaphor Perception

L2 speakers (i.e., non-native speakers) have previously been found to employ different processing strategies from L1 (i.e., native speakers) in processing of anaphors and demonstratives (e.g., for review see Cunnings, 2017; Cunnings, Fotiadou, & Tsimpli, 2017). Such L2 processing differences may not be related to similarities or differences in anaphor systems. Even though Dutch and German have typologically close anaphora systems, low proficiency Dutch learners did not have asymmetrical antecedent preferences for personal pronouns or demonstratives (Ellert, 2013). Not surprisingly, since English and German have different parameters for anaphors and demonstratives, advanced non-native speakers of German show no clear

preference regarding the referents of demonstratives or have a weak preference for the subject reference over the object reference for both pronouns/demonstratives (Wilson, 2009).

The possible underlying reasons for these differences may not be L1 proficiency or L1 and L2 typological similarities/differences, but might be attributed to: (1) L2 speakers not using pragmatic or discursive information when selecting an anaphoric expression; (2) L2 speakers' not drawing on explicit grammatical knowledge during processing (Clahsen & Felser, 2006; Papadopoulou & Clahsen, 2003), or (3) the poor real-time coordination of anaphoric choices and changing pragmatic conditions in context (thus irrespective of L1 properties) (Roberts et al., 2008). Overall, L2 speakers have a processing disadvantage compared to L1 speakers.

Current Study

The current study is a replication of Çokal et al. (2016) but with Turkish L2 speakers of English. The aim is to deepen our understanding of L2 speakers' production and comprehension of referential expressions, and preferences for the antecedents of *it* and *this.* This study provides cross-linguistic online/offline data of a less studied non-native speaker group, namely Turkish speakers. Based on the L2 literature, we predicted that advanced Turkish L2 speakers of English would have different ambiguity resolution strategies and antecedent biases than English L1 speakers, even though both have similar sensitivity to pragmatic distinctions encoded by referential expressions (discussed below).

To investigate this, we ran an eye-tracking reading experiment to index L2 readers' use of information during comprehension, and a sentence-completion experiment to explore L2 writers' focus of attention and antecedent preferences regarding information structure without time pressure (Çokal & Sturt, 2017). Our previous studies have shown the sentence-completion method to be a reliable measure for antecedent preferences (e.g., Çokal, Sturt & Ferreira, 2016; Çokal & Sturt, 2017). In addition, L2 speakers who perform in a non-native-like way on online tasks often show a native-like bias in offline tasks (Clahsen & Felser, 2006). Therefore, there is a need to examine L2 anaphora comprehension and production models in both cognitive domains.

Experiment 1

This current study's experiment 1 replicated (using L2 speakers of English) Çokal et al.'s (2016) experiment 1, with L1 speakers.

We designed a 2 × 2 within subject experiment, crossing two levels of referring expression (*it* vs. *this*) and two levels of referent type (reference to an NP vs. proposition).[1] We manipulated the antecedents of *it* and *this* by using referential expressions after *it* and *this* (e.g., *job* or *book*):

Conditions 1 and 2: *it/this* referring to the proposition:
Charlotte wrote a book. It/This was a difficult job but the sales were spectacular.

Conditions 3 and 4: *it/this* referring to the concrete entity:
Charlotte wrote a book. It/This was a difficult read but the sales were spectacular.

(Çokal et al., 2016, p. 276)

Disambiguators such as *job* or *book* were used. The disambiguating NP referred to the proposition/non-NP expressed by the previous sentence (e.g., *This/It* was a **difficult job** – referring to Charlotte's process of writing a book) or to the concrete entity/NP in object position in the previous sentence (e.g., *This/It* was a difficult read – referring to a book). We predicted that if L2 readers exhibit a preference for *it* when referring to a concrete entity, and *this* to a proposition, then – other things being equal – processing difficulty should be greater when the proposition is referred to with *it,* than with *this,* with the reverse pattern for the concrete entity. This interaction should be observed at the disambiguating region where L2 readers first encounter the disambiguating information. If L2 readers re-fixate on the context sentence after disambiguation, then the interaction will be found in the context region in second-pass reading time and total time, since these measures include refixations after the reader has progressed beyond the analysis region. All these would match L1 reader patterns reported in Çokal et al. (2016).

Overall, this antecedent preference should result in an interaction between the two experimental factors of referring expression (*it* vs. *this*) and referent type (concrete entity vs. proposition). In the L1 experiment (Çokal et al, 2016), this interaction was found in the context region in second-pass and total reading time. It was also observed where a reader first encounters the disambiguating NPs (i.e., *job/book*). In this design, because of length and frequency differences between *this* and *it,* the main effect of referential expressions in the anaphor region is not interpretable.

