Comparing Selection-Based and Topography-Based Language Systems with Verbal Adults Learning Japanese Words

Matthew A. Stratton
Western Michigan University

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COMPARING SELECTION-BASED AND TOPOGRAPHY-BASED LANGUAGE SYSTEMS WITH VERBAL ADULTS LEARNING JAPANESE WORDS

by

Matthew A. Stratton

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Masters of Arts
Department of Psychology

Western Michigan University
Kalamazoo, Michigan
April 1993
This study compared selection-based with topography-based learning of similar
deral relationships. In two previous studies, using developmentally disabled subjects,
topography-based relations were easier to learn. The previous researchers suggested
that the advantage of a topography-based system would increase as the number of
relations to be learned increased.

To investigate this possibility, the present study used a 5 and 20-stimulus
version of each system. Four independent groups of seven college students each were
used in a two by two design. The selection-based task consisted in learning to point to
the Japanese character appropriate for each English sample. The topography-based task
consisted in learning to say the Japanese word for each English sample.

With the 5-stimulus task, both kinds of verbal relations were about equally
difficult to learn, but with the 20-stimulus task the selection-based relations were easier
to learn than the topography-based relations. These results contradict the earlier
findings.
ACKNOWLEDGMENTS

I would like to thank Dr. Satoru Shimamune for stimulating my interest in this area of research and for all of his extra time and patience through the entire project. I would also like to extend my appreciation to Dr. Jack Michael for his extra time and interest in this project and to Dr. Al Poling for his cooperation throughout my course work. Thanks to Dr. Anna Kay Campbell and to Dr. Bill Redmon for their cooperation.

My greatest appreciation is to Marsha Koteskey for her help and patience during this research. I would like to thank all of the students who gave their time to participate in this study.

Matthew A. Stratton
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Comparing selection-based and topography-based language systems with verbal adults learning Japanese words

Stratton, Matthew Allen, M.A.

Western Michigan University, 1993
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INTRODUCTION

Michael (1985) was the first to make a distinction between topography-based and selection-based language systems. The two different language systems facilitate learning at different rates when studying novel stimuli presented to members of the developmentally disabled population. This fact alone stimulated the interest in determining how these two language systems would affect learning with a population that has obtained good scanning and verbal skills (e.g., college students). Michael describes topography-based verbal behavior as verbal behavior where two verbal operants (e.g., saying "cat" and saying "dog") differ from one another in the action of the various components of the vocal musculature (or movements of various muscles used when making signs) as well as in terms of the controlling variable (e.g., seeing a cat or seeing a dog). Selection-based verbal behavior occurs when the speaker responds by pointing to or touching a stimulus (e.g., upon seeing a cat the speaker points to a symbol for a cat). The foundation of these verbal operants and a behavioral analysis of verbal behavior was discussed by Skinner (1957).

There are three important differences between topography-based and selection-based systems (Michael, 1985). One is that selection-based systems involve conditional discriminations, in which two primary controlling variables exist. For example, one stimulus, the physical appearance of a cat, alters the controlling strength of another stimulus over the pointing response, a picture or symbol of a cat. However, topography-based systems involve only one controlling variable (e.g., a cat). An experiment that exemplifies selection-based verbal behavior is the Lana project conducted by Rumbaugh (1977). Lana, a chimpanzee, was taught to use a selection-based communication system where her responding consisted in pressing different

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buttons on each of which was an abstract symbol or lexigram. Thus she named an object in a tact relationship by pressing the button with the correct symbol on it when she was shown the object. The conditionality of this relation is seen in that the object as a stimulus controlled the controlling effectiveness of the particular symbol over the pressing response.

Secondly, topography-based systems always involve point-to-point correspondence between the response form and the response product. For example, when one makes a vocal response, the actions that the vocal muscles make, directly correspond to the details of the resulting response-produced stimulus (i.e., the word spoken). In selection-based systems the muscle actions of the pointing response do not directly correspond to the important features of the stimulus selected. In other words, the topography of pointing is the same regardless of the stimulus pointed at.

Finally, scanning behavior is required to select the correct stimulus when using the selection-based system. Not all of the stimuli the selection is made from can be viewed at the same time, which makes it possible for the correct stimulus to be overlooked. This is not the case with the topography-based system. It is important to determine the extent that these language systems influence learning, especially when teaching verbal behavior to those whose verbal repertoires are seriously deficient (Michael, 1985).

