

What prosody does when morphosyntax is absent: the case of Korean relative clauses

Jinyoung Jo, Juyeon Cho, Sanghee J. Kim & Sun-Ah Jun*

Abstract. This study investigates the role of prosodic information in linguistic interpretation in the absence of an explicit linguistic marker to resolve ambiguity. We particularly focus on the impact of prosody on comprehension of restrictive relative clauses (RRC) and non-restrictive relative clauses (NRC) in Korean, a language that lacks morphosyntactic or orthographic markers that distinguish between RRC and NRC. We hypothesize that narrow focus prosody may be associated with RRC, while broad focus prosody with NRC, which we test in two experiments through a picture selection task (Experiment 1) and an audio selection task (Experiment 2). Results showed that Korean listeners associated narrow focus prosody more often with RRC-biased pictures than NRC-biased pictures, suggesting that prosodic information has an impact on the resolution of syntactic ambiguity in the absence of any explicit linguistic marker. Further investigation suggests that there is variation in the impact of prosody across individuals and their sensitivity to prosody seems to be affected differently depending on the type of task.

Keywords. ambiguity resolution; syntax-prosody inter-face; non-restrictive relative clause; restrictive relative clause; Korean; language comprehension

1. Introduction. Multiple sources of linguistic information are known to be used to guide parsing, and numerous studies have demonstrated that representations about *prosodic* information can impact language comprehension. Information about prosody can have an influence on resolving syntactic ambiguities, attachment preferences, and processing difficulty (Prince 1979; Bader 1998; Fodor 1998; Schafer et al. 2000; Fodor 2002; Watson & Gibson 2004; Frazier et al. 2006; Wagner & Watson 2010; Breen 2014; Jun & Bishop 2015; Yun & Lee 2022).

For example, the sentence in (1) is ambiguous in that the prepositional phrase (PP), *with the flower*, can modify either *the frog* or the tapping event. While the sentence leads to two possible readings, the location of a prosodic boundary can help disambiguate the syntactic attachment of the PP. The double slash (/ /) in the examples indicates a large prosodic boundary and its position affects which phrase, either the noun phrase (NP) or the verb phrase (VP), is modified by the PP. In (1a), a prosodic break after *tap* leads to the interpretation of PP attaching to *the frog*, modifying the NP. On the other hand, in (1b), a prosodic break after *the frog* indicates that PP is used as an instrument to attach to the VP *tap the frog*. Watson & Gibson (2005) put forth the idea about the Anti-Attachment Hypothesis (AAH), where listeners (or parsers) have a preference for not attaching the incoming linguistic unit to the lexical head followed by a prosodic boundary. Similar findings have been reported in other studies (e.g., Carlson et al. 2001).

* Authors Jinyoung Jo, Juyeon Cho, and Sanghee J. Kim equally contributed to conceptualization, methodology, analysis, and writing. Sun-Ah Jun contributed to the methodology, discussion, review-editing, funding acquisition, and supervision. We would like to thank the attendees and the reviewers at the Linguistic Society of America 2024 Annual Meeting for their helpful comments. We also thank our experiment participants for their time. This work was supported by a University of California, Los Angeles senate grant to Sun-Ah Jun. Authors: Jinyoung Jo, University of California, Los Angeles (jinyoungjo@ucla.edu), Juyeon Cho, University of Delaware (jycho@udel.edu), Sanghee J. Kim, University of Chicago (sangheekim@uchicago.edu) & Sun-Ah Jun, University of California, Los Angeles (jun@humnet.ucla.edu).

(1) Attachment ambiguity in English (Snedeker & Trueswell 2003)

Tap the frog with the flower.

- a. Tap // the frog with the flower.
- b. Tap the frog // with the flower.

Although much research in language comprehension has explored how prosody influences the parsing of various syntactic structures across languages, the majority of it has focused on cases where syntactic ambiguity is explicitly marked by a linguistic marker, and the prosodic structure aids the parser in disambiguating among possible structures. In our present study, we aim to investigate a case where the syntactic representation is not linguistically explicit, yet the prosodic structure may reveal the syntactic representation. We do so by examining the comprehension of restrictive relative clauses (RRCs) and non-restrictive relative clauses (NRCs) in Korean (2). Korean does not exhibit overt morphosyntactic or orthographic cues to distinguish between an NRC and RRC reading. Hence, without context, both NRC and RRC readings are possible in (2), leading to parsing ambiguity.

(2) Example in Korean

Aphchima-lul ip-un yolisa-ka son-ul ssis-ess-ta.
apron-ACC wear-ADN cook-NOM hand-ACC wash-PST-DECL

‘The cook, who has an apron on, washed their hands.’ [NRC]

‘The cook who has an apron on washed their hands.’ [RRC]

Our investigation explores whether prosodic information can shape the comprehenders’ interpretation of the given RC structure even in the absence of an explicit linguistic marker to resolve ambiguity. As no prosodic cues are established to distinguish NRCs from RRCs in Korean, we manipulate focus prosody by associating broad focus prosody (representing the default prosody in Korean) with NRCs and narrow focus prosody with RRCs (specifying a referent from a contrast set). Further details on the semantic readings of NRCs and RRCs and background on the prosodic structure in Korean will be provided in subsequent sections. We show in two experiments, consisting of a picture selection task (Experiment 1) and an audio selection task (Experiment 2), that prosodic structure can influence how comprehenders interpret RCs: narrow focus prosody raises the likelihood of interpreting the sentence with an RRC reading. This indicates that prosodic information can guide parsing, even when other morphosyntactic and orthographic cues are absent, effectively directing the comprehender toward one interpretation over the other.

2. Restrictive and non-restrictive relative clauses across languages. In this section, we provide different meanings and readings of NRCs and RRCs, and contrast different families of languages that either have or do not have explicit linguistic markers to distinguish one from the other RC types. A contrast in the two types of RCs in English is shown in (3).

