Research Article

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Facilitation of processing *darenimo* 'any/everyone' negative Japanese sentences using prosodic entrainment

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Abstract: The present study examined how prosody affects Japanese speakers' processing of the polarity item *darenimo* 'any/everyone'. Upward (LHHH pitch) and downward (HLLL pitch) prosody for *darenimo* associates with negative and positive polarity, respectively. In Study 1, a corpus search showed that *darenimo* is more often associated with negative than positive polarity. In Study 2, subjective acceptability judgments indicated that *darenimo* is also more likely to be perceived as acceptable by native Japanese speakers when used with negative polarity. In line with Study 2, Study 3 showed that upward prosody with negative polarity was more accurately and quickly processed than was downward prosody with either positive or negative polarity. These three studies showed a one-sided distribution of upward prosody with negative polarity, and further indicated that only upward prosody facilitates listeners' processing of negation. Early heightened pitch of *darenimo* provides a cue to predict an ending negation *-nai* in the head-final Japanese language, resulting in faster speed and higher accuracy for the processing of negative sentences (i.e., a facilitation effect) compared to their corresponding affirmative sentences.

Keywords: one-sided distribution; polarity; predictive cue; prosodic entrainment strategy; prosody

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1 Introduction

The words 'any' and 'every' in English are associated with negative and positive polarity. These are referred to as 'polarity sensitive' expressions.

(1) He does *not* make a good impression on *any*one.

(2) He makes a good impression on *every*one.

Japanese sentences corresponding to the aforementioned English sentences (1) and (2) are as follows:

(3)

Darenimo	*yoi*	*insyoo-o*	*atae-nai.*
NP(anyone)	ADJ(good)	NP-ACC(impression)	V(give)-NEG

'φ do(es) not make a good impression on anyone.' (φ refers to an empty subject.)

(4)

Darenimo	*yoi*	*insyoo-o*	*atae-ru.*
NP(everyone)	ADJ(good)	NP-ACC(impression)	V(give)-POS

'φ make(s) a good impression on everyone.'

Unlike in the English sentences (1) and (2), the same word *darenimo* is used for both polarities of negative for 'anyone' and positive for 'everyone'. In Japanese, prosody or pitch alone distinguishes between negative and positive polarity. Upward prosody or LHHH rising pitch (H refers to high pitch while L refers to low pitch) is used to indicate negative polarity while downward prosody or HLLL falling pitch indicates positive polarity. Because polarity appears at the end of Japanese sentences, *darenimo* prosody gives a predictive cue to the following polarity. This association of prosody and polarity is referred to as *the prosodic entrainment strategy* (Ip and Cutler 2020, 2021). This prosodic entrainment strategy may facilitate the efficient processing of Japanese sentences. Thus, the present study investigates the processing mechanism used for predicting sentence ending polarity in Japanese *darenimo* expressions with prosody.

1.1 Japanese *darenimo* 'any/everyone' expressions

Previous studies in various languages (Brunellière et al. 2019 for French; Cutler and Foss 1977 and McAllister 1991 for English; Lee, Chiu, and Xu 2016 for Japanese; and Li and Ren 2012 for Mandarin Chinese) reported that words marked by prosody are likely to be understood more quickly, accurately, and deeply. Likewise, the phonetic feature of upward (LHHH pitch, ↑) and downward (HLLL pitch, ↓) prosody (↑ or ↓, hereafter, simply upward or downward) may possibly be associated with polarity of negative and positive (– or +) in Japanese.

There are two possible explanations for how prosodic entrainments of *darenimo* with polarity are achieved. The first possibility is that of the independently-stored hypothesis wherein native Japanese speakers discern features of prosody and polarity and store them cognitively. These features may be independently activated and applied to various lexical items. The second possibility is that of the lexical-attachment hypothesis in which native Japanese speakers produce a specific type of prosodic entrainment after frequently encountering a lexical item used with a certain prosody and a certain polarity. According to the exemplar theory of phonology (e.g., Johnson 1997; Luce and Galanter 1963; Pirrehumbert 2001, 2003), this phenomenon occurs when a lexical item with a certain prosody and a certain polarity is heard frequently in daily conversation, thereby encoding a specific type of prosodic entrainment in listeners' brains. After sufficient examples are encountered, it may be the case that the cognitive process of native Japanese speakers automatically utilizes the specific *darenimo* prosodic entrainment strategy.

The hypothesis that prosody and polarity features are independently stored is theoretically supported by Gunji (2006). According to this hypothesis, there is complementary distribution of *darenimo* 'any/everyone' for prosody and polarity as shown in sentences (5a) and (5b).

(5a) Entrainment of upward prosody (LHHH pitch, ↑) with negative polarity (–)

Darenimo	*kyoomi-o*	*simes-a-nai*
NP(anyone)	NP-ACC(interest)	V(show)-NEG(not)

'φ do(es) not show interest in anyone.'

(5b) Entrainment of downward prosody (HLLL pitch, ↓) with positive polarity (+)

Darenimo	*kyoomi-o*	*simes-u*
NP(everyone)	NP-ACC(interest)	V(show)

'φ show(s) interest in everyone.'

According to Gunji (2006), it is assumed that the phonological feature of prosody and the syntactic feature of polarity are stored independently in the brain, and then applied to *darenimo*. Thus, *darenimo* is expected to have a complementary distribution for upward prosody with negative polarity, and downward prosody with positive polarity. Once again, according to this hypothesis, the reliance on prosody on *darenimo* may be optional when applied to add a certain lexical item (Dogil and Williams 1999; Sluijter and Van Heuven 1996; Van Heuven and Hagman 1988).

In contrast, Kato (1985) explained that the expression *darenimo* 'any/everyone', is mostly used with negative polarity, it also occurs, albeit less frequently, with positive polarity. According to Kato (1985), *darenimo* prosody and polarity displays one-sided unbalanced distribution. Following on this, Kato's

claim (1985) is understood as a lexical-attachment hypothesis wherein a certain prosody attached to *darenimo* is associated with negative polarity. If this premise is correct, the use of *darenimo* prosody may be mandatory (Lehiste 1970) for activating the prosodic entrainment strategy with sentence-ending negation *-nai* in order to facilitate speed and accuracy in sentence processing.

The prosodic entrainment strategy (Ip and Cutler 2020, 2021) for *darenimo* functions in the following way: In the time-sequence of sentence processing as illustrated in sentence (5a) in Figure 1, native Japanese speakers first hear upward prosody of *darenimo* which then activates an expectation of subsequent negation, raising an expectation of encountering *-nai* at the end of the sentence. As a result, the upward prosodic information entrains with negation. Similarly, this strategy may work with downward prosody entraining with a positive expression as in sentence (5b). Assuming that the relationship between prosody and polarity functions independently in both combinations of (5a) and (5b), complementary distribution would be expected (Gunji 2006). In contrast, according to Kato (1985), one-sided distribution of upward prosody and negative polarity would result.

Hawkins (2014) proposed that the mechanism for sentence processing (or parsing) may vary for differing word orders, especially in SVO and SOV languages. According to Kamide and Mitchel (1999), advanced planning for sentence construction occurs incrementally before the final verb is seen in the head final SOV-ordered language of Japanese. Native Japanese speakers are able to anticipatedly form a sentence based on information provided by the case markers of noun phrases. Under pre-head anticipatory processing (Kamide 2008; Kamide and Mitchell 1999; Kamide et al. 2003), native Japanese speakers may utilize a processing strategy that continually predicts the ending verb to complete a sentence based on already processed noun phrases. If this is the case, regardless of whether *darenimo* prosody is independently-stored or lexically-attached, it is expected that *darenimo* prosody may act as a cue to predict a following polarity which may facilitate speed and accuracy of sentence processing.

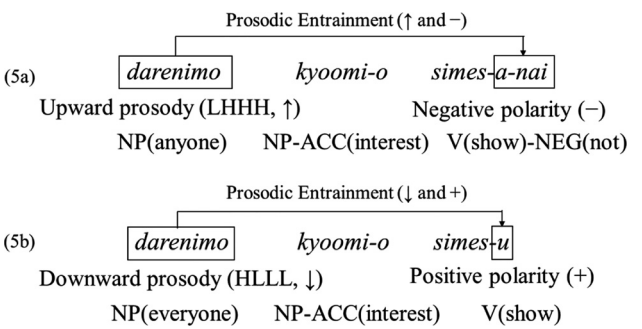

Figure 1: The prosodic entrainment strategy of *darenimo* for negative and positive polarity.

