Ann. Bull. RILP (1982) No. 16. 195-204

ACQUIRED DYSLEXIA IN JAPANESE: A CASE OF 'SURFACE DYSLEXIA'

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Evidence has accumulated in recent years indicating that among a variety of acquired dyslexias in users of alphabetically written languages two contrasting forms called 'deep' and 'surface' dyslexias can be identified (Marshall & Newcombe, 1973). The standard version of 'deep dyslexia' consists of a set of co-occurring symptoms, e.g.: (1) severe impairment in reading aloud nonsense words; (2) semantic, derivational, and visual paralexias in reading single words aloud; (3) part-of-speech effects in reading aloud words: nouns > adjectives, verbs > function words; and (4) abstractness effects in reading aloud words: imageable/concrete words > abstract ones. This symptom-complex is considered to be due to an impairment of grapheme-to-phoneme conversion rules with preserved direct access to meaning. Deep dyslexia has been a subject of intensive neuropsychological studies for the past few years, resulting in a considerably more precise understanding of the nature of the deficits as manifested in alphabetical as well as in Japanese writing systems (Shallice & Warrington, 1975; Saffran & Marin, 1977; Patterson, 1978; Coltheart et al., 1980; Sasanuma, 1980).

A contrasting syndrome called 'surface dyslexia', on the other hand, has received somewhat less attention thus far with less coherent viewpoints on its nature. According to the predominant view, however, two cardinal features of the syndrome seem to be: (1) mulfunctioning of direct lexical processing of written words, and (2) relative preservation of phonologically mediated processing (or grapheme-to-phoneme conversion). In many cases paralexic errors occur in reading orthographically 'irregular' words presumably due to a partial impairment in grapheme-to-phoneme conversion rules. Part-of-speech effects, abstractness effects, and the effects of some other variables such as word-length, word-frequency, picturability, etc. have been observed in some studies but not in others (Marshall & Newcombe, 1973; Shallice & Warrington, 1980; Deloche, Andreewsky & Desi, 1982). One consistent observation, however, appears to be that semantic errors do not occur in surface dyslexia among users of alphabetic scripts.

In this paper, we would like to present a case of acquired dyslexia in Japanese; the overall pattern of impairment displayed by this case could be accounted for in terms of the two cardinal features of surface dyslexia pointed out above. Two main issues of our concern are: (1) What are the prominent features of the reading impairment exhibited by the patient? and (2) what are some possible explanations for this pattern of impairment?

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Description of the Patient and Control Subjects

The subject, S.U., was a 46-year-old right-handed man with 14 years of education. He had had a 27-month history of aphasia due to CVA followed by the operational removal of a hematoma in the subcortical region of the left temporal lobe. A CT scan performed 18 months post onset indicated a well-defined low density area in the temporo-parieto-occipital region (involving the angular and supramarginal gyri) of the left hemisphere, with a moderate enlargement of the left ventricle.

An overall pattern of linguistic impairment at the time of the study was that of Wernicke's aphasia, characterized by fluent but paraphasic speech (only 20/100 correct responses on a test of confrontation naming of daily objects). His auditory comprehension was moderately impaired, with an increasing difficulty in comprehending longer and more complex sentences and a reduced auditory retention span (pointing span) of 3 to 4 units when object-names and digits were used, respectively.

S.U.'s reading and writing performance was severely impaired, with an overall picture of disproportionately greater difficulty in kanji processing as compared to kana processing.

Control Subjects

Three normal adults with no history of brain damage served as control subjects for selected subtests. Their age and educational levels were matched with S.U.'s.

Performance of S.U. on Selected Reading Tests

A battery of in-depth reading tests was administered to S.U. and the results were analyzed in terms of the dual process model of reading.[1] Since S.U.'s performance on three of the areas covered by these tests was particularly revealing, findings in only these three areas, viz., 'Oral Reading of Single Words', 'Grapheme-Phoneme Correspondence', and 'Reading Comprehension of Single Words', will be presented in some detail.

A. Oral Reading of Single Words

S.U. was given the following subtests (A-1 ~ A-4), requiring the processing of 300 written words in various syntactic classes: nouns, verbs, adjectives and function words, as well as words with different abstractness levels and frequency of usage.