Sundberg and Sundberg (1990) compared the effectiveness of the two language systems with the developmentally disabled population. They used sign language as the topography-based system and a small symbol board as the selection-based system. They found that the selection-based system required more trials than the topography-based system for the subjects to meet the mastery criterion. They also found that the percentage of correct responses for the selection-based system was lower than for the topography-based system. Based on the results, Sundberg and Sundberg advocated
the teaching of sign language to the developmentally disabled population because the language was easier to learn than pointing systems. They pointed out a limitation for the topography-based system. For the speaker to be trained, subjects must have demonstrated enough manual dexterity which allowed them to make the signs. In support of the research results obtained above, similar results were found in two other studies (Wraikat, 1991; and Wraikat, Sundberg, & Michael, 1991) using the same kind of subjects.

Although the work with the developmentally disabled subjects would seem to confirm Michael's speculation about these two language systems, further research is clearly called for. In addition to directly replicating the results with developmentally disabled subjects, since the previous research involves only a small number of such subjects, it is important to provide some systematic replication, with other kinds of subjects, different kinds of stimuli, task variations, etc. A systematic replication that is relatively easy to accomplish, and will also permit a considerable increase in the number of subjects would be with normal college students. If the college students do not show the same kinds of differences, then a closer look at the underlying theory is certainly called for.

With the normal subjects it is also relatively easy to investigate the proposal that as the number of verbal relations increases, the advantage of a topography-based over a comparable selection-based system should increase because of the increased difficulty of scanning the collection of stimuli in the selection-based system. In other words, the size of the stimulus set should influence learning speed more in the selection-based system than in the topography-based system. It would be difficult to test this hypothesis with the developmentally disabled population because of their poor scanning and verbal skills.
The purpose of this study, then, is to determine whether a topography-based system is easier to learn than a comparable selection-based system for normal adults who have already acquired a good verbal repertoire. Assuming some differences are found between the two systems, a secondary purpose is to see how these differences are related to the size of the set of verbal relations to be learned, and thus to investigate the possible role of the scanning requirements of the selection-based system.

Japanese words (names of common animals) and Japanese language symbols (Kanji characters) were used as learning material. In the topography-based system, the subject learned to say a Japanese word when the corresponding English word was presented. In the selection-based system the subject learned to select a Kanji character, from a list of such characters, when the English word was presented. There were two conditions for each language system, one with a set of 5 words and symbols, the other with a set of 20 words and symbols. It was of course expected that the larger set would be more difficult to learn, but the important factor was the possible interaction between type of language system and size of the sample set. If scanning difficulty differentially affects the selection-based system any differences in favor of the topography-based system should be larger with the larger stimulus set.

Sundberg and Sundberg, in the first study in this area, and also Wraikat et al., were interested in the possible differential development of equivalence relations with the two language systems, as well as the differential ease of learning. In both studies, the subjects had learned to name abstract or meaningless objects either by making a manual sign (topography-based system) or by pointing at a symbol (out of a set of three) on the modified symbol board. They had also learned to make the sign or point to the symbol when the experimenter spoke the name (a nonsense word) of the particular object. The first relation was referred to as a tact, and the second as an intraverbal relation. The test for equivalence consisted in presenting the subjects with all three objects, then speaking
the nonsense name of the object, and asking them to indicate which object had that name. This was not a task with which they had any training, and is similar to the typical test for transitivity in equivalence research (for example, Sidman & Tailby, 1982). With the present research arrangement it is possible to study another aspect of equivalence, symmetry, where a comparison stimulus from a previously learned conditional discrimination task is presented as the sample, with the previous samples as comparisons. Such a test might also reveal interesting differences between the two language systems.
METHOD

Subjects

Twenty eight college students from Western Michigan University, 12 males and 16 females, participated in this study. They were randomly assigned to one of four experimental groups. All subjects signed an informed consent before their participation in the study. This was reviewed and approved by the Human Subjects Institutional Review Board at Western Michigan University.

Setting

The experiment was conducted in an experimental laboratory (18 ft. X 28 ft.). The subject sat with an experimenter in front of a desk. On the desk, was a Macintosh personal computer system (computer, monitor, keyboard, mouse, and printer) used to control the experiment and collect data.

