A selective deficit for reading vowels in a letter-by-letter reader

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Abstract

BM, a patient with fluent aphasia and severe alexia without agraphia is presented. He manifests a clear word length effect which is the hallmark of letter-by-letter reading. However, this letter-by-letter reader comes with an unusual twist, namely a selective difficulty in reading vowels, both in words and non-words. BM´s reading was not influenced by word class, imageability or word frequency. Only one other similar case is known in the literature.

Introduction

It is well known that aphasic patients often produce more consonant errors in speech than vowel errors. Although rare, a greater impairment in oral production of vowels than consonants has also been reported (Romani, Granà & Semenza, 1996; Caramazza, Chialant, Capasso and Miceli, 2000). This demonstrates that a relative impairment in consonant production cannot be explained by consonants being articulatorily more complex. Moroever, a selective deficit for writing vowels has been reported (Cotelli, Abutalebi, Zorzi & Cappa, 2003; Cubelli, 1991) which argues against an articulatory underpinning as the sole explanation of the dissociation between consonants and vowels.

I will describe an Icelandic letter-by-letter reader with a selective difficulty for reading vowels. This deficit pattern shows that the consonant/vowel distinction is honored in reading as well as in writing and speaking. To my knowledge, only one other similar case, patient AP, has been described (Ferreres, López & China, 2003).

Case presentation

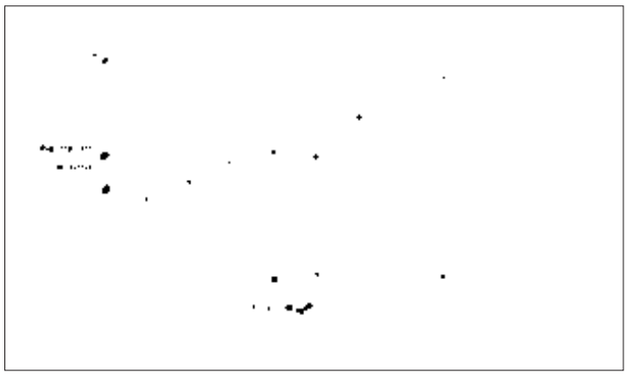
Background

BM, a right-handed male, was 60 years old when he suffered a large intracerebral hemorrhage in the left temporoparietal area. BM had 13 years of schooling and ran his own business prior to his illness. Shortly after the stroke an evaluation by a speech and language pathologist on the Icelandic version of the Boston Diagnostic Aphasia Examination revealed a typical fluent aphasia pattern.

BM was seen by the author three weeks post-onset. At that time he was anomic in all modalities of stimulus presentation. Oral and written naming were equally impaired and semantic errors were numerous. Auditory and written comprehension were quite impaired. He had great difficulties reading but spelling was intact with 92% of the words (55/60) and non-words (22/24) correctly spelled. Spelling errors were like those frequently seen by normal Icelandic spellers (e.g. i replacing y). After observing that BM seemed to have particular difficulties reading vowels his reading ability was evaluated further.

Reading evaluation

BM read a total of 418 words and 74 non-words. He correctly read 56% of the words (237/418) and 38% of the non-words (28/74) ($c^2 = 8.26$, $p < .01$) thus showing a lexical advantage. The majority (61.9%) of BM´s word reading errors were non-word responses. This is not suprising as his poor comprehension would diminish his ability to self-correct his responses. None of BM´s errors with non-words could be interpreted as a failure to correctly apply grapheme-to-phoneme rules. It should be noted that BM´s native language, Icelandic, is orthographically regular and opportunities for errors based on incorrect application of grapheme-to-phoneme rules are few. BM´s reading was not influenced by word class, imageability or word frequency.



BM showed a clear word length effect (Figure 1) with response latencies increasing by approximately one second for each letter. BM took 3.27 seconds (SD = 2.46) to read three letter words and 8.20 seconds (SD = 3.14) to read 8 letter words. Error rate did not vary with word length. When reading, BM did not say individual letters out loud but when asked how he proceeded he stated that he used the sounds of the letters in order to arrive at an answer. Thus, BM was not able to retrieve phonological forms directly from print but had to read letter-by-letter. BM correctly encoded the length of the words he read because 96% of his responses included the correct number of letters. Because of the highly regular orthography of Icelandic his responses were unambiguous as to the number of letters they included.

