

# Priya Ananth, Masaaki Kamiya

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## The Effect of Prosody on Disambiguation: A Case of Universal Quantifier and Negation

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**Priya Ananth**

Middle Tennessee State University, Tennessee, USA

**Masaaki Kamiya**

Hamilton College, New York, USA

## **The Effect of Prosody on Disambiguation: A Case of Universal Quantifier and Negation**

**Abstract:** This study is concerned with L2 Japanese learners' interpretation of scopally ambiguous sentences containing negation and universal quantifier using prosodic cues. It has been argued, in previous literature, that native adult speakers of English as well as Japanese interpret such sentences both on their surface (total negation) and inverse scope (partial negation) readings in the presence of prosodic cues. The present study shows, however, that L2 Japanese speakers predominantly favor the total negation reading even in situations where the prosodic cues point them to the partial reading. These outcomes indicate that L2 learners of Japanese do not attach "optimal relevance" to prosodic cues when disambiguating scopally ambiguous sentences. The results also imply that for L2 Japanese learners, clues other than prosody may be required to carry out disambiguation.

**Keywords:** prosody, disambiguation, negation, prosodic cues, relevance theory

### **Introduction**

Prosody has an influence on pragmatic and semantic interpretations (e.g., Lieberman & Sag, 1974; Ladd, 1996; Jackendoff, 1972; Ward & Hirschberg, 1985, among others). The scope interaction between universal quantifier and negation presents an interesting phenomenon. Consider (1) below from Jackendoff (1972) which uses prosodic nuances to distinguish total and partial negation.

- (1) All the students didn't sleep.  
    'No student slept.' (total negation)  
    'It is not the case that all the students slept.' (partial negation)

This sentence contains a universal quantifier ‘all’ and negation, both of which are scope-bearing items. Due to the interaction of these two, the sentence can have either a total negation or partial negation reading as shown above. Speakers of English or German disambiguate sentences such as (1) by different prosodic patterns (A-/B- accents) in English (Jackendoff, 1972) and a rise-fall contour in German (Buring, 1997). Recently, Nakanishi (2007) discovered that adult Japanese speakers are sensitive to the phonological contours of the Japanese equivalent in (2).

(2) Minna-wa ne-nakat-ta.

all<sub>-TOP</sub>                  sleep<sub>-NEG<sup>-</sup>PAST</sub>

‘None of the students slept.’ (total negation)

‘Not all the students slept.’ (partial negation)

Previous experimental research has shown that native speakers rely on prosodic cues to disambiguate structurally ambiguous utterances during speech production and comprehension (e.g. Krajlic & Brennan, 2005; Lingel, Pappert, & Pechmann, 2006; Schafer, Speer, Warren, & White, 2000; Snedecker & Tueswell, 2003), pointing to an important connection between prosody and meaning in language processing. Fultz (2007) has shown that even less proficient late L2 learners may be similarly sensitive to this connection between prosody and meaning during L2 speech perception. In Japanese, Nakanishi (2007) and Hattori et al. (2006) have shown evidence of a correlation between prosody and disambiguation involving universal quantifier and negation in adult and children native speakers of Japanese respectively. However, little work has been done to investigate whether L2 learners of Japanese use prosodic cues to disambiguate scopal ambiguities during L2 speech comprehension. The present study addresses this gap by investigating experimentally whether L2 Japanese adult learners can correctly comprehend scope interactions between negation and universal quantification followed by the topic marker ‘wa.’

The results of previous studies imply that native speakers of Japanese (both adults and children) were able to interpret ambiguity involving universal quantifier and negation by effectively using prosodic effects while expending minimum processing effort. The question that arises is whether or not such a tendency (or strategy for disambiguation) is available to second language users as well. We discovered that L2 Japanese speakers did not seek out the clue for disambiguation in prosody. The control group of native Japanese speakers, however, did seek out the prosodic cue for disambiguation. The L2 Japanese participants in the present study seem to follow the “Relevance Theory” (Sperber & Wilson, 1986; Wilson & Sperber, 2004) in which they consider some factor as the most optimal one to process the interpretation. Although we did not

investigate other potential factors in this paper, at least prosody does not stand out as the most optimal cue in this study.

This paper will be organized as follows: In section two, we will review the previous studies about the relation between prosody and interpretations. In particular, we will look at the interaction between universal quantifier and negation in English and Japanese, and will present the research questions of this study. In section three, we will lay out the experimental design. In section four, we will report the results of the experiment. In section five, we will discuss the theoretical implications as well as the answers to our research questions based on the results of the experiment. In section six, we will present our conclusions along with future questions.

## Previous Studies

### Two Types of ‘wa’, Prosody, and Experimental Findings in Japanese.

This section explains the important ingredients of scope interactions such as (2) in Japanese. Consider example (2) from the previous section:

(2) Minna-wa ne-nakat-ta.

all-<sub>TOP</sub>          sleep-<sub>NEG-PAST</sub>

‘No student slept (total negation).’

‘It is not the case that all students slept (partial negation).’

As the English equivalents show, example (2) is ambiguous as either total negation or partial negation. One of the keys to understanding the source of ambiguity is the type of particle ‘wa.’ Kuno (1973, p. 38) accounts for two types of particle ‘wa’:

(3) a. ‘wa’ for the theme of a sentence: ‘speaking of..., talking about...’

John-wa gakusei desu.

John-<sub>TT</sub> student is<sup>1</sup>

‘Speaking of John, he is a student.’

b. ‘wa’ for contrasts: ‘X..., but..., as for X’

Ame-wa hutte imasu ga...

rain-<sub>CT</sub> falling is but

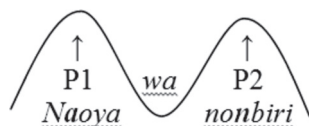
‘It is raining, but...’

<sup>1</sup> The authors added Thematic Topic (TT) and Contrastive Topic (CT) in the gloss.

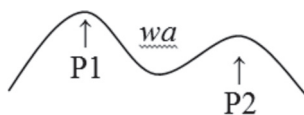


a CT. Observe the following prosodic patterns (example 6 cited from Nakanishi, 2007, pp. 179–180). Note that P1 and P2 are  $F_0$  values.

(6) TT pattern



CT pattern



Nakanishi further investigated the correlation between prosodic patterns of two types of ‘wa’ and scope interactions between a universal quantifier and negation. Recall example (2):

(2) Minna-wa ne-nakat-ta.

all-<sub>TOP</sub> sleep-<sub>NEG-PAST</sub>

No student slept (total negation).

It is not the case that all students slept (partial negation).

Nakanishi read examples such as (2) with two distinct prosodic patterns (one is TT and the other is CT) to four Japanese informants and asked for the relevant interpretations. According to Nakanishi (2007, p. 183), her informants agreed that TT corresponds to the total negation reading, while CT corresponds to the partial negation reading. Hence, she concludes that two prosodic patterns of ‘wa’ correspond to different scope interpretations in Japanese.<sup>4</sup>

To summarize so far, it appears that native speakers of Japanese are sensitive to phonological contours to distinguish ambiguous sentences, especially when universal quantifier and negation are in conjunction with the two types of ‘wa.’