Apparatus

The monitor display was used as the main source of stimulus presentation. A copy of the screen which shows a stimulus configuration used in the selection-based system is shown in Figure 1.

The subject used a mouse in the selection-based system to select the correct stimuli from the screen. HyperCard version 2.0 (Apple Computer, 1989) was used to develop a program used in the study. The program presented stimuli, recorded the subjects' responses, and summarized the data including the reaction time.
Select the Kanji Character for CLAM

<table>
<thead>
<tr>
<th>X * X X X</th>
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<tbody>
<tr>
<td>X X X X</td>
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<td>X X X X</td>
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<tr>
<td>X X X X</td>
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<tr>
<td>X X X X</td>
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</tbody>
</table>

* Note the "X" is substituted for the actual Kanji Characters.

Figure 1. A Sample of the Computer Screen Used for Stimulus Presentations.

Stimuli

Twenty words were selected as learning material. All are names of animals (e.g., dog, pig, etc.) and have two syllables when said in Japanese (e.g., i-nu, bu-ta, etc.). No special effort was made to control for similarities between Kanji characters. The 5 stimuli used in the 5-stimulus sets were randomly selected from the 20 stimuli. These 5 were used during the whole experiment, for each subject. All the 20 stimuli from both learning systems are displayed in Appendix A, page 30.

Procedures

The experiment consisted of three components: pre-training, training and, a symmetry test, all of which took place in each session. Each session lasted twenty
minutes to ninety minutes depending on the number of stimuli the subjects were required to learn (i.e., 5 or 20). The pre-training phase introduced the stimuli and correct responses to the subjects. The training phase consisted of blocks in each of which all stimuli from a stimulus set were presented in random order. The training phase continued until a mastery criterion was met.

Selection-based System

During the pre-training phase in the selection-based system, each trial started with the presentation of an English word (sample stimulus) and the corresponding Kanji character (matching stimulus). Then the subjects were asked to select the character (by moving the cursor with the mouse and clicking the mouse on it) from a list of characters (comparison stimuli) presented on the computer screen (see Figure 2).

When the subjects selected the correct Kanji character, the computer presented "good" on the screen and a corresponding auditory stimulus for reinforcement. The computer then presented an inter-trial-interval of 5-s, a blank screen, followed by the next trial. If the subject selected an incorrect comparison stimulus, or if the subject failed to respond within 20-s, the computer presented "try again" on the screen along with a corresponding auditory stimulus. Then the computer also presented the correct matching stimulus again. This process continued until the subject selected the correct Kanji character for the corresponding sample stimulus. The subjects received stimuli in random order during this phase. Each stimulus was presented once or until one correct choice was made. Presentation of the complete set of stimuli in this manner is called a "block."

The training phase immediately followed the pre-training phase. Each trial proceeded exactly as in the pre-training phase, except that no correct matching Kanji character was presented at the beginning of the trial. The phase continued until the
subject finished three consecutive blocks of correct responses. A response was not counted as incorrect unless an incorrect response was made. Trials in which no response was made were not counted as incorrect. However, this failure to respond did not count as a correct response either. This means that to demonstrate mastery, the subject had to make 15 consecutive correct responses in the 5-stimulus set, and 60 consecutive correct responses in the 20-stimulus set.

Topography-based System

For the topography-based system, the computer screen was divided so as to block the subject's view of the experimenter's side of the screen (see Figure 3). This was necessary because the experimenter had to see the correct response (e.g., "i-nu").

In the pre-training phase, the subjects were shown an English word, and the
Figure 3. Topography-based Screen Showing Subject and Experimenter Sides of Screen.

The experimenter vocally modeled the correct Japanese word. The subjects were then instructed to repeat the Japanese word. The experimenter entered the data into the computer by moving the cursor over one of two possible buttons (correct or incorrect) and then clicking the mouse to select the appropriate button contingent on the subject's response. For example, if the subject said the correct Japanese word when presented with the English sample word, the experimenter would move the cursor over the correct button and then click the mouse. Then the computer would record the subject's response as correct for that trial. In all other aspects the session was conducted exactly the same as in the selection-based phase.
The training phase immediately followed the pre-training phase. In the training phase, no model stimulus was given to the subject unless an incorrect response was made. In all other aspects the session was conducted as in the pre-training phase. The criterion for mastery, three consecutive blocks of correct responses, was the same as in the selection-based training phase.

