The Development of a Japanese SSW Test

by Floyd W. Rudmin

Introduction

The Staggered Spondaic Word (SSW) Test is a dichotic speech test for evaluating central auditory function (Katz, 1962). The test consists of 40 items each composed of a pair of spondaic words, i.e. "daylight" and "lunchtime". The pairs are matched so that the first part of the first word ("day") can be combined with the last part of the second word ("time") to form a third foil word ("daytime"). Spondaic words encourage correct responses by normals, and foil words encourage errors by abnormals. The two test words are presented dichotically in a partially overlapping manner. For example, as "daylight" is presented to one ear in the first channel, the onset of "lunchtime" to the other ear in the second channel is delayed so that "light" and "lunch" arrive at the same time and compete. The SSW Test is differentially sensitive to disorders in many regions of the cerebrum and brain stem, including cortical reception areas (Katz, 1963; 1968), various cortical non-auditory reception areas (Balas, 1971; Katz and Pack, 1975), cerebral auditory commissural tracts (Katz et al., 1975), auditory regions of the cerebellum (Katz, 1977), and upper vs. lower brain stem (Katz, 1970).

The SSW Test has several clinical strengths because its design includes: (1) common spondaic words, (2) a slow, clear, loud presentation, (3) a time staggered dichotic mode, and (4) a correction factor for word discrimination problems. The SSW is relatively insensitive to peripheral hearing loss and the resulting word discrimination problems. Normal subjects perform essentially without error and show little variability: after corrections for word discrimination, mean SSW scores for normals

is about 2% error, with a standard deviation of about 2% (Brunt, 1972). Laterality effects due to hemispheric dominance for language is clinically insignificant (Brunt, 1972). The SSW is not sensitive to sex, intelligence, or socio-economic factors (Brunt, 1972). Finally, because the subjects' task is the identification of familiar words, the test is amenable to diverse populations, including children, the aged, the mentally retarded, schizophrenics, and patients hospitalized with CNS disorders (Brunt, 1972).

At present, there is no clinical audiological test in Japanese equivalent to the SSW Test (Tanaka, 1976). The objective of this study was to develop a staggered dichotic speech test in Japanese that will parallel the design of the SSW Test, List EC. The methodology was largely empirical. Two experiments were performed. The purpose of Experiment I was to select a class of Japanese words equivalent to English spondaic words, and to then select words within that class that are both familiar and appropriate for test items. The purpose of Experiment II was to record and dichotically align the test items similarly to the SSW Test, EC, and to then select those items for the final tapes that are most intelligible.

Experiment I

Since Japanese has no class of spondaic words, several feasible classes of words were considered: (1) Numbers with counters, i.e. "ni hiki" (two animals); (2) Twosyllable words, with each syllable words a morpheme represented by a single kanji, i.e. "hei wa" (peace); (3) Threesyllable words, i.e. "sumi e" (ink painting); and (4) Four-syllable words, i.e. "shiro kuma" (white bear). A syllable

was defined as a peak of sonorancy, so that double duration vowels, as in "Kyūshū", or CVC combinations, as in "konbon", were counted as one syllable each. Most Japanese count syllables on the basis of hiragana orthography and would classify these words as four-syllable words, rather than as two-syllable words.

With the help of a Japanese language informant, 50 common words were selected for each class and recorded. Each word was preceded by the carrier phrase "tsugi wa" (Next is), and intensities were adjusted to have equal peak intensities, ± 2 dB. The subjects were 8 adult native speakers of Japanese. All had normal hearing. Speech Reception Threshold instructions (in Japanese) and 10 practice items were presented monaurally at 15 dB SL. Subsequent 10 item blocks were presented at successive 5 dB decrements, with the final presentation at -5 dB SL. A questionnaire about the quality of the word lists and of the recording was completed by the subjects after the test.

The resulting intelligibility functions for the four classes of words, as well as for English spondaic words (Hirsh et al., 1952), were graphed. All four intelligibility functions were suitably similar to that of English spondaic words for use with a staggered dichotic speech test. However, four-syllable words were selected as the most appropriate because they had the lowest threshold of intelligibility (-1 dB SL), the greatest mean correct responses for each level (6.22 out of 10), and the smallest mean standard deviation of errors (1.57). When four-syllable words are separated into component segments, i.e. "shiro" and "kuma", each segment is a complete word. The subjects' responses to the post-test questionnaire revealed that the words were common, that the recording quality was good, and that pronunciation speed was average. Five subjects reported the presence of an accent, and four of these felt that the pronunciation seemed unnatural and difficult to understand. Since none of the subjects spoke the same dialect as the speaker, the test results include dialect variables. The high performance of four-syllable words, despite

dialect effects, indicates that they have some resistance to dialect distortion.

