INTELLIGIBILITY OF MARITIME ENGLISH TERMS PRONOUNCED BY JAPANESE DECK CADETS

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ABSTRACT

Deck cadets, who are required to master a set of standardized English communication phrases for safe navigation, manifest a variety of pronunciation errors. In this study, 65 Maritime English terms spoken by 30 Japanese deck cadets were presented randomly to 65 American English listeners, and they were asked to spell out the terms in an intelligibility task. The percentage of words correctly identified as intended ranged between 1.5% and 92.3% (M = 45.8%). Monosyllabic words were found to be less intelligible than multisyllabic words, and both L1 transfer (global error) and word-level idiosyncratic errors (local error) impacted on intelligibility. The results revealed a wide range of individual speaker differences, which suggests the need for pronunciation instruction tailored to individual learners' requirements. Focusing on a specific set of words as well as segments is crucial to improve intelligibility, especially in Maritime English, a sub-category of English for Specific Purposes (ESP).

Keywords: intelligibility, Maritime English, ESP, pronunciation instruction, individual differences

1. INTRODUCTION

Maritime English is a type of English for specific purposes (ESP) "used by seafarers both at sea and in port and by individuals working in the shipping and shipbuilding industry" [2, p. 3579]. Maritime education and training institutions worldwide are required to provide instruction on Standard Marine Communication Phrases (SMCP) [4, 5, 13] for their deck cadets. They are a set of standardized phrases to be used by deck officers with different English competencies for intra-/inter-ship communications to ensure safe navigation of ocean-going vessels.

According to [6], approximately 90% of communication breakdowns stem from phonological inaccuracy, although at the same time they claim that seafarers' non-native accents are acceptable as far as they are intelligible. However, very little is known about what constitutes intelligible pronunciation.

The current study aimed to address this question. To this end, we measured the intelligibility of Maritime English terms pronounced by Japanese deck cadets. Intelligibility can be defined as "the degree of match between a speaker's intended message and the listener's comprehension" [3, p. 5] and can be measured through orthographic transcription [3]. The cadets' pronunciation errors based on previous studies [9, 14, 15] were compared with intelligibility measurements obtained from American English listeners, and the types of errors likely to have a greater impact on intelligibility were examined. Through data analysis, we also attempted to gain insights into effective ESP pronunciation instruction.

2. METHODS

2.1. Speakers and stimuli

Thirty Japanese deck cadets (all males; average age: 21.5) studying for the Certificate of Competency read aloud frequently used SMCP terms; 15 of them (labelled A01–A15) read 35 terms (List A) and the other 15 (labelled B01–B15) read 30 terms (List B), as shown below:

List A: *alarm, astern, barometer, bow, briefing, buoy, call, cargo, clear, container, control, deck, emergency, freeboard, full, hold, iceberg, information, kilometer, launch, liferaft, meter, mile, oil, order, port, pump, radar, request, rudder, smoke, starboard, tool, trim, turbine*

List B: *ahead, anchor, ballast, berth, boat, bridge, channel, course, crew, damage, diesel, draft, ETA, fairway, ladder, lifeboat, light, local, message, officer, pilot, pirate, proceed, propeller, ship, signal, speed, system, team, tug*

The terms were recorded and converted into sound files. The files were split into smaller ones, each containing one token. There were 65 words in total, with 15 tokens collected per word. For details of the speakers and stimuli selection, refer to Uchida and Sugimoto [15], who analyzed and described the cadets' pronunciation errors.

2.2. Participants

Sixty-five monolingual American English speakers (20 female, 45 male; age range: 22–70; average age: 37.0), recruited through Prolific (www.prolific.co),

completed two sets of tasks. Their average familiarity with Maritime English was 1.71 (*SD* = 1.01) and their average familiarity with Japanese-accented English was 2.40 (*SD* = 1.00), each of which was scored on a scale of 1 (*not familiar at all*) to 5 (*very familiar*). All gave online consent prior to participation.

2.3. Procedure

Intelligibility and comprehensibility rating tasks were created using Gorilla Experiment Builder [1].

The participants were instructed to wear headsets or earphones and listen to stimuli in a quiet room. After completing a questionnaire to provide their profile and language background, participants were introduced to the intelligibility task. A set of 65 tokens spoken by various speakers and 6 distracters spoken by a male American speaker were randomly presented one by one. Participants were asked to type the words that they thought were pronounced. They were allowed to listen to each token only once and were told to make their best guess if uncertain. Five practice trials preceded the actual test.

