

# A case showing selectively impaired oral spelling

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Spelling ability may be tested by asking the patient to spell aloud, to write, or to select and arrange letters given him. The spelling of dysphasic patients and of patients with Gerstmann's syndrome is often found to be impaired, however they are tested. It follows that in such instances the disorder affects central processes irrespective of the output channel.

Dissociation between oral and written spelling ability when it occurs because of motor disorder of muscles involved in articulation or in writing is not specific to spelling. More relevant to the question of the cerebral organization of spelling mechanisms are instances of dissociation between oral and written spelling ability which appear relatively selective. Observations are here reported on a patient whose oral spelling performance was selectively impaired.

J.P. (N.H. A.21481), aged 55, a car maintenance worker, was admitted under the care of Dr. John Marshall for investigation of episodic unilateral weakness with residual dysphasia. In January 1963, he had mild weakness of the left arm lasting for two hours. Later that year right-sided weakness occurred, lasting four hours. In February 1964, he woke to find his right side completely paralysed, and his speech disturbed. The paresis largely recovered over the following nine months, but he retained some difficulty in speaking.

There was no relevant family or personal history. On examination he was a well-orientated, cooperative man with evidence of expressive but not of receptive dysphasia. There was a residual mild right-sided upper motor neurone deficit, but no sensory loss or field defect. The pulse showed the irregularity of atrial fibrillation. The blood pressure was 160/100 mm. Hg. There was no clinical evidence of cardiac enlargement and no murmurs were audible.

Blood count, sedimentation rate, serum electrolytes, and cholesterol levels were within normal limits. The Wassermann reaction was negative in blood.

The electrocardiogram showed atrial fibrillation as the only abnormality. Chest radiography showed a cardiac outline of normal size. Skull radiographs were normal, but the cervical spine radiograph revealed spondylosis. The electroencephalogram showed a minimal left temporoparietal slow wave abnormality in an otherwise normal record.

It was concluded that he had suffered repeated episodes of cerebral ischaemia, the most recent in the left middle

cerebral artery territory, which, in view of the atrial fibrillation, could have been embolic in origin.

J.P. was tested on the Wechsler adult intelligence scale, and obtained a verbal I.Q. of 74 and a performance I.Q. of 112. Verbal subtest scores ranged from the dull average to the defective level in the subtest of vocabulary, during which some word-finding difficulty became apparent. He made two mistakes ('rubbing' for rubber band, and 'tip', then 'clip' for paper clip) in naming 20 relatively familiar objects, and could name objects from their verbal descriptions. He named parts of the body correctly. His powers of expression were limited, for example, in explaining the meaning of words, phrases, and proverbs. He tended to omit function words from his spontaneous speech. He could only think of six flower names in 90 seconds. He repeated a 15-word sentence correctly at his first attempt, but still omitted one word from the Babcock sentence (18 words) at the seventh attempt. His digit and his letter span were five, and he learnt six items at the third attempt. His comprehension of spoken speech (in the form of double commands and problems) was unimpaired. His reading ability for single words was intact, but for connected text impaired by errors of word substitution. He named the letters of the alphabet with only two errors (interchanging x and z). He pointed correctly to named letters. He named all the digits correctly. His writing was readily legible, and his written spelling at near average adult level. His oral spelling was grossly impaired, even with three-letter words. On the graded spelling test (Schonell, form A) he obtained scores of 53 and of 56 correct out of 100 on two occasions, when writing the words, but only two and 12 respectively when spelling them orally. On Raven's progressive matrices he scored 33 out of 60.

His drawing ability and visual memory were unimpaired. There was no spatial disorientation, unilateral neglect of body or space, or topographical agnosia. Finger agnosia and right-left disorientation were not found.

It was concluded that this patient had a dysphasia of expressive type and an unusual disorder of oral spelling which merited further study.

## FURTHER TESTS OF SPELLING AND REVERSE SPELLING

The spelling deficit, which appeared to be limited to the auditory channel, was further investigated by varying the type of presentation (auditory or visual), response (spoken or written), nature of the task (spelling or recognition of an item being spelled), and the material

TABLE  
PERCENTAGE CORRECT SCORES ON TESTS OF SPELLING AND REVERSED SPELLING

Response	Presentation				Response	Presentation					
	Letters		Digits			Words		Composite Numbers			
	Auditory	Visual	Auditory	Visual		Auditory	Visual	Auditory	Visual		
Word or composite no.	Auditory	33	93	0	73	Letter or digit series	Auditory	7	20	0	—
	Auditory with movement	74		14			Auditory with movement	33		33	—
	Visual-kinaesthetic	93	73				Visual-kinaesthetic	93	93	93	—

(alphabetical or numerical). The object was to determine the limits of the disorder of function which underlies the oral spelling defect.

