

V-Check and Word Engine Academic FAQ (v1.8)

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How does Lexxica count words?

1. How many English words are there?

Webster's Third New International Dictionary contains about 267,000 headword entries. Paul Nation classified 113,161 of those entries as Word Families (Nation, 1990). There are likely over four million English words in all forms if scientific terms and organism designations are included (Crystal, 1990). The largest credible estimate for total number of general English words that we know of comes from Henry Kucera who in 1982 indicated the probable existence of some 375,000 English words, including proper words and special terms in general use. Kucera further suggested that the 375,000 words would extend to about 600,000 total English words if all forms were counted based on the widely accepted average ratio of 1.6 various forms for each dictionary headword citation. (Kucera, 1982).

2. What constitutes a Base Word?

There are a variety of ways to count the words in the English language. Take for example the following words:

accept
accepts
accepted
accepting
acceptable
unacceptable
acceptably
unacceptably
acceptance

In accordance with the 'Word Family' approach, all nine word forms shown above can be counted and referenced by the single citation: 'accept.' The Word Family approach applies morphological rules to combine the forms of related words into a single citation. If learning one Word Family headword actually conferred knowledge of all related word forms, then the approach would be appropriate for testing and teaching applications. However, the notion that an individual who knows the word 'accept' will also know the word 'acceptable,' is simply unacceptable. Our statistical analysis of learner word recognition responses shows that non-native learners of English who know the word 'accept' almost always know the word 'accepted,' and yet very seldom know the word 'unacceptably.'

The Base Word method developed by Lexxica begins with the premise that all forms of a word that share the same measure of lexical difficulty among learners can be counted as the same Base Word. Taking the example of 'accept,' the data from millions of people responding to our Lexical Decision Tasks ("LDT") and L1-L2 multiple choice matching questions, indicate that the four inflected forms of 'accept' are equally difficult among the people, whereas the five derived forms each have different measures of difficulty. Lexxica's Base Word approach recognizes the nine forms as six different Base Words: 'accept,' 'acceptable,' 'unacceptable,' 'acceptably,' 'unacceptably,' and 'acceptance.'

It can be said that a Base Word is similar in nature to a lexeme, however, the set of word forms that constitute a lexeme are typically determined through a morphological process in accordance with grammatical assumptions. Lexxica’s Base Word approach depends on statistical analysis of individual LDT responses from millions of people at all levels of language ability including responses from both native and non-native speakers.

The term Base Word was coined by Lexxica’s chief scientist, Brent Culligan, to clarify the distinction between a statistical approach to organizing and counting word forms versus the morphological approaches. Interestingly, our most recent analysis confirm that almost all inflected forms of words do share the same level of difficulty, and almost all derived forms of words have different levels of difficulty. The response data supports the theory that inflected forms of words can be automatically deduced through a natural brain process, whereas derived forms of related words must be learned separately.

3. What about polywords and chunks, are they included as Base Words?

Typically the scanning systems used by computational linguists to count word frequencies are designed to count only single word citations such as, ‘accept’, or ‘the’. Only the most advanced scanners are able to count the occurrences of idiomatic polywords such as: ‘find out’, and ‘as well as’. Idiomatic polywords are also sometimes referred to multi word units, phrasal verbs, or even chunks. Whatever name is used to describe them, they all share a defining characteristic in that the meaning cannot be deduced through knowledge of the component words. Generally speaking, frequency analysis of a domain specific corpus will reveal as many as 50 to 100 idiomatic polywords within the first 2,000 most frequent Base Words and, therefore, such high-frequency polywords should be considered important to comprehension of that corpus domain. As an example, the polywords: ‘look for’, ‘based on’, and ‘take place’ are highly frequent within our 1.25 million-word corpus of TOEIC exams. Because polyword frequencies vary greatly from one corpus domain to another, it is essential to know which specific polywords are required for each different subject domain. Lexxica’s proprietary scanning software counts the occurrences of idiomatic polywords in the different subject domains, and Lexxica’s Word Engine teaches those polywords as Base Words.

How many English Base Words do people typically know?