**Independent Variables**

The study explored the combination of two factors; one was language systems (i.e., selection-based and topography-based), and the other was the size of the stimulus set (i.e., 5 stimuli for one condition and 20 stimuli for another condition). The combination produced four experimental groups. Each group had 7 subjects randomly assigned. A between groups comparison design was used to examine the effects of the two independent variables.

**Dependent Variables**

**Ease of Acquisition**

Ease of acquisition was measured by the number of blocks required until the mastery criterion was met (excluding the last three blocks), and the number of incorrect responses in each block for each condition.

**Reaction Time**

Reaction time was the duration between the onset of the sample stimulus and the onset of the response. The computer program measured reaction time for both systems. However, the reaction time for the topography-based system included the time the experimenter needed to judge the subject's response.
Symmetry Performance

Symmetry is one of the three stimulus-response relationships that constitute stimulus equivalence, and is demonstrated when the sample/comparison relations of a previous conditional discrimination can be reversed with no further training (Sidman et al., 1982). In the selection-based system, a test for symmetry consisted in asking the subject to circle a written English word when given a written Kanji character. Each page had the comparison stimuli from that subject’s session printed on it (this time English words functioned as comparison stimuli) along with one Japanese sample stimulus. The 5 stimulus sets had five English words to choose from and the 20-stimulus sets had twenty English words to choose from. Each subject was tested for symmetry three times for each Japanese sample stimulus (e.g. for the 5-stimulus sets the subject responded three times to each of the five Japanese sample stimulus totaling fifteen symmetric relationships). For the topography-based system the procedure was exactly the same as with the selection-based system, except that the subject was required to circle a written English word when the experimenter gave the Japanese word vocally. This test was administered immediately after the training phase. The percentage of correct responses was taken as the measurement of symmetry.

Reliability

Trials were recorded as correct or incorrect. The reliability observer, a registered nurse who volunteered her time, was trained to recognize the Japanese words (as seen on the screen and spoken by the subject) in the topography-based system. The observer used a pen and paper to score the word and sat near the subject so that she could hear the subject’s response and could see the computer screen. The
observer could not see the experimenter's record of the subject's responses. Reliability percentages were calculated as

\[
\frac{\text{trials in agreement}}{\text{(trials in agreement) plus (trials in disagreement)}} \times 100
\]

No reliability data were collected for the selection-based system. That is, the computer automatically recorded the subjects' correct and incorrect responses and could not make a mistake. Therefore, no reliability measure by an observer was required. The program was thoroughly check at several different occasions to be sure it was functioning properly.

Reliability data for both training and symmetry tasks were collected for three of the seven subject/sessions from each of the topography-based groups (5-stimulus and 20-stimulus) for a total of 6 subject/sessions in all.
RESULTS

Inter-observer Agreement

Inter-observer agreement for the topography-based 5-stimulus set was 100 percent for the three subjects for both the training session and the symmetry test. Agreement for the topography-based 20-stimulus set for the three subjects was 100, 99.3, and 98.8 percent for the training session and 100 percent for all subjects during the symmetry test. No agreement measures for the selection-based subjects were obtained due to the computer presenting and recording all of the data; no reliability observer was needed or used.

Blocks to Mastery

All of the subjects reached the criteria for mastery within 0 to 21 blocks. Figures 4, 5, 6, and 7 show the typical response patterns for one subject from each of the four conditions.

Table 1 shows the average number of blocks needed to demonstrate mastery and the range for each experimental group. For the selection-based and the topography-based systems, the average number of blocks needed for subjects to demonstrate mastery was smaller for the 5 stimulus set than the 20 stimulus sets. The average number of blocks needed to demonstrate mastery with the 5-stimulus set was approximately the same for the two language systems. For the 20-stimulus set, the subjects in the topography-based system required more blocks than the subjects in the selection-based system. An analysis of variance showed that the main effect of language system was not significant (p > 0.08), but the interaction between language
Figure 4. Typical Response Pattern for Subject Number 12 When Tested With Selection-based 5 Stimuli Set.