Three lists of 15 familiar words were prepared, with five three-letter words, five four-letter words, and five five-letter words in each list. Similarly, three lists of digit sequences, consisting of five three-digit, five four-digit, and five five-digit numbers were constructed. These lists were used in 16 different test situations, the individual list being varied to minimize learning.

Two types of test were devised: (1) tests involving the conventional spelling of words or numbers (in terms of digits) presented either auditorily or visually; (2) tests requiring the recognition of 'spelled' words and numbers (reverse spelling).

Responses were either oral or in writing. Oral responses were separately tested, both with and without the help of writing movements with the eyes closed (kinaesthetic reinforcement'). The percentage correct scores achieved under the various conditions of the experiment are given in the Table.

**REVERSED SPELLING** When letter sequences were spoken by the examiner, the patient was able to specify only 33% of the words spelled out. When comparable letter sequences were presented visually, item after item being placed before the patient (one per second) he achieved 93% success. A similar dissociation characterized his performance with digits when orally and visually presented. Digit sequences were spoken, *e.g.*, 'one-seven-two', and the patient was asked to respond with the name of the composite number spelled out, *e.g.*, 'one hundred and seventy-two'. He proved totally unable to do this. However when the digits were presented visually, one by one, he succeeded in producing the correct response 73% of the time.

The spoken presentation caused great difficulty in response. This was alleviated if the patient was permitted to perform appropriate writing movements with his right hand while listening, even if he was blindfold and thus unable to watch his own movements. Under these conditions he raised his score on letter sequences from 33 to 79% correct, and on digit sequences from 0 to 14% correct.

If permitted to respond to dictated letters directly in writing, rather than by saying the appropriate word, he did still better, raising his score to 93%

correct. When letters were visually presented the score was 73% correct.

**SPELLING** Words were presented orally and the patient was asked to spell them orally. He succeeded on only 7% of items. When they were briefly presented visually and then removed, spelling by mouth improved only a little, to 20% success. When concurrent writing movements were permitted, the score improved to 33%, and when an exclusively written response was permitted, there was 93% success, both with the auditory and with the visual presentation.

When composite numbers were presented orally the patient could not spell any of them out aloud in terms of their constituent digits. Concurrent writing movements improved the score to 33% and when the response was entirely in writing, succeeded 93% of the time.

It is apparent that both with alphabetical and with numerical material, the patient responded far better in writing than orally. When writing movements (out of sight) were permitted to precede the oral response, this yielded intermediate scores. The relative deficit on oral response to oral presentation was paralleled when words were visually presented for an oral spelling response, the stimulus being removed before response was permitted. The differential efficiency in relation to channel (auditory or visual) was maintained both with spelling and recognition of a spelled word ('reverse spelling').

#### LEARNING OF AN ARBITRARY TRANSFORMATION

The patient's difficulties with word-letter and composite number-digit transformations when mediated by the auditory channel raised the question as to whether he would also experience selective difficulty in learning arbitrary correspondence between single items and sequences. An arbitrary set of 'flags of the nations' was compiled, such that each of a series of countries was credited with a flag bearing three colours, irrespective of the characteristics of the real flag, *e.g.*: Greece, green-red-blue; Spain, yellow-white-black. The country—three colour associations were learnt in pairs and in threes.

The results showed that when presented orally for oral response, sets of pairs were learnt in two trials and sets of three pairs in four trials. It is therefore evident that this task did not cause him serious difficulty.

#### DISCUSSION

Letters may be presented for direct repetition, or for transformation into the word they conventionally denote (recognition of a word spelled aloud). Words may be repeated, or transformed into the letter series that stand for them (spelled). Digits and composite numbers (numbers written as several adjacent digits) may be used for comparable exchanges. Moreover, spoken stimuli may be followed by spoken responses, both occupying the 'auditory channel', or both stimulus and response may be in writing, occupying the visual-kinaesthetic channel. Or the stimulus may occupy one channel, the response the other.