1.2 The present study

The present study conducted three studies in an attempt to verify the functions for acquiring the processing strategy of prosody and polarity entrainment for *darenimo*. In Study 1, a corpus search was conducted for negative/positive polarity in *darenimo* to gather examples from the Japanese written corpus. Study 2 investigated subjective acceptability judgments for visually presented sentences containing *darenimo* with polarity. It was hypothesized that the more often higher frequency combinations are heard and used, the more successfully these patterns are stored in the mental lexicon of native Japanese speakers. Note that Studies 1 and 2 did not involve *darenimo* prosody. Finally, using the same stimulus sentences used in Study 2, Study 3 examined whether *darenimo* upward (LHHH) or downward (HLLL) prosody entrains with negative or positive polarity. If processing speed and accuracy showed a complementary distribution of *darenimo* prosody and polarity, the relationship of the prosodic feature to the polarity feature might be stored independently. However, if the distribution was one-sided, the relationship between a prosody and a polarity for the specific lexical item of *darenimo* might be stored as an associated lexical memory. Furthermore, following on the idea of the pre-head anticipatory processing mechanism suggested by previous studies (Kamide 2008; Kamide and Mitchell 1999; Kamide et al. 2003), the present study examines whether the upward or downward prosodic feature acts as a cue for predicting negative or positive polarity at the end of a sentence.

2 Study 1 – a corpus search

In order to find examples of *darenimo* with polarity in the Japanese written corpus, Study 1 attempted to ascertain how frequently *darenimo* was used in negative or positive contexts. For this purpose, sentences with *darenimo* were searched for in the Balanced Corpus of Contemporary Written Japanese (BCCWJ, Maekawa et al. 2014). All relevant expressions were divided into respective negative and positive polarity categories in order to ascertain their frequency of usage.

2.1 BCCWJ corpus search

The BCCWJ corpus was created as a database of written expressions in modern Japanese. BCCWJ is comprised of text data across multiple genres such as books, magazines, newspapers, white papers, blogs, online bulletin boards, textbooks, and legal documents. The total number of characters (script symbols) in the BCCWJ

Table 1: Frequencies of *darenimo* in BCCWJ corpus classified by polarity.

Polarity	Frequency	Percentage	X^2 test of goodness-of-fit
Negative (–)	1,657	88.80%	$X^2(1) = 1{,}123.64$, $p < 0.001$
Positive (+)	209	11.20%	
Total	1,866	100.00%	

corpus is 48,539,925,351. Using the search engine *Chunagon* 2.4 (Version 1.1), this corpus was searched for strings of *darenimo* expressed in both hiragana (だれにも) and kanji plus hiragana (誰にも). Excluding 13 sentences which had no predicates, 423 sentences using hiragana expressions were found. Likewise, excluding 12 sentences, 1,443 sentences using kanji plus hiragana expressions were found. A total of 1,866 sentences comprised of both hiragana and kanji plus hiragana *darenimo* expressions were divided into expressions of negative and positive polarity as shown in Table 1.

2.2 Analyzing frequencies of negative and positive polarity for *darenimo*

Darenimo expressions with negative polarity appeared 1,657 times or 88.80% of the time whereas those with positive polarity appeared 209 times or 11.20% of the time. Assuming that negative and positive polarity occurs randomly, the result of the Chi-squared test of goodness-of-fit was highly significant ($X^2[1] = 1{,}123.64$, $p < 0.001$). This result clearly indicated that negative polarity expressions were much more frequently used with *darenimo* than were positive polarity expressions; consequently, *darenimo* with polarity is unevenly distributed, and is mainly associated with negative polarity expressions.

2.3 Discussion

Study 1 conducted a corpus search using BCCWJ for *darenimo* with negative/positive polarity to find sufficient examples in Japanese written texts. Results from the BCCWJ corpus indicated that *darenimo* is most often used with negative polarity although it is also, to some degree, used with positive polarity. Unlike the complementary distribution proposed by Gunji (2006), corpus frequencies

supported the one-sided distribution suggested by Kato (1985), indicating that there is an unbalanced occurrence of negative or positive polarity with *darenimo*.

3 Study 2 – acceptability judgments

Study 2 examined acceptability judgments for visually presented sentences with *darenimo* to verify whether negative or positive polarity is perceived as more natural in Japanese. Since Study 1 indicated that the frequency of co-occurrences of *darenimo* with negative polarity in the BCCWJ corpus is higher than with positive, Study 2 deduced that native Japanese speakers perceive *darenimo* with negative polarity to be more acceptable than with positive.

3.1 Methods

3.1.1 Participants

Thirty-five participants whose native language is Japanese (14 females and 21 males) were recruited as undergraduate students from a university in Aichi prefecture, Japan to perform the acceptability judgment task. Seventeen participants came from prefectures in the Tokai region (13 from Aichi, 3 from Mie, and 1 from Gifu) while others came from various other prefectures in Japan (3 from Hiroshima, 2 each from Osaka and Okayama, 1 each from Fukuoka, Hyogo, Kanagawa, Nagano, Shizuoka, Tochigi, Toyama, and Wakayama). At the time of the questionnaire survey, they were all living in or near the city of Nagoya, Japan. Their ages ranged from 18 years and 5 months to 22 years and 7 months. The average age was 19 years and 1 month with a standard deviation of 1 year. These students voluntarily participated in the questionnaire survey. All collected information was stored in a secure location, and the participants were given numerical pseudonyms to ensure privacy.

3.1.2 Stimulus sentences

Forty pairs (80 sentences in total) of negative and positive polarity sentences with *darenimo* were created for the acceptability judgment task. Sentence (5a) is an example of negative polarity while sentence (5b) is an example of positive polarity. All sentences were presented in the non-past verb form (see all stimuli in Appendix).

3.1.3 The questionnaire for acceptability judgments

Forty negative polarity and 40 positive polarity sentences were visually presented to each participant in a written questionnaire form. Participants were asked to judge how acceptable each of 80 sentences was as a Japanese sentence by rating them from 1 point (not acceptable at all) to 7 points (very acceptable). To avoid the close placement of paired sentences, all sentences were pseudo-randomized so that paired sentences did not appear in close proximity to each other.

3.2 Results

3.2.1 Data for acceptability judgments

A total of 2,795 acceptability judgments (5 were missing values) by 35 participants using the 1–7 scale for the 80 stimuli sentences were analyzed using a linear mixed effect (LME) model (Baayen et al. 2008) and the *lme4* package (Bates et al. 2014) within R (R Core Team 2014). The fixed variable was polarity (negative or positive). The random variables were the participants and the sentences (random intercept and slopes). Results from multiple models were compared according to the Akaike Information Criterion (AIC). The final model used was the *lmer* (accptscore ~ (1 |participant) + (0 + polarity |participant) + (1|item) + polarity, data).

3.2.2 Results of LME model analyses

Acceptability judgment scores were analyzed with the *lmer* function using the restricted maximum likelihood (Harville 1977). Satterthwaite's approximations were applied via the *lmerTest* package to generate *p* values for each model (Kuznetsova et al. 2014). The best-fit LME model was chosen based on model comparisons using AIC (Akaike's Information Criterion compared by the maximum likelihood, Anderson et al. 2000). The means (*M*), standard deviations (SD), and standard errors (SE) for negative or positive polarity sentences are reported in Table 2. The result of the LME analysis is presented in Table 3.

Table 2: Data description of acceptability judgments.

Polarity	*M*	SD	SE
Negative (–)	6.16	1.56	0.04
Positive (+)	4.23	1.97	0.05

Participants = 35. *M* refers to mean, SD refers to standard deviation, and SE refers to standard error.

Table 3: The result of the LME model for acceptability judgments.

Variables	Estimate	SE	df	*t* value	Pr(>|*t*|)	*p*
(Intercept)	6.16	0.18	52.72	34.91	2.00E-16	***
Polarity	−1.93	0.26	51.76	−7.56	6.49E-10	***

Participants = 35. Items = 80. Total Observation = 2,795 (5 missing values). SE refers to standard error and df refers to degree of freedom. The LME model is *lmer*(rating ~ (1|subject) + (0 +polarity|subject) + (1| item) + polarity, data = accept). ***refers to $p < 0.001$.

As shown in Table 3, scores for acceptability judgments on the 1–7 point scale showed a significant polarity effect (t[51.76] = −7.56, $p < 0.001$, reference of negative polarity). This result indicated that negative polarity expressions with *darenimo* ($M = 6.16$, SD = 1.56, SE = 0.04) were perceived to be more acceptable as a Japanese sentence than those with positive polarity expressions ($M = 4.23$, SD = 1.97, SE = 0.05).

3.2.3 Discussion

Study 2 investigated subjective acceptability judgments for written sentences containing *darenimo* with polarity. It is assumed that, as a higher frequency of combinations in the corpus are heard and used, these patterns are firmly stored in the mental lexicon of native Japanese speakers. The result of the questionnaire survey of acceptability judgments suggested that *darenimo* is perceived as highly acceptable in Japanese when it is used in expressions with negative polarity. The result of Study 2 was congruent with the result of corpus frequencies in Study 1, indicating that the less frequently occurring positive polarity expressions with *darenimo* were judged to be less acceptable than the more frequently occurring negative polarity expressions. Consistent with findings in Study 1, subjective acceptability judgments in Study 2 supported one-sided distribution (Kato 1985) rather than complementary distribution (Gunji 2006). It should also be noted that although the frequency effect is usually discussed at the word level (e.g., Balota and Spieler 1999; Brown and Rubenstein 1961; Gordon 1983; Hino and Lupker 1998; Jescheniak and Levelt 1994; Taft 1979), the present study showed that frequency of *darenimo* with polarity expressions at the sentence level also affects the degree of subjective acceptability judgments.