Figure 5. Typical Response Pattern for Subject Number 23 When Tested With Selection-based 20 Stimulus Set.
Figure 6. Typical Response Pattern for Subject Number 5 When Tested With Topography-based 5 Stimuli Set.

Figure 7. Typical Response Pattern for Subject Number 25 When Tested With Topography-based 20 Stimuli Set.

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system and number of stimuli in the set was significant ($p < 0.05$). In other words, as the stimulus size increases, the subjects in the topography-based system required more practice than the subjects in the selection-based system.

Table 1
Average Number of Blocks to Demonstrate Mastery and Range for Each Group

<table>
<thead>
<tr>
<th>Stimulus-set Size</th>
<th>5</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topography-based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocks to Mastery</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Range</td>
<td>1 to 7</td>
<td>5 to 21</td>
</tr>
<tr>
<td>Selection-based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocks to Mastery</td>
<td>3.71</td>
<td>7.57</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 10</td>
<td>3 to 14</td>
</tr>
</tbody>
</table>

Reaction Time

The average reaction time over the last three blocks for the selection-based system was greater than the reaction time for the topography-based system as can be seen from Table 2.

For the topography-based 5- and 20-stimulus sets, the average was 1.82 s and 2.10 s respectively. The reaction time for selection-based 5 and 20 sets were 4.45 s and 5.42 s respectively. Due to the experimenter entering the subject's response into...
Table 2

Average Reaction Time for Each Group

<table>
<thead>
<tr>
<th>Stimulus-set Size</th>
<th>5</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topography-based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Reaction Time for Last 3 Blocks</td>
<td>1.82 s</td>
<td>2.10 s</td>
</tr>
<tr>
<td>Selection-based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Reaction Time for Last 3 Blocks</td>
<td>4.45 s</td>
<td>5.42 s</td>
</tr>
</tbody>
</table>

the computer, the reaction time for the topography-based condition was slightly inflated. This problem was corrected by taking an average of the experimenter's reaction time and subtracting it from the average reaction time for the subjects trained in the topography-based system. The experimenter's reaction time was obtained by recording the time between the subject's response and the experimenter's response (i.e., clicking of the mouse) with a stopwatch for several trials during several sessions, then averaging these numbers. The numbers above reflect the corrected average reaction times for the topography-based system. An analysis of variance showed that the main effect for language systems was statistically significant ($p < 0.01$). The effect of stimulus group size was also significant ($p < 0.05$). These data were expected because the increased reaction time revealed in the selection-based system was a result of the subject's scanning behavior required to locate the correct Kanji character. This is opposed to merely responding vocally as in the topography-based system, which eliminates the scanning behavior described above.
Error Analysis

This error analysis was made in order to see if a particular pair of stimuli were harder to discriminate between than other pairs. If there were more of such pairs in one group (e.g., in the 5-stimulus set) than another (e.g., 20 stimulus set) the difference in performance between the groups might have been attributed to the difference in the difficulty of the discrimination. The error analysis showed that the subjects were not repeating the same incorrect responses to the same comparison stimuli. Most subjects made only one incorrect response to a specific comparison stimulus given a specific sample. Only one subject made many more incorrect responses than any other subject, and this subject repeated the same errors several times. Another subject made two incorrect responses to the same comparison, and three subjects made three incorrect responses to the same sample. To determine if the five stimuli used in the 5-stimulus group were more difficult to learn than the other fifteen in the 20-stimulus group, the percentage of errors made to those five stimuli were compared to the errors made to the other fifteen stimuli from the 20-stimulus set. Since those five stimuli made up 25% of the stimuli in the 20-stimulus set, a percentage close to 25 was indicative that those stimuli were equally as difficult to learn as the other 15. For the selection-based system, 28% of the errors made in the 20-stimulus set were made to the 5 stimuli that were also used in the 5-stimulus set. For the topography-based system, 26% of the errors made in the 20-stimulus set were made to the 5 stimuli that were also used in the 5-stimulus set.

Symmetry Performance

Table 3 shows the summarized data for the symmetry performance in the topography-based and selection-based systems. For the topography-based system, all
subjects scored above 91%. For the selection-based system, one subject scored 87% and all of the other subjects scored 95% or above. Therefore, the subjects in both systems had very little trouble demonstrating symmetry with this type of learning task.