A-1 Reading aloud concrete nouns and abstract nouns in kanji and kana. For the kanji, a set of 20 single-character 'concrete' words and another set of 20 single-character 'abstract' words were used. They were taken from Kitao's list of the 881 kyoiku kanji characters rated by 1,000 college students in terms of concreteness (C), hieroglyphicity (H), and familiarity (F) (Kitao, Hatta, Ishida, Babazono and Kondo, 1977); the concrete words were those 20 kanji with the highest C-values in the list, while the abstract words were those 20 with the lowest C-values. The F-values of the abstract and concrete words were equivalent.

The kana version of the concrete and abstract lists consisted of 2-to 4-kana-

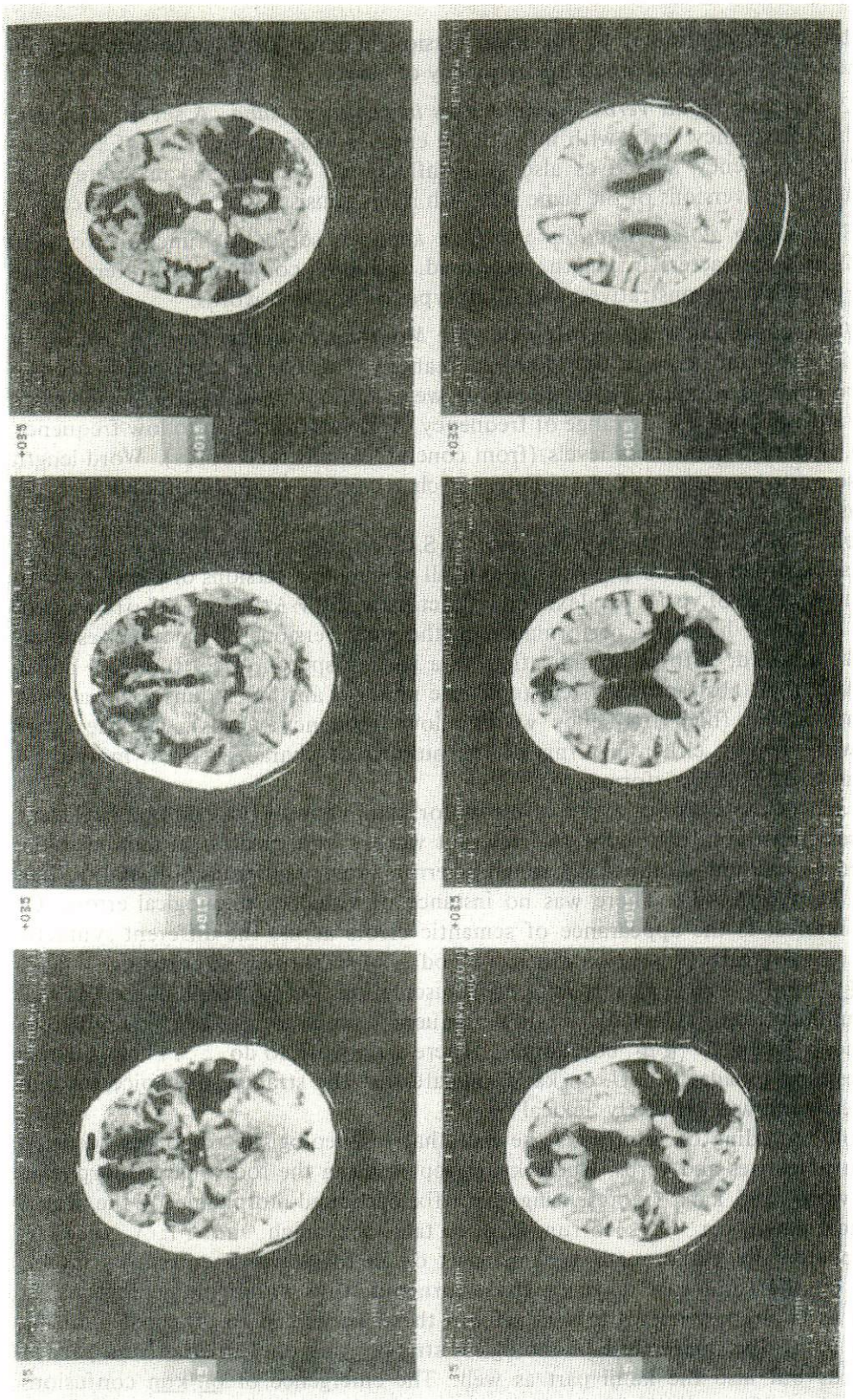

Fig. 1 *CT scan of S.U. indicating a well-defined low density area in the temporo-parieto-occipital region of the left hemisphere.*

character words equivalent to the kanji version in terms of their concreteness/abstractness values and controlled for frequency of usage.