4 Study 3 – prosody-and-polarity matching decisions

Both the corpus frequencies in Study 1 and the acceptability judgments in Study 2 indicated an unbalanced distribution of occurrence and acceptability for *darenimo* with negative or positive polarity. However, neither Study 1 nor Study 2 examined this trend while considering *darenimo* prosody. Based on both experiments, Study 3 examined whether upward (LHHH) or downward (HLLL) prosody of *darenimo* actually entrains with negative or positive polarity. Study 3 hypothesized that native Japanese speakers apply the prosodic entrainment strategy: the upward or downward prosody information on *darenimo* is used for determining the subsequent polarity of the complete expressions.

4.1 Methods

4.1.1 Participants

Forty-two undergraduate students whose native language is Japanese (15 females and 27 males) from a university in Aichi prefecture, Japan, participated in the experiment. Thirty-one participants came from prefectures in the Tokai region (22 from Aichi, 6 from Mie, and 3 from Gifu) while the others came from various other prefectures in Japan (2 from Hiroshima, and 1 each from Ehime, Fukui, Kanagawa, Osaka, Okayama, Shizuoka, Tochigi, Toyama, and Wakayama). At the time the experiment was conducted, they were all living in or near the city of Nagoya. Their ages ranged from 18 years and 3 months to 24 years and 3 months. The average age was 19 years and 10 months with a standard deviation of 1 year and 4 months. All participants received monetary compensation in exchange for their participation and provided written informed consent. All collected information was stored in a secure location, and the participants were given numerical pseudonyms to ensure privacy. Participants who took part in Study 2 were not included in Study 3.

4.1.2 Stimulus sentences

The same forty pairs of negative and positive polarity sentences used in Study 2 were used for the prosody-and-polarity matching decision task in Study 3. A female native Japanese speaker speaking standard Japanese read the negative and positive polarity sentences aloud with the appropriate prosody. All 80 sentences were recorded by Praat version 6.0.43 (Boersma and Weenink 1992–2002, retrieved June 8 2019).

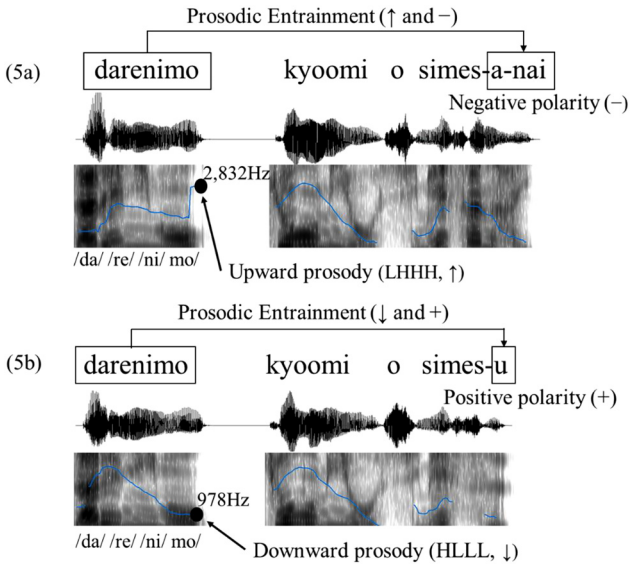

Figure 2: A stimulus pair of *darenimo* prosody and polarity entrainment. These are correctly entrained items responded to by participants as YES.

A correctly matched prosody-and-polarity pair with sound spectrums and pitches for sentences (5a) and (5b) is shown in Figure 2. The upward prosody for sentence (5a), which registered 2,832 Hz at the highest F_0 peak, matched with negative polarity. The downward prosody for sentence (5b), which registered 978 Hz at the lowest F_0 peak, matched with positive polarity (see all stimuli in Appendix).

Study 3 assumed that *darenimo* upward prosody associates with negative polarity while downward prosody associates with positive polarity. These matches were combinations to which participants were expected to respond with YES (matched). Forty (5a)-type negative polarity sentences with *darenimo* upward prosody and 40 (5b)-type positive polarity sentences with *darenimo* downward prosody were used as the stimulus sentences.

To create incorrect response pair combinations, *darenimo* sounded with upward prosody for negative polarity in (5a)-type sentences was replaced with *darenimo* downward prosody for positive polarity in (Appendix 1c)-type sentences. These made up the mismatch combinations to which participants were expected to respond with NO (incongruent). Likewise, *darenimo* sounded with downward prosody for positive polarity in (5b)-type sentences was replaced with *darenimo* upward prosody for negative polarity (Appendix 1d)-type sentences. These also comprised the prosody-and-polarity mismatch combinations responded to with

NO. Forty negative polarity sentences with *darenimo* downward prosody, and 40 positive polarity sentences with *darenimo* upward prosody were used in the experiment.

A 200 ms silent pause was inserted both before and after the sound of *darenimo*. A total of 160 sentences were prepared. Eighty sentences of (5a)-type and (5b)-type met the prosody-and-polarity matched condition (correct, YES responses) while 80 sentences of (Appendix 1c)-type and (Appendix 1d)-type met the prosody-and-polarity mismatched condition (incorrect, NO responses). In order to ensure that participants would see only one prosody/polarity combination in each sentence per experimental session, the experimental stimuli of 160 sentences were divided into four lists to be assigned to the four different participant groups.

Sound durations were controlled equally across the four conditions of prosody-and-polarity matched YES and mismatched NO responses. The means were 2,394 ms (SD = 233 ms, SE = 37 ms) for (5a)-type sentences, 2,405 ms (SD = 229 ms, SE = 36 ms) for (5b)-type sentences, 2,309 ms (SD = 250 ms, SE = 40 ms) for (Appendix 1c)-type prosody-and-polarity mismatched sentences, and 2,298 ms (SD = 253 ms, SE = 40 ms) for (Appendix 1d)-type prosody-and-polarity mismatched sentences. These means were analyzed by one-way analysis of variance (ANOVA). The result showed no significant differences ($F[3, 156] = 2.12$, $p = 0.099$, *ns*). Thus, sound durations were assumed not to influence the prosody-and-polarity matching decision task. To ensure that no influence occurred, sound durations were also included as an LME fixed factor for the subsequent analysis.

4.1.3 Procedure

The present experiment employed an online measurement task for prosody-and-polarity matching (entrainment) decision processing. A '+' symbol used as an eye fixation was initially presented at the center of the computer screen for 250 ms, followed by a sentence including *darenimo* with upward or downward prosody phonetically presented through the headphone. The participant was required to decide whether the initially presented *darenimo* prosody matched the negative or positive polarity of the rest of the sentence. In this task, if the participants thought that the upward or downward *darenimo* prosody and a negative or positive polarity matched, they were instructed to press the YES key after seeing the question mark '?', but if not (mismatch), they were asked to press the NO key. The '?' appeared just after the sound offset of *darenimo* to prompt a participant to start responding to a task. The subsequent trial started 300 ms after either the YES or NO key was pressed. The participants were asked to perform the prosody-and-polarity matching task as accurately and quickly as possible. All stimulus sentences

were randomly presented for each participant. Before the experiment proper, four practice sentences were given.

4.2 Results

4.2.1 Data and analyses of the prosody-and-polarity matching decision task

The reaction times and binomial accuracies data collected by the prosody-and-polarity matching decision task were analyzed using the linear mixed effect models (Baayen et al. 2008) and the *lme4* package (Bates et al. 2014) within R (R Core Team 2014). The fixed effects were upward or downward prosody, negative or positive polarity, and trial order. The random effects were participants and stimulus sentences (random intercept and slopes). The data for reaction times consisted only of data from trials with correct judgments. Satterthwaite's approximations were used via the *lmerTest* package to generate *p* values for each model (Kuznetsova et al. 2014) using the restricted maximum likelihoods (Harville 1977). For binomial accuracy data, the *glmer* function (logit link function) was used to calculate the *z* distribution by maximum likelihood (Laplace approximation).

4.2.2 Results of LME model analyses for accuracy data

A total of 1,680 responses (42 participants × 40 items) were analyzed. According to model comparisons using AIC (Anderson et al. 2000), the fixed factor of sound duration was removed in the best-fit LME model for accuracy because it was not significant. The final best-fit LME model was *glmer* (acc ~ (1|subject) + (1|item) + prosody*polarity + trial.z, data, family = binominal). The means (*M*), standard deviations (SD), and standard errors (SE) are reported in Table 4.

Table 4: Descriptive statistics for accuracies of prosody-and-polarity (mis)matching (%).

Correctness	Prosody	Polarity	*M*	SD	SE
Matched-YES responses	Upward (↑)	Negative (–)	90.24%	29.72%	1.45%
	Downward (↓)	Positive (+)	47.62%	50.00%	2.44%
Mismatched-NO responses	Downward (↓)	Negative (–)	75.95%	42.79%	2.09%
	Upward (↑)	Positive (+)	46.43%	49.93%	2.44%

Participants = 42. Items = 40. Observations = 1,680. *M* refers to mean, SD refers to standard deviation, and SE refers to standard error.