J.P. presented with an apparently disproportionate impairment of oral spelling ability. He was formally tested on all letter-word exchanges which could be constructed as well as on a number of comparable digit composite number exchanges (see Table).

The parameters were: nature of stimulus, whether single (word or composite number) or group (letters or digits); nature of response, whether letters, word, digits, or composite number; stimulus channel, auditory or visual-kinaesthetic; response channel, auditory or visual-kinaesthetic.

Where possible the material was chosen from standard lists. It would have presented little difficulty to J.P., premorbidly, as far as can be judged from his occupation, educational background, and the available evidence as to his premorbid intelligence. The results showed scattered errors consistent with a moderate degree of expressive aphasia, the presence of which had been demonstrated by tests of verbal learning and explanation of proverbs. He showed full comprehension of test instructions, consistent with the failure to demonstrate any degree of receptive dysphasia, using multiple commands and a test story for interpretation. But on two of the transformations tested for he showed outstanding impairment, such as otherwise occurs only in patients with the most severe generalized language disorder. This impairment was remarkably selective.

The difficulty was in oral spelling, the transformation of a heard word into spoken letters. The converse transformation, letters to word, was equally affected, and so were the corresponding digit composite number transformations. Thus it was a particular transformation, within a particular channel (audi-

tory), which was selectively impaired, irrespective of its direction or of the nature of the material (alphabetical or numerical).

The disproportionately low scores on the transformation in question cannot be attributed to the effect of increased task difficulty, as the comparable transformation involving both channels, rather than just the auditory, should then have been at least as difficult but was in fact far better performed. The selective nature of the impairment was repeatedly verified over an observation period of six months, with the use of a wide variety of test materials and procedures. The results will now be considered.

The impairment was maximal when both stimulus and response were within the auditor channel. It could be reduced by enlisting the visual-kinaesthetic channel in the response. Holding a pen without ink, J.P. moved it over the paper as if writing the word to be spelled, but not leaving any trace. His oral response was then much more accurate, if short of perfect, as if he had 'read off' his own movements. As this improvement was maintained even when he had his eyes closed while making writing movements with his hand, it could not have been a strictly visual read-out, but rather one based on the kinaesthetic input, or possibly on monitoring of the innervation of his own movement sequences. A similar advantage was obtained if J.P. was permitted to move his hand appropriately as a word was spelled out to him letter by letter. Moreover the corresponding digit-composite number transformation was similarly aided by side-stepping the direct auditory-auditory stimulus response connexion. A selective block had been circumvented.

These findings suggest that J.P. had previously performed letter-word and digit-number transformations along the same or neighbouring lines of communication. An attempt to teach him a comparable but arbitrary transformation between colours/colour names and 'flags of the nations' did not reveal obvious impairment, so that it may be that the line of communication in question handles alphabetical and numerical material exclusively. More evidence is needed on this point.

Clinically J.P. presented with disproportionate difficulty with oral, as compared with written, spelling. As these two ways of spelling are not normally both tested for, and as the other relevant tasks used here were designed specifically for this study, it is not possible to estimate the frequency with which a similar clinical situation might have occurred in previous large-scale studies of dysphasics. In the authors' experience this is the first such case. If the view that it is rare is borne out, this need imply no more than that a rather precisely placed and limited lesion is required to produce it.

Comparable cases could then only be detected by detailed individual study, as statistical analyses of extensive clinical material would be likely to submerge the rare but significant case.

The selectivity of impairment of function demonstrated here must be based on a comparable anatomical differentiation of the neural structures implicated. While information available about the present case permits no speculations in terms of the precise anatomy of the relevant cortical locus, the findings would best be explained on models of cerebral functioning which incorporate the occurrence of certain transformations along anatomically separate and distinctive lines of communication, with the possibility of their selective disconnection by naturally occurring disease.

## SUMMARY

A patient with a moderate degree of expressive

dysphasia had disproportionate difficulty in oral spelling and in the recognition of words spelled out to him. Transformations between digit sequences and the names of the composite numbers they constitute were similarly affected. The selective defect was limited to the auditory channel. When the visual-kinaesthetic channel was introduced by presenting the material in writing, or permitting a written response, the deficit was overcome, and even making appropriate writing movements with the right hand substantially improved performance.

The findings suggest that auditory letter-word and digit-composite number transformations proceed along distinct central lines of communication which may be selectively disconnected by naturally occurring disease.

We are most grateful to Dr. John Marshall for giving us permission to study and report this case.

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