

## Differences between native and non-native English listeners in the use of prosodic focus and event structure to anticipate discourse structure and resolve reference

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### Abstract

A series of experiments tested discourse processing in native speakers of English and Japanese- and Korean-native adult second-language learners of English. Results from offline (story continuation) and online (visual world) experiments show that both groups can show sensitivity in their processing decisions to prosodic prominence, grammatical aspect, verb bias, and the form of referential expression, but that the groups are not identical, especially in their tendency to generate expectations relevant to co-reference.

### 1 Introduction

Language is used to communicate not just familiar states of affairs but unfamiliar ones. As listeners, we regularly encounter sentences that convey novel information. And, much of the time, we are able to rapidly extract the intended meaning. To do so efficiently, listeners do not merely react to linguistic forms after the material has arrived in the speech signal. Listeners also anticipate what might be conveyed in the upcoming signal (e.g., Altmann & Kamide, 1999). This combination of the inherent unpredictability of language and listeners' tendency to nevertheless make predictions raises multiple questions about how speakers and listeners manage their processing resources and take advantage of the distinctions available in their language to facilitate effective communication.

One set of important resources that speakers draw on to connect sentences into a coherent discourse are cues that encode information structure, i.e. distinctions such as given, new, or contrastive information. Identification of the information structure of a sentence allows the listener to connect the given information to material already encoded in the discourse representation, and update the discourse model with the new information (Clark & Haviland, 1977). For example, a reduced referential expression such as the pronoun in example (1) serves as a gradient cue that the intended referent is highly accessible in the linguistic representation, such as the entity denoted by the subject or topic of the preceding sentence (Ariel, 1990; Grosz, Joshi, & Weinstein, 1995; Gundel, Hedberg, & Zacharski, 1993). Information structure can be encoded via a number of linguistic devices, including syntactic form (e.g., clefts), morphological marking (e.g., topic markers), and prosody and intonation (henceforth, "prosody"). Notably, the available forms and their patterns of usage vary across languages, and so second language-learners must learn new sets of cues and the appropriate probabilities for them.

(1) David was serving Paul a pint of beer. He<sub>(David/Paul/other)</sub> ...

This paper summarizes a series of experiments testing the processing of co-reference in sentences like (1) by native speakers of English and adult second-language learners of English. Our research team varied a set

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of factors that we predicted would significantly influence the referential decisions of native English speakers, but perhaps not those of non-native speakers. Some of these distinctions occurred at the point of comprehending or choosing an anaphoric expression. Others occurred earlier in the stimuli, prior to the point that an anaphor appeared. This allowed us to probe how different types of linguistic information promote predictions about the upcoming material during in-the-moment (“online”) processing, and test one of our key hypotheses: that non-native speakers would show a *Reduced Ability to Generate Expectations* (RAGE; Grüter, Rohde & Schafer, 2017).

One of our critical factors was prosody. Prosody is influential for a number of areas of native-language processing (Carlson, 2009), but is often a challenge for second language learners (Akker & Cutler, 2003; Lee & Fraundorf, 2016; Nakamura, Arai, Hirose & Flynn, 2016). Surprisingly, it has received relatively little attention in experimental investigations of co-reference. Across our experiments, we manipulated the presence of prosodic prominence on a subject pronoun, or on names mentioned earlier in the discourse (i.e., on *David*, *Paul*, or *He* in (1)), with an aim to address some critical gaps in research on information structure, co-reference, online processing, and second language acquisition of prosody. Further details are given in below. But first, Section 2 provides some general background on referential processing and describes three other factors that were important to our investigation.

## **2 Co-reference and event structure**

A substantial body of research has explored native speakers’ preferences for co-reference. Together, these studies show that multiple factors have gradient or probabilistic effects on co-reference decisions. Relevant factors include surface cues such as the linear position of a potential antecedent in a sentence, structural cues such as syntactic position, and higher-level factors such as causal reasoning about plausible scenarios (Arnold, 2010). There has also been considerable interest in how non-native speakers resolve co-reference. A prominent claim is this area that non-native speakers differ from native speakers in the interpretation of anaphoric expressions even at advanced levels of proficiency (Sorace, 2011).