The result of the best-fit LME model is reported in Table 5. The results indicated that all three fixed factors were significant: prosody ($z = 5.56$, $p < 0.001$), polarity ($z = -8.62$, $p < 0.001$), and trial ($z = 2.30$, $p < 0.05$). Furthermore, the interaction between prosody and polarity was significant ($z = -4.75$, $p < 0.001$). To examine the results in detail, accuracies of the four prosody/polarity combinations were compared using the R package of *lsmeans* (least-squares means, Searle et al. 1980). The means with standard errors are depicted and the comparison results are shown in Figure 3, indicating that upward prosody with negative polarity ($M = 90.24\%$) was the most accurately identified, followed by downward prosody with negative polarity ($M = 75.95\%$). Both upward and downward prosody with negative polarities were perceived more accurately than upward ($M = 46.43\%$) and downward ($M = 47.62\%$) prosody with positive polarity, both of which showed approximately equal accuracies (i.e., not significantly different). The most important result from Experiment 3 was obtained from the prosody-and-polarity matched combinations (YES responses). The combination of *darenimo* upward prosody with negative polarity was judged most accurately while the combination of *darenimo* downward prosody with positive polarity was judged accurately only randomly.

It should also be noted that, as shown in Figure 3, downward prosody with negative polarity was more accurately processed than both combinations of upward and downward prosody with negative polarity. This may have been caused by the fact that negative polarity is usually presented with a phonologically prominent feature (i.e., upward prosody or rising pitch). Because native Japanese speakers have sensitivity to upward prosody entrained with negative polarity, they may have been better able to correctly reject downward prosody associated with negative polarity than upward and downward prosody with positive polarity. This accuracy trend also supports the idea that *darenimo* with upward prosody strongly entrains with negative polarity.

Table 5: The results of the LME model analysis for accuracy.

Variables	Estimate	SE	*z* value	Pr(>|*z*|)	*p*
(Intercept)	1.28	0.16	7.86	3.96E-15	[b]
Prosody	1.14	0.21	5.56	2.00E-16	[b]
Polarity	−1.37	0.16	−8.62	2.70E-08	[b]
Trial	0.14	0.06	2.30	2.14E-02	[a]
Prosody*polarity	−1.20	0.25	4.75	2.02E-06	[b]

[a]$p < 0.05$. [b]$p < 0.001$. Participants = 42. Items = 40. Observations = 1,680. SE refers to standard error. The LME model is *glmer* (acc ~ (1|participant) + (1|item) + prosody*polarity + trial.z, data, family = binominal).

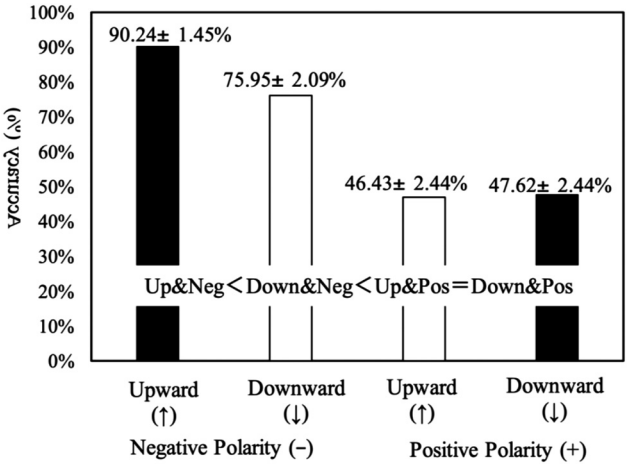

Figure 3: Bar graph for accuracies of prosody-and-polarity (mis)matching.
Values in bars are means and values following ± are standard errors. Bars in black are correctly matched prosody-and-polarity combinations (YES responses) while bars in white are incorrectly matched prosody-and-polarity combinations (NO responses). < and = refer to the results of comparison by least-squares means.

4.2.3 Results of LME model analyses for reaction time data

Twenty-three items of extremely quick responses (less than 30 ms) and 5 items of extremely slow responses (greater than 10,000 ms) were removed from the original data set of 1,680 responses (42 participants × 40 items). After excluding the outliers, the remaining 1,070 items with correct responses were analyzed for reaction times. Based on the Box–Cox power transformation technique (Box and Cox 1964; Venables and Ripley 2002), a logarithmic transformation (natural log) was applied to the reaction times to attenuate skewness in their distribution. Reaction times were analyzed with the *lmer* function using the restricted maximum likelihood (Harville 1977). Satterthwaite's approximations were used via the *lmerTest* package to generate *p* values for each model (Kuznetsova et al. 2014).

The fixed factors of prosody and polarity were coded by a contrast of 0.5 and −0.5. The variables were the four fixed factors of prosody, polarity, sound duration, and trial, and two random factors of participant and item. The fixed factor of trial was centralized into *z* values, coded as trial.z. Sound duration was initially included for analysis, but it was found not to be significant, and did not demonstrate a good model fit, so it was removed from the LME model. According to model comparisons using AIC (Anderson et al. 2000), the best-fit LME model was

Table 6: Result of the LME model analysis for reaction times.

Variables	Estimate	SE	df	*t* value	Pr(>|*t*|)	*p*
(Intercept)	6.35	0.08	57.18	78.43	2.00E-16	[b]
Prosody	−0.34	0.05	976.16	−6.75	2.47E-11	[b]
Polarity	−0.03	0.06	990.37	−0.56	0.58	
Trial	−0.04	0.02	995.20	−1.99	4.57E-02	[a]
Prosody*polarity	0.47	0.09	987.96	5.55	3.59E-08	[b]

[a]$p < 0.05$. [b]$p < 0.001$. Participants = 42. Items = 40. Observations = 1,039. SE refers to standard error. The final LME model is *lmer*(log(rt) ~ prosody + polarity + trial.z + (1|participant) + (1|item), data).

lmer (log(rt) ~ prosody + polarity + trial.z + (1|participant) + (1|item), data). After this, potentially influential outliers were removed with standardized residuals exceeding 2.5 standard deviation units of the final best-fit LME model (31 of 1,070 responses were removed). The result of the LME model analysis for 1,039 responses is reported in Table 6. The means (*M*), standard deviation (SD) and standard errors (SE) for prosody and polarity were calculated and reported in Table 7 after the removal of potentially influential outliers.

As shown in Table 6 and depicted in Figure 4, reaction times for prosody-and-polarity matching decisions were significant for prosody ($t[976.16] = -6.75$, $p < 0.001$), but not for polarity ($t[990.37] = -0.56$, $p = 0.58$, *ns*). The factor of trial was also significant ($t[995.20] = -1.99$, $p < 0.05$). Moreover, the interaction of polarity and prosody was significant ($t[987.96] = 5.55$, $p < 0.001$). To examine the details, reaction times of the four conditions were compared using the R package of *lsmeans* (least-squares means, Searle et al. 1980). The results of comparisons indicated that upward prosody with negative polarity ($M = 573$ ms) was recognized faster than the other three combinations of downward prosody with negative polarity ($M = 765$ ms), and upward ($M = 809$ ms) and downward ($M = 864$ ms) prosody with positive polarity. These final three combinations were processed at similar speeds (i.e., not significantly different).

Table 7: Descriptive statistics for reaction times of prosody and polarity (ms).

Correctness	Prosody	Polarity	*M*	SD	SE
Congruent-	Upward (↑)	Negative (–)	573	531	29
YES responses	Downward (↓)	Positive (+)	864	775	56
Incongruent-	Downward (↓)	Negative (–)	765	712	40
NO responses	Upward (↑)	Positive (+)	809	729	52

Participants = 42. Items = 40 each condition. Observations = 1,039. *M* refers to mean, SD refers to standard deviation, and SE refers to standard error.

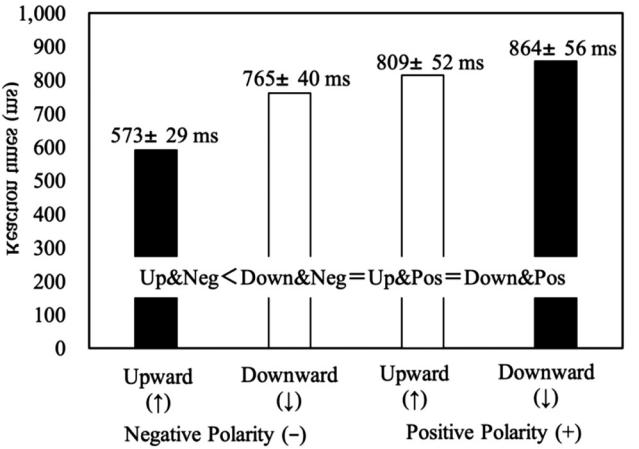

Figure 4: Bar graph for reaction times of prosody-and-polarity (mis)matching.
Values in bars are means and values following ± are standard errors. Bars in black are correctly matched prosody-and-polarity combinations (YES responses) while bars in white are incorrectly matched prosody-and-polarity combinations (NO responses). < and = refers to the results of comparison by least-squares means.