**Prosody and Interpretations in English.** Japanese is not the only language that disambiguates scopally ambiguous sentences. Jackendoff (1972), Ladd (1996), Liberman and Sag (1974), as well as Ward and Hirschberg (1985) among others, claim that there is a correlation between phonological contours and scope interpretations. Jackendoff’s examples 8.159 and 8.160 (1972, p. 352) are given below as (7a) and (7b).

<sup>4</sup> Nakanishi (2007) attempts to account for the correlation between the prosodic patterns and the interpretations in alternative semantic framework (Büring, 1997). However, we will not adhere to this particular theoretical framework of this phenomenon in this paper. Rather, we would like to investigate whether or not L2 Japanese speakers interpret ambiguous sentences using the same strategy as native speakers of Japanese. Also see Hattori et al. (2006) for the Japanese-speaking children’s interpretations of the interaction between universal quantifier and negation. They report that the Japanese-speaking children have the same interpretations as adults.

- (7) a. ALL the men didn't go. ("A accent:" surface scope)
- b. ALL the men didn't go. ("B accent:" inverse scope)

These examples are ambiguous, representing total negation and partial negation. According to Jackendoff (1972), the phonological contours correspond to the relevant interpretations as shown above. Namely, when the sentence ending falls as in (7a), it means total negation (A-accent). On the other hand, when the sentence ending falls and rises as in (7b), it is partial negation (B-accent).<sup>5</sup> Ward and Hirschberg (1985), Pierrehumbert and Hirschberg (1990), and Steedman (1991) claim that the type of pitch accent on the focused quantifier such as 'all' also affects interpretation. So it is not entirely clear which of the two claims holds true. To investigate this point, Leddon (2003) conducted two types of experiments: production and comprehension tests. Unlike Jackendoff's examples, Leddon used 'every' for universal quantifier. For the production task, Leddon had adult native speakers of English read stories to children that included ambiguous sentences. These sentences were produced by adult native speakers of English and were recorded. For the comprehension task, Leddon made use of the recorded sentences from the production task. She had adult native speakers of English listen to the sentences to judge the relevant readings. According to Leddon, no prosodic pattern emerged in the ambiguous sentences (production test). Moreover, the results of the comprehension test showed that the participants were not sensitive to the phonological patterns to interpret ambiguous sentences. In addition, Leddon's participants preferred a partial negation reading to a total negation reading, regardless of the intonational contour found at the end of the sentence. Hence Leddon concludes that intonation did not have an effect on perceived interpretation, and the perception of a given interpretation was not affected by prosody. Rather, intonational contour is only indirectly related to interpretation of ambiguous sentences in the line of reasoning given by Ward and Hirschberg (1985). It is worthwhile to mention here that in recent experimental research done on children's interpretation of ambiguous English sentences containing both negation and a quantifier (Musolino, 1998; Musolino et al., 2000; Musolino & Gualmini, 2004; Gualmini, 2004; Musolino & Lidz, 2006, among others), two clear conclusions have been drawn. First, that at a certain point in their language development, children (unlike adults) predominantly access total scope interpretations. And second, that children can overcome such difficulty and become able to access the partial scope interpretation when

<sup>5</sup> Precisely speaking, the presupposition contains negation in A-accent, while the focus is negated in B-accent.

these sentences are accompanied by additional contexts that satisfy the felicity conditions for the use of negative statements.

**Relevance Theory.** This section explains the theoretical framework of “Relevance Theory” that will be later incorporated in the discussion to explain how L1 and L2 Japanese speakers interpret ambiguous sentences involving UQ and negation. With respect to how a speaker achieves comprehension, Sperber and Wilson (1986) as well as Wilson and Sperber (2004) proposed a pragmatic account called “Relevance Theory” which involves two factors—cognitive effect and processing effort. According to this theory, “an input is relevant to an individual when it is processing in a context of available assumptions yields a positive cognitive effect” (Wilson & Sperber, 2004, p. 608). Wilson and Sperber (2004, p. 609) claim:

- (8) a. Other things being equal, the greater the positive cognitive effects achieved by processing an input, the greater the relevance of the input to the individual at that time.
- b. Other things being equal, the greater the processing effort expended, the lower the relevance of the input to the individual at that time.

In other words, according to Relevance Theory, relevance is assessed in terms of (a) (cognitive) effect factor and, (b) effort factor. In general, other things being equal, the more (cognitive) effect processing an input achieves, the more relevant it will be. And the less effort processing an input requires, the more relevant it will be. Thus, in relevance theoretic terms, L2 Japanese may consider some cues as more relevant than others.

To sum up, while Nakanishi’s (2007) study with Japanese adults confirmed that added cues (prosodic in their case) play a role in access to the partial negation readings in Japanese, Leddon (2003) concluded in her production study with L1 English speakers that prosody does not play a role in disambiguation of structurally ambiguous sentences. This leads to the question how L2 learners comprehend scopally ambiguous sentences containing negation and universal quantifier, and how their comprehension is influenced by additional cues such as prosody. In other words, how much is prosody relevant to processing ambiguous sentences, and can the results be explained using Relevance Theory?

**Research Questions for This Study.** In the above subsections, we laid out the results of previous studies regarding disambiguation by prosody. The primary purpose of Leddon’s and Nakanishi’s studies was to investigate whether or not prosody plays an important role in disambiguation. It is certainly true



that prosody is a key factor in disambiguation, but it is also true that prosody is not the only clue for disambiguation. Therefore, one thing that these previous studies indicate is that prosody may or may not be a relevant factor for disambiguation for L2 Japanese speakers. In other words, it may be the case that some factors for disambiguation are parameterized, and the speakers of the language put a priority on one factor over the other. Theoretically speaking, human recognition tends to be geared to maximization of relevance (Cognitive Principle: Relevance Theory; Sperber & Wilson, 1986; Wilson & Sperber, 2004). In terms of such a formal theory, native speakers of Japanese tend to be geared to prosody as maximization of relevance. This may or may not be the case with L2 Japanese speakers. Also, recall that L1 English children tend to interpret scopally ambiguous sentences in total negative scope reading, but when the felicity condition is met, they are able to interpret both total and partial negative scope readings (Gualmini, 2004).

In light of the previous studies, we propose the following research questions:

1. Do L2 Japanese speakers differentiate total versus partial negation by prosody?
2. If Yes to the above, how?
3. Do L1 Japanese speakers differentiate total versus partial negation by prosody? (Although Nakanishi conducted this experiment, she had only four informants.)
4. If Yes to the above, how?

In order to answer these questions, we conducted an online picture matching task that will be described in the next section.

