Preliminary analysis on the identification of English consonants in noise and/or reverberation by native Japanese and English listeners*

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1 Introduction

When we listen to speech sounds in our daily lives, we do not hear them in a quiet, laboratory condition. Instead, we are surrounded by various background noise and reverberation. Speech perception in such conditions is difficult for all listeners, but the difficulty affects non-native listeners more even if they have high foreign language proficiency [1-3]. Despite this fact, perception of foreign sounds is often trained under laboratory environments and does not take real-life listening environments into consideration. Our series of study [4-6] aim to understand the mechanism of foreign language perception in background noise and reverberation, and to make use of the data for developing perceptual training materials for language learners.

Perception of foreign sounds by non-native listeners has been investigated for decades. An experiment conducted by Nabelek & Donahue (1984) [7] on English word identification in quiet and reverberant listening conditions by native and non-native listeners found that while non-native listeners of various first languages performed almost as well as native listeners in the quiet condition, the difference between native listeners became larger as reverberation time (RT) became longer, with RT ranging from 0.4 s, 0.8 s, to 1.2 s. The paper [7] does not explicitly report the English proficiency of the non-native listeners; however all of them had learned English as teenagers, were residing in the U.S. at the time of experiment, and scored higher than 94% in the quiet listening condition, which suggests that they were more or less proficient in English.

Another study by Takata & Nabelek (1990) [8] reported the English word identification scores of native and non-native Japanese listeners in quiet, background noise (multi-speaker babble noise) at SNR (signal-to-noise ratio) = -3 dB, and reverberation at RT = 1.2 s. This study also found that native and non-native listeners performed similarly in the quiet condition, but the difference between the two listener groups became larger under noise and reverberation. All non-native listeners were fluent in English, were residing in the U.S. at the time of the experiment, and their length of residence ranged from one to 13 years.

Cutler *et al.* (2004) [9] investigated the effect of background noise (multi-speaker babble noise) in the perception of English consonants and vowels by native and non-native Dutch listeners. They found that non-native listeners' performance did not reach native-like level under quiet and noisy listening conditions, and the performance of both native and non-native listeners became worse with the increase in SNR ranging from 16 dB, 8 dB, to 0 dB.

There are numerous studies on non-native speech sounds in quiet, background noise, and reverberation conditions. The studies reviewed above are some of the closest research to ours. However, none of them investigates the difference between native and non-native listeners by taking the non-native listeners' proficiency in the target language into consideration, and exams the confusion patterns of each listener group. This paper therefore aims to investigate the differences in overall correct rates as well as the differences in consonant confusion patterns between native English and Japanese L2 learners of English with varying English proficiency.

2 Perceptual experiment

2.1 Participants

Twenty-four native American English listeners and thirteen native Japanese listeners participated in the experiment. American English listeners were recruited at a university in the United States, and native Japanese listeners at a university in Japan. All Japanese listeners had received English education in mandatory classes at school starting at the age of 12 – 13. There were 7 participants that began to learn English prior to age 12 – 13. None of the listeners reported any hearing problems.

2.2 Stimuli

Participants were presented with twenty-three

English consonants /b, tʃ, d, f, g, h, dʒ, ʒ, k, l, m, n, p, ɹ, s, ʃ, t, θ, ð, v, w, j, z/ embedded in the context "You are about to hear a__a". The stimuli were produced by a female Japanese-English bilingual speaker, and were recorded in a sound-proof room using a digital sound recorder (Marantz PMD 660) and a microphone (SONY ECM-23F5) at a sampling frequency of 48 kHz, later downsampled to 16 kHz.

Participants listened to the stimuli in the order of 1) the reverberation-only conditions at RT = 0.78 s (D50 value 67.5%), 1.12 s (D50 value 47.7%), and 1.43 s (D50 value 32.2%) in randomized order), 2) the noisy and reverberant condition (SNR = 10 dB added to reverberation RT = 0.78 s), and 3) the quiet condition. Impulse responses were recorded at NHK (0.78 s and 1.12 s) and Kamakura Museum of Art (1.43 s). Multi-speaker babble noise was used as background noise [10], since it resembles background noise that learners encounter in their daily lives.