4.2.4 Discussion

Using stimulus sentences from Study 2, Study 3 examined whether *darenimo* upward or downward prosody entrains with negative or positive polarity to clarify their entrainment distributions. If processing speed and accuracy showed complementary distribution of *darenimo* for prosody and polarity, the prosodic feature applied to the polarity feature might be understood to be stored as separate aspects of prosody and polarity (Gunji 2006). However, if the distribution were unbalanced, it would suggest that the way in which a particular prosody attached to the lexical item of *darenimo* entrains with a certain polarity is stored as an associated lexical memory. The result showed that upward prosody of *darenimo* for negative polarity, which was the most frequent pattern found in Study 1 and the most highly perceived as natural Japanese in Study 2, was the most accurately and quickly perceived. In contrast, downward prosody of *darenimo* for positive polarity resulted in random accuracies (slightly lower than 50%) and slower reaction times. Therefore, Study 3 strongly supported the unbalanced distribution of *darenimo* for prosody and polarity (Kato 1985); that is, the prosodic entrainment strategy functions only when upward prosody is attached to *darenimo* with subsequent negative polarity.

5 General discussion

The present study focused on the Japanese *darenimo* 'any/everyone' association of the phonological feature of upward (LHHH) and downward (HLLL) prosody and the syntactic feature of negative and positive prosody. The study showed a one-sided distribution of upward prosody co-occurring with negative polarity: only upward prosody facilitates listeners' processing of negation (i.e., negative polarity). In the head-final Japanese language, early heightened pitch of *darenimo* seems to provide a cue to predict an ending negation *-nai*. Subsequently, further questions were raised as to why one-sided distribution *darenimo* with polarity occurred, and how *darenimo* with negation facilitates processing speed and accuracy. The following sections discuss these two questions.

5.1 How did one-sided distribution *darenimo* with polarity occur?

There are two possible mental structures. The first assumption (the independently-stored features hypothesis) is that native Japanese speakers obtain and store features of prosody and polarity independently, and then apply them to various lexical items including *darenimo*. This assumption supports the idea of complementary distribution of *darenimo* for prosody and polarity (Gunji 2006). The second assumption (the lexical-attached hypothesis) is that, as suggested by Kato (1985), *darenimo* almost always co-occurs with negative rather than with positive polarity. The BCCWJ corpus search in Study 1 indicated that there is an unbalanced occurrence of *darenimo* with negative polarity: the frequency of co-occurrences of *darenimo* with a negative statement is much higher than with a positive statement. This one-sided distribution pattern of *darenimo* with negation is congruent with Kato's one-sided distribution, rather than with Gunji's complementary distribution. The BCCWJ corpus search in Study 1 supported Kato's (1985) one-sided distribution. Building on this idea, it is further hypothesized that native Japanese speakers perceive *darenimo* with negative polarity to be more acceptable than that with positive. Study 2 verified that *darenimo* with negative polarity was perceived as more natural in Japanese than was *darenimo* with positive polarity.

Study 3 hypothesized that native Japanese speakers may apply the prosodic entrainment strategy exclusively with upward *darenimo* prosody co-occurring with negative polarity. In fact, the result of Study 3 showed that upward prosody of *darenimo* for negative polarity, which was the most frequent pattern found in Study 1 and the most highly perceived as natural Japanese in Study 2, was the most

accurately (90.24%) and quickly (573 ms) perceived. In contrast, downward prosody of *darenimo* for positive polarity resulted in random accuracies (47.62%) and much slower reaction times (864 ms). Study 3 indicated that the prosodic entrainment strategy (Ip and Cutler 2020, 2021) functions only for upward prosody attached to *darenimo* with subsequent negative polarity.

The Japanese *darenimo* association of negative polarity has the effect of negating an entire statement (see variety of negation, Prieto and Espinal 2020). In order to express negation, upward prosody with *darenimo* is 'mandatory' (Lehiste 1970). In some cases, *darenimo* with positive polarity may be descriptive, in which case the use of downward prosody could be 'optional' (Dogil and Williams 1999; Sluijter and Van Heuven 1996; Van Heuven and Hagman 1988, see also Cutler and McQueen 2014). This optional nature may result in prosodic ambiguity with positive polarity, accounting for random accuracies for *darenimo* with positive polarity. The prosodic prominence principle proposed by Yaeger-Dror (1985, 1996, 2002) and also Pierrehumbert and Hirschberg (1990) fits well with the case of *darenimo* with negation. According to this principle, prosodic highlighting in linguistic morphemes or words is crucial for providing vital information for interpreting sentences. *Darenimo* marked with upward prosody or rising pitch acts as an early indicator of negation. In this sense, the question of whether the use of prosody is 'mandatory' or 'optional' (Cutler and McQueen 2014) is directly related to a distinctive identification or 'markedness' (Battistella 1990; De Lacy 2006) within a certain expression.

5.2 How does *darenimo* with negation facilitate processing speed and accuracy?

Japanese is a head final SOV-ordered language. Even so, negation *-nai* in Japanese comes after the head verb. Study 3 showed that *darenimo* with upward prosody facilitates listeners' processing of a negated sentence. Kamide and Mitchell (1999) and Kamide et al. (2003) provided evidence for pre-head processing in Japanese using the 'visual-world' eye-tracking paradigm. In this paradigm, multiple pictorial items are presented on a single screen, some of which are related to a sentence which will be auditorily presented. Participants look at this screen for approximately 1 s. A sentence is then auditorily presented and the sequential duration of eye fixation times is recorded by the eye-tracker. The studies by Kamide and Mitchell (1999) and Kamide et al. (2003) found that participants were likely to focus on pictorial items on the screen which had not yet been auditorily presented. Based on this result, Kamide and Mitchell (1999) suggested that advanced planning for constructing sentences occurs incrementally before the final verb is seen. Under

pre-head anticipatory processing (Kamide 2008; Kamide and Mitchell 1999; Kamide et al. 2003), native Japanese speakers may utilize the prosodic entrainment strategy (Ip and Cutler 2020, 2021) to predict the ending negation *-nai*.

In various languages, negation arises from the embedded or subordinate clause of certain predicates (containing verbs such as believe, think, want) preceding the main clause. This linguistic phenomenon is called 'negative raising' or 'Neg-raising' in the syntactic approach of generative grammar (Collins and Postal 2014; Fillmore 1963; Horn 2020). For instance, negation in an embedded sentence such as 'I don't believe that he wants me to think that he did it' (Fillmore 1963, p. 220), the negation 'not' is associated with 'he did it'. The negation 'not' is moved in front of the main verb from the sentence 'I believe that he wants me to think that he didn't do it.' The early cue of negation in the main clause may reduce the semantic cognitive load of sentence processing. More generally, negation comes very early in the sentence in many languages as seen in the example of 'He did not go to school today.' This early statement of 'not' provides a semantic cue that the rest of the context is negated: listeners perceive negation at an early stage of sentence processing. In this sense, upward prosody on *darenimo* functions like 'not' presented in the early stage of the processing of English sentences.

Nordmeyer and Frank (2018) reported that, in English, negation is harder to process and learn than is affirmation for both children and adults. Nevertheless, the present study showed that *darenimo* is unique in that negative sentences with *darenimo* were processed faster and more accurately than their corresponding affirmative sentences. Therefore, upward prosody or rising pitch on *darenimo* functions as a cue for predicting the ending negation *-nai* which denies the entire context presented after *darenimo*.

So how does a native Japanese speaker process prosodic entrainment of *darenimo* with the negation *-nai*? As shown in sentence (5a) in Figure 5, when native Japanese speakers hear *darenimo* with upward prosody or rising pitch, they are able to assume an empty subject (φ) and to anticipate negation *-nai* at the end of sentence. From the perspective of syntactic structure, they can insert a negation phrase (NegP) at the very early stage of sentence processing as [$_{TP}$ φ [$_{NegP}$ [$_{VP}$ NP(anyone) [$_{V'}$ …]] Neg] T]. When native Japanese speakers hear the noun phrase *kyoomi-o* 'interest', they can still understand that the phrase containing the negation information applies to this noun phrase as [$_{TP}$ φ [$_{NegP}$ [$_{VP}$ NP(anyone) [$_{V'}$ NP(interest) …]] Neg] T]. Finally, the head verb *simes-a* 'show' with negation *-nai* appears, and the whole sentence structure is completed as [$_{TP}$ φ [$_{NegP}$ [$_{VP}$ NP(anyone) [$_{V'}$ NP(interest) V(show)]] Neg] T]. Because native Japanese speakers can insert a negation phrase at the beginning of a sentence, they can negate the following context before hearing the final negation *-nai*. In accordance with pre-head anticipatory processing (Kamide 2008; Kamide and Mitchell 1999; Kamide

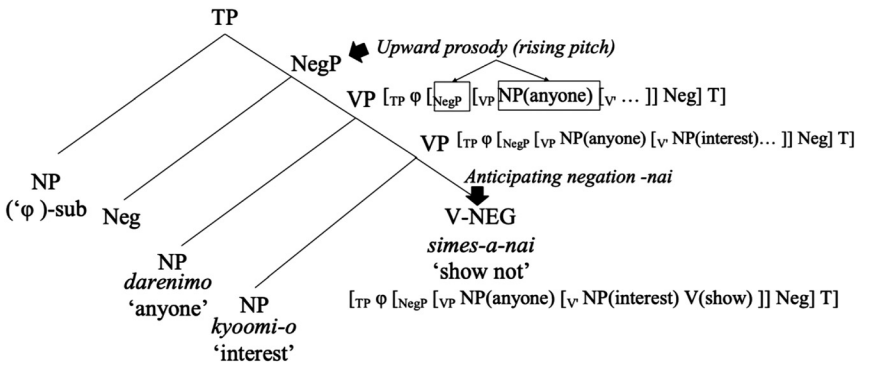

Figure 5: Pre-head anticipatory 'negation' processing based on upward prosody *darenimo*.

et al. 2003), upward prosody on *darenimo* may result in faster speed and higher accuracy for the processing of negative sentences compared to the processing of their corresponding affirmative sentences. In this way, the facilitation effect on the processing of negative *darenimo* Japanese sentences is seen with the use of upward prosody on *darenimo*.