(3) Example in English

- a. The doctor, who has glasses on, is Kelly’s friend. [NRC]
- b. The doctor who has glasses on is Kelly’s friend. [RRC]

NRCs (or appositive relative clauses) are known to be less important in the main point of utterance and to provide secondary or side-commentary information about the noun (Potts 2005; Koev 2022). The noun phrase *the doctor* itself in (3a) subsets a specific group of doctors in the given context, and the information that the doctor *has glasses on* is supplementary. This contrasts with RRC as in (3b), where the relative clause provides necessary information by picking out a specific referent from a contrast set (as in Partee 1975). The semantic and pragmatic difference between NRC and RRC becomes particularly pronounced when, for example, one has to pick out a specific referent among two doctors, one who is wearing glasses and the other who is not. In this scenario, singling out a referent by using a structure in (3a) is unnatural and infelicitous. The distinction between NRCs and RRCs, in terms of their semantics (i.e., whether they function as apposition or restriction), has been investigated across various languages.

Languages differ in whether they have an overt marker or not in distinguishing between NRC and RRC, and the way to utilize explicit markers also differs across languages. Some use specific relative pronouns or classifiers and others use orthographic markers like commas. Languages with overt linguistic or orthographic markers include Italian, Catalan, most Romance languages, English, Romanian, Polish (Cecchetto & Donati 2023; De Vries 2023), Hausa (Jaggar 1998), and Santiago Laxopa Zapotec (Duff et al. 2022). The Italian example in (4) demonstrates the use of distinct relative pronouns for RRCs and NRCs. The NRC sentence contains the relative pronoun *il quale*, as in (4a), while *che* is used for the RRC sentence, as in (4b).

(4) Example in Italian (Cinque 2008:110)

Gianni ha un bellissimo appartamento ...
Gianni has a beautiful apartment

‘Gianni has a beautiful apartment ...’

- a. **il quale** da’ sul Central Park, e adesso ne vuole un altro.
which overlooks Central Park and now he wants a another
‘, which overlooks Central Park, and now he wants another.’ [NRC]
- b. **che** da’ sul Central Park, e adesso ne vuole un altro.
which overlooks Central Park and now he wants a another
‘which overlooks Central Park, and now he wants another.’ [RRC]

On the other hand, some languages, such as Japanese and Korean, lack overt linguistic markers for distinguishing between NRCs and RRCs. In these languages, there are no explicit morphosyntactic or orthographic cues to indicate the difference in meaning (Kuno 1973; Inoue 1976; Keenan 1985; Fukui 1986; Kim 1987; Sohn 2001). For instance, in Japanese, a sentence in (5) can be interpreted as either an NRC or RRC without context.

(5) Example in Japanese (Ishizuka 2008:3)

Ken-ga ani-ga karite-ki-ta muzukasii syoosetu-o yon-da.
Ken-NOM brother-NOM borrow-come-PST difficult novel-ACC read-PST

‘Ken read a difficult novel, which his older brother checked out.’ [NRC]

‘Ken read the difficult novel that his older brother checked out.’ [RRC]

Given that parsing ambiguity may arise when there are no morphosyntactic or orthographic markers to distinguish between NRC and RRC, we ask whether prosodic cues can play a role in resolving this ambiguity, even when the interpretation of RCs is not transparent in the language.

3. Korean prosody. Korean has a hierarchical prosodic structure, the biggest prosodic unit being the Intonational Phrase (IP), which consists of one or more intermediate phrases (ip), which in turn can consist of one or more accentual phrases (AP) (Jun 1993, 2006; Jun & Cha 2015). In broad focus prosody, which is the default prosody, each word tends to form one AP. In narrow focus prosody, the focused word begins an ip, and post-focus words are often dephrased (post-focus words are sometimes not dephrased, but maintain prosodic phrasing in compressed pitch range). An ip boundary has been shown to mark syntactic boundaries and focus structure (e.g., Jun 2011; Jun & Jiang 2019).

However, there have been no reported studies using prosodic cues to differentiate between NRCs and RRCs in the context of Korean relative clauses. Nonetheless, we assumed that prosodic cues might be the key, as some studies indeed show that prosody influences the disambiguation of relative clause interpretation, as observed in English. For example, the placement of a substantial prosodic boundary has been identified as a disambiguating factor in configurations involving two noun phrases followed by a relative clause (NP1 NP2 RC) in English (Jun & Bishop 2015; Clifton & Frazier 2018). Furthermore, the presence of an Intonational Phrase (IP) boundary has been found to be more likely to precede NRCs than RRCs in English constructions (Watson & Gibson 2004).

Building on these findings, this study aims to examine whether prosodic information plays a role in influencing listeners' interpretations of two types of relative clauses in Korean. We hypothesized that distinct focus prosody types could potentially serve as discriminative markers for NRCs and RRCs. More specifically, we assumed that putting a narrow focus on the RC material aligns with the RRC interpretation, as both share the characteristic of singling out a referent from a contrast set, whereas broad focus prosody is predicted to correspond to the NRC interpretation. The contrast shown in (7) illustrates the two possible prosodic phrasings within the relative clause of the Korean example, repeated here as (6). In (7a), the broad focus prosody, each word in the relative clause forms an AP (see Figure 1a). In comparison, in the narrow focus prosody (7b; see Figure 1b), the focused word *aphchima-lul* begins an ip with an expanded pitch range. Subsequent words, including the post-focus words *ip-un* and *yolisa-ka*, can each form one AP in a reduced pitch range or belong to the same single phrase (AP) as the focused word (i.e., the whole phrase can form one AP and one ip). Pitch patterns shown in Figure 1a and 1b will be described again in 4.1.3.