2.3 Procedure

A laptop computer was used to present the stimuli and to record the listeners' responses. All experimental procedure was conducted using Praat [11]. Stimuli were presented to the Japanese listeners through an USB audio amplifier (ONKYO MA-500U) and headphones (Sennheiser HDA200). The laptop computer and audio amplifier were digitally connected via USB interface. English listeners were presented with the stimuli through Sennheiser HD 280 Pro headphones connected directly from Mac computers.

Participants were first presented with 23 practice trials before proceeding to the 575 main trials (23 consonants x 5 repetitions x 5 listening conditions). Listeners were asked to listen to each stimulus, and to choose the consonant that was most similar to what they heard from the list of 23 consonants, for example "B as in Be", "CH as in Chin", etc. Participants listened to each stimulus once, and trials proceeded automatically after pressing the button on the computer screen. Reaction time was not recorded.

3 Results

Table 1 shows the average overall correct percentages by English and Japanese listeners, and the differences between the two groups. English listeners performed better than Japanese listeners in all listening conditions. Analysis of Variance between subjects showed a significant difference between native and non-native listener groups [F (1, 175) = 5.95, $p < 0.05$]), and a significant difference in the effect of listening conditions [F = (4, 175) = 48.79, $p < 0.0001$]. *Post-hoc* comparisons using the Tukey-Kramer test revealed significant differences ($p < 0.01$) in all but RT = 0.78 s / RT = 1.12 s and RT = 1.12 / RT = 1.43 conditions. The interactions of the two main factors was not significant [F (4, 175) = 0.22, $p = 0.92$].

Table 1 Average overall correct percentages by native listeners (NL) and non-native listeners (NNL), and their differences (%).

Conditions	*Listener groups*		*Diff. (%)*
	NL (%)	NNL (%)	
Quiet	91.3	90.2	-1.1
RT = 0.78 s	81.1	76.1	-5.0
RT = 1.12 s	74.8	67.8	-7.0
RT = 1.43 s	70.3	67.0	-3.3
SNR = 10 dB + RT = 0.78 s	55.5	48.7	-6.8

Detailed analyses on Japanese listeners showed that the correlation between Japanese listeners' TOEIC® (Test of English for International Communication provided by ETS) scores and correct percentages in each listening condition becomes stronger as listening conditions became more severe (Table 2). The most severe condition had the strongest correlation with the TOEIC® score. Further investigation with a larger number of listeners is needed to reinforce this observation.

The Japanese group was further divided into two groups according to their age of acquisition, either before age 8 (N=7) or after age 10 (N=6). Analysis of Variance showed no significant difference in the effect of age of acquisition [F (1, 55) = .09, $p = 0.75$].

Table 2 Pearson's correlation between TOEIC® scores and listening conditions.

Correlation with TOEIC® scores	*Correlation coefficient*
Quiet	0.22 ($p > 0.1$)
RT = 0.78 s	0.13 ($p > 0.1$)
RT = 1.12 s	0.32 ($p > 0.1$)
RT = 1.43 s	0.35 ($p > 0.1$)
SNR = 10 dB + RT = 0.78 s	0.55 ($p = 0.05$)

4 Discussion

The overall correct percentages showed a significant difference between English and Japanese listeners. Moreover, the consonant confusion patterns differed according to listeners' English proficiency. Tables 3-5 show the confusion matrices of Japanese listeners that achieved 1) below 605 (lower half of Japanese data) or 2) above 765 (higher half of Japanese data) in TOEIC®, and English listeners, in the most challenging listening environment.

The confusion patterns in the noisy + reverberant listening condition showed both similarities and differences between native and non-native listeners. The similarity between native and non-native listeners was observed in the identification of /tʃ, d, m, j/. All listeners were able to identify the sounds well, even in the most adverse listening condition in the present experiment.