5.3 Closing remarks

The present study indicated that early heightened pitch of *darenimo* provides a cue for predicting an ending negation *-nai* in the head-final Japanese language. Based on the results of the three Studies, the present study provides an explanation for acquisition and processing of *daremino* according to the exemplar theory of phonology (e.g., Johnson 1997; Luce and Galanter 1963; Pirrehumbert 2001, 2003). Native Japanese speakers encounter different combinations of *darenimo* prosody and polarity. Upward prosody *darenimo* with negative polarity is enhanced from phonologically prominent usages in daily life. In the early stage, these examples are stored as episodic memory. When enough examples are collected, the *darenimo* entrainment of upward prosody and negative polarity is withdrawn. Once this relation is established, the prosodic entrainment strategy (Ip and Cutler 2020, 2021) functions well in that native Japanese speakers are able to use the early presentation of *darenimo* with upward prosody or rising pitch to anticipate the ending negation *-nai*. This pre-head 'negation' anticipatory processing (Kamide 2008; Kamide and Mitchell 1999; Kamide et al. 2003) accelerates the processing speed of negative sentences, resulting in even faster processing than for their corresponding affirmative sentences. The present study uniquely shows the facilitation effect for processing a negative sentence.

Corpus Web-site

The Balanced Corpus of Contemporary Written Japanese (BCCWJ) is produced by the National Institute for Japanese Language and Linguistics, for more information, see the Web-site at https://pj.ninjal.ac.jp/corpus_center/bccwj/en/index.html (accessed on April 2, 2021).

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Author contributions: The first author Tamaoka designed the entire study and programmed the experiment in Study 3, analyzed the data, and wrote the paper. The second author Ji conducted the experiments and the corpus search.
Competing interests: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Statement of ethics: This study involving human participants was reviewed and approved by the Ethics Committee of the Graduate School of Humanities, Nagoya University, Japan (NUHM-19-010). Written informed consent to participate in this study was provided by the participants.

Appendix

Forty pairs of stimulus sentences used for Experiments 2 and 3

Study 2 for acceptability judgments used correct Japanese sentences of negative (–) 1a and positive (+) 1b polarity without *darenimo* prosody. Study 3 for prosody-and-polarity matching decisions used 1a–1d. The prosody-and-polarity of 1a and 1b are correctly matched and responded to as YES while 1c and 1d are incorrectly matched and responded to as NO.

1a 誰にも(HHHH, ↑) …. よい印象を与えない(–)。
Darenimo (HHHH, ↑) *yoi insyoo-o atae-nai* (–).
NP(anyone) ADJ(good) NP-ACC(impression) V(give)-NEG(not)
‘φ do(es) not give good impression to anyone.’

1b 誰にも(HHHL, ↓) よい印象を与える(+)。
Darenimo (HHHL, ↓) *yoi insyoo-o atae-ru* (+).
NP(everyone) ADJ(good) NP-ACC(impression) V(give)-POS
'φ give(s) a good impression to everyone.'

1c 誰にも(↓) よい印象を与えない(–)。
Darenimo (HHHL, ↓) *yoi insyoo-o atae-nai* (–).

1d 誰にも(↑) よい印象を与える(+)。
Darenimo (HHHH, ↑) *yoi insyoo-o atae-ru* (+).

Hereafter, only correctly matched prosody-and-polarity pairs of a and b are listed.

2a 誰にも(↑) 鳴き声が聞こえない(–)。
Darenimo (↑) *nakigoe-gakikoe-nai* (–).
'No one can hear crying.'

2b 誰にも(↓) 鳴き声が聞こえる(+)。
Darenimo (↓) *nakigoe-gakikoe-ru* (+).
'Everyone can hear crying.'

3a 誰にも(↑) 秘密を漏らさない(–)。
Darenimo (↑) *himitu-o moras-a-nai* (–).
'φ do(es) not reveal the secret to anyone.'

3b 誰にも(↓) 秘密を漏らす(+)。
Darenimo (↓) *himitu-o moras-u* (+).
'φ reveal(s) the secret to everyone.'

4a 誰にも(↑) 良し悪しを判断できない(–)。
Darenimo (↑) *yosiasi-ohandandeki-nai* (–).
'No one can judge good or bad.'

4b 誰にも(↓) 良し悪しを判断できる(+)。
Darenimo (↓) *yosiasi-ohandandeki-ru* (+).
'Everyone can judge good or bad.'

5a 誰にも(↑) 使い方を覚えることができない(–)。
Darenimo (↑) *tukaikata-o oboerukoto-ga deki-nai* (–).
'No one can learn how to use it.'

5b 誰にも(↓) 使い方を覚えることができる(+)。
Darenimo (↓) *tukaikata-o oboerukoto-ga deki-ru* (+).
'Everyone can learn how to use'

6a 誰にも(↑) 電話をかけない(–)。
Darenimo (↑) *denwa-okake-nai* (–).
'φ do(es) not telephone anyone.'

6b 誰にも(↓) 電話をかける(+)。
Darenimo (↑) *denwa-okane-ru* (+).
'φ telephone(s) everyone.'

7a 誰にも(↑) 興味を示さない(–)。
Darenimo (↑) *kyoomi-osimes-a-nai* (–).
'φ show(s) no interest to anyone.'
7b 誰にも(↓) 興味を示す(+)。
Darenimo (↓) *kyoomi-osimes-u* (+).
'φ show(s) interest to everyone.'
8a 誰にも(↑) 手紙を書かない(–)。
Darenimo (↑) *tegami-okak-a-nai* (–).
'φ do(es) not write a letter to anyone.'
8b 誰にも(↓) 手紙を書く(+)。
Darenimo (↓) *tegami-okak-u* (+).
'φ write(s) a letter to everyone.'
9a 誰にも(↑) 事情を説明しない(–)。
Darenimo (↑) *zizyoo-osetumeis-i-nai* (–).
'φ do(es) not explain the situation to anyone.'
9b 誰にも(↓) 事情を説明する(+)。
Darenimo (↓) *zizyô-osetumeis-u-ru* (+).
'φ explain(s) the situation to everyone.'
10a 誰にも(↑) 本名を明かさない(–)。
Darenimo (↑) *honmyoo-oakas-a-nai* (–).
'φ do(es) not reveal your real name to anyone.'
10b 誰にも(↓) 本名を明かす(+)。
Darenimo (↓) *honmyoo-oakas-u* (+).
'φ reveal(s) your real name to everyone.'
11a 誰にも(↑) 笑顔を見せない(–)。
Darenimo (↑) *egao-omise-nai* (–).
'φ show(s) no smile to anyone.'
11b 誰にも(↓) 笑顔を見せる(+)。
Darenimo (↓) *egao-omise-ru* (+).
'φ show(s) a smile to everyone.'
12a 誰にも(↑) 挨拶をしない(–)。
Darenimo (↑) *aisatu-os-i-nai* (–).
'φ do(es) not greet anyone.'
12b 誰にも(↓) 挨拶をする(+)。
Darenimo (↓) *aisatu-os-u-ru* (+).
'φ greet(s) everyone.'
13a 誰にも(↑) 気軽に話しかけない(–)。
Darenimo (↑) *kigaru-nihanasikake-nai* (–).
'φ do(es) not talk to anyone casually.'