## Experiment

**The Study: Overview.** The aim of this study was to investigate whether L2 Japanese speakers resorted to interpreting scopally ambiguous sentences (into partial and total readings) using prosodic cues that were provided as part of the context. This study consisted of an online version of a picture matching task in which the target language was Japanese. The particular focus of the study was on scope interactions of the universal quantifier *minna* ‘all’ and negation, yielding two distinct readings—total negation and partial negation. Of interest was whether L2 Japanese speakers would appropriately differentiate these readings using prosodic cues and how far or close they would be to the responses from the control group consisting of L1 Japanese speakers.

**Participants.** This study included 33 adult L2 learners of Japanese (mean age = 21.51, SD = 1.66) whose levels ranged from beginning high to advanced. The control group consisted of 33 adult L1 Japanese speakers (mean age = 41.06, SD = 8.89). All of the L2 Japanese participants were enrolled in undergraduate Japanese language classes at universities in the United States. All of the L1 Japanese participants were qualified teachers of Japanese at universities and office workers in the United States. A demographic questionnaire was administered prior to conducting the experiments, which elicited background information, including age, nationality, total number of years of instruction, and length of stay in Japan. The L2 proficiency scale for the experimental group was based on the classes they were enrolled in at that time (1st year = level 1; 2nd year = level 2; 3rd year = level 3). All participants signed a written consent and were assigned an identification code such that their responses remained anonymous.

**Method and Materials.** An online version of a picture matching task (Kamiya & Look, 2012) was designed for the experiment. In this task, each of the short stories (a brief lead-in sentence and the target sentence) was narrated in the target language and was illustrated with two pictures presented on power point slides. The narration of the story was digitally recorded and embedded into each slide. Additional prosodic cues were provided for each slide. Depending on how the test sentence was presented (using specific prosodic cues controlled to indicate partial or total reading), the interpretation matched the left or the right picture. Participants chose one of the two pictures, and were given an opportunity to write a comment on why they chose that interpretation.

To illustrate with an example, the present study involved an interpretation task designed to tap learners' interpretations of scope readings using prosodic cues. The task presented learners with stories that depicted events that either had a partial negative reading or a total negative reading with the universal quantifier. (2) below illustrates the two readings in Japanese.

(2) Minna-wa ne-nakat-ta.

all-<sub>TOP</sub> sleep-<sub>NEG-PAST</sub>

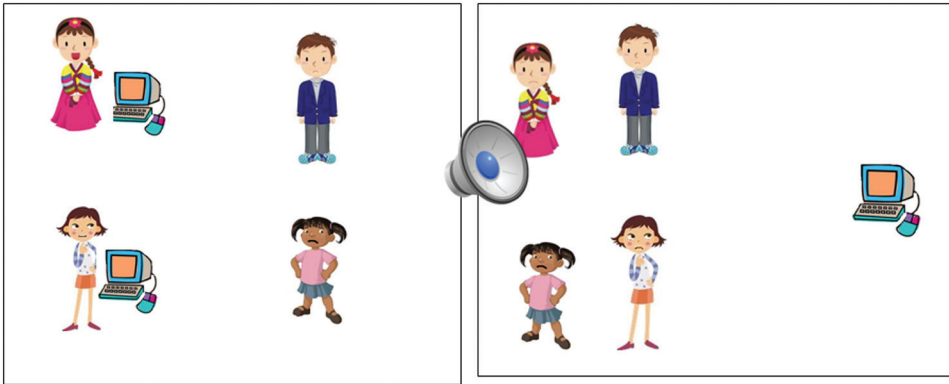
'None of the students slept.' [total negation = *wa* marks topic]

'Not all the students slept.' [partial negation = *wa* marks contrast]

A screen shot of a sample slide with the embedded target sentence is given below (Figure 1). The full list of test sentences is given in the Appendix. (Audio clue) Lead in + **Target Sentence**:

コンピューターは便利ですが、みんなは持っていませんでした。

'Computers are convenient, but all the students didn't have them.'



みんなは、もっていませんでした。

Figure 1. Sample slide of the test sentence.

When creating the target sentences, we investigated the average  $F_0$  before/after ‘wa’ in our sentences. Let us say that  $F_0$  before ‘wa’ is P1 and after ‘wa’ P2:

Table 1

*Average  $F_0$  before/after ‘wa’*

	P1	P2	Difference between P1 and P2
Total negation	155.5 Hz	245.1 Hz	89.6
Partial negation	193.1 Hz	136.3 Hz	56.8

As can be seen in Table 1, there are different patterns in Japanese prosody when it comes to ‘wa.’ For total negation, P2 is higher than P1, while for partial negation, P1 is higher than P2.

Qualtrics software was used to create the online test and the responses were automatically recorded on excel spreadsheets. The test had an introduction page, where participants read a short background narrative about a foreign student studying in Japan, who has to complete a class assignment involving listening to audio clips and transcribing the notes by way of interpreting the audio recordings. The introduction page was followed by a warm-up phase which had five pre-test questions. The pre-test questions checked the participants’ knowledge of the universal quantifier, negation, total reading, and partial reading. The main experimental task consisting of 30 questions followed the warm-up phase. The 30 questions were divided into 16 test questions (eight each for partial and total interpretation), and 14 distractor sentences. It was estimated that the tests could be completed in 30–40 minutes depending on the version (L1 or L2).

**Procedures.** The experimenters contacted the Japanese language classes as well as the native Japanese speakers face to face or via email and solicited voluntary participation for the study. Candidates were briefed about the goals of the study and the directions on how to do the online questionnaire. The instructions were made available in both oral and written formats. They were told that their participation would take about 30–40 minutes. The students were made aware that they would remain anonymous and their responses would be used only for research purposes and would not be used to evaluate their classroom performance. They were also informed that their refusal to participate or discontinuation of participation would never result in prejudice against them.

Those who agreed to participate were asked to give their signed consent and to send back their background questionnaires via email. After receiving the two completed documents, the experimental and control groups were divided up such that half of the participants from each group were given a brief training session aimed at ensuring that they understood that the semantic interpretation of the sentences may change due to the prosodic cues (sentences used for the training session are included in the Appendix). They were given examples from structures other than those used in this study. The remaining half of the participants did not receive this training.

After completing the training phase, a link to the experiment was sent via email to the participants along with a cryptic identification code. The participants were asked to complete the experiment within a week.

## Results

First, let us look at the overall trends in responses in terms of percentages of correct answers for the experimental and control groups.

L2 Japanese learners without training answered total negation 76.6% and partial negation 30% of the time. Those with training answered total negation 79.8% and partial negation 27% of the time.

As for the L1 Japanese speakers (i.e. the control group), those without training answered total negation 89.0% and partial negation 62.5% of the time. On the other hand, those with training answered total negation 85.2% and partial negation 86% of the time. These results are illustrated in Figure 2 below.

