An auditory perception study investigated the ability of 104 Japanese university students, all learners of English as a second language, to distinguish between five English voiceless fricatives in nonsense syllables. Stimuli consisted of 75 tokens presented in consonant-vowel, vowel-consonant-vowel, and vowel-consonant syllables spoken within a varied-vowels environment and recorded by three native speakers of English. Response rates for each of the target sounds varied from 55 percent to 88 percent. Certain consonants posed greater difficulty than others, particularly in specific phonological environments. (MSE)
Recognition of Voiceless Fricatives by Japanese L2 Learners
1. INTRODUCTION
This paper presents the preliminary results of a perception test which was administered to 104 Japanese adult learners to examine their ability to distinguish between the English fricatives /f/, /θ/, /s/, /ʃ/, and /h/ in nonsense syllables. The stimuli consisted of 75 tokens (a total of over 23,000 responses) presented in consonant-vowel (CV), vowel-consonant-vowel (VCV) and vowel-consonant (VC) syllables spoken within a varied-vowel environment /i e a u o/ and recorded by three native speakers of English. Overall, the listener judgments observed in the perceptual experiment indicated the following response rates for each of the target sounds: /f/: (79%), /s/: (72%), /ʃ/: (88%), /θ/: (55%), and /h/: (79%).

2. METHOD
Subjects
The subjects were 104 Japanese adults ranging in age from 18 to 20 years old. They were first year students at the University of Aizu in Japan and were taking a course in English pronunciation. As is common in Japan, all had six years of prior English training at the junior and senior high school levels. The subjects had little or no formal training in English pronunciation. None of the subjects had any known speech or hearing impediments.

Recording Method
The speech samples were generated using a binaural recording system located in a large anechoic chamber at the University of Aizu. The talker was located approximately 2 meters from the Brüel & Kjær Head and Torso Simulator (Type 4128), using the Right Ear Simulator (Type 4158) and the Left Ear Simulator (Type 4159). The talker was positioned at ear level, but slightly off the median plane of the mannequin, at an azimuth angle of approximately 15 degrees. Listening to these binaural speech samples via headphones confirmed that this configuration gave a very clear auditory image that would not sound as if it were located in the center of the listener's head (a rather unnatural sensation associated with monaural listening). The samples were recorded at a 48 kHz sampling rate using a Denon Model DTR-80P digital audio recorder. The samples were reproduced via Sony HL-90 headphones in the University of Aizu Language Media Laboratory. The stimuli were presented at a mean presentation level of 69 dB in each ear.

Procedure
The subjects were asked to identify each syllable they heard as containing either /f/, /θ/, /s/, /ʃ/, or /h/. These were natural speech (nonsense syllables) produced by three phonetically-trained male native speakers of English. To avoid the problem of sequential ordering, the stimuli were recorded in three randomized blocks. Before the test, a brief introduction to each of the five fricative sounds was administered and five-choice answer sheets were handed out to the subjects. For each stimulus, the subjects marked one of five possible responses and were asked to give a response to each item even if they were unsure of the identity of the fricative they heard. Four separate groups of students participated in the test. There was a pause of five seconds between each speech sample.

3. RESULTS and DISCUSSION

<table>
<thead>
<tr>
<th></th>
<th>/f/</th>
<th>/θ/</th>
<th>/s/</th>
<th>/ʃ/</th>
<th>/h/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>39%</td>
<td>33%</td>
<td>56%</td>
<td>79%</td>
<td>314</td>
</tr>
</tbody>
</table>

The /ʃ/ had the highest correct response rate at 88%, and /s/ was the third highest at 71%. The confusability between these two fricatives was quite high, particularly within the /f/ vowel in CV and VCV syllables. Here, the
number of /s/ responses for /f/ and the
number of /f/ responses for /s/ increased considerably. (See Table 2.) Excluding syllables with the /i/ vowel, the correct response rate of /f/ was 96%.

Table 2. The response rates of /f/ and /s/ within /i/ (in percentages).

<table>
<thead>
<tr>
<th>/f/</th>
<th>/s/</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.84</td>
<td>41.29</td>
</tr>
<tr>
<td>49.68</td>
<td>42.58</td>
</tr>
<tr>
<td>7.74</td>
<td>85.16</td>
</tr>
<tr>
<td>72.17</td>
<td>12.94</td>
</tr>
<tr>
<td>56.77</td>
<td>14.84</td>
</tr>
<tr>
<td>43.87</td>
<td>2.26</td>
</tr>
</tbody>
</table>

The /θ/ was the most difficult fricative for the Japanese subjects to perceive. There were more /θ/ responses for /s/ (25%) and /s/ responses for /θ/ (28%) than responses from any other fricative, although the number of /f/ responses for /θ/ was quite high at 13%. (See Table 1.)