Upon completion of the first task, participants were encouraged to take a short break, followed by a comprehensibility rating task. At the end of the two tasks, a list of maritime terms used in the study was shown on the screen, and the participants were asked to choose terms unfamiliar to them. Responses of terms that participants reported as unfamiliar were excluded from the data set.

It took 20.5 minutes on average for the participants to complete the study. Only the results of the intelligibility task are analyzed and reported here.

3. RESULTS

This section reports on the results of intelligibility task.

3.1. Analysis by word

The following shows words that had high (over 80%) and low (under 20%) correct response rates.

Over 80% correct response (8 words): *information* (92.3%), *smoke* (92.3%), *container* (89.2%), *control* (86.2%), *starboard* (85.5%), *emergency* (83.1%), *ETA* (82.8%), *speed* (81.5%)

Under 20% correct response (13 words): *course* (18.5%), *mile* (16.9%), *propeller* (15.4%), *astern* (15.2%), *call* (12.3%), *fairway* (10.9%), *turbine* (10.8%), *radar* (9.2%), *freeboard* (8.8%), *tool* (7.7%), *trim* (6.2%), *berth* (1.9%), *full* (1.5%)

High response rate words included long words: 2 three-syllable words and 2 four-syllable words. Among the 65 target words, there were 4 three-syllable and 4 four-syllable words. Half of them were in the top 8, indicating that longer words were relatively easier for listeners to understand.

Another interesting point concerns words that involve the initial /s/ cluster (*smoke, starboard, speed*). Of the 65 target words, there were only 3 with initial /s/ clusters, and all were among the top 8 words.

Regarding words with a low response rate, 8 of the 13 words were monosyllabic, which again suggests that short words were more difficult.

In addition, all 13 words were /l/- and/or /r/-related, meaning that they included the consonants /l, r/, or rhotic vowels. The 65 target words included 9 words with a final dark /l/. Because the correct response rate of 5 words (*control, signal, local, oil, diesel*) was not necessarily low, we cannot say anything conclusive. However, 4 words (*mile, call, tool, full*) showed a low response rate of less than 20%, suggesting that words with final dark /l/ pose a problem for intelligibility. As for rhotic vowels, 3 of the 13 words include /ɚː/ (*astern, turbine, berth*), 2 /ɔɚ/ (*course, freeboard*), and 1 /eɚ/ (*fairway*).

To conduct a more detailed analysis, words that resulted in over 10 identical instances of responses were extracted. The speaker column in Table 1 shows the speaker(s) for the word in question. This indicates that the same stimulus was heard as the same word by multiple listeners. The following is an observation of the tendencies and possible explanations for incorrect responses.

(i) Vowels: A number of cases of vowel confusion were observed, all of which are often noted as difficulties Japanese learners face based on L1 transfer. The first case is a short /ɪ/ heard as a long /iː/ (e.g., *bridge → breach/breech, reach; trim → three*). The second case is /ɔː/ heard as /oʊ/ (e.g., *call → cold, coal*). Third, the short vowel /æ/ was heard as /ʌ/ (e.g., *anchor → uncle*). Finally, some responses reflected the influence of rhoticity (e.g., *course → coast, port → boat*). One notable example is *berth* heard as *bus*.

A problem unique to Japanese speakers is also observed: the vowels in *launch* pronounced as [au] and *radar* pronounced as [a] are both influence of Roman pronunciation, which may have caused the words to be taken as *lunch* and *ladder*, respectively.

(ii) Consonants: A significant area of consonant confusion was observed regarding /l/ and /r/: /l/ heard as /r/ or vice versa (e.g., *crew → clue, pilot ⇄ pirate, clear → career, Korea; radar → ladder, order → older, alarm → around*).

The results also suggest difficulty when hearing word-final consonants (e.g., *tool → two*, *bow → boat*). In particular, dark /l/ poses a problem for listeners (e.g., *mile → mine, call → cold*).

Voicing is another issue. The word-initial /p/ in *port* heard as /b/ indicates weak aspiration, and a

word-initial cluster /tr/ in *trim* heard as /dr/ indicates a lack of devoicing in /r/. Combined with vowel problems, these words were misheard as *boat* and *dream*, respectively.