13b 誰にも(↓) 気軽に話しかける(+)。
Darenimo (↓) *kigaru-nihanasikake-ru* (+).
'φ talk(s) to everyone casually.'
14a 誰にも(↑) 行き先を知らせない(–)。
Darenimo (↑) *yukisaki-osirase-nai* (–).
'φ do(es) not let anyone know where to go.'
14b 誰にも(↓) 行き先を知らせる(+)。
Darenimo (↓) *yukisaki-osirase-ru* (+).
'φ let(s) everyone know where to go.'
15a 誰にも(↑) 好感を持たない(–)。
Darenimo (↑) *kookan-omot-a-nai* (–).
'φ do(es) not have a good impression to anyone.'
15b 誰にも(↓) 好感を持つ(+)。
Darenimo (↓) *kookan-omot-u* (+).
'φ have(s) a good impression to everyone.'
16a 誰にも(↑) 理想を語らない(–)。
Darenimo (↑) *risoo-okatar-a-nai* (–).
'φ do(es) not tell anyone the ideal.'
16b 誰にも(↓) 理想を語る(+)。
Darenimo (↓) *risoo-okatar-u* (+).
'φ tell(s) everyone the ideal.'
17a 誰にも(↑) お土産を買わない(–)。
Darenimo (↑) *omiyage-oka-wa-nai* (–).
'φ do(es) not buy souvenirs for anyone.'
17b 誰にも(↓) お土産を買う(+)。
Darenimo (↓) *omiyage-oka-u* (+).
'φ buy(s) souvenirs for everyone.'
18a 誰にも(↑) 文句を言わない(–)。
Darenimo (↑) *monku-oi-wa-nai* (–).
'φ do(es) not complain anyone.'
18b 誰にも(↓) 文句を言う(+)。
Darenimo (↓) *monku-oi-u* (+).
'φ complain(s) to everyone.'
19a 誰にも(↑) すぐ影響されない(–)。
Darenimo (↑) *sugueikyoosare-nai* (–).
'φ do(es) not immediately affected by anyone.'
19b 誰にも(↓) すぐ影響される(+)。
Darenimo (↓) *suguêkyôsare-ru* (+).
'φ is(are) immediately affected by everyone.'

20a 誰にも(↑) 本音で話さない(–)。
Darenimo (↑) *honne-dehanas-a-nai* (–).
'φ do(es) not talk to anyone.'

20b 誰にも(↓) 本音で話す(+)。
Darenimo (↓) *hone-dehanas-u* (+).
'φ talk(s) to everyone.'

21a 誰にも(↑) いたずらをしない(–)。
Darenimo (↑) *itazura-osi-nai* (–).
'φ do(es) not prank anyone.'

21b 誰にも(↓) いたずらをする(+)。
Darenimo (↓) *itazura-osu-ru* (+).
'φ prank(s) everyone.'

22a 誰にも(↑) 挑戦する資格がない(–)。
Darenimo (↑) *tyoosensurusikaku-ganai* (–).
'Anyone (be) not eligible to challenge.'

22b 誰にも(↓) 挑戦する資格がある(+)。
Darenimo (↓) *tyôsensurusikaku-gaa-ru* (+).
'Everyone (be) eligible to challenge'

23a 誰にも(↑) 厳しく注意しない(–)。
Darenimo (↑) *kibisikutyuuisi-nai* (–).
'φ do(es) not strictly warn to anyone.'

23b 誰にも(↓) 厳しく注意する(+)。
Darenimo (↓) *kibisikutyuuisu-ru* (+).
'φ strictly warn(s) to everyone.'

24a 誰にも(↑) タバコを勧めない(–)。
Darenimo (↑) *tabako-osusume-nai* (–).
'φ do(es) not recommend cigarettes to anyone.'

24b 誰にも(↓) タバコを勧める(+)。
Darenimo (↓) *tabako-osusume-ru* (+).
'φ recommend(s) cigarettes to everyone.'

25a 誰にも(↑) 積極的に協力しない(–)。
Darenimo (↑) *sekkyokuteki-nikyooryokus-i-nai* (–).
'φ do(es) not actively cooperate with anyone.'

25b 誰にも(↓) 積極的に協力する(+)。
Darenimo (↓) *sekkyokuteki-nikyôryokus-u-ru* (+).
'φ actively cooperate(s) with everyone.'

26a 誰にも(↑) 真剣に指導しない(–)。
Darenimo (↑) *sinken-nisidoosi-nai* (–).
'φ do(es) not seriously teach anyone.'

26b 誰にも(↓) 真剣に指導する(+)。
Darenimo (↓) *sinken-nisidoosu-ru* (+).
'φ seriously teach(s) everyone.'
27a 誰にも(↑) あれこれ干渉しない(–)。
Darenimo (↑) *arekorekansyoos-i-nai* (–).
'φ do not interfere this and that with anyone.'
27b 誰にも(↓) あれこれ干渉する(+)。
Darenimo (↓) *arekorekansyoos-u-ru* (+).
'φ interfere(s) this and that with everyone.'
28a 誰にも(↑) いちいち口を出さない(–)。
Darenimo (↑) *ititikuti-odas-a-nai* (–).
'φ do(es) not speak out anyone in detail.'
28b 誰にも(↓) いちいち口を出す(+)。
Darenimo (↓) *ititikuti-odas-u* (+).
'φ speak(s) out everyone in detail.'
29a 誰にも(↑) 感情的にならない(–)。
Darenimo (↑) *kanzyôteki-ninara-nai* (–).
'φ(be) not emotional to anyone.'
29b 誰にも(↓) 感情的になる(+)。
Darenimo (↓) *kanzyôteki-nina-ru* (+).
'φ (be) emotional to everyone.'
30a 誰にも(↑) お金を貸さない(–)。
Darenimo (↑) *okane-okas-a-nai* (–).
'φ lend(s) no money to anyone.'
30b 誰にも(↓) お金を貸す(+)。
Darenimo (↓) *okane-okas-u* (+).
'φ lend(s) money to everyone.'
31a 誰にも(↑) 安全を保障しない(–)。
Darenimo (↑) *anzen-ohosyoos-i-nai* (–).
'φ guarantee(s) no one's safety.'
31b 誰にも(↓) 安全を保障する(+)。
Darenimo (↓) *anzen-ohosyoos-u-ru* (+).
'φ guarantee(s) everyone' safety.'
32a 誰にも(↑) 食べ物を分け与えない(–)。
Darenimo (↑) *tabemono-owakeatae-nai* (–).
'φ do(es) not give food to anyone.'
32b 誰にも(↓) 食べ物を分け与える(+)。
Darenimo (↓) *tabemono-owakeatae-ru* (+).
'φ give(s) food to everyone.'

33a 誰にも(↑) 友達を紹介しない(–)。
Darenimo (↑) *tomodati-osyookais-i-nai* (–).
'φ do(es) not introduce one's friends to anyone.'
33b 誰にも(↓) 友達を紹介する(+)。
Darenimo (↓) *tomodati-osyookais-u-ru* (+).
'φ introduce(s) one's friend(s) to everyone.'
34a 誰にも(↑) プレゼントを贈らない(–)。
Darenimo (↑) *purezento-ookura-nai* (–).
'φ do(es) not give a present to anyone.'
34b 誰にも(↓) プレゼントを贈る(+)。
Darenimo (↓) *purezento-ooku-ru* (+).
'φ give(s) a present to everyone.'
35a 誰にも(↑) 話を合わせない(–)。
Darenimo (↑) *hanasi-oawase-nai* (–).
'φ do(es) not play along with anyone.'
35b 誰にも(↓) 話を合わせる(+)。
Darenimo (↑) *hanasi-oawase-ru* (–).
'φ play(s) along with everyone.'
36a 誰にも(↑) 迷惑をかけない(–)。
Darenimo (↑) *meiwaku-okake-nai* (–).
'φ do(es) not trouble anyone.'
36b 誰にも(↓) 迷惑をかける(+)。
Darenimo (↓) *meiwaku-okake-ru* (+).
'φ trouble(s) everyone.'
37a 誰にも(↑) 魅力を感じない(–)。
Darenimo (↑) *miryoku-okanzi-nai* (–).
'φ do(es) not find anyone attractive.'
37b 誰にも(↓) 魅力を感じる(+)。
Darenimo (↓) *miryoku-okanzi-ru* (+).
'φ find(s) everyone attractive.'
38a 誰にも(↑) 援助を求めない(–)。
Darenimo (↑) *ennzyo-omotome-nai* (–).
'φ do(es) not ask anyone for help.'
38b 誰にも(↓) 援助を求める(+)。
Darenimo (↓) *ennzyo-omotome-ru* (+).
'φ ask(s) everyone for help.'
39a 誰にも(↑) 嘘をつかない(–)。
Darenimo (↑) *uso-otuk-a-nai* (–).
'φ do(es) not lie to anyone.'

39b 誰にも(↓) 嘘をつく(+)。
Darenimo (↓) *uso-otuk-u* (+).
'φ lie(s) to everyone.'
40a 誰にも(↑) 権利を主張しない(–)。
Darenimo (↑) *kenri-osyutyoos-i-nai* (–).
'φ claim(s) no rights to anyone.'
40b 誰にも(↓) 権利を主張する(+)。
Darenimo (↓) *kenri-osyutyoos-u-ru* (+).
'φ claim(s) the right to everyone.'

References

Anderson, David R., Kenneth P. Burnham & William L. Thompson. 2000. Null hypothesis testing: Problems, prevalence, and an alternative. *The Journal of Wildlife Management* 64(4). 912–923.

Baayen, R. Harald, Douglas J. Davidson & Douglas M. Bates. 2008. Mixed-effects modelling with crossed random effects for subjects and items. *Journal of Memory and Language* 59(4). 390–412.

Balota, David. A. & Daniel H. Spieler. 1999. Word-frequency, repetition, and lexicality effects in word recognition tasks: Beyond measures of central tendency. *Journal of Experimental Psychology: General* 128. 32–55.