Turkish Referential Expressions

A basic understanding of the Turkish referential system helps explain how correspondence of referential expressions works in Turkish and whether L2 speakers' processing difficulties are attributable to the Turkish anaphora system. Turkish translations of our stimuli[2] (see below) show the correspondence of *this* would be *bu*, while the correspondence of *it* would be a pro-drop. Similar to English, the use of Turkish referential expressions is also sensitive to pragmatic distinction encoded by *pro-drop* (i.e.,

[1] L2 speakers show effects in different measures and/or different regions from L1 speakers, so it is difficult to compare eye-tracking data. Therefore, the combined analysis of L1 and L2 speakers was not performed.

it) and bu (i.e., *this*). Note: a concrete entity is most often referred to with a pro-drop, whereas a proposition is referred to with *bu.*

Condition 1: *it* referring to a proposition: Charlotte bir kitap yazdı. Ø Zor bir işti ama satışlar harikuladeydi.

Condition 2: *this* referring to a proposition: Charlotte bir kitap yazdı. **Bu** zor bir işti ama satışlar harikuladeydi.

Condition 3: *it* referring to a noun phrase: Charlotte bir kitap yazdı. Ø Okunması zor bir kitaptı ama satışlar harikuladeydi.

Condition 4: *this* referring to a noun phrase: Charlotte bir kitap yazdı. Okunması zor bir kitaptı **bu** ama satışlar harikuladeydi.

If Turkish speakers perform as L1 English speakers, then overlapping features in L1 and L2 will facilitate their processing. However, if they employ shallow processing, this is due to poor real-time coordination of anaphoric choices and changing pragmatic conditions in context irrespective of L1 properties.

Types of referents of *it* and *this* are not taught explicitly in language class, but Middle East Technical University (METU) proficiency tests require students to identify antecedents of *this* and *it* in reading texts.

Methods

Participants

The study's participants were forty paid Turkish non-native English-speaking METU students (ages 21-24, M = 22; SD = 1.126) all unaware of the study's purpose. These L2 speakers were either third- or fourth-year English language teaching students who had passed the METU English proficiency exam (listening and writing) at the beginning of their university education. The mean proficiency exam score was 80, equivalent to a 102 TOEFL (IBT) or 7.5 IELTS score, and indicative of an advanced level of English proficiency. In addition, participants rated their English speaking, comprehension, writing, reading, and grammar skills as advanced, and also reported English was their most frequently used language when reading books, watching films, or sending Facebook messages. They were not advanced or intermediate non-native speakers of any other languages.

To date, studies on demonstratives and anaphora show non-native speakers with advanced English skills still have difficulty using anaphors (Blagoeva, 2004; Çokal & Ruhi, 2006; Niimura & Hayashi, 1996; Wilson, 2009). Therefore, only advanced non-native speakers of English were included in this study.

Apparatus

We used an Eyelink 1000 eye-tracker and monitor (SR Research Ltd, Ottawa, Canada) in tower-mounted mode, with a chin rest to stabilize a participant's head.

[2] Eight native speakers of Turkish checked and approved the translations of the conditions in Turkish: several of these speakers were linguists working on Turkish.

Materials

Following a Latin Square procedure, the forty stimuli were distributed into four lists, in which each item appeared in only one condition and each condition appeared an equal number of times. Each list was assigned to ten participants. There were 60 fillers and eight practice items, all of which were similar in length to the experimental sentences. Filler sample: (1) Vicky opened her bag and realized that she had forgotten to put her towel in it.

The texts were presented on one or two written lines. Each line had between 75 and 100 characters. *It* and *this* always appeared near the middle of the line. In addition to the authors, two native speakers of English checked the stimuli and confirmed anaphoric relations in the stimuli.

Procedures

We presented 108 texts in Times New Roman 18 font, in fixed random order, with no two experimental items adjacent. The experiment began with eight fillers to familiarize participants with the experimental procedure. While viewing was binocular, only the right eye was tracked. Items appeared on a 19" monitor approximately 70 cm from a participant's eyes. In order for the experimenter to check the calibration of participants' eyes, before each item the participant fixated on a black square. After reading each item, the participant pressed a button to end the sentence. For 50% of items, a comprehension question then appeared, which the participant answered by pressing a button on the left or right side of the button box. Comprehension questions (true/false and yes/no) never probed the referents of *it/this*. Data were collected in similar settings in to the study conducted in Scotland, reported by Çokal et al (2016). After the experiment, L2 speakers were provided with a list of words (including words used in the stimuli) and asked if there were any words they did not know. They reported knowing 95% of the listed words.