Table 3
Percentage of Correct Scores on Symmetry Tests

<table>
<thead>
<tr>
<th>Topog. 5 Stim.</th>
<th>Topog. 20 Stim.</th>
<th>Selec. 5 Stimuli</th>
<th>Selec. 20 Stimuli</th>
</tr>
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<tbody>
<tr>
<td>Subj. %</td>
<td>Subj. %</td>
<td>Subj. %</td>
<td>Subj. %</td>
</tr>
<tr>
<td>#3 100</td>
<td>#6 98</td>
<td>#1 100</td>
<td>#2 100</td>
</tr>
<tr>
<td>#5 100</td>
<td>#8 100</td>
<td>#4 100</td>
<td>#7 100</td>
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<tr>
<td>#9 100</td>
<td>#14 98</td>
<td>#10 100</td>
<td>#11 100</td>
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<tr>
<td>#13 100</td>
<td>#16 92</td>
<td>#12 100</td>
<td>#18 100</td>
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<td>#17 100</td>
<td>#19 97</td>
<td>#15 100</td>
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<td>#24 100</td>
<td>#21 95</td>
<td>#22 87</td>
<td>#23 95</td>
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<tr>
<td>#27 100</td>
<td>#25 95</td>
<td>#28 100</td>
<td>#26 98</td>
</tr>
</tbody>
</table>
DISCUSSION

In the present study, with the 20-stimulus set, the selection-based system was easier to learn than the topography-based system. The topography-based 20-stimulus task took an average of six more blocks to master than the selection-based task. This result is clearly inconsistent with the previous studies using developmentally disabled subjects, where the topography-based task was much easier to learn. With the 5-stimulus task the two systems were about equally easy to learn, which is also not what would be expected in terms of the previous research results. The previous studies both used very small stimulus sets, and the present results now raise the question whether the selection-based system might have been easier than the topography-based for the developmentally disabled subjects if the size of the stimulus set had been larger.

Reaction time data support the notion that the selection-based system requires scanning responses, but this requirement clearly did not result in the selection-based task becoming more difficult than the topography-based task. Comparison stimuli for each trial during the selection-based testing were also randomized. That is, the locations of the comparison stimuli were randomized when presented in the 4 by 5 matrix for each trial. This probably served to slightly inflate the reaction times for the selection-based systems, and was probably unnecessary.

The similar performances of the two groups with the 5-stimulus set of stimuli may be in part a floor effect, in that this task seemed very easy for the subjects used in this experiment. The clear superiority of the selection-based group with the 20-stimulus set, however, strongly implies that, at least with normal subjects, further analysis of the variables affecting task learning is necessary. The topography-based task is essentially learning 20 new foreign words for 20 English words. There are
clearly two aspects to this task: learning to say the foreign words as units, and learning to say the correct one when the English word is shown. The first aspect of the task is made somewhat easier if the foreign words are composed of familiar verbal syllable units, as was the case here. The subjects in this experiment did not have to acquire any new non-English phonemes (as in trying to learn to make a correct German umlaut sound), but only to learn new two-syllable combinations as units. The other aspect of the task consists in acquiring an increasingly strong tendency to emit the appropriate new unit in the presence of a particular English word. These two aspects of the task were learned together in the present experiment, and all 20 relationships were acquired at the same time. An alternative approach might have been to teach a small number of relations, for example five, and only when they were mastered would the next five be learned, etc.

The selection-based task consists in learning to identify the Kanji symbol, which for these subjects is essentially a nonsense shape, that goes with each of the twenty English words. For a good performance each English word as a visual stimulus must result in a clear increase in the controlling strength of one and only one particular Kanji character over some kind of identifying response. A typical subject probably looked at the English word on the screen, which was a familiar animal name, and then said the word to herself as she looked at the 4 by 5 matrix of Kanji symbols. Being able to say the word would make it unnecessary to look again at the word as the symbols in the matrix were being inspected, but it is not clear whether or not this functioned as much of an improvement over having to frequently reexamine the word. For these highly verbal subjects the relations among a familiar word as a visual stimulus, the possible stimulus feedback resulting from saying the word overtly or covertly, possible imagery, and possible other verbal responses related to the particular animal that was named, are all closely linked in the subjects' repertoires. This probably
means that the effect of the reinforcement of being correct is an increase in the controlling relation between the written word and the control by the particular Kanji character over an identifying response, even if the written word was not functioning as a visual stimulus at the moment of reinforcement (if the subject had stopped looking and was instead repeating the word covertly). Here too, all twenty relations were being learned together, rather than learning a small number before being presented with the others. Looking at the two tasks in terms of these aspects it is possible to arrive at some possible reasons for the experimental results.

