

Surface Dyslexia and Its Relationship to Developmental Disorders of Reading

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A comparison is made of characteristics of the reading and spelling of five adult neurological patients suffering from the reading disorder known as surface dyslexia, and four children suffering from reading disorder in the absence of any observable signs of neurological damage. The four main symptoms of surface dyslexia are: (1) greater difficulty in reading aloud irregularly-spelled words (such as *gauge*, *debt*) than regularly-spelled words (such as *grill*, *turn*), (2) errors in reading aloud characterised by regularizations and visual errors, (3) spelling errors are usually phonologically correct, (4) confusions between homophones in defining printed words. These symptoms were all found in the reading and spelling of the four children with reading disorder.

Since Marshall and Newcombe in 1973 drew attention to the fact that acquired dyslexics can be grouped together into syndromes such as deep and surface dyslexia on the basis of the types of error they make in reading, there have been a number of attempts in the literature on reading disorders in children to draw parallels between certain of these acquired dyslexic syndromes and childhood reading disorder. For example Jorm (1979) and Snowling (1980) suggest that the relative difficulty that developmental dyslexics have in reading aloud non-words parallels the difficulty that deep dyslexics have with this type of material.

However, there is only one study, as far as I can ascertain, which has consisted of making a direct comparison between the reading behaviour of acquired dyslexic patients and a group of children with developmental reading disorder. This was the study of Jane Holmes (1973) who gave over 800 words for reading aloud to each of four boys with developmental reading disorder and to two surface dyslexic patients. She analysed reading errors according to violations of rules of English spelling such as the rule that final silent *e* indicates that a preceding vowel should take its long form, or that the ambiguous consonants *g* and *c* are soft before *e*, *i*, and *y*, otherwise hard. She found that errors involving the violation of these rules could be observed for the developmental dyslexic boys as well as for the acquired surface dyslexic patients.

The present investigations involved some new tests of surface dyslexia and the aim was to show that further characteristics of the disorder can be observed in children with developmental disorder of reading. The subjects of the investigations were five acquired surface dyslexic patients, four of whom had a reading disorder as a result of head injury, and one of whom had become dyslexic following a cerebrovascular accident, and four children suffering from reading disability in the absence of any observable signs of neurological abnormality. The four children were of average or average to bright intelligence and had adequate cultural and educational opportunity but were nevertheless reading at a level that was in excess of two years below their chronological age. Background information for all nine dyslexics is summarised in Table I.

Surface dyslexia can be diagnosed fairly easily by presenting the patient with a set of matched regular and irregular words for reading aloud and looking for a decrement in performance with the irregular set. Because the surface dyslexic is forced to rely on letter-sound, or grapheme-phoneme rules to read, due to the occasional inavailability of the direct route, irregular words will be read aloud incorrectly since, by definition, they form exceptions to these letter-sound rules. However, since the only means to read aloud that the surface dyslexic has is by means of letter-sound rules he will treat irregular words as if they were regular so that his errors to these will consist of regularisations, that is, of treating an irregular correspondence as if it were a common or regular one.

A matched set of regular and irregular words, randomly intermixed, was presented to the five acquired dyslexic patients and to the four developmental dyslexics for reading aloud and the results of this test are presented in Table II. The subjects all show a decrement in performance for irregular over regular words. The largest decrement in performance is shown for the developmental dyslexic K.W. Holmes (1973) has suggested that developmental dyslexics may develop a phonological reading strategy as a result of phonics-type remedial therapy that they may receive for their reading problem. K.W. had been receiving this type of therapy for the last two years so this may account for the large regularity effect that she shows. However, the other three developmental dyslexic subjects have not received remediation for their reading problem so this factor cannot be invoked to account for the regularity effect that they show.

Table III gives the results of two of Cochran's Q tests carried out on the errors of the acquired dyslexics to the regular and irregular sets of words. These revealed that there was agreement across subjects in the errors made to the irregular word set, but not to the regular word set. When the errors of the acquired and developmental dyslexics were compared for the irregular words, that is, when the number of subjects reading individual items incorrectly was compared across the two groups, it was found that there was a strong relationship between the words found difficult by the two groups of subjects, as the result of the Pearson's *r* test shows. In other words, the developmental dyslexics not only show a relative difficulty in reading aloud ir-

Table I. Background information for the five acquired and four developmental dyslexics.

Developmental dyslexics		C.D.	F.E.	M.J.	K.W.
1.	Age	16 Yrs.	26 Yrs.	10:6 Yrs.	10:6 Yrs
2.	Sex	Female	Male	Male	Female
3.	Handedness	Right	Right	Right	Right
4.	Family left handedness?	Yes	Yes	Yes	Yes
5.	Family history of reading problems?	Yes	No	No	No
6.	Intelligence	Average	Verbal: average Non-verbal: superior	Bright average	Average
7.	Reading age	10:2	12:3	7:10	8:4

Acquired dyslexics		A.B.	E.E.	C.H.	K.M.	P.M.
1.	Age	16	41	54	20	19
2.	Sex	Male	Male	Male	Female	Male
3.	Employment	Fitter	Postman	Author	Hairdresser	Mechanic
4.	Handedness prior to accident	Left	Left	Right	Right	Right
5.	Cause of accident	Road accident	Fall	CVA	Road accident	Road accident
6.	Site of Lesion	Right frontal area	Bilateral (right: temporo-parietal area) lesion not specified)	Left (fronto-parietal area)	Bilateral (left: Bronca's cortical)	Brainstem lesion, bilateral pyramidal signs.

regular words, as do the acquired dyslexics, but they also give erroneous responses to the same items as the acquired dyslexics.