Data Analysis

Texts were divided into 5 regions defined in Table 1. Below, we will report data for the *context*, *anaphor* and *disambiguation* regions. Fixations of less than 80, or more than 1200 ms, were excluded from analysis. All participants scored at least 90% correct in their answers to the comprehension questions.

Table 1. Analysis regions in experiment 1.

Region	Sample Stimulus
1: Context	Charlotte wrote a book.
2: Anaphor	It/This was
3: Disambiguation	a difficult job/read.
4: Spillover	but the
5: Final	sales were spectacular.

Critical regions are 1–3.

Results

We report results for regression path times (the sum of all fixations from the first entry into the region from the left, until the first fixation to a later region), second-pass reading times (i.e., The sum of all fixation durations following the first exit of the region either to right or left.), and total reading times (i.e., The sum of all fixations in the region, reflecting overall processing.). Regression path time was our measure of early processing, as this reflects the fixation behaviour that immediately follows the reader's initial inspection of a given region. In the analysis, we removed zeros from regression path times, and such trials were treated as missing data. On the other hand, for second-pass reading time, where a region was not re-fixated, this contributed a value of 0ms, as these zero values are meaningful (a region did not require a second pass). For total reading time, regions with no fixations in any given trial were treated as missing data and removed from total reading time. All analyses were conducted using linear mixed effects regression (LMER) and the lme4 R package. An additional package (plyr) was used to compute p-values. For each region and measure, an LMER model, incorporating all fixed effects and their interactions in a single step, was constructed. Factor labels were transformed into numerical values and centered prior to analysis, to have a mean of 0 and a range of 1. The results provide coefficients, standard errors, and t-values for each fixed effect and interaction. All analyses reported below incorporated crossed random intercepts for participants and items. Random slope parameters (levels of referring expressions) (e.g., *it* and *this*), two levels of referent types (e.g., *noun phrase* and *proposition*), and the interaction in the slopes (anaphor* referent_type+1|subject) were included in the maximal model for both participants and items.

Table 2: L1 and L2 speakers' means (standard errors) for second-pass and total reading times.

	Context		Anaphor		Disambiguation	
Second-pass reading times	L1	L2	L1	L2	L1	L2
It referring to a NP	456[1] (29)	666 (58)	87 (12)	127[5] (19)	228 (29)	351 (46)
This referring to a NP	488[1] (33)	604 (63)	175 (20)	133[5] (16)	268 (34)	341 (47)
It referring to a non-NP	600[2] (37)	721 (82)	104 (17)	110[6] (15)	269 (36)	338 (49)
This referring to a non-NP	521[2] (33)	678 (85)	159 (18)	170[6] (21)	268 (36)	351 (42)
Total reading times						
It referring to a NP	1644[3] (79)	2293 (121)	215 (20)	398[7] (23)	676 (30)	1050 (55)
This referring to a NP	1680[3] (99)	2335 (110)	376 (26)	509[7] (25)	697 (34)	1042 (53)
It referring to a non-NP	1800[4] (112)	2348 (125)	228 (23)	366[8] (20)	721 (38)	1044 (48)
This referring to a non-NP	1691[4] (89)	2251 (112)	362 (28)	538[8] (27)	702 (39)	1044 (53)

[1] pairwise comparison of *it*/*this referring to a NP*: t (40) = .902, p >.05; [2] pairwise comparison of *it*/*this referring to a non-NP*: t (40) = 1.997, p = .049; [3] pairwise comparison: t = .587, p >.05; [4] pairwise comparison: t = 1.545, p > .05; [5] pairwise comparison: t(40) = -.687, p = p >.05; [6] pairwise comparison: t (40)= -3.536, p = .001; [7] pairwise comparison: t (40) = -5.812, p = .001; [8] pairwise comparison: t (40) = -8.465, p = .001.

L1 speakers

The predicted interaction between referring expression and referent type was seen in regression path time in disambiguation region (β = -92.52, *SE*= 34.33, t = -2.695, p <. 05; *it* referring to a NP: *M= 561, SE = 28* vs. *this* referring to a NP: *M= 616, SE = 35*; *it* referring to a non-NP: *M*= 620, *SE* = 31 vs. *this* referring to a non-NP: *M* = 585, *SE* = 30) as well as second-pass (β = -111.49, *SE* = 48.00, t = -2.312, p < .05) and total (β = -147.42, *SE* = 68.74, t = -2.113, p < .05) time in the context region. The means for the interaction showed the predicted cross-over pattern, with (1) longer reading times when *it* referred to a proposition (a non-NP) than when *this* referred to a proposition and (2) the reverse effect when *it* or *this* referred to an entity (see Table 2). Among measures showing an interaction, there were significant pairwise comparisons for both second pass in the context region and regression path in the disambiguation region.