(6) Example in Korean

Aphchima-lul ip-un yolisa-ka son-ul ssis-ess-ta.
apron-ACC wear-ADN cook-NOM hand-ACC wash-PST-DECL

'The cook, who has an apron on, washed their hands.' [NRC]

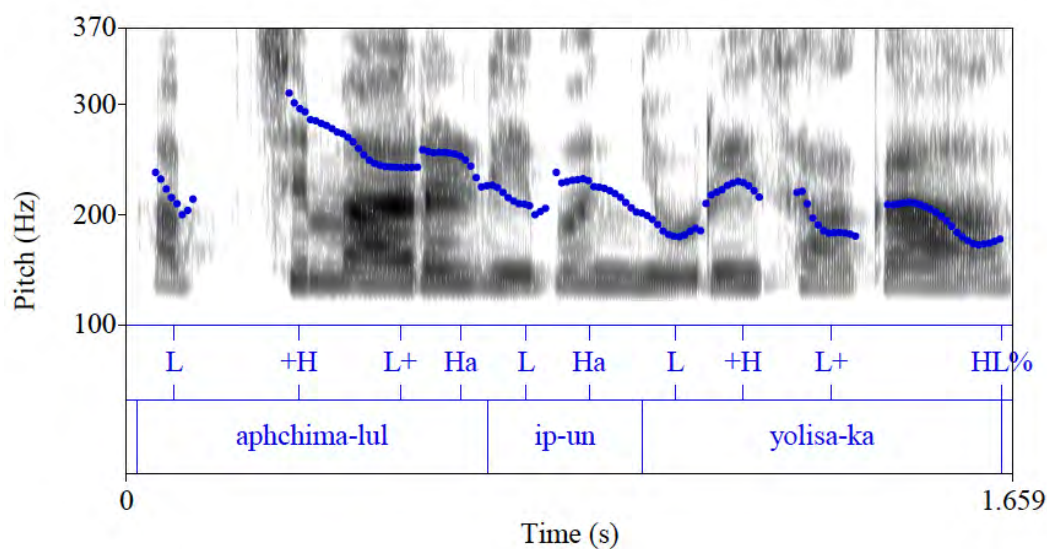
'The cook who has an apron on washed their hands.' [RRC]

(7) a. Broad focus prosody

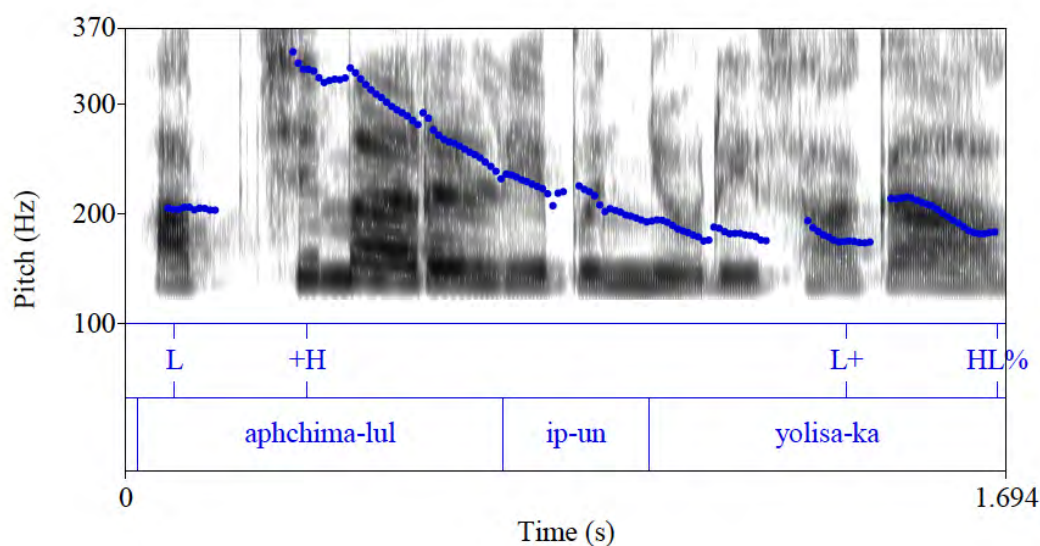
$ip[ip[AP[aphchima-lul] \quad AP[ip-un] \quad AP[yolisa-ka]]]$

b. Narrow focus prosody

ip[ip_{LAP}[aphchima-lul ip-un yolisa-ka]]]



(a) Broad Focus Prosody



(b) Narrow Focus Prosody

Figure 1. Pitch track of (a) broad focus prosody and (b) narrow focus prosody for *aphchima-lul ip-un yolisa-ka* (“The cook who has an apron on”). The tone labels follow the Korean-ToBI conventions (Jun 2000, 2005). ‘Ha’ represents an AP-final H tone and ‘+H’ represents the H tone that follows the AP-initial L tone. The whole phrase forms one IP with a HL% (falling) boundary tone.

This investigation, aligning with prior research, would illustrate the impact of prosodic cues in disambiguating RC interpretation, emphasizing the potential cross-linguistic relevance of these

prosodic patterns. This would be particularly notable in languages such as Korean, which lack overt markers for distinguishing between NRCs and RRCs.

4. Experiment 1. To address this question, we conducted two experiments in this study. In Experiment 1, we first employed a picture selection task to examine the potential role of prosody as a cue in influencing ambiguity resolution and guiding the interpretation of RCs. This investigation aimed to determine whether distinct prosodic patterns significantly contribute to participants' preferences in selecting pictures. If prosody indeed plays a crucial role, we would expect to observe a significant difference in participants' picture selection preferences, providing evidence for the impact of prosody on resolving ambiguity in RC interpretation.

4.1. METHODS.

4.1.1. **PARTICIPANTS.** A total of 69 native Korean speakers participated (40 female, 28 female, 1 unknown; age mean = 31.8, range = 23-53). Participants were recruited online via Prolific and through multiple social media platforms. They were compensated for their participation.