Three factors involved in referential processing decisions are central to the studies summarized below. First, verbs can be separated into classes that differ systematically in their patterns for re-mention of arguments (Garvey & Caramazza, 1974; Hartshorne & Snedeker, 2013). The critical sentences in the current studies described transfer-of-possession events, for which there is a tendency to select the Goal of the transfer event (*Paul*, in (1)) as the syntactic subject of the next sentence, even when the Source (*David*, in (1)) is in a favored position for co-reference (Stevenson, Crawley & Kleinman, 1994). For simplicity, this will be described as a preference for “Goal mention” over “Source mention” in transfer-of-possession contexts.

Second, pronouns are preferentially interpreted as referring to material that is highly accessible and in a parallel syntactic position. In our experiments, the Source argument always served as the syntactic subject of the critical sentences, and so we expected that continuations that began with a subject pronoun would tend to select the Source as the referent, despite the verb-based pull toward Goal mention.

Third, comprehenders are sensitive to whether a sentence describes a completed event or an ongoing one. Comprehenders use a combination of the linguistic signal and their real-world knowledge to construct situation models of discourse, which capture information such as the entities involved, their locations in space and time, motivation, and causation (Zwaan & Radvansky, 1998). Completed transfer-of-possession events promote

attention to the end state and continuations that describe what will happen next (e.g., results involving the Goal entity), while ongoing events support relatively more attention to the internal structure of event and explanations or elaborations of it (Ferretti, Rohde, Kehler & Crutchley, 2009; Moens & Steedman, 1988). Such types of connections between sentences, or *coherence relations*, correlate with which entity is mentioned next in a discourse. Consequently, the manipulation of event structure, as encoded by grammatical aspect, affects co-reference choices – at least in native speakers of English, Japanese, and Korean (Kehler, Kertz, Rohde & Elman, 2008; Kim, Grüter, & Schafer, 2013; Ueno & Kehler, 2017). We tested whether it would also affect non-native speakers’ co-reference choices, and whether either group of speakers would anticipate reference prior to reaching the anaphor. Our two primary factors – event structure and prosody – are linked in that each is postulated to shape higher-level discourse processing decisions, including the preferred coherence relation.

### 3 Co-reference and prosody

Prosody’s significant role information structure has long suggested a strong connection to co-reference, as in well-known examples in which accented pronouns differ in preferred referent from unaccented versions: *John called Bill a Republican and then HE<sub>Bill</sub> insulted HIM<sub>John</sub>* (vs. *he<sub>John</sub>/him<sub>Bill</sub>*; Akmajian & Jackendoff, 1970; Lakoff, 1971). Nevertheless, only a handful of experimental studies have investigated the role of prosody in co-reference (see Itzhak & Baum (2015) for a recent summary), with mixed results.

One key question to address is exactly how prosody exerts an influence. More prominent accentuation on a potential antecedent (e.g., on *David* in (1)) can facilitate subsequent reference to it, but is this due to merely the acoustic prominence, which could strengthen an expression’s auditory memory representation? To a more accessible entity in the situation model? To semantically-encoded contrastiveness? As for an accented pronoun, is it analyzed as a fuller expression that is less favored for an antecedent in subject/topic position (Gundel et al., 1993)? Is it mapped to a contextually plausible alternative to the referent preferred for an unaccented pronoun (Hirschberg & Ward, 1991; Kameyama, 1999)? Is its reference resolved through consideration of plausible coherence relations for the sentence’s focal structure (Cummins & Rohde, 2015; Kehler, 2005; Kehler et al., 2008)? These proposals lead to disparate predictions for the effect of prosody on co-reference. A full understanding of their relationship requires specification of the exact mechanisms used to resolve reference, yet there has been limited connection between the theoretical linguistic literature, empirical findings, and psycholinguistic models (of native or non-native processing/acquisition) that could link the two.