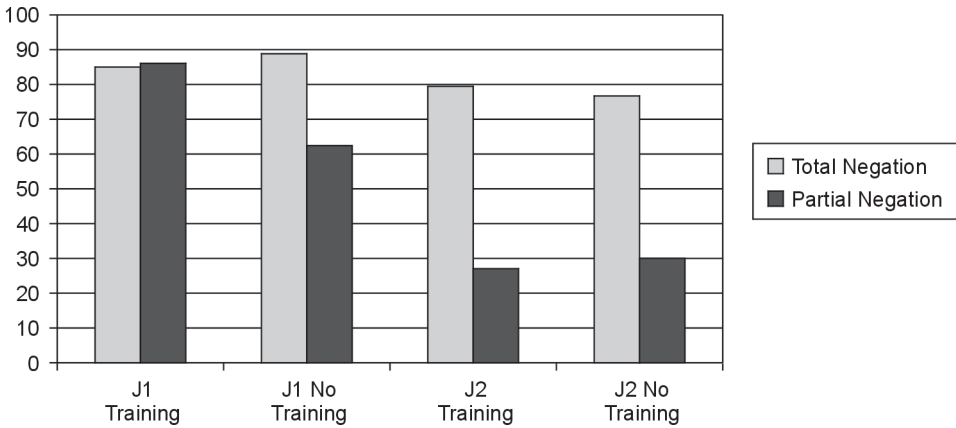


Figure 2. Percentage of Correct Answers in Japanese Test.

The main goal of the analyses was to determine if the responses by the L1 and L2 Japanese speakers to the target sentences differed depending on the scope interactions (i.e., total negation or partial negation). Since each participant responded to the sentences in both the total and partial negations, multivariate m-ANOVA was performed with the type of negation (total or partial) as the dependent variables and training (no training vs. with training) and nationality (American vs. Japanese) as the between subject factors (independent variables).

There was no interaction found between Training x Nationality  $F(2, 123) = 1.223$ ,  $p = 0.298$ . The interactions were further examined by running a general linear model for the test. There was a significant difference found between experimental and control groups with  $F(2, 63) = 21.896$ ,  $p = 0.000$  and particularly on partial scope with  $F(1, 64) = 24.71$ ,  $p = 0.000$ . The independent samples t-tests (two-tailed) also confirmed that the L1 Japanese speakers (control group) did significantly better than the L2 Japanese speakers (experimental group) on partial negation  $t(64) = -4.971$ ,  $p = 0.000$ . The mean for the control group on partial scope was higher than that for the experimental group: 5.90 ( $SD = 3.07$ ) and 2.30 ( $SD = 2.81$ ) respectively.

Let us now turn to participants' justifications for the choice of their responses. Beginning with the L1 Japanese control group, 24 participants mentioned that prosody was a key factor to determine the choice. Their main reasons were "the stress on 'minna' and the stress on the predicate", "the pronunciation of 'minna', whether or not there is a stress on 'wa', or 'it sounds like that'." One of the participants said that s/he could not think of any reason, but realized that the stress on *minna* is a key which s/he noticed half way through the test. Five out of 24 Japanese speakers (who gave phonology as a reason) noticed that prosody is a reason from the 1st question. Five out of 24 noticed prosody as a reason

from the 2nd question. Six out of 24 noticed at the 3rd, 4th, and 5th questions. So, among 24 who stated prosody as a reason, 16 noticed it earlier in the test.

Four L2 Japanese learners mentioned that they used prosody as a clue for the choice. They said “‘it is about tone’, ‘something about tone of voice’, or ‘it is about the sound of *minna*’.” The four participants mentioned prosody as their reason at the 2nd, 3rd, 7th and 12th questions respectively.

As a corollary to our study, we also conducted a second round of experiments offering a bidirectional component to our original objectives. The aim of this second part was to examine if L1 and L2 English speakers responded differently to scope interactions between negation and universal quantification in the presence of prosodic cues in English sentences. In order to be able to compare findings across the two experiments, procedures were analogous and experimental tasks were translation equivalents of each other. The same participants were employed for the second experiment and it was conducted after a gap of one week from the first one.

The procedure was just like the Japanese counterpart. Namely, we had a native speaker of English read an ambiguous sentence such as ‘All the students didn’t sleep’, intending either total or partial negation (see full list in the Appendix). For the English patterns, we measured the minimum and maximum of  $F_0$  in ‘all’. It seems that there is not much difference between maximum and minimum of  $F_0$  when it is intended to be read as total negation (the difference = 11.9 Hz). On the other hand, there is a big gap between the minimum and maximum of  $F_0$  on ‘all’ when it is intended as the partial negation (difference = 89.9Hz) (Table 2).

Table 2

*Average minimum and maximum of  $F_0$  ‘all’*

	Minimum	Maximum	Difference
Total negation	94.2 Hz	106.1 Hz	11.9
Partial negation	108.4 Hz	198.3 Hz	89.9

Below we will report the findings from the second experiment. First, the overall trend in responses in terms of percentages of correct answers for both groups of participants (L1 and L2 English speakers) was as follows.

Regarding the English test, L1 English speakers (American nationals) without training answered total negation 72.5% and partial negation 30% of the time. On the other hand, American nationals with training answered total negation 68% and partial negation 37.5% of the time. About the English test taken by L2 English speakers (Japanese nationals), those without training answered total negation 64.8% and partial negation 32.8% of the time. On the other hand, those with training answered total negation 66.9% and partial negation 47.7% of the time. These results are summarized in Figure 3 below.

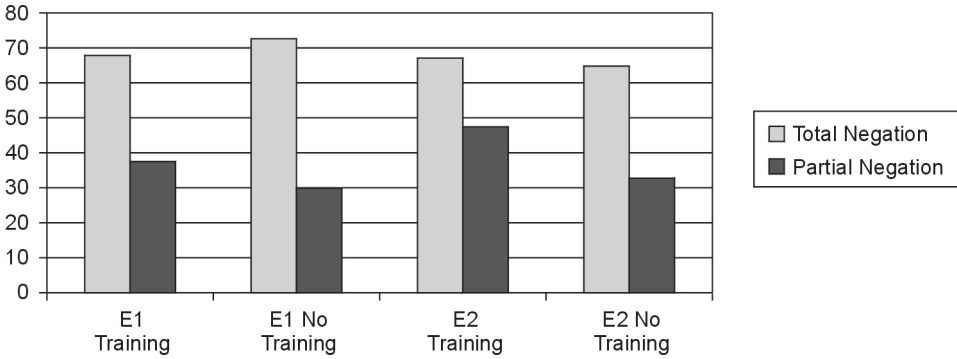


Figure 3. Percentage of Correct Answers in English Test.

Since each participant responded to the sentences in both the total and partial negative scope contexts, multivariate m-ANOVA was performed with the type of negation (total or partial) as the dependent variables and training (no training vs. with training); nationality (American vs. Japanese); and test version (English vs. Japanese) as the between subject factors (independent variables).