4.1.2. **DESIGN.** There were two conditions: the No Prosody condition and the Prosody condition (Broad Focus Prosody and Narrow Focus Prosody). Conditions were randomly assigned to participants, with 45 individuals in the Prosody condition and 24 individuals in the No Prosody condition. The number of participants in the Prosody condition was approximately two times greater than the one in the No Prosody condition; this is because the two conditions had an equal number of target sentences ($N=24$), but those in the Prosody condition were divided into trials in which the Broad Focus Prosody was presented ($N=12$) and those in which the Narrow Focus Prosody was presented ($N=12$). To ensure the number of responses collected is similar across three types of trials (No Prosody condition, Broad and Narrow Focus Prosody within the Prosody condition), we assigned twice as many participants to the Prosody condition. In both Prosody and No Prosody conditions, 24 target items and 32 filler items were included. Half of the filler trials were presented in broad focus prosody and the other half in narrow focus prosody.

4.1.3. STIMULI.

Visual stimuli We used two types of images for the target trials. The first type featured only one person, intended to be interpreted with a non-restrictive reading, and the other had more than one person, to be interpreted with a restrictive reading. For instance, two images were prepared for the target sentence as in (2). Both of the pictures present a cook wearing an apron, but Figure 2A has only that individual (NRC-biased), while Figure 2B has that individual plus others in it (RRC-biased). In the RRC-biased picture, the description *aphchima-lul ip-un* ('wearing an apron') matched only one of the many people in the image; thus, *aphchima-lul ip-un* restricts the meaning of the noun *yolisa* ('cook'). In the NRC-biased image, however, the description does not restrict the meaning of the noun because there is only a single individual in the image. We expected that when participants hear the narrow focus prosody that places a focus on *aphchima-lul* ('the apron-ACC'), they would interpret it as singling out the cook wearing an apron among many other cooks, thus choosing the RRC-biased picture. In the filler trials, the description was either compatible or incompatible with the image. For instance, for a filler sentence '(I) could not print because the printer broke,' the compatible image depicted workers in an office reading paper documents, while the incompatible picture presented a scene completely irrelevant to the sentence (people lying down on the grass).



Figure 2. Example pictures of target trials. Picture A is for triggering the NRC meaning and Picture B is for triggering the RRC meaning.

Auditory stimuli In the Prosody condition, participants listened to audio recordings of each sentence. A female native speaker of Korean trained in producing Korean intonation recorded each target sentence in both broad focus prosody and narrow focus prosody. For instance, the sentence in (2) itself is ambiguous between NRC and RRC readings, but the noun phrase *aphchima-lul ip-un yolisa-ka* was recorded with different prosodic phrasing depending on the prosody type. In broad focus prosody (7a), each word constitutes an AP, indicated by a pitch rise at the beginning of the word and the word-final H tone to mark the AP-final boundary (Figure 1a). In comparison, in narrow focus prosody in which *aphchima-lul* is focused (7b), the post-focus elements are dephrased; thus, the entire noun phrase makes up a single AP (Figure 1b).

As for the filler sentences, half of them were recorded in the broad focus prosody and the other half in the narrow focus prosody. Since the participants were presented with half of the target sentences in broad focus prosody and the other half in narrow focus prosody, we ensured consistency in prosodic composition across target and filler trials.

4.1.4. **PROCEDURE.** Participants were presented with a sentence, either auditorily (Prosody condition) or in written form (No Prosody condition). They were asked to select one of the two pictures, NRC-biased or RRC-biased, that aligns with the auditory description. The order of sentences presented was randomized. The experiment began with a practice session with four filler-like sentences. After the main session, information on language backgrounds and Autism-Spectrum Quotient (AQ) (Baron-Cohen et al. 2001) were collected through questionnaires. We collected the AQ scores because earlier work has shown that autistic traits, particularly communicative skills, are useful predictors for sentence processing in tasks involving pragmatic inferences (e.g., Xiang et al. 2013) and individuals' sensitivity to prosodic prominence (e.g., Bishop 2013; Jun & Bishop 2015). We used a Korean version of the Baron-Cohen et al.'s original AQ questionnaire, available in Shim & Lee (2019).

4.1.5. **ANALYSIS.** We conducted mixed effects logistic regression analysis to test whether the likelihood of selecting an RRC-biased picture differs significantly across prosody types. We used the *glmer* function of the *lme4* package (Bates et al. 2015) in R (R Core Team 2021). The dependent variable was PICTURE SELECTION, with two levels, NRC-biased (baseline) or RRC-biased. PROSODY was included as a fixed effect with three levels, Broad Focus Prosody (baseline), Narrow Focus Prosody, and No Prosody. AQ SCORES (continuous) was also included as a fixed factor. The model also included random intercepts for SUBJECT and ITEM. Both PICTURE SELEC-

TION and PROSODY were dummy-coded. Further, post-hoc pairwise comparisons of all levels of PROSODY were conducted using the *emmeans* function of the *emmeans* package (Lenth 2023).

4.2. RESULTS. We present the participants' selection of images first at the group level; as will be shown below, there was no significant effect of prosody type on the image selection. We then turn to an individual-level analysis to examine if the null result is due to large individual differences.

4.2.1. GROUP-LEVEL ANALYSIS. Figure 3 shows the proportion of NRC-biased and RRC-biased image selection in the three prosody conditions. In all prosody conditions, participants chose NRC-biased pictures more frequently than RRC-biased pictures. The proportion of RRC-biased pictures was 35.4% in the No Prosody condition, 39.3% in the Broad Focus Prosody condition, and 41.1% in the Narrow Focus Prosody condition. Although there was a numerical trend in which the proportion of RRC-biased pictures was higher in the Narrow Focus Prosody condition than in the Broad Focus Prosody condition, the difference was not significant ($p=.31$). The difference between Broad Focus Prosody and No Prosody was not significant ($p=.59$), nor was the difference between Narrow Focus Prosody and No Prosody ($p=.30$; post-hoc pairwise comparison). Finally, the effect of AQ SCORES was not significant ($p=.32$).