V-Check English Base Word recognition averages as of January 2012:

Culture	Average number of general English Base Words
North American / Ages 17-20	26,964
Korean / Ages 17-20	6,477
Japanese / Ages 17-20	4,613
Chinese / Ages 17-20	4,375

What is coverage?

1. The traditional and first meaning of coverage

In the domain of linguistics the term ‘coverage’ has two distinct meanings. The traditional and first meaning describes **the value of a particular list of words to a particular corpus of text**. In theory, computational linguists use scanning software to count the frequency of word occurrences in large bodies of texts and the most frequently occurring words are then assembled into word lists that ‘cover’ up to certain specified percentages of running word occurrences within the corpus. An example of this interpretation of coverage would be the number of headwords indicated as required for comprehension of a particular level in a graded reader series. Another example would be a list of specific headwords said to correspond to certain specified percentages of running word coverage in a large general corpus such as the British National Corpus.

The chart below shows the coverage results that are reported by Nation, et al (1991) after scanning the British National Corpus (BNC) for occurrences of words in all forms. The single word forms identified by the scan were combined and reduced in number using the Word Family citations approach which implements morphological rules that combine all inflected and derived forms of related word forms into single citations.

<u>Word Family words</u>	<u>Percentage Coverage of BNC</u>
1	7
10	25
100	50
1000	75
2000	85
3300	90
4000	95
6000	98

The next chart shows the results from scanning the same BNC, however, the words in all forms were later combined and reduced in accordance with Lexica’s Base Word approach.

<u>Base Words</u>	<u>Percentage Coverage of BNC</u>
1	7
10	25
109	50
1072	75
2297	85
3954	90
5083	95
7627	98

Bear in mind that both approaches count the actual frequencies of every different form of every different word. The only difference is the way the word counts were reduced for counting purposes. Comparing the two charts above one can see that the Word Family approach requires about 25 percent fewer words to achieve the same key levels of coverage.

2. The second meaning of coverage

The second meaning of coverage describes **the lexical ability of a human in relation to a corpus**. A simple way to describe this is to say the percentage of words that a reader can comprehend in running text within a particular domain. Researchers, including Nation (2003), have suggested that comprehension tends to improve significantly at or above

certain key coverage thresholds. Nation and others define these key coverage thresholds in accordance with the second meaning of coverage - the percentage of words a reader can comprehend in running text. Laufer (1992) suggested that 95 percent coverage is a key tipping point above which there will be more students able to read their textbooks without consulting a dictionary than students unable to read without consulting a dictionary. Nation, et al (2007) suggested that 97 percent lexical coverage is the amount required to facilitate comprehension.

The following two readings simulate the experience of lexical coverage at two key levels of reader comprehension ability. The first passage simulates the human condition of 70 percent coverage by presenting a total of 59 words where 18 words are scrambled beyond recognition. Try to figure out the meaning of this passage and/or identify the missing words through context – the same way teachers so often advise their students:

Brad Pitt told Esquire mviswabe that he and Angelina Jolie will not be winplurtzd until the smorte to winplurtz is fromptes to bilps and plortes. Pitt, who trimpted the fitzleg of the smigteglar bortslig fratmack, says, “Angie and I won’t even nosigdcr gigrit the tonk until everyone else in the nonctron who wants to be winplurtzd is bleah to.”

Next, read the same paragraph at 95 percent coverage with only three of the 59 total words scrambled. Again, try to figure out the meaning and or identify the missing words.

Brad Pitt told Esquire magazine that he and Angelina Jolie will not be married until the right to marry is given to gays and plortes. Pitt, who trimpted the cover of the magazine’s recent issue, says, “Angie and I won’t even consider tying the tonk until everyone else in the country who wants to be married is able to.”

The example above seems to confirm that 95 percent is enough coverage to figure out the missing words through context, however, more research is called for to better understand the relationships between lexical ability, comprehension, and proficiency.

How does V-Check assess vocabulary size?