The response rates of /θ/ and /s/ also appeared to be influenced by vowel and syllable context. When the /e/ vowel was excluded, the correct response rate of /θ/ within VC syllables increased from 39% to 75%. Also, within the /e/ vowel, the response rate of /s/ increased considerably in all syllable positions. (See Table 4.)

The /f/ and /h/ both had the second highest response rate at 79%. At first glance, the overall response rate of /h/ was high. However, within the /u/ vowel, the response rates of both /f/ and /h/ significantly decreased, and the confusability between these two fricatives increased. When the /u/ vowel was excluded, the response rate of /h/ within CV and VCV syllables was 95%. Also, within the /u/ vowel, the number of /h/ responses for /f/ increased considerably within CV and VCV syllables. The number of /θ/ responses for /f/ within the /u/ vowel was also quite high. (See Table 3.)

Table 3. The response rates of /f/ and /h/ within /u/ (in percentages).

<table>
<thead>
<tr>
<th>/f/</th>
<th>/h/</th>
</tr>
</thead>
<tbody>
<tr>
<td>56.45</td>
<td>12.90</td>
</tr>
<tr>
<td>7.51</td>
<td>35.55</td>
</tr>
<tr>
<td>66.67</td>
<td>9.71</td>
</tr>
<tr>
<td>43.55</td>
<td>2.26</td>
</tr>
<tr>
<td>55.81</td>
<td>43.23</td>
</tr>
<tr>
<td>52.26</td>
<td>42.26</td>
</tr>
</tbody>
</table>

Table 4. The response rates of /θ/ and /s/ within /e/ (in percentages).

<table>
<thead>
<tr>
<th>/θ/</th>
<th>/s/</th>
</tr>
</thead>
<tbody>
<tr>
<td>36.77</td>
<td>24.52</td>
</tr>
<tr>
<td>21.94</td>
<td>48.71</td>
</tr>
<tr>
<td>21.94</td>
<td>36.45</td>
</tr>
<tr>
<td>0.65</td>
<td>9.71</td>
</tr>
<tr>
<td>0.00</td>
<td>89.68</td>
</tr>
<tr>
<td>0.00</td>
<td>85.48</td>
</tr>
</tbody>
</table>

4. CONCLUSIONS
Overall, the results suggest the subjects had the most difficulty perceiving the English fricatives /θ/ within /e/, /f/ and /s/ within /i/, and /f/ and /h/ within /u/. The subjects had the least difficulty perceiving /s/ within /e/, /f/ in VC syllables within all vowel positions except /i/, /h/ in CV and VCV syllables, excluding /u/, and /f/ in all three syllable positions, excluding /u/.

ACKNOWLEDGMENT
We wish to extend our special appreciation to William Martens for his assistance in the recording and for his other invaluable input into the study.
Title: Recognition of Voiceless Fricatives by Japanese L2 Learners

Author(s): Jonathan Berman, Brian Nelson, and Stephen Lamberger

Corporate Source:

Publication Date:

I. DOCUMENT IDENTIFICATION:

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, Resources in Education (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK one of the following two options and sign at the bottom of the page.

Check here For Level 1 Release: Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical) and paper copy.

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Level 1

Check here For Level 2 Release: Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical), but not in paper copy.

The sample sticker shown below will be affixed to all Level 2 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Level 2

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Printed Name/Position/Title: Jonathan Berman Asst. Prof

Telephone: 0242-37-2597

E-Mail Address: berman@u-tkyo.ac.jp

Date: 5/20/98
III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:

Procedures of the Acoustical Society of Japan, 1997

Address:

E-keda - Building, 2-7-7, Yoyogi, Shibuya, Tokyo 151-00 53

Japan

Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:

Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

ERIC Clearinghouse on Languages & Linguistics
1113 22nd Street NW
Washington, D.C. 20037

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
1100 West Street, 2d Floor
Laurel, Maryland 20707-3598

Telephone: 301-497-4080
Toll Free: 800-799-3742
FAX: 301-953-0263
e-mail: ericfac@inet.ed.gov
WWW: http://ericfac.piccard.csc.com