L2 speakers

In regression path times, for the disambiguation region, there was a main effect of referential expression (β = -64.45 , *SE* = 31, t = -2.074, p < .05). The same region did not reveal a main effect of referent type (β = 33.86, *SE* = 25 , t = 1.386 , p > .05) and an interaction between the two factors (β = -69.96, *SE* = 46 , t = -1.537, p > .05; *it* referring to a NP: *M = 846, SE = 41* vs. *this* referring to a NP: *M= 814, SE = 33*; *it* referring to a non-NP: *M*= 914 *SE* = 57 vs. *this* referring to a non-NP: *M* = 814, *SE* = 34).

Second-pass and total reading times for the context region did not reveal any main effects and/or an interaction between the variables (second-pass reading times: second-

pass reading: referential expressions: β = -52.51, *SE* = 40.79, *t* = -1.287, *p* > .05; referent type: β = 64.45, *SE* = 47.24, *t* = 1.364, *p* > .05; referential expressions x referent types: β = 18.27, *SE* = 73.46, *t* = 0.249, *p* > .05; Total reading times: referential expressions: β = -27.74, *SE* = 48.08, *t* = 0.577, *p* > .05; referent type: β = -11.93, *SE* = 48.17, *t* = 0.248, *p* > .05; expressions x referent types: β = -135.38, *SE* = 96.17, *t* = -1.408, *p* > .05). Second-pass reading times for the anaphor region showed a main effect of referential expression (β = 33.85, *SE*= 12.81, *t* = 2.642, *p* < .05) and a significant interaction between the variables (β = 50.64, *SE* = 21.39, *t* = 2.367, *p* < .05) (see Table 2). References to a proposition led to shorter second-pass reading times for *it* than *this*. Participants did not have a strong preference for either *this* or *it* when referring to a noun phrase. Total reading times for the same region revealed an interaction with a similar pattern (β = 61.108, *SE*= 26.488, *t* = 2.307, *p* < .05) as well as a significant main effect of anaphor (β = 141.571, *SE* = 14.844, *t* = 9.537, *p* <.05), again probably reflecting a length effect (total reading times were shorter for *it* than for *this*). Neither main effects nor the interaction between the variables were seen in the disambiguation, and spill-over regions for regression path, second-pass, and total reading times.

The results do not show evidence that L2 speakers use native-like referent preferences for *it* and *this*. Although there were interactions in total time and second-pass reading time in the anaphor region, this effect was not found in any other measure or region, raising the possibility that it may be a Type 1 error, and even if this is a genuine effect, the pattern of the interaction was opposite to that of the L1 English speakers reported in Çokal et al (2016).

Experiment 2

Experiment 2, in which we explored the role of referent type in the use of *it* and *this*, used L2 speakers of English to replicate Çokal et al.'s (2016) Experiment 2, which used L1 speakers. Previous studies have shown L2 speakers have native-like preferences in sentence completion; therefore, we explored whether our L2 speakers would also show similar antecedent preferences to those of native speakers of English, namely using *it* for references to a concrete entity and *this* for references to a predicate/proposition. Participants were given the sentences used in Experiment 1, but, unlike in Experiment 1, the rest of the sentence after *it* or *this* was left blank (see sample stimulus below).

1- Jenny felled the sapling. *It*/*this*…….

Methods

Participants

Participants included sixteen Turkish and sixteen English native speakers of English. To prevent variability due to participants' knowledge of English, L2 participants were a subset of Experiment 1. There was no bias in selecting these 16 participants in regard to proficiency, response accuracy and processing performance during Experiment 1. The reading and sentence completion experiments were conducted at least 8 months apart.

Materials and procedures

There were 40 experimental and 60 filler stimuli. The experimental stimuli used context sentences from Experiment 1. There were two types of referential expressions (*it* and *this*) and this factor was manipulated within items and subjects. Two versions of each sentence and two files were constructed. In each file, each sentence appeared in only one condition, but each condition appeared an equal number of times. Sentences were presented in a booklet in a fixed random order. Each participant was asked to complete the stimuli sentences coherently.

Results

While coding sentence completions, we counted participants' antecedent choices for *it* or *this* (i.e., a concrete entity or a proposition). We also coded pre-nominal uses of *this* (i.e., *this* + Noun Phrase [NP]), cleft sentences with *it* or unclear references as "other". Subsequently, we excluded all trials coded as "other" from further statistical analysis. Two research assistants independently transcribed the data and coded the continuations according to predetermined categories. Any continuations that annotators did not understand were excluded from data analysis. Figure 1 shows the relative proportions of references to an NP and proposition for each referential expression.