Bates, Douglas M., Martin Maechler, Ben Bolker, Steven Walker, Rune Haubo Bojesen Christensen, Henrik Singmann & Bin Dai. 2014. *lme4: Linear mixed-effects models using Eigen and S4* (version 1.1-7) [R Cran package].

Battistella, Edwin L. 1990. *Markedness: The evaluative superstructure of language*. Albany, NY: State University of New York Press.

Boersma, Paul & David Weenink. 1992–2022. Praat: Doing phonetics by computer [Computer program]. Version 6.0.43. https://www.praat.org (accessed 8 June 2019).

Box, George E. P. & David R. Cox. 1964. An analysis of transformations (with discussion). *Journal of the Royal Statistical Society B* 26. 211–252.

Brown, Charles R. & Herbert Rubenstein. 1961. Test of response bias explanation of word-frequency effect. *Science* 133. 280–281.

Brunellière, Angèle, Cyril Auran & Laurence Delrue. 2019. Does the prosodic emphasis of sentential context cause deeper lexical-semantic processing? *Language, Cognition and Neuroscience* 34(1). 29–42.

Collins, Chris & Paul M. Postal. 2014. *Classical NEG raising: An essay on the syntax of negation*. Cambridge, MA: MIT press.

Cutler, Anne & Donald J. Foss. 1977. On the role of sentence stress in sentence processing. *Language and Speech* 20. 1–10.

Cutler, Anne & James M. McQueen. 2014. How prosody is both mandatory and optional. In Johanneke Caspers, Yiya Chen, Willemijn Heeren, Jos Pacilly, Niels O. Schiller & Ellen Van Zanten (eds.), *Above and beyond the segments: Experimental linguistics and phonetics*, 71–82. Amsterdam: Benjamins.

De Lacy, Paul. 2006. *Markedness: Reduction and preservation in phonology*. Cambridge University Press.

Dogil, Grzegorz & Briony Williams. 1999. The phonetic manifestation of word stress in Lithuanian, Polish and German. In Harry van der Hulst (ed.), *Word prosodic systems in the languages of Europe*, 273–334. Berlin: Mouton de Gruyter.

Fillmore, Charles J. 1963. The position of embedding transformations in a grammar. *Word* 19. 208–231.

Gordon, Barry. 1983. Lexical access and lexical decision: Mechanisms of frequency sensitivity. *Journal of Verbal Learning and Verbal Behavior* 22. 24–44.

Gunji, Takao. 2006. Nihon-go no NPI no inritsu to imi [Japanese NPI prosody and semantics]. *Theoretical and Applied Linguistics at Kobe Shoin* 9. 17–30.

Harville, David A. 1977. Maximum likelihood approaches to variance component estimation and to related problems. *Journal of the American Statistical Association* 72(358). 320–338.

Hawkins, John A. 2014. *Cross-linguistic variation and efficiency*. Oxford: Oxford University Press.

Hino, Yasushi & Stephen J. Lupker. 1998. The effects of word frequency for Japanese Kana and Kanji words in naming and lexical decision: Can the dual-route model save the lexical-selection account? *Journal of Experimental Psychology: Human Perception and Performance* 24. 1431–1453.

Horn, Laurence R. 2020. Neg-raising. In Viviane Déprez & M. Teresa Espinal (eds.), *The Oxford handbook of negation*, 199–215. Oxford: Oxford University Press.

Ip, Martin Ho Kwan & Anne Cutler. 2020. Universals of listening: Equivalent prosodic entrainment in tone and nontone languages. *Cognition* 202: 104311.

Ip, Martin Ho Kwan & Anne Cutler. 2021. In search of salience: Focus detection in the speech of different talkers. *Language and Speech*, (November 2021). https://doi.org/10.1177/00238309211046029.

Jescheniak, Jörg D. & Willem J. M. Levelt. 1994. Word frequency effects in speech production: Retrieval of syntactic information and of phonological form. *Journal of Experimental Psychology Language Memory and Cognition* 20. 824–843.

Johnson, Keith. 1997. Speech perception without speaker normalization. In Keith Johnson & John W. Mullennix (eds.), *Talker variability in speech processing*, 145–166. San Diego, CA: Academic Press.

Kamide, Yuki. 2008. Anticipatory processes in sentence processing. *Language and Linguistics Compass* 2(4). 647–670.

Kamide, Yuki & Don C. Mitchell. 1999. Incremental pre-head attachment in Japanese parsing. *Language and Cognitive Processes* 14(5/6). 631–662.

Kamide, Yuki, Gerry T. M. Altmann & Sarah L. Haywood. 2003. The time-course of prediction in incremental sentence processing: Evidence from anticipatory eye-movements. *Journal of Memory and Language* 49. 133–159.

Kato, Yasuhiko. 1985. *Negative sentences in Japanese*. Tokyo: Sophia Linguistica (Working Papers in Linguistics, 19, 1–229).

Kuznetsova, Arnout, Per Bruun Brockhoff & Rune Haubo Bojesen Christensen. 2014. *lmerTest*: Tests for random and fixed effects for linear mixed effect models (*lmer* objects of lme4 package) (version 2.0-6) [R Cran package].

Lee, Albert, Faith Chiu & Yi Xu. 2016. Focus perception in Japanese: Effects of focus location and accent condition. *The Journal of the Acoustical Society of America* 140. 3398.

Li, Xiao-qing & Gui-qin Ren. 2012. How and when accentuation influences temporally selective attention and subsequent semantic processing during on-line spoken language comprehension: An ERP study. *Neuropsychologia* 50. 1882–1894.

Lehiste, Ilse. 1970. *Suprasegmentals*. Cambridge, MA: Massachusetts Institute of Technology Press.

Luce, R. Duncan & Eugene Galanter. 1963. Discrimination. In R. Duncan Luce, Robert R. Bush & Eugene Galanter (eds.), *Handbook of mathematical psychology*, 191–243. New York: John Wiley & Sons.

Maekawa, Kikuo, Makoto Yamazaki, Toshinobu Ogiso, Takehiko Maruyama, Hideki Ogura, Wakako Kashino, Hanae Koiso, Masaya Yamaguchi, Makiro Tanaka & Yasuharu Den. 2014. Balanced corpus of contemporary written Japanese. *Language Resources and Evaluation* 48. 345–371.

McAllister, Jan. 1991. The processing of lexically stressed syllables in read and spontaneous speech. *Language and Speech* 34. 1–26.

Nordmeyer, Ann E. & Michael C. Frank. 2018. Early understanding of pragmatic principles in children's judgments of negative sentences. *Language Learning and Development* 14(4). 262–278.

Pierrehunbert, Janet B. 2001. Exemplar dynamics: Word frequency, lenition, and contrast. In Joan Bybee & Paul Hopper (eds.), *Frequency effects and the emergence of linguistic structure*, 137–157. Amsterdam: John Benjamins.

Pierrehunbert, Janet B. 2003. Phonetic diversity, statistical learning, and acquisition of phonology. *Language and Speech* 46. 115–154.

Pierrehumbert, Janet B. & Julia Hirschberg. 1990. The meaning of intonational contours in the interpretation of discourse. In Philip R. Cohen, Jerry Morgan & Martha E. Pollack (eds.), *Intentions in communication*, 271–311. Cambridge MA: MIT Press.

Prieto, Pilar & M. Teresa Espinal. 2020. Negation, prosody, and gesture. In Viviane Déprez & M. Teresa Espinal (eds.), *The Oxford handbook of negation*, 677–693. Oxford: Oxford University Press.

R Core Team. 2014. *R: A language and environment for statistical computing* (version 3.1.2). Vienna: R Foundation for Statistical Computing. Available at: http://www.R-project.org.

Searle, Shayle R., F. M. Speed & George A. Milliken. 1980. Population marginal means in the linear model: An alternative to least squares means. *The American Statistician* 34(4). 216–221.

Sluijter, Agaath M. C. & Vincent J. van Heuven. 1996. Acoustic correlates of linguistic stress and accent in Dutch and American English. In *Proceeding of Fourth International Conference on Spoken Language Processing. ICSLP '96*, vol. 3, 630–633. Philladelphia, PA.

Taft, Marcus. 1979. Recognition of affixed words and the word frequency effect. *Memory & Cognition* 7. 263–272.

van Heuven, Vincent & Peter Hagman. 1988. Lexical statistics and spoken word recognition in Dutch. In Peter Coopmans & Aafke Hulk (eds.), *Linguistics in the Netherlands 1988*, 59–68. Dordrecht: Foris.

Venables, William N. & Brian D. Ripley. 2002. *Modern applied statistics with S*, 4th edn. New York: Springer.

Yaeger-Dror, Malcah. 1985. Intonational prominence on negatives in English. *Language and Speech* 28. 197–230.

Yaeger-Dror, Malcah. 1996. Register as a variable in prosodic analysis. *Speech Communication* 19. 39–60.

Yaeger-Dror, Malcah. 2002. Register and prosodic variation, a cross language comparison. *Journal of Pragmatics* 34. 1495–1536.