There was no interaction found among Training x Nationality x Test type  $F(2, 123) = 0.405$ ,  $p = 0.668$ . Moreover, there was no interaction between Training x Nationality  $F(2, 123) = 1.223$ ,  $p = 0.298$ , or between Training x Test type  $F(2, 123) = 0.025$ ,  $p = 0.975$ .

However, the m-ANOVA indicated a significant interaction between nationality and test version on the two dependent variables (total and partial negative scope) with Wilks's Lambda value<sup>6</sup> = 0.82 and  $F(2, 123) = 13.82$ ,  $p = 0.000$ . Further, the tests of between-subjects effects revealed that the interaction between nationality and test version was significant on partial negative scope with  $F(1, 124) = 8.93$ ,  $p = 0.003$ , and not on total negative scope with  $F(1, 124) = 1.94$ ,  $p = 0.166$ .

Next, the interactions were further examined by running a general linear model m-ANOVA between test version and nationality factors. Let us look at the two test versions (English and Japanese) and the performance of the Japanese nationals and the American nationals on the two test versions.

For the English test version, there was no significant difference found between the American and Japanese nationalities  $F(2, 63) = 0.218$ ,  $p = 0.805$ . However, for the Japanese test version, there was a significant difference found between American and Japanese nationalities with  $F(2, 63) = 21.896$ ,  $p = 0.000$  and particularly on partial scope with  $F(1, 64) = 24.71$ ,  $p = 0.000$ . The inde-

<sup>6</sup> In statistics, Wilks's lambda distribution (named for Samuel S. Wilks), is a probability distribution used in multivariate hypothesis testing, especially with regard to the likelihood-ratio test and Multivariate analysis of variance.

pendent samples t-tests (two-tailed) also confirmed that on the Japanese test the Japanese nationals did significantly better than the American nationals on partial negation  $t(64) = -4.971, p = 0.000$ . The mean for the Japanese nationals on partial scope was higher than that for American nationals: 5.90 (SD = 3.07) and 2.30 (SD = 2.81) respectively.

Next, let us look at the two nationalities (American and Japanese) and their performance on the two test versions (English and Japanese). For the American nationals, there was no significant difference found between English and Japanese test versions with  $F(2, 63) = 0.392, p = 0.677$ . On the other hand, for the Japanese nationals, there was a significant difference between English and Japanese test versions with  $F(2, 63) = 20.373, p = 0.000$ , and significant on both the total negative scope and partial negative scope. For total scope,  $F(1, 64) = 9.70, p = 0.003$ . The mean for the Japanese test version was higher than that for the English test version: 6.94 (SD = 1.71) and 5.27 (SD = 2.55) respectively. For partial scope,  $F(1, 64) = 13.76, p = 0.000$ . The mean for the Japanese test version was again higher than that for the English version: 5.91 (SD = 3.08) and 3.21 (SD = 2.83) respectively. The independent samples t-tests (two-tailed) also confirmed that the Japanese nationals did significantly better on the Japanese test than on the English test on both total negative scope  $t(64) = -3.19, p = 0.002$  and partial negative scope  $t(64) = -3.73, p = 0.000$ .

Finally, a set of independent t-tests (two-tailed) was carried out to confirm any significant differences between Japanese and Americans for their first language L1, second language L2, length of stay in the target country as show in Table 3.

Table 3

*Independent t-tests for Japanese and Americans*

	Japanese means	American means	t	P (two tailed)
L1 Total	6.96	5.60	-2.36	*0.021
L1 Partial	5.90	2.81	-4.06	*0.000
L2 Total	5.27	6.21	-1.6	0.114
L2 Partial	3.21	2.27	+1.35	0.181
Length of stay in target country	15.54	0.19	+11.38	<*0.0001

It is interesting to see the results of the independent t-tests between the American and Japanese groups for the overall performance on their first and second languages. For their native languages, there was a significant difference ( $p < 0.05$ ) between the Japanese and American groups of participants for both the total and the partial readings. For their second languages however, statistically there was no significant difference between the two groups of partici-



pants for both the total and the partial readings. Note that although there was a significant difference found in the length of stay in the target country by the respective groups, there was no reflection of this fact in the difference in the performance of the L2 groups.

Let us also look at participants' justifications of the choice of their responses in the second experiment (English test).

Twelve Japanese reported that they made use of prosody as a clue. Their comments included 'the stress on *didn't* and stress on *all*', 'pronunciation of *all*' or 'the emphasis on *all*'. Two of them noticed it at the 1st question, and four of them at the 2nd question. Therefore, half of the participants observed that the phonological contour is the reason for the ambiguity even in the English test. Eight American respondents also mentioned that prosody was the key to answer the questions. Their comments included 'the tone of the speaker's voice', 'the way to read *all* the students, 'emphasis on *all*', or 'accent on *all*.' One of the participants mentioned that 15 out of 16 questions are about the stress on *all*, but only 3 questions were correct. Out of 8 native speakers of English, 5 of them considered the sound as a reason at the 2nd question, which is early in the test.

The next section will examine the results of the two experimental tests and their theoretical implications.

## Discussion

The motivation for the current study was to examine whether or not learners of Japanese are able to interpret ambiguous sentences based on prosody. From the viewpoint of L1 Japanese, prosody before/after the particle 'wa' helps them to distinguish total negation from partial negation (Kuno, 1973; Hattori et al., 2006; Nakanishi, 2007). However, there is no experimental research available that supports L2 Japanese learners' interpretation of these two readings. At the end of section two, we raised the following research questions:

1. Do L2 Japanese speakers differentiate total versus partial negation by prosody?
2. If Yes to the above, how?
3. Do L1 Japanese speakers differentiate total versus partial negation by prosody?
4. If Yes to the above, how?

Let us answer these questions based on the results of our experiment. There was a significant interaction between the experimental and control groups particularly on partial negation. This indicates that the L2 Japanese learners tend

to interpret the test sentences as total negation reading. It is not surprising that the control group performed better overall as this confirms Nakanishi's study. The statistically significant difference between L1 and L2 Japanese speakers' performance on partial negation indicates sensitivity (or lack thereof) to the phonological contours of the particle 'wa.'

Based on the correct percentages of total and partial reading responses, both groups showed a strong tendency towards total negation interpretations. In other words, without context but just sound, it seems that the total negation reading is the default case. Let us again look at the percentage of correct responses as tabulated below (see Table 4).

Table 4

*Japanese test results*

	Total negation %	Partial negation %
J1 with training	85.2	86.0
J1 without training	89.0	62.5
J2 with training	79.8	27.0
J2 without training	76.6	30.0

As reported in the previous section, four L2 participants indicated prosody as a reason. This implies that some participants were aware of the phonological difference for the relevant interpretations. Then, why is their population so small? We will return to this issue when we consider the theoretical implications. Regarding the L1 Japanese speakers, 24 of them resorted to prosody as the reason to choose their answers. Overall, the L1 Japanese speakers are aware of the prosodic cues used for disambiguation.