Because this experiment's data were categorical, the statistical analyses in this section involved logistic mixed effects regression,[3] taking the condition (*it* vs. *this*) as the fixed effect and including crossed random intercepts and slopes for subjects and items.

L1 speakers: 18% of antecedents of *this* and *it* were coded as "others". L1 speakers had a strong preference for *it* when referring to a noun phrase and *this* to a proposition/non-NP (β = 3.44, *Z*= -8.133, *p* <.05; *it: NP:67 % vs. Non-NP: 33%; this: NP: 30% vs. Non-NP: 70%*) (see Figure 1).

L2 speakers: 14% of antecedents of *this* and *it* were coded as "others". Analysis yielded a significant effect of referential expressions (β = 2.335 *Z*= -2.610, *p* <. 05). Participants had a strong preference for *it* when referring to an NP, *it: NP:62 % vs. Non-NP: 38%; this: NP: 49% vs. Non-NP:51%.*

[3] The analyses were computed using the lme4 package in R: (see http://lme4.r-forge.r-project.org). The official number of lme4 was 999375-35. R 3.0 for Windows was used.

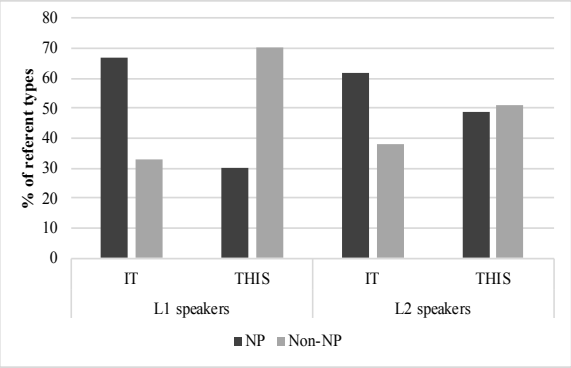

Figure 1. Proportion of NP or non-NP responses for each referential expression.

References to a proposition/non-NP with *this* were slightly more frequent than with *it.* L2 speakers showed a sensitivity to different antecedent preferences for *it* and *this*. However, their preference was stronger for *it* referring to a NP/concrete entity than *this* referring to a proposition. The interaction between the language groups and condition, β = 0.653, Z= 4.450, p <.05, showing that, although the L2 speakers showed qualitatively the same preferences as the native speakers, this preference was not as pronounced as it was for the L1 speakers.

General Discussion

Our previous study (Çokal et al., 2016) showed that native speakers of English had different antecedent preferences for *it* and *this* irrespective of task type (online reading or sentence completion). However, in our study with Turkish non-native speakers, while L2 speakers did not show strong antecedent preferences in the eye-tracking reading experiment (and, if anything the preference was the opposite to those of L1 speakers), their biases matched those of L1 speakers in the sentence completion experiment. Supporting previous findings, Turkish L2 speakers had native-like referential dependency in sentence completion (i.e., offline task) and non-native-like preferences in online tasks (i.e., eye-tracking reading) Clahsen & Felser, 2006; Papadopoulou & Clahsen, 2003). The overall pattern of findings might be attributable to poor real-time coordination of anaphoric choices, changing pragmatic conditions in context, and limited use of cues to resolve ambiguity among L2 speakers.

Previous studies on L2 speakers' online processing of anaphors from a null subject language show contradictory results. While Cunnings et al. (2017) showed L1 Greek speakers of L2 English learners from a null-subject language have nativelike referent dependencies in a non-null subject L2, Roberts et al. (2008) demonstrated Turkish L2 Dutch speakers did not have native-like preferences for overt Dutch pronouns. While these studies focused on personal overt and null pronouns, we investigated a NP and non-NP cases with *it/this*. Our online eye-tracking reading experiment results are in line with Roberts et al. (2008). Overall, we suggest our L2 speaker online preferences are due to processing disadvantage (Roberts' et. al, 2008), which is attributed two factors: (a) exposure to L2 and (b) proficiency. Even if L2 speakers frequently use the target language for education purposes, computing predicate-subject relations requires rapid incremental processing and thus requires naturalistic input exposure. Compared to the UK participants, our L2 learners do not have enough naturalistic input. In addition, while our L2 subjects are advanced, perhaps rapid online processing requires a higher proficiency level. Therefore, further research should be conducted on the processing of highly proficient (e.g., near-native) L2 learners who have studied abroad with resulting high levels of exposure to naturalistic input.

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