The differences among the three listener groups varied among sounds. Although the identification of the sounds /b, f, g, p/ were difficult for all listeners, there was a larger disadvantage for the non-native listeners. For example, native listeners were able to identify the sound /g/ 39.2% of the time (mostly confused with /k/), while Japanese with lower TOEIC® scores reached only 8.6% (confused with /t/) and those with higher TOEIC® scores 3.3% (confused with /k/ and /t/). The confusion patterns show that Japanese with higher TOEIC® scores is intermediate between the confusions of Japanese with lower TOEIC® scores and native listeners.

There were three sounds that Japanese listeners with higher TOEIC® scores performed similarly to native listeners: /θ, ɹ, w/. Japanese with higher TOEIC® scores and native English listeners were able to identify /θ/ by approximately 60%, whereas Japanese with lower TOEIC® scores marked 5.7%. Similarly, the two more proficient group achieved approximately 80% for the sound /ɹ/ and approximately 55% for the sound /w/, whereas the scores of the lower TOEIC® group reached only 42.9% (/ɹ/) and 22.9% (/w/).

5 Conclusion

The present experiment investigated the perception of English consonants in quiet, reverberation, and background noise + reverberation conditions by English and Japanese listeners. The results showed a significant difference in overall correct percentages between English and Japanese listeners. Confusion matrices in the most challenging listening condition revealed that the identification and confusion patterns of some of the consonants by Japanese listeners with higher TOEIC® scores located between Japanese with lower TOEIC® scores and English listeners.

These results suggest that 1) overall correct percentages of English and Japanese listeners are not enough to look into the influence of foreign speech perception in detail, 2) confusion matrices reveal non-native listeners' difference with the native listeners, and 3) detailed analyses based on the non-native listeners' foreign language proficiency is essential. Although the results of the present experiment are not enough to make a conclusive generalization, the data provide some hint at how learners with varying TOEIC® scores confuse English consonants. These results may be used to develop a perceptual training material for Japanese listeners with varying English proficiency.

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Table 3 Confusion matrix of Japanese listeners with TOEIC® scores under 605 (SNR = 10 dB + RT = 0.78 s)

		RESPONSES																						
		b	tʃ	d	f	g	h	ʒ	dʒ	k	l	m	n	p	r	s	ʃ	t	θ	ð	v	w	j	z
STIMULI	b	20.0	5.7	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.4	2.9	0.0	0.0	0.0
	tʃ	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	d	0.0	0.0	88.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.4	0.0	0.0	0.0	0.0
	f	0.0	0.0	0.0	25.7	0.0	2.9	0.0	2.9	2.9	0.0	0.0	0.0	25.7	0.0	5.7	0.0	8.6	14.3	2.9	2.9	5.7	0.0	0.0
	g	2.9	0.0	11.4	2.9	8.6	0.0	0.0	0.0	2.9	5.7	0.0	2.9	5.7	0.0	0.0	2.9	40.0	8.6	5.7	0.0	0.0	0.0	0.0
	h	0.0	0.0	0.0	11.4	0.0	48.6	0.0	0.0	0.0	2.9	28.6	2.9	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	ʒ	0.0	0.0	0.0	0.0	0.0	0.0	31.4	68.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	dʒ	0.0	2.9	0.0	0.0	0.0	0.0	45.7	51.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	k	0.0	0.0	0.0	25.7	0.0	0.0	0.0	0.0	42.9	0.0	0.0	0.0	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	l	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.6	11.4	5.7	0.0	25.7	0.0	0.0	0.0	5.7	0.0	0.0	17.1	5.7	0.0
	m	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	94.3	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0
	n	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	48.6	48.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	p	0.0	0.0	0.0	31.4	0.0	5.7	2.9	0.0	0.0	0.0	0.0	0.0	22.9	0.0	0.0	0.0	25.7	5.7	5.7	0.0	0.0	0.0	0.0
	r	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	0.0	0.0	0.0	42.9	0.0	0.0	0.0	0.0	0.0	0.0	5.7	14.3	0.0
	s	0.0	2.9	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	2.9	5.7	11.4	0.0	0.0	2.9	51.4
	ʃ	0.0	51.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	t	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	2.9	0.0	0.0	0.0	60.0	22.9	11.4	0.0	0.0	0.0	0.0
	θ	2.9	0.0	0.0	37.1	2.9	0.0	0.0	0.0	0.0	0.0	0.0	2.9	20.0	0.0	2.9	0.0	2.9	5.7	5.7	2.9	14.3	0.0	0.0
	ð	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.6	60.0	0.0	0.0	2.9	2.9
	v	17.1	0.0	5.7	14.3	2.9	8.6	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	2.9	0.0	2.9	5.7	11.4	8.6	5.7	0.0	0.0
	w	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	11.4	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	22.9	8.6	0.0
	j	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
	z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	8.6	0.0	0.0	0.0	77.1