With the help of a Japanese language informant, a list of 90 pairs of matched four-syllable words was compiled. Words were selected to be common and not emotionally loaded (Broadbent, et al., 1967). Words were paired so that the non-competing segments could be combined to form a foil word. For example, "yūbin kyoku" (post office) paired with "denwa bangō" (telephone number) can yield the foil word "yūbin bangō" (postal code). This list of 90 pairs of four-syllable words was sent to 3 survey assistants in Japan. Each assistant interviewed: (1) a child under age 10, (2) a teenager, (3) an adult male, (4) an adult female, and (5) an adult over age 50. These people were asked to select 20 items from the list of 90 that would be familiar and easy for children, and 20 to 30 items that would be unfamiliar or difficult for Japanese in general. Based on their judgements, 30 of the original 90 pairs of four-syllable words were eliminated. A recording script was prepared, consisting of the 60 remaining test items, 8 words for practice items, and instructions in Japanese.

Experiment II

An analysis of the SSW Test, List EC, revealed (1) that there is a slight unnatural pause between the two segments of each spondaic word, and (2) that the competing segments are dichotically aligned to have simultaneous centers. For example, the test item "meat sauce"/"base ball" can be perceived as a two-word task (to encourage correct responses by normal subjects) or as a four-word task (to encourage differential errors by abnormal subjects) because there is a slight unnatural pause splitting each spondaic word. Also, the competing segments "sauce" and "base" do not have simultaneous onsets, as is common with dichotic tests, but simultaneous centers, i.e. "base" begins 130 msec after "sauce" but also ends 130 msec before "sauce" ends. The 60 items for the Japanese experimental tape were recorded in standard Japanese by a native speaker. Although pitch contours

for four-syllable words were maintained, slight pauses were introduced between segments. Thus, by pitch contours, "shiro kuma" can be perceived as one word, yet by the pause it can be perceived as two words. The 60 paired items were aligned dichotically to have simultaneous centers, ± 26 msec. Instructions and practice items were dubbed onto the experimental tape. The carrier phrase "De wa ii desu ka?" (Are you ready?) preceded each test item in the lead channel. Intensity was adjusted so that competing segments had equal intensity, ± 4 dB.

The subjects were 8 adult native Japanese with normal hearing bilaterally. Instructions in Japanese were presented at 30 dB SL. Practice items and the 60 dichotic test items were presented at 15 dB SL. This low presentation level, rather than the 50 dB SL level used clinically, was necessary to challenge the normal subjects and thereby generate errors. Items were presented alternately left ear first, then right ear first, and so on. Half of the subjects began with the right ear first, half with the left ear first. Errors were noted as omissions or as substitutions, which were transcribed phonetically. With 480 presentation (8 subjects $\times$ 60 items) overall mean intelligibility was just over 85%. 27 items were reported correctly by all 8 subjects, and 10 items accounted for over 50% of the errors. These 10 items and an additional 10 items were rejected from consideration for the final tapes. The arrangement of the remaining 40 items for the adult Japanese SSW Test, and the selection and arrangement of the easiest 20 items for the children's version of the test, were decided on the basis of intelligibility and familiarity. Katz (1977) indicates that the difficulty of the SSW Test, List EC, is not uniform, but that the first 10 items and the last 10 items are easier than the middle two blocks of 10 items. The test items for the final versions of the Japanese SSW Test were organized to have a similar difficulty pattern. (Copies of the final scripts and tapes may be obtained from the author, at cost.)

Discussion

Obviously, this study represents a beginning, rather than the completion, of a project to develop a Japanese SSW Test for clinical use. The English and Japanese versions of the test have parallel designs. Errors made by subjects on the 60 dichotic items on the experimental tape were qualitatively similar to those that appear on the SSW Test during clinical use: there were a total of 37 omissions, 60 substitutions (5 involving the use of the foil word), and 3 reversals. Considering the 40 items selected for the adult version of the Japanese test, no laterality effects due to hemispheric dominance for language are apparent: out of 640 presentations per ear, there were 12 errors for each ear.