A-2 Reading aloud verbs and adjectives in kanji and kana. A set of 20 single-kanji, high-frequency verbs with inflectional endings in kana, and a set of 20 single-kanji high-frequency adjectives also with inflectional endings in kana were used, along with kana versions of the same sets with items consisting of 2 to 4 characters.

A-3 Reading aloud 'function' words in kana. A set of 40 function words in kana, 2 to 4 characters in length, were used, including conjunctions, interrogative words, particles, demonstratives, and other types of function words.

A-4 Reading aloud 50 words from the Modified Peabody Test. A set of 50 words in kanji and kana in the Modified Peabody Test (to be described in section D) were used as stimuli. These 50 words were all nouns except five (which were verbs), and spanned a wide range of frequency of usage (from high to low frequency words), and of abstractness levels (from concrete to abstract words). Word-length was also varied in terms of the number of characters (1 - 3 for kanji and 1 - 6 for kana) as well as of moras (1 - 6).

Table 1 summarizes the performance of S.U. on these tests. It can be seen that S.U. made perfect or near perfect scores in all of the kana versions of the tests, with only one instance of visual paralexia on a function word: あるいは or → あるいた walked.

On the other hand, his performance on the kanji versions of the same tests was severely impaired, with clear indication of a part of speech effect (nouns > adjectives, verbs), an abstractness effect (concrete nouns > abstract nouns), and a word frequency effect (high frequency words > low frequency words). On the other hand, word length, either in terms of the number of characters or of moras, did not seem to affect his performance.

An analysis in terms of types of errors for kanji shows (Table 2) that irrelevant responses (mostly substitutions to irrelevant words) were greatest in number (47), followed by circumlocutions (22), semantic errors (15), neologisms (14) and on/kun reading confusions (3). There was no instance of visual or phonogical errors. Of special interest is the appearance of semantic errors across the different syntactic classes (e.g.門 gate → 入口 entrance; 神 god → 神社 shrine; 強い strong → 固い hard; 飛ぶ to fly → 飛行機 airplane; 聴診 ausculation → 病院 hospital, etc.) as well as circumlocutions, especially on low frequency nouns (e.g., 裁判官 a judge → "Punishes a bad guy," 退屈 boredom → "There is no work to do . . . . ." etc.) These error responses made by S.U. on kanji indicate that the strategy of choice for him to process kanji was definitely 'lexical'.

Another finding of interest is the fact that his neologistic responses occurred only on adjectives and verbs, where kanji (representing the root or free-morpheme of the word) and kana (representing the affix or bound-morpheme of the word) are concatinated, e.g., 走る to run, 話す to talk; 高い high, and 冷たい cold). As was expected, he could read the kana part of all these words correctly, but his reading on the kanji part of them was errorneous, thus producing neologisms. It appears as if the presence of a kana affix in these words had an effect of inducing S.U. to apply the non-lexical phonological strategy not only for the kana part of the words but also the kanji part as well. The emergence of on/kun confusions (substitution of phonological readings for semantic readings) on three of these

Table 1 *Performance of S.U. on the oral reading of single words*

	Concrete Nouns (20 items)	Abstract Nouns (20 items)	Adjectives (20 items)	Verbs (20 items)	Function Words (40 items)	Peabody (50 items)
	*					
Kanji	11(55.0)	3(15.0)	4(20.0)	3(15.0)	_____	5(10.0)
Kana	20(100.0)	20(100.0)	20(100.0)	20(100.0)	39(97.5)	50(100.0)

* Per cent of correct responses

Table 2 *Types of errors made by S.U. in the oral reading of single words in kanji*

	Concrete Nouns (20 items)	Abstract Nouns (20 items)	Adjectives (20 items)	Verbs (20 items)	Peabody (50 items)	Total (130 items)
Paralexic Errors	9	16	16	17	43	101
Visual	0	0	0	0	0	0
Phonological	0	0	0	0	0	0
Semantic	3	3	4	1	4	15
Circumlocution	1	1	1	1	18	22
Irrelevant	5	12	12	7	21	47
Neologisms	0	0	7	7	0	14
On/Kun	0	0	2	1	0	3
No Response	0	1	0	0	2	3

words, appears to be in accord with this interpretation.