A second key question involves the prosodic representation. English allows for considerable variation in prosodic form (Pierrehumbert & Hirschberg, 1990; Speer, Warren & Schafer, 2011), and subtle choices in prosody, such as the shape of a rising accent, can influence the meaning that is conveyed (Hirschberg & Ward, 1992; Ito & Speer, 2008). Unfortunately, most studies in this area have provided only partial descriptions of the prosodic form of the stimuli. Our stimuli employed robust and carefully controlled manipulations of the prosodic prominence, using a rate of speech appropriate for non-native listeners. Some of our conditions were pronounced with broad focus. Others employed L+H\* L-H% contours<sup>1</sup> on the Source/Goal NP of the critical sentence, or on a subsequent pronominal subject. The L+H\* pitch accent is commonly described as inviting contrastive focus, and the L-H% suggests some kind of incompleteness. L+H\* L-H% tunes are a type of rise-

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<sup>1</sup> This annotation follows the ToBI labelling system for Mainstream American English (see <https://www.ling.ohio-state.edu/~tobi/>). Sample soundfiles and further details of the stimuli are available at: <http://www2.hawaii.edu/~aschafer/snds.html#GRS>

fall-rise contour associated with (but not limited to) contrastive topics, which have been analyzed as including a nested marking of focus (Constant, 2012; Roberts, 2012; Tomioka, 2010), and so the tune can be taken to involve prosodic focus and contrast. Here, the prosody will be described as “contrastive” or “prominent.”

The contrastive portions our stimuli were realized with salient acoustic features also associated with contrastive focus in Japanese and Korean (Beckman & Pierrehumbert, 1986; Jun & Oh, 1996; Ito, Jincho, Minai, Yamane & Mazuka, 2012), so we anticipated that the non-native speakers would have no difficulty detecting the presence of prosodic prominence. The question was how successfully they would incorporate it into their processing decisions about co-reference.

For native speakers of English, contrastive prosody on the Source NP was predicted to increase Source mention. It was less clear what effect prominence on the Goal NP might have. On the one hand, it should provide a salience-lending effect at one or more levels of linguistic representation, and so might be expected to increase Goal mention. On the other hand, the prosodic prominence could be taken to highlight the existence of alternative Goals. If so, speakers might choose to sustain discussion of who received what (Roberts, 2012). This could result in continuations that repeat use of the Source entity as the referent of the syntactic subject and go on to discuss alternative Goals, creating a set of sentences about transfer events, each of which is a partial answer to the broader question. Some support for this latter possibility comes from an experiment with contrastively-marked Goals that tested native speakers of Korean (Kim, Grüter, & Schafer, 2014).

For accented subject pronouns, the simplest prediction is for a general decrease in reference to the otherwise-favored Source (although specific hypotheses vary in the exact explanation given for such an outcome). More complex possibilities will be considered further below.

As outlined above, co-reference depends on the combined effect of multiple gradient constraints. As such, controlled experiments have been a critical tool in clarifying the interpretative preferences across varying discourse situations, identifying the linguistic and cognitive factors that may be at play, and probing the particular ways in which those factors combine in a dynamic fashion as the discourse progresses.

## 4 Experiments

Five experiments (some still in progress) are summarized here. Each tested native and non-native speakers of English. The latter were native speakers of Japanese or Korean, except for Experiment 4, which drew from a mix of native languages. Each experiment used variants of stimuli like (1) and manipulated grammatical aspect (e.g., *was serving*, *served*); control tasks measured proficiency and confirmed that participants understood the relationship between aspect and ongoing/completed events. Experiments 1-3 asked participants to comprehend the critical sentence and then type a continuation to it, which was subsequently coded for Source versus Goal mention and coherence relation. Experiments 4-5 presented two- or three-sentence stories to participants, who answered simple comprehension questions. Throughout the stories, participants' eye gaze was tracked using the visual world paradigm (Tanenhaus, Spivey-Knowlton, Eberhard & Sedivy, 1995). This allowed us to investigate the participants' *anticipation* of reference during the natural pause between the offset of the critical transfer-of-possession sentence and the onset of the next sentence.

### 4.1 Experiment 1

Experiment 1 (Grüter et al., 2017) crossed grammatical aspect with the presence/absence of a pronoun in

the prompt to continue the story. Participants read a complete critical sentence like (1), presented on a computer screen. In half of the trials, the screen also displayed a pronoun to use as the first word in a continuation of the story, which participants typed into a text box. In the other half, participants were free to begin the continuation in any fashion. Responses for free prompts, in which names were often chosen for Goal mention, were also coded for form of referential expression.