Researchers Beverly Goldfield and J. Steven Reznick (1989) sought to identify common patterns in vocabulary as it is first acquired by normal children beginning from birth on up through to age 12. Expanding on Goldfield and Reznick’s pioneering work, Lexxica set out to develop practical tools to identify all of the specific English vocabulary words that are known by people at all ages, and at all levels of vocabulary ability. After several years of complex and often frustrating research and development work, Lexxica released its first beta Word Engine with the V-Check vocabulary test in 2006. Word Engine has been upgraded seven times since 2006 and the current version now provides:

- Vocabulary size estimates for selected subject domains
- Coverage percentages for selected subject domains
- Comparisons to the average scores of other test users
- Personalized lists of missing vocabulary for each user for each subject domain
- High speed learning games with spaced repetition to promote long term retention

V-Check is an Item Response Theory (“IRT”), Computer Adaptive Test that works by assessing each user’s lexical ability along a statistical ogive comprised of 50,000 Base Words each having a unique difficulty measure called a lexit. The first word displayed during a V-Check test is randomly selected from words having an average difficulty lexit for people similar to the respondent. Based on the user’s responses, each next word will be selected from a higher or lower lexit point along the ogive. The advantage of Computer Aided Testing is that each next question can be formulated to produce the maximum amount of useful information and, therefore, the test may be conducted in the shortest possible amount of time. It is important to bear in mind that at any given point along the ogive there may be anywhere from 5 to 200 different Base Words all having the same lexit of difficulty. The test words displayed during a V-Check are selected at random from among all calibrated words that are available at any particular lexit of difficulty. As a result, the V-Check rarely displays the same series of test words in different tests.

For more information on how the V-Check measures vocabulary size see the white paper entitled: [IRT, Reliability and Standard Error](#)

How does Lexica determine the difficulty lexis of different words?

The entire process is mathematically driven and based on the differing lexical abilities of people and the thousands of different high frequency words that are required to effectively cover different important subject domains. Without going into the specific math, the ways that people collectively respond to the different words displayed during thousands of V-Check tests taken all over the world is what allows Lexica to mathematically calibrate the difficulty lexis for each different word and determine the ability lexit of each different respondent. When we first started in 2006, our online V-Check database consisted of just 6,000 calibrated words which had been determined through extensive paper testing conducted by Brent Culligan among thousands of college students over a five-year period. Today, Lexica has about 50,000 Base Words in its database, far more than are required to comprehend any one subject domain.

We maintain two classifications of Base Words in our database: ‘Calibrated Base Words’ and ‘Estimated Base Words.’ The Calibrated Base Words are those words that have received enough responses from different learners at all different levels of ability so that we can mathematically calculate the difficulty lexis. During a V-Check test, only calibrated words are used to determine a respondent’s ability. We do, however, systematically insert a subset of uncalibrated words in each V-Check test so as to collect the response data needed to calculate the lexis for any such uncalibrated words. When we don’t have enough response data to calibrate the difficulty of a word, we apply a set of morphological rules to estimate their difficulty lexis. These rules were developed by Brent Culligan based on the morphological patterns identified among the calibrated Base Words including, for example, part of speech, frequency, and syntactic complexity. We assign estimated lexis to uncalibrated words when they are required for comprehension a particular subject domain such as the GRE. The estimated lexis allow us to better position these words in a learner’s sequence of new vocabulary for study.

How does V-Check operate to prevent students from guessing at words and generating overly high scores?

An essential aspect of the V-Check testing process from the beginning was the inclusion of pseudo-words which appear randomly throughout the testing process and in accordance with the standard precepts of Signal Detection Theory. These pseudo-words are spelled in

accordance with English grammatical conventions; however, they have no meaning. The pseudo-words are used to control for guessing behavior. A typical V-Check test will display a total of about 50 to 60 total words and about half of the total words will be pseudo-words. If a respondent replies 'yes' to more than two pseudo-words, the test stops and no score is given.

Additionally, in 2012, Lexica completed an assessment of the correlation between V-Check definitional responses and the correct response ratio exhibited during study of the first 100 items presented in the WordEngine games. The combined V-Check and WordEngine system is designed so that a learner should be able to correctly respond to about 68 percent of the first 100 words presented in the WordEngine games. As one might expect, students who guessed aggressively during the V-Check LDT word recognition tasks, and yet managed to avoid guessing yes to more than two pseudo-words, consistently scored lower on their definitional questions, and consistently exhibited lower than expected Correct Response Ratios in the learning games. Conversely, students who responded accurately to the LDT tasks consistently scored higher marks in the definitional section, and had no problems hitting the expected 68 percent correct response ratio in the WordEngine games. This front-to-back analysis allowed us to develop an improved scoring algorithm that adjusts the V-Check score to more accurately predict how many words a respondent is able to comprehend regardless of how aggressively they guess during the LDT recognition tasks.