To explain our results, we will make use of the "Relevance Theory" (Wilson & Sperber, 1986; 2004). Relevance Theory consists of the following two principles: (1) Cognitive Principle: that human cognition is geared to the maximization of relevance; and (2) Communicative Principle: that utterances create expectations of optimal relevance.

According to Wilson and Sperber, the goal of inferential pragmatics is to account for the way the hearer infers the speaker's meaning on the basis of the evidence provided (Wilson & Sperber, 2004, p. 250). In addition, an input is considered to be relevant to an individual when a positive effect is yielded for the processing. Wilson and Sperber (2004, p. 609) claim:

- (8) a. Other things being equal, the greater the positive cognitive effects achieved by processing an input, the greater the relevance of the input to the individual at that time.
- b. Other things being equal, the greater the processing effort expended, the lower the relevance of the input to the individual at that time.

As the relevance of an input to an individual says, it seems that relevant information (or optimal relevance) has to do with how an individual interprets a sentence. Importantly, ‘the greater the processing effort expended, the lower the relevance of the input to the individual at that time’. In terms of this condition, the learners of languages may be parameterized into two classes in the current study. Namely, there are participants who consider prosody to give positive cognitive effects and those who do not. The optimal relevance of processing a sentence may be related with grammar. In the present study, the acquisition of two types of ‘wa’ eliminates potential ambiguity from sentences for native speakers of Japanese. The two types of ‘wa’ differ in not only meaning but also prosody. Both pieces of information are \*relevant\* to the native speakers of Japanese.

On the other hand, it is not necessary for the L2 Japanese speakers to expunge anything in the ambiguous test sentences of the present study. Therefore, L2 speakers consider prosody to be not as optimal information as other possible factors (e.g., context). In other words, based on the above two conditions, it could be conjectured that the cognitive effect due to the prosodic cues is not very large in the case of partial negation readings. The absence of enough positive evidence in the environment to identify partial negation readings from prosodic clues necessarily increases the listener’s corresponding processing effort. Therefore, the relevance to these sentences is not maximized to the extent of accurate identification. The unambiguous alternative of the partial negative reading using “not all...”—such as “Not all the students came to class”—has a larger cognitive effect due to the availability of positive evidence in the environment, and hence lower processing effort.

Optimality seems to be carried over to second language acquisition. This was the reason why we witnessed that the L1 Japanese group seeks for prosody as a clue due to the optimal relevance for interpretations, while it was not the case with L2 Japanese. Because prosody may not be optimally relevant, it may be the case that they do not pay careful attention to the two types of ‘wa’ during L2 learning.

In order to increase the cognitive effect and the optimal relevance of the test sentences in the present study, a preceding contextual clue also needs to be tested out. In case of American nationals, it could be the case that the additional preceding context will provide that extra contextual effect and hence reduce the processing effort.

As for the results of the second round of experiment (English test) with L1 and L2 English speakers, there is no significant difference between the American and the Japanese nationals. However, as the result section showed, the tests of between-subjects effects revealed that the interaction between nationality and test version was significant on partial negation. Observe that summarizes the result from the English test.

Table 5  
*English test results*

	Total negation %	Partial negation %
E1 with training	68	37.5
E1 without training	72.5	30
E2 with training	66.9	47.7
E2 without training	64.8	32.8

Based on the correct percentages, both nationals showed a strong tendency towards total negation interpretations of the English sentences. In other words, without context but just sound, it seems that the total negation reading is the default case. These results can be explained using Relevance Theory as well. The percentage of correct responses is lower in partial reading as compared to total reading because the cognitive effect of the prosodic cues is not very large in the case of partial readings. And this is supported, in part, by the lack of sufficient positive input in the natural environment that would reinforce the interpretation of partial readings for these sentences.

The above results are analogous to the results obtained in the Goss and Nakayama (2011) study, where English native speakers seem not to be sensitive to prosody for disambiguation of structurally ambiguous sentences in Japanese. The purpose of Goss and Nakayama is to figure out how accurately L1 and L2 Japanese give a pause in the following examples when they read aloud, especially ambiguous sentences. The following phrases are unambiguous NP (Goss and Nakayama, 2011: modified their example (5)):

- (9) a. [ookii [natsu no miitingu]]  
       ‘the large meeting in the  
       summer’  
       (Right Branching modification)
- b. [[yasui apaato no] [soto]]  
       ‘outside of the cheap  
       apartment’  
       (Left Branching modification)

The following example is ambiguous with different interpretations in (a) and (b):

- (10) Abunai mati-no koosaten
- a. [[abunai] [mati no koosaten]]  
       ‘the dangerous intersection in  
       the town’  
       (Right branching modification)
- b. [[abunai mati no][koosaten]]  
       ‘the dangerous town’s  
       intersection’  
       (Left branching modification)

Goss and Nakayama report that there are preferences by L1 and L2 Japanese. While L1 Japanese gives accurate answers for right branching modification

(88% for right and 79% for left), L2 Japanese show preference for left branch modification over right branch modification (53% for right vs. 77% for left). Goss and Nakayama assume that L2 Japanese speakers' preference for left branching modification may be due to their L1 preference (i.e., left branch modification for English; Goss and Nakayama cite works by Fodor, 2002; Jun, 2003; Maynell, 2005) (L1 transfer might have occurred). Surprisingly, the accuracy rate for syntax-prosody matching of ambiguous sentences by L1 Japanese is 79%, which is close to L2 Japanese 74%. Hence, it may be conjectured that there must be a preferred prosody-syntax match such as left-branching modification or right-branching modification, depending on the participants' first language. However, Goss and Nakayama suggest that the mismatch between production (prosody) and interpretation exists even for L1 Japanese speakers. They suspect that learners may consider prosody as "extraneous or secondary information" when acquiring Japanese. In other words, their study supports the argument that prosody was found to have lower optimality for the L2 Japanese speakers to produce structural ambiguity. In the present study, there seems to be a preference (or a tendency) to interpret one pattern over the other pattern (in our test sentences, total negation is preferred). But prosody is not optimal enough to turn around such a preference when it comes to ambiguity resolution.

## Conclusion and Future Study

The aim of this study was to examine if L2 Japanese learners use prosody to disambiguate the total and partial negation readings of sentences involving negation and universal quantifier. Based on the results of this study, it was shown that L2 Japanese speakers were not able to use prosodic cues to disambiguate the scopally ambiguous sentences used in this study. Their performance was better on identifying the total negation reading as opposed to the partial negation reading, which can be explained using the Cognitive Principle defined under the Relevance Theory.