The results replicated previous findings for native speakers: Source mention significantly increased for imperfective transfer-of-possession sentences (versus perfective ones), and for pronoun prompts (versus free prompts). However, only prompt type had a significant effect on non-native speaker's mention choices. The patterns in their coherence relation demonstrated that the non-native speakers were influenced by aspect, but only relatively late in their processing decisions. This is consistent with the claim that non-native speakers have a reduced ability to generate expectations, even when they have the grammatical knowledge to do so.

## **4.2 Experiment 2**

Experiment 2 utilized spoken sentences, produced with contrastive prosody on either the Source or Goal NP in critical trials. Participants listened to a context sentence (counterbalanced for aspect type), and then saw a subject pronoun prompt. Starting with the provided pronoun, they typed a continuation into a text box.

The aspect results replicated the findings of Experiment 1: a significant effect only for native speakers. As for prosody, the two groups showed similar significant effects: a higher proportion of Source mention when the Source NP had carried contrastive prosody than when the Goal NP was prominent, and scant evidence for continuations about alternative Goals. These findings clarify some of the informational structure preferences for native speakers, and provide new evidence of non-native speakers' facility with contrastive prosody and co-reference. Yet the results leave open which cognitive processes account for the effect. Prosodic prominence is associated with stronger memory traces (Lee & Fraundorf, 2016) and increased attention (Ito & Speer, 2008). If the non-native speakers waited to make reference-related decisions until after the subject pronoun prompt had appeared, they could have simply favored the referent that was more accessible in memory, and done so without employing semantic distinctions of focus or contrast. Thus, these results allow for the possibility that the two groups responded to the prosodic prominence via different mechanisms.

## **4.3 Experiment 3**

Experiment 3 placed the prosodic manipulation on the pronoun prompt. The context sentence was produced with broad focus, and the prompt contained either an accented subject pronoun or an unaccented one. The auditory stimulus began with the critical sentence, continued with an inter-sentential pause (of a natural but controlled duration), and ended before the matrix verb of the next sentence. By default, English pronouns are unaccented and unstressed. To avoid an unnatural ending point in the continuation sentence and clearly indicate the prosodic manipulation on the pronoun, the subject pronoun was followed by an adverb intended to be relatively neutral in its effect on Source/Goal mention. Stimuli were truncated at the offset of this adverb. Participants listened to the recorded stimulus, and then completed the continuation sentence by typing its ending into a text box.

Once again, native speakers' preferences for Source/Goal mention were significantly affected by aspect and by prosody. Source mention increased following imperfective sentences, and decreased when the subject

pronoun was accented. Neither of these main effects was significant in the non-native group taken as whole. However, Source mention significantly increased with increasing proficiency. A participant's overall bias for Source mention is relevant to each of the experiments discussed here, but it is particularly important to the analysis of accented pronouns. This is because in many of the semantic analyses of accented pronouns, the effect of accent is related to more general preferences for co-reference, as outlined in section 3. Moreover, non-native speakers could differ from native speakers, and across proficiency levels, in their likelihood of treating accented versus unaccented pronouns as fuller versus more reduced expressions, and in their mappings from expression form to other distinctions relevant to co-reference (Sorace, 2011). We are currently probing the more detailed relationships among aspect, prosody, proficiency, and mention bias in these data. Nevertheless, the results show robust effects of pronoun accentuation on native speakers' processing of co-reference, and very different effects across the speaker groups. It may be the case that (some of) the non-native speakers engaged in sophisticated linguistic decisions about contrast, but, at least as a group, they did not produce the type of significant prosodic effects seen in the previous experiment.

#### **4.4 Experiment 4**

Experiment 4 moved to a visual world task to provide a more direct test of the use of expectations in processing decisions. Because it was our first online experiment in this series, we limited the prosody to broad focus for all critical trials. Unlike the other experiments, the Source and Goal characters mismatched in gender within each story. Participants viewed a screen displaying the Source, Goal, and Theme object (the beer, for (1)) while listening to a broad focus critical sentence and a pronoun-initial continuation sentence. We analyzed eye gaze to the three depicted objects, as a measure of participants' linguistically-driven attention.