One of my students scored high on V-Check but, I don't believe they know that many words. What's going on?

V-Check began in 2006 as a pure LDT word recognition ability test – not a word comprehension ability test. V-Check's initial purpose was to diagnose which specific words a student does not need to study so that we could reduce their vocabulary study burden. Teachers and students benefitted from our word recognition scores, but teachers and students were also very clear that they preferred to know how many words they can actually comprehend instead of how many words they can merely recognize. After several years of data collection, in 2012, we were able to implement a new algorithm designed to identify the number of words a student can comprehend in the context of multiple choice definitional tasks. The possibility remains, however, that even with our more advanced scoring algorithm, an aggressive and lucky student might defeat our multiple screening mechanisms and end up generating a higher (or lower) score than their actual ability to comprehend words merits.

Teachers using Lexica's V-Admin learning management system can easily identify students who guessed aggressively, or perhaps underreported their ability, by monitoring students' Correct Response Ratio during their first month of study. Students with a Correct Response Ratio below 50 percent during the first month are likely to have guessed aggressively. Students with a Correct Response Ratio above 96 percent are likely to have underreported their ability. Cases of underreporting ability are rare but they occasionally crop up in a compulsory learning environment where an unmotivated yet extremely clever student understands that by dumbing-down his V-Check his homework assignments will be made easier. It is important for teachers to make any such assessment during the first month of study because, beyond the first month, the number of words coming back for review inside the spaced repetition system will cause the Correct Response Ratio to stabilize somewhere between 60 to 95 percent. At the teacher's option, aggressive scorers, or egregious under-reporters, can be adjusted by contacting Lexica and requesting that a lower or higher ability be applied to the student's existing account. In that way, learning progress will not be lost by making a new account.

What is the purpose of the V-Check test?

The V-Check is first and foremost a diagnostic test designed to help establish the optimal starting point for a personalized course in new vocabulary acquisition. The main purpose of the V-Check test is to create a personal database of likely unknown words so that each student can more efficiently acquire his or her missing vocabulary for important academic and career subjects. The V-Check LDT questions identify the level of difficulty at which 50 percent of the words are recognized by the respondent and 50 percent of the words are not recognized. The V-Check definitional questions confirm how many words can be correctly understood at the level of ability indicated by the LDT tasks. Beginning from 2012, data from both parts of the test were combined to generate a score indicating the number of words the respondent can comprehend, and establishing the optimal starting point for each respondent's learning course.

V-Check is supposed to remove known words but my students still see some words they knew when they started out. Why is that?

There are three reasons for this. First, there are many high frequency words that are so important to comprehension we believe they should be reviewed by all learners, in all cases, just to be certain that they are fully understood. Second, we seek to adjust the starting point to a targeted 68 percent known words during the first stage of the learning games in order to help students develop confidence with the learning games before moving on to wholly unfamiliar new vocabulary. Third, by targeting the starting point at 68 percent known words, it also ensures that many high-frequency words located on the fringe of the respondent's comprehension ability will be reviewed and fully acquired before moving up to wholly unfamiliar new vocabulary.

How does V-Check calculate known words and coverage ability for different subjects such as TOEIC and TOEFL?

To help explain this aspect of the V-Check process let us review a hypothetical example of Ms. Sasaki, a university student living in Japan. Ms. Sasaki's V-Check responses demonstrate that she consistently comprehends 50 percent of the Base Words that have been calibrated at the 1.00 lexit of difficulty level. And because ability and difficulty occur along the same logarithmic scale, it can be said that Ms. Sasaki's ability is equivalent to the 1.00 lexit level of word difficulty. Therefore, words with a lexit of difficulty above 1.00 are less likely to be known to Ms. Sasaki. Essentially the V-Check test moves up and down the lexit scale to confirm, and reconfirm with definitional tasks, the difficulty level at which Ms. Sasaki has a 50 percent likelihood of correctly comprehending Base Words. Having established Ms. Sasaki's ability, V-Check will next compare her lexit of ability (in this case 1.00) against the lexits for all individual Base Words in Lexica's lists of required words for different domain subjects such as TOEIC and TOEFL.