The difficulty with irregular words that acquired surface dyslexics have can also be shown in silent reading tests. The results of one such test are presented in Table IV. In this test the subject is required to judge whether pairs of printed words sound similar or whether they sound different. Three types of material are used: regular words, irregular words, and non-words, and there are fifty pairs of each type. It can be seen from the table that performance for the seven subjects for whom data is available is roughly equivalent for regular words and non-words and worst with irregular words. This pattern is what one would expect if the direct route for reading is sometimes unavailable since regular words and non-words can both be read by means of grapheme-phoneme rules whereas irregular words cannot. The performance of adult normal readers appears under that of the seven subjects.

Table II. Results for nine subjects reading aloud regular and irregular words (39 of each). Results are expressed in terms of percent correct.

Acquired dyslexics						
AB	EE	CH	KM	PM	X	
Regular	69	56	72	64	54	63
Irregular	51	26	46	51	33	41
Developmental dyslexics						
	CD	FE	MJ	KW	X	
Regular	90	79	59	77	76	
Irregular	67	38	46	28	45	

Table III. Incorrect responses to regular and irregular words made by acquired dyslexics

	Regular	Irregular
Cochran's Q	4.23 (p > .05)	9.85 (p > .05)
Incorrect responses to irregular words made by acquired and developmental dyslexics.		
Pearson's R	0.67 (P > .001)	

Table IV. Results for nine subjects on silent tests of phonology in terms of percent correct.

Acquired dyslexics						
	AB	EE	CH	KM	PM	X
Regular	78	74	—	68	74	73
Non-words	76	70	—	70	65	70
Irregular	60	52	—	54	56	55
Developmental dyslexics						
	CD	FE	MJ	KW	X	
Regular	88	—	78	72	79	
Non-words	78	—	74	72	75	
Irregular	68	—	62	58	63	
Mean adult performance on silent tests of phonology (N = 13)						
Regular	99					
Non-words	96					
Irregular	97					
Mean performance of children with reading age = 10.00 years on silent tests of phonology (N = 18)						
Regular	95					
Non-words	89					
Irregular	89					

We have also found that normal beginning readers experience the same difficulty in reading irregular words that is demonstrated by acquired surface dyslexics. However, this difficulty does not persist into adolescence for normal readers as it has for the four developmental dyslexics who are reported here. If we compare the performance of one of the developmental dyslexics, C.D., on the silent tests of phonology with that of children matched for reading age, whose results are at the bottom of the table, we can see that her difficulty with irregular words is not just due to the fact that she has a depressed reading age. That is, despite the fact that she has only a reading age of 10 years when her chronological age is 16 years, she should not, having achieved this reading age, still show a regularity effect in her reading. Given that she does show such an effect when her reading-age matched controls do not, we must conclude that it is a consequence of her reading difficulty rather than a natural consequence of having such a depressed reading age.

Table V shows that the difficulty with irregular words relative to regular and non-words is not a feature of the reading of all developmental dyslexics and indeed seems

Table V. Results for 21 developmental dyslexics on silent tests of phonology (per cent correct).

Children showing a decrement in performance for non-words			
	Regular	Non-word	Irregular
S1	84	54	64
S2	84	74	82
S3	100	84	96
S4	62	50	68
S5	94	78	86
S6	72	54	68
S7	84	62	74
X	83	65	77
Children showing a decrement in performance for irregular words			
	Regular	Non-word	Irregular
S1	92	92	80
S2	88	84	68
S3	66	64	44
S4	80	84	66
X	81	81	64
Children showing neither pattern			
	Regular	Non-word	Irregular
X	83	83	80

(N = 10)

to be a feature of only a minority of them, since 7 of the 21 developmental dyslexics in this sample showed a greater degree of difficulty with non-words than with irregular words compared to regular words. These children were all untreated developmental dyslexics, between the ages of 12 and 18 (Masterson, 1982, unpublished experiment).

Turning now to a qualitative, rather than a quantitative comparison of the errors of the nine subjects, it was mentioned earlier that irregular words should produce regularization errors when they are read aloud by the surface dyslexic because he is relying on grapheme-phoneme rules to read them. This type of error was observed for the five adult surface dyslexics and also for the four developmental dyslexics. Examples of regularization errors are to be found in Table VI. Visual errors are also

observed in the reading of all acquired surface dyslexics (for examples, see Table VI), and these also occurred in the reading errors of the four children.