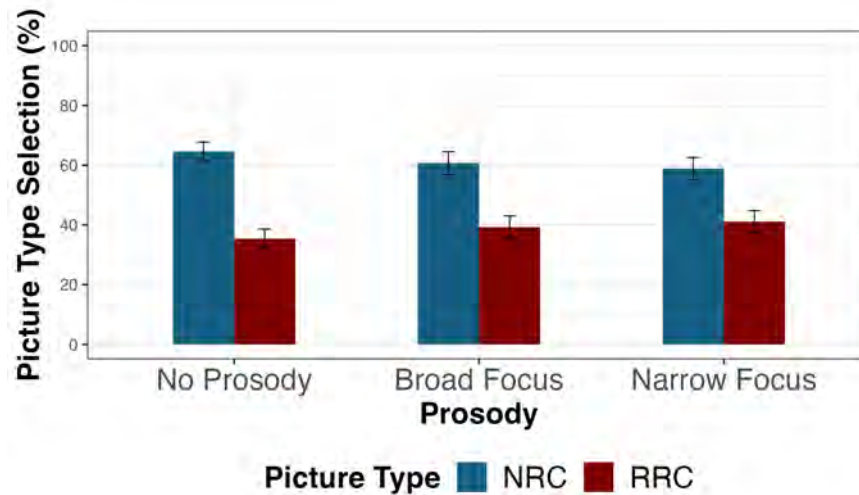


Figure 3. Experiment 1. The proportion of each picture type selection given each prosody type. Error bars indicate the standard errors of the mean.

4.2.2. INDIVIDUAL-LEVEL ANALYSIS. Figure 4 shows individual differences in the selection of *RRC-biased* images by those who participated in the Prosody condition. Those who chose RRC-biased images more frequently in the Narrow Focus Prosody condition than in the Broad Focus Prosody condition (represented by red bars higher than blue bars) align with our hypothesis. The average of blue bars in Figure 4 is 39.3%, and the average of red bars in the same graph is 41.1%, which are the proportions of RRC-biased picture selection reported above in 4.2.1.

We found that approximately 50% of the participants were consistent with our hypothesis. However, approximately 30% of the participants chose RRC-biased images more frequently in the Broad Focus Prosody condition, contrary to our hypothesis. Thus, the results demonstrated

a large degree of individual variability in the preference for RRC-biased images across different prosody types. A linear regression analysis showed that AQ scores did not predict such variability measured by the difference between Broad Focus Prosody and Narrow Focus Prosody in the proportion of RRC-biased picture selection ($p=.45$).

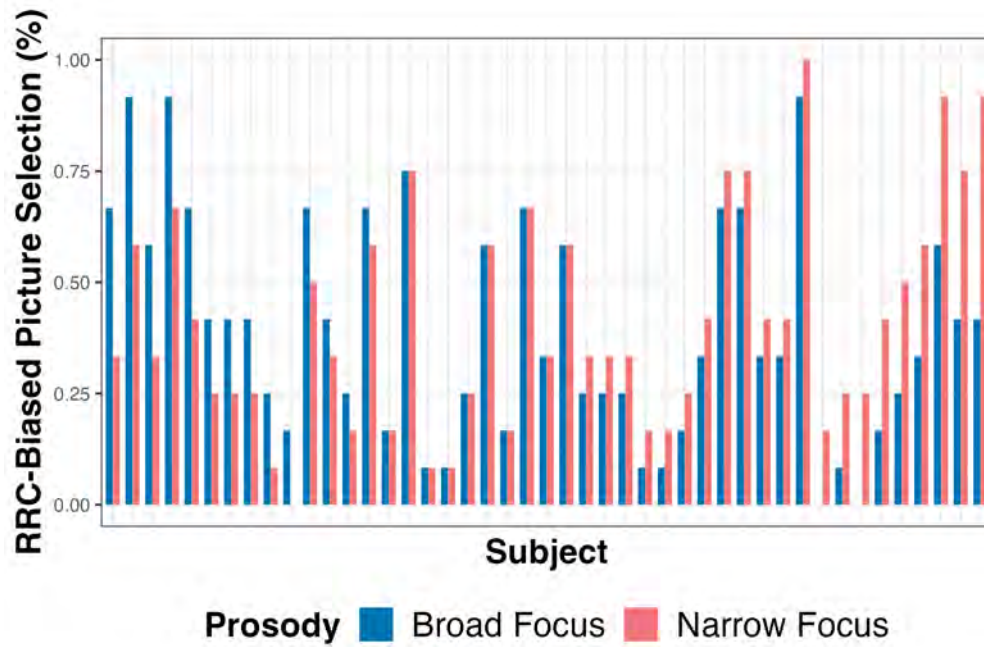


Figure 4. Experiment 1. The proportion of RRC-biased picture selection in Broad Focus and Narrow Focus Prosody conditions for each individual.

4.3. DISCUSSION. We found an overall preference for NRC interpretation. We attribute this result to a potential task effect. Each target sentence describes a single individual, and because the NRC-biased pictures show only one person, it may have been more natural to choose the NRC-biased picture regardless of the type of prosody. Furthermore, there was a large degree of individual differences in their mapping between prosody and relative clause interpretation. Therefore, we could not confirm if Korean listeners interpret broad focus prosody as an NRC and narrow focus prosody as an RRC.

As shown in Figure 2, two pictures differ by multiple aspects, not just one person vs. multiple people. Since interpreting the pictures and selecting one picture out of two while listening to a sentence has a high cognitive load, it is possible that subjects did not pay much attention to prosody. Thus, we decided to show only one picture and ask listeners to choose one out of two different prosodic patterns, hoping that listeners may show more sensitivity to prosody.

5. Experiment 2. Experiment 2 employed an audio selection task to examine if participants, when presented with a single picture (either RRC-based or NRC-based), use prosodic differences to resolve the ambiguity in RC structures. The primary focus is on determining whether narrow focus prosody consistently leads participants to prefer RRC interpretations, independent of any visual bias that might have caused the task effect in Experiment 1.