B. Grapheme-Phoneme Correspondence

From the foregoing tests it was suggested that the knowledge of the grapheme-phoneme correspondence might be well preserved in S.U. To confirm this point, we examined his phonological coding in a context in which the possible effects of the lexical-semantic system were eliminated: S.U. was given a reading aloud test for nonsense words in kana as well as a test of recognizing the presence or absence of rhyme in a pair of kana characters.

B-1 Reading aloud nonsense words in kana. A set of 20 non-words were constructed by changing the sequential order of the characters, or replacing one kana character with another character, in each of 20 2-character high frequency real words.

B-2 Recognition of rhyming in kana. S.U. was presented with a set of 20 pairs of single kana characters, of which half of the pairs rhymed (had the same vowel) and the other half did not, and was asked to judge whether each pair rhymed or not.

As shown in Table 3, S.U. performed well within the normal range on both the oral reading of nonsense kana strings and the rhyming test, indicating that indeed his grapheme-to-phoneme conversion process was well preserved.

C. Reading Comprehension of Single Words

In the previous sections, S.U.'s oral reading of kanji, but not kana, was found to be severely impaired. To what extent, then, is this pattern of his oral reading performance related to his visual comprehension performance on the same sets of kana and kanji words?

C-1 Word/picture matching test adapted from the Peabody Picture Vocabulary Test (PPVT). The Peabody Picture Vocabulary Test (Dunn, 1965) was modified in such a way that we could require S.U. to match words written in kanji or kana (instead of spoken words) to pictures. In addition, to avoid fatigue on the part of patients, the test was compressed into one third of the original length (i.e., into 50 words) of increasing difficulty.

The results are summarized in Table 4, together with the performance of the control subjects. For purposes of comparison, the results of S.U.'s oral reading (cf. A-4) and auditory comprehension of the same set of 50 words are also listed. It can be seen that S.U.'s performance on the visual comprehension of kana words (98% correct responses) was well within the normal range, just as was his performance on the oral reading of the same words. His comprehension performance on kanji (78% correct responses) on the other hand, was somewhat inferior to the normal level of performance, although markedly superior to his oral reading performance on the same set of words (only 10% correct responses), indicating a clear-cut dissociation between comprehension and oral production.

Analysis of his visual comprehension errors on kanji revealed that out of 11 errors 8 (73%) were semantic errors (e.g. 肘 elbow → 耳 ear, 疲労 fatigue → 恐怖 horror, etc.). Three other errors were 'irrelevant' responses in the sense that the pictures he pointed to had nothing to do with the targets.

Table 3 *Performance of S.U. on grapheme-to-phoneme correspondence tasks*

	S.U. %	Controls %
Oral reading of 2-character strings (20 items)	100.0	100.0
Rhyming (20 items)	95.0*	89.7 (R:85.0-100.0)

* Chance level = 50.0 per cent

Table 4 *S.U.'s reading comprehension of 50 single words from the Modified Peabody in relation to his oral reading and auditory comprehension of the same words.*

	S.U.		Controls	
	Kanji %	Kana %	Kanji %	Kana %
Reading comprehension	78.0*	98.0	100.0	98.3 (R:95.0-100.0)
Oral reading	10.0	100.0	97.3 (R:92.0-100.0)	100.0
Correct both on comprehension and reading	10.0	98.0		
Correct only on comprehension	68.0	0		
Correct only on reading	0	2.0		
Errors both on comprehension and reading	22.0	0		
Auditory comprehension	96.0		100.0	
Correct only on auditory comprehension	20.0	0		

* Chance level = 25.0 per cent

All of the five kanji words that S.U. was able to read aloud correctly were those on which he demonstrated 'comprehension' by matching pictures to them, suggesting that access to the output phonology for each of these words is preceded by a retrieval of its semantic representation. What happened, then, for those words that he 'comprehended' correctly and yet failed to read aloud (34/50, or 68% of the test words)? Obviously, 'comprehension' as measured by a word-picture matching task does not guarantee a retrieval of the full semantic representation of any given word, suggesting the possibility that in S.U. access to the semantic representation of some kanji words might have been incomplete or underspecified so as to effect the retrieval of their output phonology. To clarify this point further, two additional tests were devised.