Table 1: Responses with over 10 instances

Word	Responses (*n*)	Speaker (*n*)
course	*coast* (29)	B04/14 (4), B06/12/15 (3), B01/02/05/07/11/13 (2)
anchor	*uncle* (27)	B10/14 (4), B04/07 (3), B01/03/09/11 (2), B02/06/12/13/15 (1)
call	*cold* (21)	A06 (4), A03/08/10 (3), A02/13 (2), A04/05/11/12 (1)
port	*boat* (21)	A08/12/14 (3), A01/04/07 /10/15 (2), A03/06 (1)
tool	*two* (19)	A05/09 (3), A04/08/10 (2), A02/03/06/07/11/13/14 (1)
call	*coal* (16)	A13 (4), A01 (3), A05/07 /11 (2), A03/12/14 (1)
launch	*lunch* (16)	A04/06/10 (3), A11 (2), A01/07/13/14/15 (1)
mile	*mine* (15)	A01/06/13 (3), A07/11 (2), A02/15 (1)
crew	*clue* (14)	B03 (5), B01 (3), B02 (2), B07/13/14/15 (1)
pilot	*pirate* (14)	B06 (3), B04/07/11 (2), B02/03/10/14/15 (1)
pirate	*pilot* (14)	B08/15 (3), B03/04/14 (2), B01/13 (1)
trim	*three* (14)	A08 (5), A03 (3), A04/14 (2), A11/12 (1)
berth	*bus* (13)	B07 (5), B02/13 (2), B04/08/09/14 (1)
bridge	*breach/ breech* (13)	B14 (3), B01/04/07/11 (2), B01/09 (1)
bridge	*reach* (12)	B06/15 (3), B10 (2), B04/07/09/13 (1)
clear	*career* (12)	A14 (3), A02/07 (2), A01/04/10/13/15 (1)
clear	*Korea* (12)	A11 (4), A06 (3), A02/03/07/10/12 (1)
draft	*raft* (12)	B12 (3), B06/13 (2), B01/03/04/09/14 (1)
radar	*ladder* (12)	A12 (3), A06/07 (2), A02/04/08/14/15 (1)
trim	*dream* (12)	A07 (3), A04/09/15 (2), A06/12/14 (1)
alarm	*around* (11)	A14 (5), A13 (3), A02/10/11 (1)
bow	*boat* (10)	A12 (3), A02/04 (2), A01/05/11 (1)
order	*older* (10)	A03 (3), A15 (2), A02/05/06/07/10 (1)

(iii) Syllable structure: Problems related to syllable structure, notably consonant clusters, were observed. One example is *clear* which was heard as *career* and *Korea*. Both instances indicate a consonant cluster involving vowel insertion, along with an /l/ taken as /r/. Another example is dropping the initial consonant in clusters, as in *bridge* heard as *reach* and *draft* heard as *raft*.

3.2. Analysis by speaker

The average correct response rate of listeners who worked on Set A was 44.5% (*SD* = 9.4), and that of Set B was 48.9% (*SD* = 8.0), indicating high inter-speaker variation. To demonstrate individual differences, the performances of speakers who obtained the highest and lowest rates were compared for both sets: Speakers A09 (71.1%) and A02 (37.0%) for Set A and Speakers B08 (62.6%) and B12 (34.8%) for Set B.

A09 aimed for English-like pronunciation overall at both the segmental and suprasegmental levels. For instance, his *turbine* was realized as two syllables with stress on the first syllable and vowel quality /ɚː/ as the target. His dark /l/ was better understood than that of A02. By contrast, A02's pronunciation was in the opposite direction. His conspicuous *katakana* pronunciation apparently hindered intelligibility. Some examples are: *turbine* [tā.a.bi.ɴ] (problem with /ɚː/, misheard by listeners as *tavern, cabin, caravan*), *tool* [tsū.u.ru] (problem with word-initial consonant, leading to the responses *soon, Sue*), and *meter* [mē.e.ta.a] (problem with vowel, resulting in the responses *may tour, red heart*). It was evident that the replacement of English sounds with *katakana* pronunciations contributed to low intelligibility.

On the other hand, the comparison of B08 and B12 did not yield much difference in pronunciation competency. Both had problem areas typical of Japanese learners of English described above. The apparent differences between the two, however, were that the articulation of B08 was clearer with a slower speed and a wider pitch range than that of B12. Also, the voice quality of B12 was somewhat muffled, which might have made it difficult for listeners to identify words.

4. DISCUSSION

This section discusses the results of data analysis and their implications for pronunciation teaching.