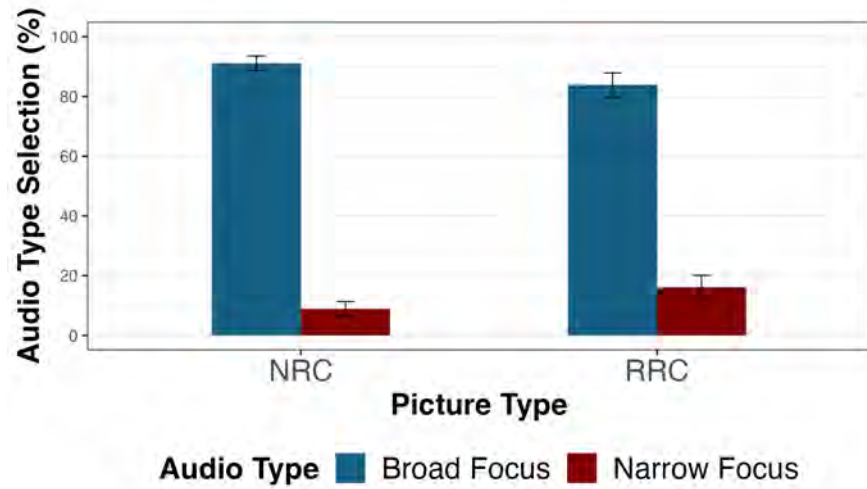


Figure 5. Experiment 2. The proportion of audio type selection given each picture type. Error bars indicate the standard errors of the mean.

5.1. METHODS.

5.1.1. PARTICIPANTS. A total of 25 native Korean speakers participated. (6 males, 19 females, age mean = 29.7, range = 20-45). Participants were recruited online via Prolific and through multiple social media platforms. They were paid for their participation.

5.1.2. DESIGN, STIMULI, AND PROCEDURE. Participants were presented with an image in each trial, either NRC-biased or RRC-biased. They listened to the auditory stimuli in both Broad and Narrow Focus Prosody in each trial and chose the type of prosody that they thought was more suitable for the picture. The order of item presentation was randomized.

We used 24 target trials, with 12 of them presenting NRC-biased pictures and the other 12 presenting RRC-biased pictures. We also included 32 filler trials. The same materials as in Experiment 1 were used.

As was the case in Experiment 1, the session began with four practice trials. After the main session, participants completed a questionnaire on their language background as well as the AQ questionnaire (Baron-Cohen et al. 2001).

5.1.3. ANALYSIS. We conducted a mixed effects logistic regression analysis to test whether the likelihood of selecting narrow focus prosody differs significantly across image types. The *glmer* function of the *lme4* package (Bates et al. 2015) in R (R Core Team 2021) was used. The dependent variable was AUDIO SELECTION, with two levels, Broad Focus Prosody (baseline) and Narrow Focus Prosody. IMAGE TYPE was included as a fixed effect with two levels, NRC-biased (baseline), and RRC-biased. AQ SCORES (continuous) was included as a fixed factor. The model also included random intercepts for SUBJECT and ITEM. Both AUDIO SELECTION and IMAGE TYPE were dummy-coded.

5.2. RESULTS. Figure 5 presents the proportion of Broad Focus Prosody and Narrow Focus Prosody audio selections in the two picture conditions. We observed a consistently higher response rate for Broad Focus Prosody across both NRC- and RRC-biased picture conditions.

More importantly, the likelihood of selecting the Narrow Focus Prosody significantly differed based on picture type. Specifically, participants exhibited a stronger preference for Narrow Focus Prosody when presented with RRC-biased pictures (16.1%) compared to NRC-biased pictures (8.9%) ($p < .01$). This indicates a preference for Narrow Focus Prosody when paired with RRC-biased images.

5.3. DISCUSSION. Experiment 2 investigated the impact of prosody on the interpretation of RRCs and NRCs in Korean, using an audio selection task. Our primary objective was to investigate whether prosody, specifically Narrow Focus Prosody, would bias participants toward selecting pictures that are compatible with RRC interpretations. The results from Experiment 2 revealed an overall preference for Broad Focus Prosody, aligning with the general trend observed in Korean prosody in which broad focus prosody is considered a default prosody type.

Crucially, however, the proportion of Narrow Focus Prosody selections significantly differed based on the picture type. Participants exhibited a stronger preference for Narrow Focus Prosody when presented with RRC-biased pictures compared to NRC-biased pictures. This finding supports our hypothesis that Narrow Focus Prosody is more frequently associated with RRC interpretation, even in the absence of explicit linguistic markers. The preference for Narrow Focus Prosody in the context of RRC-biased pictures suggests that participants utilized prosody as a cue to disambiguate RC interpretations, particularly in situations where linguistic cues were absent. This aligns with previous research (e.g., Watson & Gibson 2004; Jun & Bishop 2015; Clifton & Frazier 2018), demonstrating the role of prosody in guiding syntactic attachment preferences in languages with explicit markers.

6. General discussion. To summarize our findings, there was an overall preference for NRC interpretation and Broad Focus Prosody. However, when the Korean listeners were given a choice between Broad and Narrow Focus Prosody, the chances of selecting the Narrow Focus Prosody increased when they saw RRC-biased pictures, compared to when they saw NRC-biased pictures. The increased preference for Narrow Focus Prosody when an RRC-biased picture was presented (compared to when an NRC-biased picture was presented) suggests that the prosodic information was at play in guiding syntactic parsing and linguistic interpretation, aligning with our hypothesis.

We suspect that the global preference for an NRC interpretation is partly due to a task effect, as mentioned in Section 4.3. Recall that the participants in Experiment 1 were asked to select a more appropriate picture for the given prosody. In Narrow Focus Prosody trials, we expected participants to choose the RRC-biased picture because the prosody is used to highlight one person among many people. However, what seemed to have happened was that the Narrow Focus Prosody was also compatible with the NRC-biased picture because the picture depicts one individual and similarly the Narrow Focus Prosody describes one individual. As to the global preference for a Broad Focus Prosody, we again suspect that it may be attributed to a task effect. It is likely that the Broad Focus Prosody was compatible not only with NRC-biased pictures but also with RRC-biased pictures, because RRC-biased pictures do include one individual that matches the description of the target sentence produced in Broad Focus Prosody. This suggests that simply seeing more than one person in the picture did not provide strong enough background in consistently triggering narrow focus prosody. The task effect found in this study echoes the findings of previous studies on English focus domain and prosodic patterns where whether or not a mapping between the two is found depends on the type of task (Gussenhoven 1983; Birch & Clifton

1995; Welby 2003; Breen et al. 2010).

