

NTHLY?

Some thoughts on Wordle

by David Parlett

Wordle is often described as a guessing game in which you have to discover a target word by calling out test words and being told how many of the letters in your test word appear in the target word. Each letter is shown in a green box if it appears in the correct position, or a yellow box if it belongs to the target word but in a different position. Whether it should be classed as a guessing game is questionable, as this implies a game won by chance or luck. It's better regarded as a game of skill, to be won largely by deduction, partly by bluff, and essentially by the deployment of a good vocabulary and knowledge of the structure of the language involved (English, in my case.)

In my youth we played an ancestor of Wordle in the form of a pencil-and-paper word game called Bull and Cow. One player thought of a five- or six-letter target word and wrote down a row of as many dashes as the word contained. The other sought to deduce the target word by calling out test words. For each test word the setter would state how many bulls or cows it scored. A 'bull' was a letter in the test word appearing in exactly the same position in the target word, a 'cow' a letter that appeared in both words but in different positions. So if the target was ATTIC and you tested with CATER you'd be told 'One bull and two cows'. I don't suppose the game originated as late as my introduction to it – it looks to me like the sort of thing that might have been invented by prisoners-of-war in 1939-45 or even 1914-18. Whatever, you can readily see this as the essence of Wordle, with green letters equivalent to bulls and yellow ones to cows.

In 1971 the Romanian-born Israeli telecommunications expert Mordecai Meiorowitz invented an equivalent game played with coloured pegs, which was marketed in Britain by Invicta Plastics under the name Mastermind. The following year BBC TV started its continually popular quiz game of the same name but bearing no relation to the deductive mechanics of the board game. I used to think the deductive board game owed its title, and hence its success, to the popularity of quiz show, and have just been surprised to discover that the board game came first.

How do you approach the task of solving this game? At first sight it's pretty obvious that a knowledge of letter frequencies in English must help. But there are two problems with this. The first is that letter frequencies vary depending on whether the text analysed is horizontal or vertical (my terminology). Horizontal text is words put together to be read for their content as messages; vertical text is a word list, such as a list of dictionary headwords.

It was in my teens that I first needed a frequency distribution for word games. At that time there was no internet and the only frequency tables I could find came from books or articles on cryptography, as filtered through the medium of the *Children's Encyclopaedia* and/or an appendix to *Nuttall's Standard Dictionary of the English Language* ('based on the labours of the most eminent lexicographers', if I remember aright). These in turn tended to be based on Samuel Morse's counting of the relative number of sorts (letters) in compositors' cases, which proved to be ETAINOSHRDLUCMFWYGPBVKQJXZ. But of course this is a count of horizontal text, in which the frequency of letters is skewed by their appearance in the most frequently used words. Cryptography is designed to conceal messages, for which purpose only horizontal text is relevant. In this connection I can't help being reminded that in Erle Stanley Gardner's 60-plus *Perry Mason* novels, written between 1930 and 1965, his detective Paul Drake invariably says, of a dodgy female witness (or client), that 'She has plenty of this and that and these and those', a passage of text from which you might assume that English words are composed almost entirely of S, H and T.

But in word games based on individual words rather than messages it is the frequency of letters in vertical text that counts – that is, the frequency of their appearance in dictionary headwords. When I got my first home computer in 1979 one of the first things I did with it was to list the first headword on every tenth page of Chambers dictionary and from these to calculate the relative frequencies of individual letters. My result (reported in an appendix of my *Penguin Book of Word Games*, 1982) was almost identical to the more recent and sophisticated table at <https://www3.nd.edu/~busiforc/handouts/cryptography/letterfrequencies.html>

For comparison, the following table shows, in row one, the relative frequencies of letters in horizontal text; in row two, the same in vertical text; in row three, frequency of letters in first position; in row four, letters in final position (vertical).

E	T	A	I	N	O	S	H	R	D	L	U	C	M	F	W	Y	G	P	B	V	K	Q	J	X	Z
E	A	R	I	O	T	N	S	L	C	U	D	P	M	H	G	B	F	Y	W	K	V	X	Z	J	Q
S	P	C	A	M	T	B	R	D	F	H	E	I	W	G	L	O	U	N	V	K	J	Q	Y	Z	X
S	E	T	Y	N	L	R	D	C	A	H	M	G	P	O	K	F	W	B	X	I	U	Z	J	Q	V

In solving Wordle, then, the question is whether the target words are picked at random from a given vocabulary, in which case the vertical frequency list is more relevant, or are deliberately chosen from vertical text by the setter, in which case you might expect a skew towards words containing rarer rather than commoner letters. My impression is that the setter selects a word at random but may then tweak it to be slightly more awkward to solve, or to avoid targeting a word that some players may find objectionable. The setter also seems to consciously avoid target words ending in S, either as a plural or as a verbal suffix.

Tweaking is where the element of bluff comes into play. If your first few shots produce a word ending in -EARS the target word could be any of 12 possibilities ranging from BEARS to YEARS. If the target was chosen at random the likeliest probability is R or T, but if the setter has considered all the possibilities they may well have gone for VOWED or, more craftily, WOWED. (Query: is someone being WOWED a WOWEE?) It can help to memorise a four-fold scheme of letters: six vowels (AEIOUY), six common consonants (CLNRST), seven less common consonants (BDFGHMP), and seven positively rare ones (JKQVWXZ). It's certainly worth starting with words containing the vertically commonest letters. Even an unusual word like SYLPH contains three of the commonest, and using this as your first test word would quite likely give you two or three yellows, perhaps even a green.