However, further studies need to be considered before these tapes can be adopted for clinical use. Considering the 40 items selected for the adult version, the leading four-syllable words had more errors (16) than the lagging four-syllable words (2). This type of "lag effect" has been reported by others (Porter et al., 1969; Studdert-Kennedy et al., 1970; Katz, 1977), and may be inherent in dichotic testing. The magnitude of the "lag effect" in this study may be due to low presentation level and/or to the dubbing and alignment techniques. This requires further study. Also, the tapes need to be tested with larger populations of normal subjects to quantify the effects, if any, of age, intelligence, educational background, and dialect. Normal subjects with peripheral hearing loss need to be tested to determine if Japanese SSW dichotic intelligibility correlates with monaural word discrimination scores. Because the SSW scores have a high correlation ($r = .93$) with word discrimination scores, a correction factor for peripheral disorders is possible (Katz et al., 1963). Finally, it is crucial to establish the ability of the Japanese SSW Test to locate central auditory disorders.

抄 録

日本語 SSW テストの考案

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諸外国及び諸外国語で用いられている中枢性聴覚テストについては今日その基準化が必要となっている。Staggered Spondaic Word (SSW) テストは中枢性聴覚機能をテストする一種の dichotic speech test である。このテストは2音節語よりなり、2チャンネルテープに、第1チャンネルの語の第2音節と第2チャンネルの第1音節が重なり合うように録音し、両耳に与えるものである。SSW は Heschl の横回や、その他の大脳皮質領野、上部脳幹、下部脳幹を含む中枢性聴覚系のいろいろな部位の障害に敏感である。SSW は、①正常な被検者にとっては極めてやさしく、②末梢性聴力障害があっても差しつかえがなく、③大脳半球の優位性に影響されず、④いろいろな領野の人びとに適合する、などの点で強力な中枢性聴覚テストといえる。SSW をモデルにした検査法が数か国で考案されたが、本研究の目的は、SSW をデザインにしてそれに匹敵する日本語の検査を作成することにある。

実験Ⅰは、SSW の spondee words に相当する日本語の単語リストを作成することを目的とした。このためにまず次の4クラスを考慮した。すなわち、①物や動物の数え方（たとえば「2匹」）、②2音節語でその音節が漢字で表わされるもの、③3音節単語（たとえば「墨絵」）、④4音節単語（たとえば「白熊」）。これらの音節は仮名単位よりも sonorancy のピーク数によって決めた。各クラスとも日常よく使われることは50語を録音し、日本人8名に域値付近の強さで1側耳にきかせた。そして、明瞭度関数（intelligibility function）をもとに、spondee word に最も匹敵するものとして4音節語を選んだ。次いで、第1語の前半部を第2語の後半部と組み合わせて第3の4音節語を作るという方式で、90組の日常的な4音節語を作成した（たとえば郵便局と電話番号を組み合わせて郵便番号とするように）。これら90組の単語については、日本在住の3名の研究協力者が、おのおの5名の代表的日本人に依頼して、その精通度および難易度を判定してもらった。これらの判定にもとづいて60組の用語を録音用に選定した。

実験Ⅱでは、日本語 staggered dichotic test の最終版を作るべく、最良の dichotic intelligibility を有する語の組み合わせを選択した。まず、準備段階として60組の語を各語とも前後2音節間にわずかの間を置いて（たとえば郵便と局の間に）、標準日本語で録音した。この場合、2チャンネルで重なり合う音節部分は、それらの出だしを揃えるよりも音の中央が同時になるように配列した。実験テープには初めの部分に日本語による検査の指示と4個の練習項目を加え、8名の日本人被検者に15 dB SL にて与えた。この dichotic intelligibility の成績に基づいて40組を日本語 staggered dichotic test 用語として選出し、SSW の難易度に応じて子供用リスト20組と成人用リスト40組を作成した。

ところで、この日本語 staggered dichotic test が臨床上 SSW に匹敵するかどうかは今後更に検討を要するが、しかしながらこれまでの実験的テストによると、日本人被検者にみられた誤りは SSW テストで生じたものに類似している。また第2語（遅れてきこえる語）における誤りは第1語（最初にきこえてくる語）に比べてより少ない傾向がみられた。この“遅延効果 (lag effect)”は SSW テストやその他の dichotic test においてもすでに報告されている。また、最終成人用リスト40組においては、大脳半球優位効果はみられなかったし、15 dB SL における dichotic intelligibility は20 dB SL における SSW テストのそれよりはるかに良好であった。このテストを臨病的に活用するに当たっては、それ以前に多数の正常な聴力者についていろいろな特性の影響を吟味しておく必要があり、また末梢性の語言弁別障害を修正する手段の確立、ならびに限局性中枢神経障害を有する患者の反応パターンについても研究して置く必要がある。

（本論文は、紙数の関係で細部にわたってまでは述べられていない。本法の詳細について興味のある方は帝京大学医学部耳鼻咽喉科学教室 田中美郷か、あるいは直接著者に照会願いたい）。

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