Table 4 Confusion matrix of Japanese listeners with TOEIC® scores above 765 (SNR = 10 dB + RT = 0.78 s)

		RESPONSES																						
		b	tʃ	d	f	g	h	ʒ	dʒ	k	l	m	n	p	r	s	ʃ	t	θ	ð	v	w	j	z
STIMULI	b	6.7	0.0	36.7	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	46.7	3.3	0.0	0.0	0.0
	tʃ	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	d	0.0	0.0	93.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0
	f	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	10.0	63.3	0.0	0.0	0.0	0.0	3.3
	g	0.0	0.0	3.3	0.0	3.3	0.0	0.0	0.0	30.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	40.0	10.0	6.7	0.0	0.0	0.0	0.0
	h	0.0	0.0	0.0	26.7	0.0	33.3	0.0	0.0	0.0	0.0	3.3	0.0	23.3	0.0	0.0	0.0	0.0	3.3	0.0	0.0	10.0	0.0	0.0
	ʒ	0.0	0.0	0.0	0.0	0.0	0.0	56.7	43.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	dʒ	0.0	23.3	0.0	0.0	0.0	0.0	10.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	k	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	60.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	3.3	16.7	0.0	0.0	0.0	0.0	0.0
	l	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	23.3	0.0	0.0	0.0	0.0	10.0	3.3	10.0	0.0	3.3
	m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	96.7	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	n	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	p	0.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	3.3	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0
	r	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	80.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0
	s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	23.3	16.7	0.0	0.0	0.0	43.3
	ʃ	0.0	36.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	t	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	0.0	0.0	0.0	6.7	0.0	0.0	0.0	30.0	50.0	0.0	0.0	0.0	0.0	0.0
	θ	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	3.3	3.3	3.3	0.0	0.0	66.7	10.0	0.0	0.0	0.0	0.0
	ð	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	36.7	50.0	0.0	0.0	0.0	6.7
	v	13.3	0.0	3.3	10.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	13.3	13.3	10.0	0.0	0.0	3.3
	w	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.7	3.3	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.7	0.0	0.0
	j	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
	z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0	0.0	56.7

Table 5 Confusion matrix of English listeners (SNR = 10 dB + RT = 0.78 s)