To the best of our knowledge, this is the first experimental work to investigate the mapping between interpretation of an ambiguous RC structure and prosodic structures in Korean. The current finding resonates with earlier findings on the role of prosodic information in impacting syntactic parsing (Kjelgaard & Speer 1999; Schafer et al. 2000; Snedeker & Trueswell 2003; Watson & Gibson 2005; Carlson & Tyler 2018; Nakamura et al. 2022). It is conceivable that when broad or narrow focus may not explicitly aim to resolve NRC and RRC ambiguity in Korean, native listeners utilize available prosodic cues—narrow focus being employed to distinguish a specific referent from multiple candidates—for syntactic disambiguation in lieu of other absent linguistic information.

To summarize, the present study showed an association between RRC interpretation and narrow focus prosody in Korean, although the strength of the link was affected by task type. The findings can be interpreted to further suggest that prosodic cues can lead (beyond biasing) listeners toward a particular linguistic interpretation when an explicit linguistic cue to resolving ambiguity in interpretation is not available. This argument can be further tested in future work by examining different syntactic structures and individual differences in preference for different focus prosody patterns (e.g., Jun & Jiang 2019). Our work will also benefit from production studies involving sentences with NRCs and RRCs as well as real-time comprehension studies to understand listeners' decoding of prosody. These follow-up investigations will address the potential caveats of offline measures such as their weak sensitivity to evaluating listeners' knowledge about prosodic well-formedness.

References

- Bader, Markus. 1998. Prosodic influences on reading syntactically ambiguous sentences. In Janet Dean Fodor & Fernanda Ferreira (eds.), *Reanalysis in sentence processing*, 1–46. Dordrecht: Kluwer.
- Baron-Cohen, Simon, Sally Wheelwright, Richard Skinner, Joanne Martin & Emma Clubley. 2001. The autism-spectrum quotient (AQ): Evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders* 31. 5–17. <https://doi.org/10.1023/A:1005653411471>.
- Bates, Douglas, Martin Mächler, Ben Bolker & Steve Walker. 2015. Fitting linear mixed-effects models using lme4. *Journal of Statistical Software* 67(1). 1–48. <https://doi.org/gcmkw>.
- Birch, Stacy & Charles Clifton, Jr. 1995. Focus, accent, and argument structure: Effects on language comprehension. *Language and Speech* 38(4). 365–391. <https://doi.org/gg466p>.
- Bishop, Jason. 2013. *Prenuclear accentuation: Phonetics, phonology, and information structure*. Los Angeles, CA: UCLA dissertation.
- Breen, Mara. 2014. Empirical investigations of the role of implicit prosody in sentence processing. *Language and Linguistics Compass* 8(2). 37–50. <https://doi.org/10.1111/lnc3.12061>.
- Breen, Mara, Evelina Fedorenko, Michael Wagner & Edward Gibson. 2010. Acoustic correlates of information structure. *Language and Cognitive Processes* 25(7-9). 1044–1098.
- Carlson, Katy, Charles Clifton, Jr. & Lyn Frazier. 2001. Prosodic boundaries in adjunct attachment. *Journal of Memory and Language* 45(1). 58–81. <https://doi.org/cxnk7s>.
- Carlson, Katy & Joseph C. Tyler. 2018. Accents, not just prosodic boundaries, influence syntactic attachment. *Language and Speech* 61(2). 246–276. <https://doi.org/gds9cs>.

- Cecchetto, Carlo & Caterina Donati. 2023. Relative clauses in Romance. *Oxford Research Encyclopedia of Linguistics*. <https://doi.org/10.1093/acrefore/9780199384655.013.663>.
- Cinque, Guglielmo. 2008. Two types of nonrestrictive relatives. In Olivier Bonami & Patricia Cabredo Hofherr (eds.), *Empirical issues in syntax and semantics* (vol. 7), 99–137. Paris: CNRS.
- Clifton, Charles, Jr & Lyn Frazier. 2018. Context effects in discourse: The question under discussion. *Discourse Processes* 55(2). 105–112. <https://doi.org/gjmzx6>.
- De Vries, Mark. 2023. Are there different kinds of appositive relative clauses? *Linguistics in the Netherlands* 40(1). 230–247.
- Duff, John, Ivy Sichel & Maziar Toosarvandani. 2022. Redundancy and restriction in the derivation of relative clauses. In Lalitha Balachandran & John Duff (eds.), *Syntax & semantics at Santa Cruz* (vol. 5), 35–58. Santa Cruz, CA: UCSC Department of Linguistics.
- Fodor, Janet Dean. 1998. Learning to parse? *Journal of Psycholinguistic Research* 27. 285–319.
- Fodor, Janet Dean. 2002. Psycholinguistics cannot escape prosody. In Bernard Bel & Isabelle Marlien (eds.), *Proceedings of speech prosody*, 83–90. Laboratoire Parole et Langage: SProSIG, Aix-en-Provence, France.
- Frazier, Lyn, Katy Carlson & Charles Clifton, Jr. 2006. Prosodic phrasing is central to language comprehension. *Trends in Cognitive Sciences* 10(6). 244–249. <https://doi.org/bbmdn2>.
- Fukui, Naoki. 1986. *A theory of category projection and its applications*. Cambridge, MA: MIT dissertation.
- Gussenhoven, Carlos. 1983. Testing the reality of focus domains. *Language and Speech* 26(1). 61–80. <https://doi.org/10.1177/002383098302600104>.
- Inoue, Kazuko. 1976. *Henkei bumpoo to nihongo [transformational grammar and japanese]*. Tokyo: Taishukan.
- Ishizuka, T. 2008. Restrictive and non-restrictive relative clauses in Japanese: Antisymmetric approach. Manuscript, UCLA.
- Jaggar, Philip J. 1998. Restrictive vs non-restrictive relative clauses in Hausa where morphosyntax and semantics meet. *Studies in African Linguistics* 27(2). 199–238.
- Jun, Sun-Ah. 1993. *The phonetics and phonology of Korean prosody*. Columbus, OH: OSU dissertation.
- Jun, Sun-Ah. 2000. K-tobi (Korean tobi) labelling conventions: version 3. *Speech Sciences* 7. 143–169.
- Jun, Sun-Ah. 2005. Korean intonational phonology and prosodic transcription. *Prosodic typology: The phonology of intonation and phrasing* 1. 201.
- Jun, Sun-Ah. 2006. Intonational phonology of Seoul Korean revisited. In Timothy Vance & Kimberly Jones (eds.), *Japanese-Korean Linguistics 14*, 15–26. Stanford: CSLI.
- Jun, Sun-Ah. 2011. Prosodic markings of complex NP focus, syntax, and the pre-/post-focus string. *Proceedings of the West Coast Conference on Formal Linguistics* 28. 214–230.
- Jun, Sun-Ah & Jason Bishop. 2015. Priming implicit prosody: Prosodic boundaries and individual differences. *Language and Speech* 58(4). 459–473. <https://doi.org/f75rgc>.
- Jun, Sun-Ah & Jihyeon Cha. 2015. High-toned [il] in Korean: Phonetics, intonational phonology, and sound change. *Journal of Phonetics* 51. 93–108. <https://doi.org/mmvp>.
- Jun, Sun-Ah & Xiannu Jiang. 2019. Differences in prosodic phrasing in marking syntax vs. focus: Data from Yanbian Korean. *The Linguistic Review* 36(1). 117–150.