Architecture. Before plunging directly into the letter-frequency approach, however, you need to take into account the target word's basic architecture, **firstly** in the balance between consonants and vowels. For example, the relative frequency of vowels in vertical text is (according to my calculations) about 43 per cent. With X representing a consonant and O a vowel, five-letter words are often based on the structure XOXOX, such as PETAL; sometimes XXOXO, like CHASE; and sometimes XOXXO, like LATHE. It therefore seems sensible to start with three words each containing two vowels and three consonants, and representing all six vowels and nine different consonants. A good selection of three initial test words might be CATER, POUND, FILMY.

Six vowels? Yes - never neglect Y, which is a vowel more often than not. There are many words containing no other vowel - LYMPH, SLYLY, PYGMY, to name but a few. Y is only more or less consonantal at the start of a distinct syllable, as in YEAST and YOYOS, though a delightful counter-example is the admittedly archaic YCLEPT.

But of course you have to modify your approach depending on what results you get for your first words. For example, if CATER turns up three yellows for A, T and E then a sensible choice for your

second shot would be something like SATED, thus giving you further information about the positions of A, T and E, and introducing two more test consonants (S, D). I'd be very surprised if SATED did not produce at least one green in addition to the two known yellows.

Even if your first word produces five blanks, at least that's useful information, and your second line may prove correspondingly more profitable – as it did in this one (LATER-POUCH-POUND). It also shows how important it is never to try a word containing a letter already shown to be a dud. Following this method, you can usually establish the basic architecture of the target word, if not the thing itself, by your third shot.

L	A	T	E	R
P	O	U	C	H
P	O	U	N	D

The positioning of specific letters in a word is another part of its basic architecture. Once a letter has been confirmed as yellow it then become necessary to consider its possible or probable position as a green. B, for example, is least likely to be found the at the end of a word, whereas H is most worth testing in second or fifth position, bearing in mind that it frequently follows C, G (as in THIGH), P, S, T, and (at the start of a word) W. The commonest letters in first position are S, P, C, D, M, A. Letter X is usually best at the end of a word (INDEX, LATEX), but also occurs frequently in second position following an initial vowel, as in AXIOM, EXTOL, and OXBOW. If you get three or more yellows on your first shot it's helpful if you can just shift them by one position *en bloc*, as in the example of LATER-SLATE-PLEAT.

L	A	T	E	R
S	L	A	T	E
P	L	E	A	T

British solvers will soon become aware that the target word might be missed because it appears in its American spelling (FAVOR, HUMOR, etc). And it's easy to get fixated on a particular but misleading pronunciation. On one occasion I tried MOULD, which produce four greens following the M. Being unable to find a word of similar spelling and pronunciation I completely overlooked COULD and WOULD.

Scoring. Given that Wordle is a game of skill, you might want to devise a method of scoring for your successes. Mine is to value greens at 2 points each and yellows at one, and to score for reaching the target word 10 minus the value of letters obtained on my first shot. Thus LATER-POUCH-POUND gave me 10/10, while CATER-ARGON-PARKA-GRASP-SPRAG gave me 8/10 – for which I thanked my lucky stars, as I didn't know the word SPRAG and had to look it up before entering it.

C	A	T	E	R
A	R	G	O	N
P	A	R	K	A
G	R	A	S	P
S	P	R	A	G

Note that my scoring doesn't take into account the number of test words it takes to reach the target. If you happen to get it on your first shot that's purely a matter of luck, and you (quite rightly) score 0/10 for it. On the other hand, I got 9/10 for one that took up all six shots, namely LATER-INGOT-POSIT-JOIST-FOIST-MOIST. Having got the essentials of the target word by line 3, it was only a matter of guessing the first letter, which, besides J, F and W, could also have been B (obsolete word for box or cask), H, or R.

L	A	T	E	R
I	N	G	O	T
P	O	S	I	T
J	O	I	S	T
F	O	I	S	T
M	O	I	S	T

I did consider adding to my score 1 point for each of the six shots I left unused, so my first example (LATER-POUCH-POUND) would have counted an extra 3, giving a slightly anomalous score of 13/10. But, in the interests of consistency (that 'hobgoblin of little minds', according to Ralph Waldo Emerson), I now prefer to make 10 the maximum possible score.

One aspect of Wordle that one might take exception to is a target word containing duplicated letters (as in LATER-TEASE-GRATE-SPATE-SKATE-STATE), as each duplication reduces by one unit the amount of information provided by each shot containing that letter. One of the worst possible target words would be MAMMA, and if it were ever set I would add 3 points to my score: two for the duplicated Ms and one for the duplicated A – so long, of course, as it didn't exceed the maximum 10. Some really nasty duplicated-letter words that I have yet to see used include ESSES and PZAZZ.

L	A	T	E	R
T	E	A	S	E
G	R	A	T	E
S	P	A	T	E
S	K	A	T	E
S	T	A	T	E

As a matter of interest I find that the average number of shots it take me to hit the target is 3.6 (range 3.8 - 4.4, SD 0.19) for an average score of 8/10.

Further thoughts on the vowel-consonant structure of individual words might not come amiss. Amongst those omitted above are OXXXX (such as the German-derived ANGST, and ANKHS, borrowed from ancient Egyptian), OOXXX (AITCH, EIGHT, etc) and XXXXO (SCHWA, defined by Wikipedia as 'the mid central vowel sound in the middle of the vowel chart, denoted by the IPA symbol (ə)'). Even an example of XXXXX exists in *Collins Official Scrabble Words* – namely CRWTH, a Welsh musical instrument. In Welsh W is a vowel, and *crwth* rhymes, more or less, with *sooth*. There are also the lovely patterns XOOOO of QUEUE and OOOXO of OUIJA – a word useful for testing four vowels at a time.

A final thought. The series beginning *first, second, third*, etc, also includes the indeterminate ordinal NTH. That being so, would its adverbial form be, by analogy with *firstly, secondly thirdly*, etc, NTHLY?