In this study we only investigated the usefulness of prosody in disambiguation. The next step would be to examine the effect of a preceding context on disambiguation. In previous empirical studies, while prosody and/or context have robustly been utilized to control the meaning of any utterance, another corollary that needs investigation is a "no clue" condition, that is, to not provide any clues—contextual or prosodic—and examine if the participants are sensitive to the ambiguities of these constructions in their written form. These issues will be taken up in our next study.

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## Experimental Stimuli

### Training Session Sentences

- |                     |                   |     |                 |                    |
|---------------------|-------------------|-----|-----------------|--------------------|
| (1) soo desu ka ↗   | (raising the end) | vs. | soo desu ka ↘   | (lowering the end) |
| ‘Is it so?’         |                   |     | ‘It is so.’     |                    |
| (2) ii desu ↗       |                   | vs. | ii desu ↘       |                    |
| ‘good’              |                   |     | ‘no thanks’     |                    |
| (3) Really ↗        |                   | vs. | Really ↘        |                    |
| (4) Is that right ↗ |                   | vs. | Is that right ↘ |                    |

### Pretest Sentences

- (P1) Sooda to biiru-ga arimasita. Lisa to Mari-wa soda-o nomimasita-ga, John to Naoya-wa biiru-o nomimasita.  
‘There was soda and beer. Lisa and Mari drank soda, while John and Naoya drank beer.’
- (P2) Kyoo-wa tomodati-no tanzyoobi desu. Minnade puresento-o kaimasyou.  
‘Today is our friend’s birthday. Let’s all buy her a present together.’
- (P3) Omosiroosona geemu-ga arunode minnade geemu-o simasita.  
‘The game looked interesting, so all the students played it together.’
- (P4) Tomodati-ga pai-o tukutta node minnade pai-o tabemasyoo.  
‘My friend made a pie, so let’s all eat it together.’
- (P5) Lisa to Mari-wa ikimasitaga, Naoya-wa ikimasendesita.  
‘Lisa and Mari went, but Naoya did not go.’

### Test Sentences

- (1) Computer-ga benri desu ga, minna-wa motteimasendesita. (Total negation)  
computer-<sub>NOM</sub> convenient is but all-<sub>TOP</sub> had not  
‘Computers are convenient, but all the students didn’t have them.’
- (2) Ame-ga hutteiru node kasa-ga irimasu ga, minna-wa arimasen. (Partial negation)  
rain-<sub>NOM</sub> falling so umbrella-<sub>NOM</sub> necessary but all-<sub>TOP</sub> have not  
‘It is raining and they need umbrellas, but all the students don’t have them.’
- (3) Computer-ga benridesu ga, minna-wa tukaimasen desita. (Total negation)  
computer-<sub>NOM</sub> convenient is but all-<sub>TOP</sub> use did not  
‘Computers are convenient, but all the students didn’t use them.’
- (4) Geemu-ga omosiroosoo desu ga, minna-wa simasendesita. (Partial negation)  
game-<sub>NOM</sub> interesting is but all-<sub>TOP</sub> did not  
‘The game looked interesting, but all the students didn’t play it.’
- (5) Omosiroi hon desu kedo, minna-wa yomimasendesita. (Total negation)  
interesting book is but all-<sub>TOP</sub> read did not  
‘It is an interesting book, but all the students didn’t read it.’
- (6) Kyoo-wa gakkoo-ga arimasita ga, minna-wa ikimasendesita. (Partial negation)  
today-<sub>TOP</sub> school-<sub>NOM</sub> there was but all-<sub>TOP</sub> go did not  
‘Today they had school, but all the students didn’t go.’
- (7) Spring break-de biichi-ni ikimasu ga, hotel-wa takai node, minna-wa tomarimasen.

spring break-at beech-to go but hotel-<sub>TOP</sub> expensive because all-<sub>TOP</sub> stay did not (Partial negation)

‘During spring break they will all go to the beach. But since the hotel is expensive, all the students will not stay there.’

- (8) Keetaidenwa-wa benri desu ga, minna-wa motteimasendesita. (Partial negation)  
Cellphone-<sub>TOP</sub> convenient is but all-<sub>TOP</sub> have not  
‘Cell phones are convenient, but all the students don’t have them.’
- (9) Asita-wa tesuto desu. Coffee-ga arimasu ga, minna-wa nomimasendesita (Total negation)  
tomorrow-<sub>TOP</sub> test is coffee-<sub>NOM</sub> there is but all-<sub>TOP</sub> drink did not  
‘Tomorrow is test. There was coffee there, but all the students didn’t drink it.’
- (10) Party-ga arimasita kedo, minna-wa ikimasendesita. (Partial negation)  
Party-<sub>NOM</sub> there was but all-<sub>TOP</sub> go did not  
‘There was a party, but all the students didn’t go.’
- (11) Nihongo-no syukudai-wa asita made desu ga, minna-wa simasendesita. (Total negation)  
Japanese-<sub>GEN</sub> homework-<sub>TOP</sub> tomorrow until is but all-<sub>TOP</sub> do did not  
‘The Japanese homework was due tomorrow, but all the students didn’t do it.’
- (12) Kanji-wa muzukasii kedo, minna-wa benkyoosimasendesita (Partial negation)  
kanji-<sub>TOP</sub> difficult but all-<sub>TOP</sub> study did not  
‘Kanjis are difficult, so all the students didn’t study them.’
- (13) Pai-o tukuritakattanodesu ga, minna-wa tukurimasendesita. (Total negation)  
Pie-<sub>ACC</sub> make wanted is but all-<sub>TOP</sub> make did not  
‘Although they wanted to make pies, all the students didn’t make them.’
- (14) Oisisoona keeki-ga arimasita ga, minna-wa tabemasendesita (Partial negation)  
delicious cake-<sub>NOM</sub> there was but all-<sub>TOP</sub> eat did not  
‘The cake looked delicious, but all the students didn’t eat it.’
- (15) Omosiroosona geemu-ga utteimasu ga, minna-wa kaimasendesita. (Partial negation)  
interesting game-<sub>NOM</sub> selling but all-<sub>TOP</sub> buy did not  
‘There was an interesting looking game in the market, but all the students didn’t buy it.’
- (16) Omosiroosona eiga-ga arimasita ga, minna-wa mimasendesita (Total negation)  
interesting movie-<sub>NOM</sub> there was but all-<sub>TOP</sub> watch did not  
‘The movie seemed interesting, but all the students didn’t watch it.’