As expected, both native and non-native listeners responded to the gender information on the pronoun to shift their gaze to the appropriate Source or Goal character shortly after the onset of the pronoun. Earlier in the discourse, during the pause between the sentences (i.e. *before* the pronoun was mentioned), the native speakers' gaze patterns were differentiated by the aspect of the critical sentence. Native speakers were significantly more likely to look at the Goal character following a perfective sentence than an imperfective one, suggesting that they generated expectations related to mention well before the continuation sentence began, and that the specific expectation for Goal/Source mention was influenced by the completed/ongoing state in the preceding sentence. This strongly supports the claim that the effect of aspect is due, at least in part, to anticipatory processes. As in Experiments 1-3, though, aspect did not emerge as significant for non-native speakers, providing further evidence that native and non-native speakers differ in their tendency to use grammatical aspect to predict how a discourse will continue.

Interestingly, though, non-native speakers did show evidence of anticipatory behavior. In the critical transfer-of-possession sentences, which have a general bias for Goal continuations, the non-native participants showed a significant pattern of anticipatory looks to the Goal character that was not present in filler sentences less biased toward Goal continuations.

#### **4.5 Experiment 5**

Data collection is still in progress for Experiment 5, but some preliminary results will be presented in the talk. This experiment employs a more complex discourse situation than the preceding experiments, to provide

a stronger test of whether native speakers use aspect predictively. It also extends the test of predictive processing to prosody. The critical sentence has one of three prosodic forms: broad focus, Source prominence, or Goal prominence. Each trial begins with a preamble sentence that precedes the critical sentence and mentions the Source, Goal, and an alternative person; this licenses the subsequent use of contrastive prosody to distinguish among the characters. Visual scenes depict these three characters, the Theme object, and a situationally-plausible alternative theme (e.g., a glass of wine, for (1)). The preamble is followed by the critical sentence and then a plausible continuation that begins with Source or Goal reference.

Based on Experiments 1-4, we predict that native speakers will anticipate co-reference on the basis of aspect, but that non-native speakers will not show effects of aspect until late in the course of processing the stories, if at all. Recall that both groups of speakers exhibited significant effects of prosody in Experiment 3, but not necessarily because of the same cognitive operations. If prosodic prominence merely leads to a stronger memory representation, we might expect effects at the point the anaphor is heard, but we would not expect sustained or anticipatory gaze to prominently mentioned characters. However, if speakers do show anticipatory increases in looks to these characters, it would support the conclusion that the participants construct semantic representations and situation models that reflect the contrastive prosody, and use those representations proactively to anticipate a coherence relation and co-reference.

## **5 General discussion and conclusion**

To summarize the results to date, native speakers shifted in preferred referent in response to all of the factors we manipulated. Contrastive prosody in a context sentence increased native speakers' selection of the prominently mentioned entity as the referent of a subsequent subject pronoun, and contrastive prosody on the subject pronoun resulted in decreased selection of the entity favored for unaccented pronouns.

The aspect effect found for native speakers replicated across written and spoken stimuli, and in tests with three different prosodic situations: broad focus, contrastive prosody within the transfer-of-possession sentence, and contrastive prosody on the subject pronoun of the continuation. It appeared when native speakers produced continuations in a story-continuation task, and when the continuations were provided in a visual world task. This latter task demonstrated that native speakers *generate* expectations based on event structure. Work in progress assesses whether native speakers also generate expectations in response to contrastive prosody.

Non-native speakers demonstrated skilled understanding of aspect, but repeatedly appeared unable to draw on it in anticipatory fashion, although they did demonstrate an anticipatory effect of verb bias. For prosody, they showed (superficially) native-like responses to contrastive prominence on antecedents, but quite different behavior from native speakers in response to the same prosodic tune on an anaphoric pronoun. Together, the tests of aspect and prosody suggest weaker facility for non-native speakers in rapidly computing the full range of discourse decisions generated by native speakers. For aspect, this may be solely because non-native speakers lack the capacity for certain anticipatory decisions, even though they have the requisite grammatical knowledge. For prosody, non-native speakers may have incomplete linguistic knowledge as well as processing limitations. Both cases underline the importance of teasing apart the series of decisions that must be made at multiple levels of representation during discourse processing, and the benefit of conducting experiments on a diversity languages and many distinct speaker populations.

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