4.1. The impact of global errors on intelligibility

Many of the misheard words reflected global errors (deviations due to L1 phonological/phonetic transfer) [12, 14]. Examples include problem with vowels /iː/-/ɪ/, /ʌ/-/æ/, /ɔː/-/oʊ/, /ɚː/, consonants /l/-/r/, /θ/-/s/, /f/, and consonant clusters, which do not exist in Japanese.

As for word stress, we found multiple instances of stress misplacement where the words were

successfully heard as the target words (e.g., *bárometer*, *cóntrol*). However, when stress was misplaced on an inserted extra syllable, intelligibility was strongly affected (e.g., *bridge* [búrɪdʒ] → *porridge*; *trim* [tórɪm] → *current*).

Since Japanese has a simple syllable structure (C)V, consonant clusters often pose a problem for Japanese speakers. Among a variety of word-initial clusters, this study showed that the /s/ clusters (e.g., *speed*) may not require practice, possibly because of a positive transfer of vowel devoicing in Japanese [7]. On the other hand, the /l/ and /r/ clusters often resulted in low intelligibility (e.g., *draft, bridge, clear*).

Among a number of phonetic problems exhibited by Japanese learners of English, prioritizing phonetic items that greatly impact intelligibility is key to successful pronunciation instruction [3, 11], although this requires thorough examination. One example is /l/ and /r/. Japanese teachers tend to spend more time practicing /r/ than /l/, since the latter is considered closer to Japanese /r/. However, the low intelligibility of simple monosyllabic words with the final dark /l/ (e.g., *full, call, tool, mile*) suggests a strong need to focus on /l/ in this position.

4.2. The impact of local errors on intelligibility

This study also suggested the negative impact of local errors (deviations idiosyncratic to individual words that cannot be explained by L1 transfer) [12]. Both *katakana* and Roman pronunciations contributed to low intelligibility. While the deviations described in this study are shared among many Japanese speakers, what makes Maritime English as ESP unique is limited specialized terms that learners must acquire. Such terms often have corresponding *katakana* loanwords and are memorized with representations that depart phonologically and phonetically from the original word. Eradicating persistent and fossilized *katakana* pronunciation may be challenging yet essential. In Japanese educational settings, learners often only master the written forms of such words. To acquire specialized terms for successful oral communication, word-level pronunciation instruction in which the written form, meaning, and spoken form go hand in hand is imperative [8, 16].

4.3. Variation among speakers

The wide range in individual speakers' intelligibility points to the importance of paying attention to individual differences. Even though speakers shared the same L1, their pronunciation problems varied greatly. For example, one learner consistently used Japanese /r/ for both English /l/ and /r/, and another learner was good at English /l/ but not /r/. In addition, some learners stuck to *katakana* pronunciation even though its use considerably reduced intelligibility, whereas others made an effort to achieve target-like pronunciation. Even speakers with the least number of misheard cases had pronunciation issues that required improvement.

Because each learner has their own list of points to improve, rather than teaching uniformly, tailored instruction and feedback for individual learners should be highly effective [10].

Additionally, it was observed that factors other than pronunciation, namely speech rate, clarity of articulation, and appropriate pitch range, are likely to affect intelligibility. At least at the word level, advising learners to pronounce each segment clearly and articulating the words at a slow speed may be beneficial.

4.4. The implications of the word-level intelligibility task and the limitations of the current study

In the current word-level task, the intelligibility of long polysyllabic words was higher than that of the monosyllabic words. The reasons may be twofold: First, a long word usually does not have a minimal pair word, and thus does not have a rival. Second, even when one syllable contains a deviation, a listener can use other syllables as clues to identify the word.

Despite the current study's interesting findings, careful interpretation is necessary. Intelligibility is a complicated issue, and it is impossible to pinpoint the underlying reason for each response because we cannot dissect what is happening inside a listener's mind as they perform the task. The influence of word familiarity, word frequency, and phonological neighborhood density should also be taken into account [17].

Furthermore, we cannot assume that the intelligibility of a word spoken in isolation is comparable to that of the same word used within a particular context. Deck officers communicate using phrases and sentences, rather than words in isolation. To help improve their intelligibility, both as speakers and listeners, intelligibility in a larger context needs to be investigated.

5. CONCLUSION

This study investigated the intelligibility of Maritime English terms at the word level. While L1 transfer partially explained the low intelligibility of the terms produced by Japanese deck cadets, the complicated interactions of individual differences in words and speakers yielded outcomes that cannot always be explained in a straightforward manner. To guarantee safe navigation at sea, intelligible and comprehensive pronunciation needs to be further pursued.

6. ACKNOWLEDGEMENTS

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