		RESPONSES																						
		b	tʃ	d	f	g	h	ʒ	dʒ	k	l	m	n	p	r	s	ʃ	t	θ	ð	v	w	j	z
STIMULI	b	49.2	0.0	12.5	0.8	5.0	0.0	0.0	0.8	0.0	5.0	0.8	1.7	0.8	0.0	0.8	0.0	1.7	3.3	5.8	10.0	0.8	0.8	0.0
	tʃ	0.0	85.8	0.8	0.8	0.0	1.7	4.2	4.2	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.8	0.8	0.0	0.0	0.0	0.0	0.0
	d	0.0	0.0	75.8	0.8	1.7	0.0	0.0	0.8	0.0	5.0	0.8	0.8	0.8	0.0	0.0	0.0	4.2	4.2	4.2	0.0	0.0	0.0	0.8
	f	1.7	0.0	0.0	30.8	2.5	0.0	0.8	0.0	7.5	0.0	0.8	0.0	34.2	0.0	0.0	0.0	6.7	9.2	2.5	1.7	1.7	0.0	0.0
	g	0.0	0.0	0.0	1.7	39.2	3.3	1.7	0.0	31.7	0.8	0.0	2.5	4.2	0.8	0.0	0.0	3.3	3.3	3.3	4.2	0.0	0.0	0.0
	h	0.8	0.0	0.8	4.2	0.8	58.3	0.0	0.0	2.5	4.2	4.2	0.8	20.0	0.0	0.0	0.0	0.0	1.7	0.8	0.8	0.0	0.0	0.0
	ʒ	0.8	2.5	0.0	0.0	1.7	0.0	50.8	40.8	0.0	0.8	0.0	0.0	0.0	0.8	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.8	0.0
	dʒ	0.0	1.7	0.8	0.0	0.0	0.0	28.3	65.8	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.8	0.0	1.7	0.0	0.0	0.0	0.0	0.0
	k	0.8	0.0	0.0	0.8	0.8	0.0	0.8	0.0	40.0	0.0	0.8	0.0	50.0	3.3	0.0	0.0	0.8	0.8	0.0	0.8	0.0	0.0	0.0
	l	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.8	64.2	16.7	0.0	0.8	5.8	0.8	0.0	0.0	0.0	0.8	8.3	0.8	0.0	
	m	0.8	0.0	0.8	0.0	0.0	15.0	0.0	0.0	0.8	0.0	80.8	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
	n	0.0	0.8	0.0	0.8	0.0	5.8	0.0	0.0	1.7	0.8	50.0	31.7	5.0	0.0	0.0	0.0	2.5	0.0	0.8	0.0	0.0	0.0	0.0
	p	0.0	0.0	0.0	17.5	0.0	5.8	0.8	0.0	10.0	0.8	0.8	0.0	59.2	0.8	0.0	0.0	0.8	1.7	1.7	0.0	0.0	0.0	0.0
	r	0.0	0.0	0.0	0.8	0.0	0.0	0.0	1.7	0.8	7.5	0.0	0.0	1.7	80.8	0.8	0.0	0.8	0.8	0.0	0.0	4.2	0.0	0.0
	s	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.7	0.8	0.0	0.0	0.0	0.8	0.0	43.3	0.0	0.0	2.5	0.0	0.0	0.0	0.0	50.0
	ʃ	0.0	32.5	0.0	0.8	0.0	0.0	7.5	0.8	0.0	0.0	0.0	0.0	0.8	0.0	0.0	60.0	0.8	0.0	0.8	0.0	0.0	0.0	0.0
	t	0.0	0.8	1.7	0.0	3.3	2.5	0.0	0.0	0.8	0.8	1.7	0.0	33.3	0.0	0.0	1.7	34.2	14.2	9.2	0.0	0.0	0.0	0.0
	θ	2.5	0.0	0.0	10.8	0.8	1.7	0.0	0.0	0.8	2.5	0.0	0.0	10.0	0.0	1.7	0.8	2.5	55.8	8.3	5.8	0.0	0.0	0.0
	ð	0.0	0.0	3.3	4.2	0.0	0.8	0.0	0.8	0.8	6.7	0.8	0.0	4.2	0.0	0.0	0.0	6.7	35.0	39.2	0.8	0.8	0.0	0.0
	v	51.7	1.7	0.0	1.7	0.8	6.7	0.0	0.0	0.0	2.5	4.2	0.0	19.2	3.3	0.0	0.0	0.0	3.3	0.0	7.5	1.7	0.0	0.0
	w	0.0	0.0	1.7	0.8	0.0	0.0	0.0	0.8	1.7	32.5	1.7	0.8	0.0	1.7	0.0	0.8	0.0	0.0	0.0	0.8	53.3	3.3	0.0
	j	1.7	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.8	0.8	0.0	1.7	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	2.5	90.0	0.8
	z	0.0	0.0	3.3	0.0	1.7	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	1.7	2.5	1.7	0.8	0.0	3.3	81.7