1. In the topography-based task twenty new two-syllable units must become a part of the subjects' repertoires, whereas no new topographies are required in the selection-based task.

2. With the selection-based task all symbols are available to be selected in the 4 by 5 matrix on the screen as one looks at or repeats the English word. It is probably not correct to characterize the topography-based task as a search for the correct word among a set of twenty readily available repertoire units. An unlearned relation may involve a Japanese term that is not yet a topographical unit, and even if the two-syllable unit has been strengthened by previous exposure, its availability is nothing like the availability of the correct Kanji character in the 4 by 5 matrix on the screen.

3. Both tasks become simpler as each stimulus-response relationship is learned, but being able to say the Japanese term for the English snake does not help as much in being able to say the term for cat as being able to eliminate the Kanji for snake helps by reducing the number of remaining Kanji symbols as one looks for one that seems to go with cat.

These three points all lead to the conclusion that the selection-based system should be the easiest to learn. In addition, the scanning requirement of this system,
although possibly time consuming, didn’t seem to detract much, if at all, from the ease of learning of the selection-based system.

Another factor that may make the learning of the selection-based relations easier than one might first expect is the capacity of these subjects to take advantage of learning strategies, such as noting similarities between the animal named in English, or of some feature of the word itself, and some aspect of the correct Kanji character. One subject said out loud that the Kanji character for cat looks like the whiskers of a cat. Such vocal or private prompts would certainly serve to facilitate learning for the subjects used in this experiment, and it is quite possible that such strategies are not as available for the topography-based task.

Although no empirical comparison of the two verbal systems with respect to these various task components is currently available, the analysis seems quite reasonable, and involves no particularly controversial issues. If it had not been for the earlier writings of Michael (1985), Sundberg and Sundberg (1990) and Wraikat et al. (1991) it is unlikely that the present experiment would have been carried out. Therefore, it is the conflict with the earlier theory and results that becomes the most important issue for this discussion. Perhaps the issue can be considered in terms of two questions. Given the kind of obvious analysis that is available, why did the earlier workers expect the topography-based system to be easier, more effective in use, better retained, etc.? Why were their results so different from the results of the present experiment?

The answer to the first question is probably related to the context in which that research arose, namely the need to develop some form of verbal behavior in subjects who had none, or very little. This is also a context in which one is led to think about the development of language in a normal infant. Considering the three numbered advantages listed above, neither the second (all symbols available), the third (as one
relation is learned the number of remaining relations is reduced), nor the advantage of available learning strategies would seem very relevant to first language learning. Only the first disadvantage of the topography-based system, having to learn new topographical units, is easy to relate to first language learning, and this would seem to occur gradually with early units developing and being well controlled by independent variables (establishing operations and SDs) before new units are learned. In any case, such a context difference may at least partially explain the earlier experimenters' expectations. Another factor may be a generally negative reaction on the part of these earlier researchers toward the symbol-board movement (versus training in sign language) in current language training work with the developmentally disabled (J. Michael, personal communication, September 24, 1992).

With respect to the question about the discrepancy between the present and the earlier results, there are several possible explanations. First, irrespective of the differences between the present procedure and that of the other studies, it is possible that the earlier results cannot be replicated. Only a few subjects were used, and some as yet unrecognized aspect of the procedure may have unfairly favored the topography-based system. Extensive replication is needed with more developmentally disabled subjects, using a variety of visual stimuli to be learned as discriminative stimuli for the verbal responses and as stimuli to be selected, and using a variety of different kinds of topographies as responses. These previous studies only involved a very small number of verbal relations to be learned, and it is possible that the findings with such a small number may be replicated, but that the relative ease of learning the two systems may reverse as the number of relations increases.