C-2 Detection of pal words. S.U. was shown a list of three words in kanji and was asked to point to the one item from a display of three other words in kanji that he thought was semantically related to the three words in the first list. There were 20 items in the test, of which S.U. responded correctly to only 12 or 60.0% (the chance level for this test was 33.0%).

C-3 Classification of kanji-words into superordinate categories. There were four tasks in this test. In each task, S.U. was asked to classify 25 words in kanji (each printed on an index card) according to their five superordinate categories. A different set of 25 kanji words and five superordinate categories were used in each task. The results showed that S.U. was able to classify correctly only 50 words out of 100, or 50.0% correct responses (the chance level for this test was 20.0%).

The results obtained from these two additional tests can indeed be interpreted as indicating certain malfunctions, either in the retrieval of the full semantic description for kanji words, or in the internal organization of semantic memory itself, or both.

Remarks

The above findings indicate that the overall pattern of reading impairment by S.U. is basically in accord with the predominant view of surface dyslexia in alphabetically written languages. On the other hand, S.U. exhibited a substantial number of semantic errors in his oral reading of kanji words of various syntactic classes (i.e., nouns, adjectives and verbs), while his oral reading of kana words was almost perfect, with only one instance of visual paralexia. This is in contradiction to the general observation that no semantic errors ever occur in surface dyslexic users of alphabetical scripts, while they characteristically make many phonological errors on 'irregular' words. Why should this be so? On possible explanation which immediately suggests itself would be the basic difference in the nature of the orthographic codes used by these patients, i.e., kanji/kana and alphabets.

Kanji, which are a logographic code, are closely associated with lexical/semantic representation, thus making them highly suitable to a direct lexical strategy, but unsuitable to phonologically mediated strategies. In other words, there was little or no alternative for S.U. to using this direct strategy for kanji. However, due to a malfunction somewhere in the lexical process, most probably at the point of access to meaning, S.U.'s retrieval of the output phonology for kanji tended to be

defective, leading to a large number of 'lexical' errors, including semantic errors and circumlocutions.

Kana, in contrast, are particulary suited to a phonological or grapheme-to-phoneme conversion strategy, because the grapheme-phoneme correspondence rules for kana are highly consistent. Apparently, S.U. must have used this strategy on the kana task, with relative success. All in all, he exhibited a clear-cut kana-kanji dissociation in performance.

Alphabetical scripts, on the other hand, can be processed either lexically or phonologically, depending on the demands of the situation. Since surface dyslexic patients, by definition, are impaired in lexical processing, brain-damaged users of alphabetical scripts may make exclusive, or near exclusive, use of a phonological or grapheme-to-phoneme conversion strategy, which in turn would tend to produce phonological errors for 'irregular' words. And if they do not use lexical strategies, no semantic errors will be produced.

In summary, the findings obtained in the present study indicate that the differences between the symptom patterns of surface dyslexia shown by S.U. and those by users of alphabetical scripts can be accounted for in terms of the script-specific strategies used by the respective patients. The findings also indicate that the dual-coding hypothesis of reading, which proved to be useful in the analysis of S.U.'s reading performance, can provide a valid framework within which universal mechanisms underlying different types of dyslexia in different scripts can be analyzed and explained.

Acknowledgment

The authors wish to express their thanks to Dr. Yoko Fukusako and Ms. Hisako Monoi of the Tokyo Metropolitan Geriatric Hospital for their cooperation.

Note

1. The standard dual-coding model of reading assumes two pathways for the processing of written words, one for direct visual coding and the other for phonological coding. According to this model, there are at least two possible ways for a written word to attain a correct reading with comprehension. One is via direct processing and the other is via phonologically mediated processing. Direct processing makes use of visual or orthographic coding, i.e., the written word form achieves direct access to the internal lexicon so as to be recognized and comprehended and from this internal representation obtain its phonological specification for output. In other words, the correct oral production of the word is attained post lexically. Phonologically mediated processing, on the other hand, makes use of phonological coding in order for a written word form to gain access to the internal lexicon, i.e., the written word form is converted into its phonological representation by means of grapheme-phoneme conversion rules, and then from this phonological code obtains lexical access.

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