Two judges, trained in phonetic transcription, were given the individual error corpora for all nine subjects to the regular and irregular words and were asked to judge whether each set of errors had been made by an acquired or a developmental dyslexic. From Table VII it can be seen that although the judges were mostly correct in their judgements about the developmental dyslexics, they also thought that the errors of the five acquired dyslexics had been made by developmental dyslexics, indicating that the errors of the two types of subject in this study cannot be reliably differentiated.

The spelling errors of the five acquired dyslexics in the sample were found to be mostly phonologically correct (see Table VI for examples), and this was found to be true also for the developmental dyslexics.

Acquired surface dyslexia can be diagnosed by a fourth symptom: that of homophone confusions. Since reading is mediated by phonological recoding in this type of reading disorder, the patient will be unable to differentiate, in terms of meaning, between printed words which, although spelt differently, sound the same. When the patients were presented with printed homophones for which they had to provide spoken definitions before reading them aloud, they made homophone confusion errors, examples of which are to be found in Table VI. It can be seen from this table that the errors involved providing a definition appropriate for the target's homophone. When the same test was administered to the developmental dyslexics they also made these errors. Thus, all of the characteristics of acquired surface dyslexia—a regularity effect in reading aloud, regularizations and visual errors, phonologically correct mis-spellings, and homophone confusions—were observed for the four developmental dyslexic subjects in this study (see Masterson, 1983, for a full comparison of the data for the nine subjects).

It is tempting to speculate that the type of reading disorder exhibited by the four developmental dyslexics described here is the same as that shown by the children in Eleanor Boder's category of developmental dyslexia which she calls dyseidetic dyslexia and which she says is the same as the subtype of visual dyslexia described by other authors who have conducted subgrouping studies of developmental dyslexia. Boder (1971, 1973) describes dyseidetic dyslexia as involving reading through a process of phonetic analysis of printed words and also a phonological spelling strategy. She found that dyseidetic dyslexics formed only 9 per cent of the sample of 107 developmental dyslexics that she tested.

However, the reading and spelling errors made by the dyseidetic dyslexics in Boder's study, and by children in subgroups of other studies, have not been described in sufficient enough detail for us to conclude that any of these subgroups correspond to the form of reading disorder described here.

This highlights the need for the detailed recording of data from individual subjects in investigations of developmental dyslexia in order that the strides forward that

Table VI. Examples of different types of error in reading and spelling made by the five acquired and four developmental dyslexic subjects.

Regularization errors in reading aloud irregularly-spelled words
 e.g., bury—/bxri/, sword—/swxd/, mortgage—/mxtgeidx/, subtle—/sxbtal/

Visual errors in reading aloud
 e.g., gang—gag, check—cheek, bowl—blow, quick—quack

Phonologically correct spelling errors
 e.g., search—SURCH, cough—COF, concert—CONSERT, safety? SAIFTY

Homophone confusions in defining printed words
 e.g., pain—“a piece of glass in a window”, blew—“a colour”, brake—“to smash”,
 seas—“to grab someone”

Table VII. Judgements about whether errors were made by a developmental or by an acquired dyslexic.

		Judge 1	Judge 2
Acquired	AB	Developmental	Developmental
	EE	Acquired	?
	CH	Developmental	Developmental
	KM	Developmental	Developmental
	PM	Developmental	Developmental
Developmental	CD	Developmental	Developmental
	FE	Acquired	?
	MJ	Developmental	Developmental
	KW	Developmental	Developmental

have been made in studies of acquired dyslexia can also be made for investigations of developmental disorders of reading.

In conclusion, all of the features of acquired surface dyslexia observed for the five adult neurological patients were also observed in the four developmental dyslexics in the present study. A number of investigators have expressed the view that the reading characteristics of acquired and developmental dyslexics are unlikely to be similar. For example, Masland (1981) writes of acquired and developmental dyslexia that "the disorders of function which result from the destruction of an already established structure must be very different from those which occur when functions are developed within a structure which has been abnormal or damaged throughout the developmental period". The investigations presented here indicate that both types of disorder can have identical consequences for reading behaviour.

References

- Boder, E. (1971). Developmental dyslexia: A diagnostic screening procedure based on three characteristic patterns of reading and spelling. In B. Bateman (Ed.), *Learning Disorders*, Seattle: Special Child Publications.
- Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. *Developmental Medicine and Child Neurology*, 15, 663-687.
- Holmes, J. (1973). Unpublished Ph.D. thesis. University of Edinburgh.
- Jorm, A. F. (1979). The cognitive and neurological basis of developmental dyslexia: A theoretical framework and review. *Cognition*, 7, 19-33.
- Marshall, J. C., and Newcombe, F. (1973). Patterns of Paralexia. *Journal of Psycholinguistic Research*, 2, 175-199.
- Masland, R. L. (1981). Neurological aspects of dyslexia. In G. T. Pavlidis and T. R. Miles (Eds.), *Dyslexia Research and Its Application to Education*, New York: John Wiley and Sons.
- Masterson, J. (1983). Unpublished Ph.D. thesis. University of London.
- Snowling, M. J. (1980). The development of grapheme-phoneme correspondence in normal and dyslexic readers. *Journal of Experimental Child Psychology*, 29, 294-305.

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