#### Filler Sentences

- (1) Kyoo-wa tesuto-ga arimasita. Minna-wa yoku dekimasita.  
Today-<sub>TOP</sub> test-<sub>NOM</sub> there was all-<sub>TOP</sub> good did  
‘Today there was a test. All the students did well on it.’
- (2) Oisisoona aisukuriimu-ga arimasita. Minna-wa kaimasita.  
Delicious ice cream-<sub>NOM</sub> there was all-<sub>TOP</sub> bought  
‘There was ice-cream that looked delicious, so all the students bought it.’
- (3) Science-no zyugyoo-ga arimasita. Minna-wa yoku wakarimasita.  
Science-<sub>GEN</sub> class-<sub>NOM</sub> there was all-<sub>TOP</sub> good understood  
‘There was a science lesson today, and all the students understood it well.’
- (4) Oisisoona ringo-ga arimasita. Minna-wa tabemasita.  
Delicious apple-<sub>NOM</sub> there was all-<sub>TOP</sub> ate  
‘The apples looked delicious, and all the students ate them.’
- (5) Sooda-ga arimasita. Minna-wa nomimasita.  
Soda-<sub>NOM</sub> there was all-<sub>TOP</sub> drank  
‘There were pop drinks, and all the students drank them.’
- (6) Computer-wa benri nanode minna-wa motteimasu.



- Computer-<sub>TOP</sub> convenient so all-<sub>TOP</sub> have  
 ‘Computers are convenient, so all the students have them.’
- (7) Ame-ga hutteite kasa-ga irimasu ga, minna-wa arimasu.  
 Rain-<sub>NOM</sub> falling umbrella-<sub>NOM</sub> necessary but all-<sub>TOP</sub> have  
 ‘It is raining and they need umbrellas. All the students have them.’
- (8) Computer-wa benrinanode, minna-wa tukaimasita.  
 Computer-<sub>TOP</sub> convenient so all-<sub>TOP</sub> use  
 ‘Computers are convenient, so all the students used them.’
- (9) Omosiroi nihongo-no hon-ga attanode, minna-wa kaimasita.  
 Interesting Japanese-<sub>GEN</sub> book-<sub>NOM</sub> there was so all-<sub>TOP</sub> bought  
 ‘There was an interesting Japanese book, so all the students bought it.’
- (10) Spring break-de hoteru-ni ikimasu. Minna-wa tomarimasu.  
 Spring break-for hotel-to go all-<sub>TOP</sub> stay  
 ‘During spring break they’ll go to a hotel, and all the students will stay there.’
- (11) Oisisoona coffee-ga arimasita. Minna-wa nomimasita.  
 Delicious coffee-<sub>NOM</sub> there was all-<sub>TOP</sub> drank  
 ‘The coffee looked delicious, so all the students drank it.’
- (12) Nihon dewa keetaidenwa-wa benri nanode, minna-wa motteimasita.  
 Japan in cellphone-<sub>TOP</sub> convenient so all-<sub>TOP</sub> have  
 ‘Cell phones are convenient in Japan, so all the students had them.’
- (13) Omosiroosona eiga-ga arimasita kara, minna-wa mimasita.  
 Interesting movie-<sub>NOM</sub> there was because all-<sub>TOP</sub> watched  
 ‘The movie seemed interesting, so all the students watched it.’
- (14) Omosiroosona hon nanode, minna-wa yomimasita.  
 Interesting book so all-<sub>TOP</sub> read  
 ‘The book seemed interesting, so all the students read it.’

### English Version

#### Pretest Sentences

- (1) There was soda and beer. Lisa and Mari drank soda, while John and Naoya drank beer.
- (2) Today is our friend’s birthday. Let’s all buy her a present together.
- (3) The game looked interesting, so all the students played it together.
- (4) My friend made a pie, so let’s all eat it together.
- (5) Lisa and Mari went, but Naoya did not go.

#### Test Sentences

- (T1) Computers are convenient, but all the students didn’t have them. (Total negation)
- (T2) It is raining and they need umbrellas, but all the students don’t have them. (Partial negation)
- (T3) Computers are convenient, but all the students didn’t use them. (Total negation)
- (T4) The game looked interesting, but all the students didn’t play it. (Partial negation)
- (T5) It is an interesting book, but all the students didn’t read it. (Total negation)
- (T6) Today they had school, but all the students didn’t go. (Partial negation)
- (T7) During spring break they will all go to the beach. But since the hotel is expensive, all the students will not stay there. (Partial negation)
- (T8) Cell phones are convenient, but all the students don’t have them. (Partial negation)
- (T9) There was coffee there, but all the students didn’t drink it. (Total negation)

- (T10) There was a party, but all the students didn't go. (Partial negation)  
 (T11) The Japanese homework was due tomorrow, but all the students didn't do it. (Total negation)  
 (T12) Kanjis are difficult, so all the students didn't study them. (Partial negation)  
 (T13) Although they wanted to make pies, all the students didn't make them. (Total negation)  
 (T14) The cake looked delicious, but all the students didn't eat it. (Partial negation)  
 (T15) There was an interesting looking game in the market, but all the students didn't buy it. (Partial negation)  
 (T16) The movie seemed interesting, but all the students didn't watch it. (Total negation)

#### Filler Sentences

- (F1) Today there was a test. All the students did well on it.  
 (F2) There was ice-cream that looked delicious, so all the students bought it.  
 (F3) There was a science lesson today, and all the students understood it well.  
 (F4) The apples looked delicious, and all the students ate them.  
 (F5) There were pop drinks, and all the students drank them.  
 (F6) Computers are convenient, so all the students have them.  
 (F7) It is raining and they need umbrellas. All the students have them.  
 (F8) Computers are convenient, so all the students used them.  
 (F9) There was an interesting Japanese book, so all the students bought it.  
 (F10) During spring break they'll go to a hotel, and all the students will stay there.  
 (F11) The coffee looked delicious, so all the students drank it.  
 (F12) Cell phones are convenient in Japan, so all the students had them.  
 (F13) The book seemed interesting, so all the students read it.  
 (F14) The movie seemed interesting, so all the students watched it.

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Priya Ananth, Masaaki Kamiya

## **Prosodie vs. Mehrdeutigkeit bei allgemeinem Quantor und bei Negationen**

### Zusammenfassung

Die in dem Artikel geschilderte empirische Forschung zeigt, auf welche Weise die das Japanische als zweite Sprache Lernenden die, eine Negation und einen Quantor (eng.: *universal quantifier*) enthaltenen mehrdeutigen Sätze bei prosodischen Signalen (eng.: *prosodic cues*) interpretieren. Frühere Forschungen bewiesen, dass die japanische Sprache lernenden Erwachsenen bei prosodischen Signalen solche Sätze entweder als völlig negativ (eng.: *total negativ*) oder teilweise negativ (eng.: *partial negativ*) interpretierten. Derzeitige Forschung hat diese Ergebnisse in Frage gestellt, indem sie besonders die völlige Negation als vorherrschende Interpretation von mehrdeutigen Sätzen darstellte, selbst bei den prosodischen Signalen, die nur eine partielle Negation bestätigen würden. Die Verfasser gelangten zum Schluss, dass die Japanisch lernenden Personen den prosodischen Signalen bei Interpretation von mehrdeutigen Sätzen keine große Bedeutung beimessen und wahrscheinlich andere Merkmale für eindeutige Interpretation der Sätze ausschlaggebend sind.