Assuming that the results with the developmentally disabled clients can be replicated, and that they occur in the same direction when a considerably larger number of relations is being learned, the most obvious explanation of the contradiction is in
terms of the well-developed verbal repertoires of the subjects of the present study.
However, exactly how this well-developed repertoire results in the selection-based system being considerably easier to learn is at present unclear, although further research as described below can certainly contribute to our understanding of these results. The four factors listed above (no new topographical units, all stimuli to be selected available, ready reduction of the set size as learning is taking place, and available learning strategies) that favored the selection-based system certainly seem reasonable. Another difference is possibly related to the present subjects' familiarity with the English words used as sample stimuli. The sample stimuli of the earlier research were nonsense objects, chosen to avoid resembling any objects that the subjects would have had any experience with. The earlier studies also used manual signing as the topography to be learned, and it is possible that with vocal responses different results would have been obtained, even with the same subjects.

The present results, and their clear difference from the earlier ones, suggest several possible further studies using essentially the same methodology and type of subjects. An improvement in the present methodology might involve simply a change in the number of relations to be learned, with 10 and 25 stimuli instead of 5 and 20. It seemed that the 5-stimulus set was too easy for the subjects in both learning systems. Another might be to use nonsense syllables or nonsense pictures or other foreign language characters as sample stimuli, instead of familiar English words. This would possibly make the task somewhat more like early language learning. Another possibility would be to program the learning with both systems, in the sense that only a few relations would be learned at a time, and new ones not attempted until the previous ones were mastered. Further work with subjects whose verbal and scanning skills are less effective than those of the present college student subjects, but still better than those of the very low functioning subjects of the earlier work. In this respect, work
with higher functioning developmentally disabled individuals, or with normal subjects but who have suffered some form of traumatic brain injury, or possibly with aged subjects with memory deficits.
Appendix A

All Stimuli Including English Words, Japanese Words, and Kanji Characters
## Appendix A

**English Words and the Topography- and Selection-based Equivalents**

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<td>SHIKA</td>
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<td>熊</td>
<td>CUMA</td>
<td>*CAT</td>
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<td>BUTA</td>
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<td>象</td>
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* Indicates Stimuli used for 5 stimulus set

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Appendix B

Approval Letter From Human Subjects
Institutional Review Board
Date: April 13, 1992
To: Matthew Stratton
From: Mary Anne Bunda, Chair
Re: HSIRB Project Number: 92-03-41

This letter will serve as confirmation that your research protocol, "Comparing Selection-Based Topography-Based Language Systems with Verbal Adults Learning Japanese Words" has been approved under the exempt category of review by the HSIRB. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the approval application.

You must seek reapproval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date.

The Board wishes you success in the pursuit of your research goals.

xc: Poling, Psychology

Approval Termination: April 13, 1993
Appendix C

Copy of Form for Informed Consent
I am Matthew Stratton, a graduate student in the Department of Psychology at Western Michigan University. I am doing a study on selection-based and topography-based learning systems. You are invited to participate in this research.

The purpose of this research is to investigate the effectiveness of two language systems when teaching the corresponding Japanese words or Kanji characters to English words. If you decide to participate in this research, you will be requested to participate in a session of approximately one half hour to an hour and a half depending on the group you are in. In the session, you will use the computer to learn the correct corresponding Japanese word or symbol to the English word and then be tested on it. The session will take place at Wood Hall #305.

Your participation in this research will not expose you to much risk. Although there is a chance that you will experience an increase in stress when you have trouble understanding the material or answering the questions in the test. If you find the task too difficult, you can quit the session anytime.

In order to protect your confidentiality when the results of this research are presented publicly (for example when they are presented in the written report of the research, or are presented at a professional meeting) your data will be identified only by a code number which will randomly assigned to you. A master list of participant names and code numbers will be stored in a locked file cabinet and will be destroyed at the conclusion of this research.

Your participation in this research is completely voluntary and you may withdraw at any time by telling me in person or by phoning me. You can stop at any time during the session by telling me that you do not want to continue. Please note that if you withdraw before completion of the research, I will not be able to use your data. Therefore, please do not volunteer unless you think you can complete the session.

If you have any questions regarding this research, please feel free to contact me, at 387-4491 (Office) or at 1-457-9522 (Home). If you would like to participate in this study, please sign this form in the space provided below.

Your signature below indicates that you understand the above information and have decided to voluntarily participate.

(Please Print Your Name)

(Your Signature) (Date)
BIBLIOGRAPHY


Michael, J. (September, 1992). Personal communication.


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