- Keenan, Edward L. 1985. Relative clauses. In Timothy Shopen (ed.), *Language typology and syntactic description vol. 2: Complex constructions*, 141–170. Cambridge: Cambridge University Press.
- Kim, Young-Joo. 1987. *The acquisition of relative clauses in English and Korean: Development in spontaneous production*. Cambridge, MA: Harvard University dissertation.
- Kjelgaard, Margaret M & Shari R. Speer. 1999. Prosodic facilitation and interference in the resolution of temporary syntactic closure ambiguity. *Journal of Memory and Language* 40(2). 153–194. <https://doi.org/10.1006/jmla.1998.2620>.
- Koev, Todor. 2022. *Parenthetical meaning* (Oxford Studies in Semantics and Pragmatics). Oxford: Oxford University Press.
- Kuno, Susumu. 1973. *The structure of the Japanese language*. Cambridge, MA: MIT Press.
- Lenth, Russell V. 2023. *emmeans: Estimated marginal means, aka least-squares means*. R package version 1.8.4-1. <https://CRAN.R-project.org/package=emmeans>.
- Nakamura, Chie, Jesse A Harris & Sun-Ah Jun. 2022. Integrating prosody in anticipatory language processing: how listeners adapt to unconventional prosodic cues. *Language, Cognition and Neuroscience* 37(5). 624–647. <https://doi.org/gq7nbt>.
- Partee, Barbara. 1975. Montague grammar and transformational grammar. *Linguistic Inquiry* 6(2). 203–300. <http://www.jstor.org/stable/4177870>.
- Potts, Christopher. 2005. *The logic of conventional implicatures*. Oxford: Oxford University Press.
- Prince, Ellen F. 1979. On the given-new distinction. In Paul R. Clyne, William F. Hanks & Carol L. Hofbauer (eds.), *Fifteenth Regional Meeting of the Chicago Linguistic Society*, 267–278. Chicago: University of Chicago.
- R Core Team. 2021. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing Vienna, Austria. <https://www.R-project.org/>.
- Schafer, Amy J, Shari R Speer, Paul Warren & S David White. 2000. Intonational disambiguation in sentence production and comprehension. *Journal of Psycholinguistic Research* 29. 169–182.
- Shim, Lee Seul & Ok Bun Lee. 2019. A preliminary cross-cultural study: The Korean version of the autism-spectrum quotient (K-AQ). *Journal of Speech-Language Hearing Disorders* 28(3). 71–80. <https://doi.org/10.15724/jslhd.2019.28.3.071>.
- Snedeker, Jesse & John Trueswell. 2003. Using prosody to avoid ambiguity: Effects of speaker awareness and referential context. *Journal of Memory and Language* 48(1). 103–130.
- Sohn, Ho-Min. 2001. *The Korean language*. Cambridge: Cambridge University Press.
- Wagner, Michael & Duane G Watson. 2010. Experimental and theoretical advances in prosody: A review. *Language and Cognitive Processes* 25(7-9). 905–945. <https://doi.org/bntpwg>.
- Watson, Duane & Edward Gibson. 2004. The relationship between intonational phrasing and syntactic structure in language production. *Language and Cognitive Processes* 19(6). 713–755. <https://doi.org/10.1080/01690960444000070>.
- Watson, Duane & Edward Gibson. 2005. Intonational phrasing and constituency in language production and comprehension. *Studia Linguistica* 59(2-3). 279–300. <https://doi.org/dpztrx>.
- Welby, Pauline. 2003. Effects of pitch accent position, type, and status on focus projection. *Language and Speech* 46(1). 53–81.

- Xiang, Ming, Julian Grove & Anastasia Giannakidou. 2013. Dependency-dependent interference: NPI interference, agreement attraction, and global pragmatic inferences. *Frontiers in Psychology* 4. 708. <https://doi.org/10.3389/fpsyg.2013.00708>.
- Yun, Jiwon & Hye-Sook Lee. 2022. Prosodic disambiguation of questions in Korean: Theory and processing. *Korean Linguistics* 18(1). 18–47.