BM´s responses demonstrated that he was able to assign letters to the correct categories of consonants and vowels. The vast majority (98.6%) of his single letter substitutions, which was the most frequent error (Table 1), preserved the consonant/vowel status of the stimulus. Examples of BM´s errors which clearly demonstrate this are: vika -> veke, máfur -> kefir; marmari -> vervari; traust -> treyst (see Table 2). Single letter substitutions accounted for the majority of vowel errors. The pattern was different for consonants for which substitutions accounted for 73% of the errors and omissions and additions together accounted for a further 20%.

The most striking aspect of BM´s reading was that he made significantly more errors in reading vowels than consonants. This was true for words as well as non-words. Taking into account all errors except those that were whole word errors the error rate for vowels was 23.5% (196/835) and the error rate for consonants was 6.0% (88/1465) ($c^2 = 148.3$, $p < .001$). The pattern was remarkably similar for non-words in which 22.5% of the vowels and 5.6% of the consonants were incorrect ($c^2 = 25.3$, $p < .001$).

When presented with isolated letters BM´s performance with vowels was also significantly worse than with consonants ($c^2 = 5.96$, df = 1, $p < .02$). He named 33/38 consonants correctly (17 upper case and 16 lower case) and 16/28 vowels were correctly named (8 lower case and 8 upper case). In another session when asked to say the sounds of the individual letters 31/38 consonants were correct and 13/28 vowels ($c^2 = 7.45$, df = 1, $p < .01$). Nevertheless, saying the sounds of the consonants would appear to be a more demanding task as their name and sounds are not identical as is generally the case for vowels in Icelandic.

It was established that BM´s difficulty in reading vowels was not a reflection of a general difficulty with vowels. BM could repeat correctly words that he could not read and he could correctly assemble individual phonemes that were presented auditorily (phonemic blending).

BM´s reading is still slow but the selective deficit in reading vowels disappeared with further recovery and the consonant-vowel discrepancy could therefore not be evaluated in more detail.

Table 1 BM´s errors in reading words

Error types	Vowels (%)	Consonants (%)
Single Letter Errors		
Substitutions	189 (96.4)	64 (72.7)
Omissions	4 (2.1)	9 (10.2)
Additions	3 (1.5)	9 (10.2)
Multiple Letter Errors		
Exchanges	0	1 (1.2)
Errors on geminates	Not applicable	5 (5.7)
Whole word errors		
No responses	5 function words	
Fragments/complex errors	9 content words	

Table 2 Examples of BM´s incorrect reading

Stimulus	Response
auk (in addition)	eik (oak)
eftir (after)	aftur (again)
marmari (marble)	vervari (non-word)
morgunver_ur (breakfast)	vergunvar_ur (non-word)
straujar (irons)	streitir (non-word)
_akklæti (gratitude)	_ettlæta (non-word)
píanó (piano)	teyna (non-word)

Discussion

A letter-by-letter reader with a selective deficit for reading vowels has been presented. A case quite as the one presented here has, to my knowledge, not been described previously. Ferreres, López and China (2003) described a Spanish-speaking patient, AP, who had phonological alexia with significantly more difficulties in decoding vowels than consonants although the difference was not quite as marked as in the case described here. Moreover, AP´s vowel impairment was only apparent for non-words. Cubelli (1991) reported on two Italian patients who had a selective deficit for writing vowels. Like Italian, BM´s native language, Icelandic, is orthographically transparent. However, this does not account for the clear separation between vowels and consonants as it is also seen in orthographically irregular languages (Jónsdóttir, Shallice & Wise, 1996).

In Berent and Perfetti´s (1995) two-cycles model of reading, consonants and vowels are processed differently. Activation of consonants is fast and relatively automatic whereas the decoding of vowels is a slower controlled process. Berent and Perfetti´s model may well be specific to English and in a recent Italian study (Colombo, Zorzi, Cubelli & Brivio, 2003) it is suggested that the model may not apply to Italian. The applicability of the two-cycles model of reading to Icelandic has not yet been investigated. However, if it is true that, in reading, decoding of vowels is slower and less automatic than the decoding of consonants, one might hypothesize that following brain injury one would never see difficulties in decoding consonants without parallel diffficulties in decoding vowels. One could also hypothesize that transient difficulties in reading vowels are more frequent than one might assume as controlled cognitive processes tend to be more susceptible to the acute effects of brain injury. Other letter-by-letter readers should thus be investigated with respect to the dissociation between consonants and vowels.

However, a reading pattern such as the one described here does not only speak to theoretical issues in reading but also has practical implications. The possible discrepancy between vowels and consonants needs to be kept in mind when evaluating patients with acquired reading disorders as this dissociation might have therapeutic implications.

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