For this explanation let us assume that we are discussing a word list for TOEFL consisting of 7,500 total words which account for 99 percent of all words occurring in a one million word TOEFL corpus, excluding proper nouns. Let us further assume that half of the 7,500 total words have the same difficulty lexit of 2.00, and the other half all have the same difficulty lexit of 0.50. Because ability and difficulty occur along the same scale, it can be said that Ms. Sasaki has a 25 percent likelihood of comprehending the words with a difficulty of 2.00, and a 75 percent likelihood of comprehending the words with a difficulty of 0.50.

By calculating the sum of all probabilities for all 7,500 words, we can establish that Ms. Sasaki will likely comprehend 938 total words (25 percent) among the more difficult half of the words, and 2,813 total words (75 percent) among the less difficult half of the words. All together, Ms. Sasaki will likely comprehend 3,751 words among the 7,500 words which account for 99 percent of all words occurring in the TOEFL corpus. If all of her 3,751 known words (938 + 2,813 = 3,751) were equal in terms of value to comprehension, then Ms. Sasaki's coverage of the TOEFL corpus would be about 50 percent. However, because certain of the 3,751 words she knows occur much more often than the others, we must factor her 3,751 known words by the frequency with which each word occurs in the TOEFL corpus.

To continue with this simplified example let us assume that the 938 more difficult words she knows each occurs 10 times within the TOEFL corpus of one million total words. As a result, the relative coverage value of each of those 938 words is 0.001 percent. Let us also assume that the 2,813 easier words she knows each occur 255 times in the corpus. As a result, the relative coverage value of each of those 2,813 words is 0.0255 percent. The V-Check system would then calculate that Ms. Sasaki's overall coverage for the TOEFL corpus is as follows:

- Ms. Sasaki's 938 more difficult known words cumulatively contribute .938 percent coverage of the TOEFL corpus ($938 \times 0.00001 = 0.00938$)
- Ms. Sasaki's 2,813 easier known words cumulatively contribute 72 percent to coverage of the TOEFL corpus ($2,813 \times 0.000255 = 0.717315$)
- All combined, Ms. Sasaki's 3,751 known words provide an aggregate 73 percent coverage of the TOEFL corpus.

The processes that Lexxica uses to calculate coverage for its different business and academic subjects are basically similar, however, the calculations involved are far more complex because practically all of the words required for comprehension in a particular corpus have different individual relative coverage values.

What are the practical benefits of combining vocabulary ability assessments and word list coverage analysis?

1. Traditional word list coverage versus human ability coverage

Traditional corpus analysis is conducted with large bodies of selected texts and designed to reveal a list of specific high-frequency words that will most effectively cover a particular domain such as TOEIC or TOEFL. By combining traditional corpus coverage analysis with V-Check word comprehension scores, we can identify and report the percentage of coverage that a person already possesses for a TOEFL exam, for example, and also which specific high-frequency TOEFL words the person is likely missing. The advantage for the student is that Lexxica can provide a personal target list of missing TOEFL vocabulary words which the student can rapidly acquire using Word Engine's learning games. And teachers can use the free V-Admin service to track scores, coverage, and the number of new words each student has learned. With a large enough sample, any researcher can collect sufficient data to study the relationship between increased human lexical ability and respective score increases on standard tests such as TOEIC and TOEFL.

2. Coverage ability

The data Lexica has collected for English word recognition suggests that many of the English words taught in EFL schools are selected without regard for how frequently those words occur in general English corpora and on standard tests such as TOEIC and TOEFL. For example, first year Japanese college students typically know about 4,500 total Base Words, however, only about 3,800 of those words are high-frequency words within a general English corpus such as the BNC. The other words they tend to know are lower frequency words contributing little if anything to coverage of general English as it is used by the rest of the world. A Japanese college student's general English vocabulary of 4,500 words should provide BNC coverage of about 93 percent (see the BNC Base Word coverage chart above), however, their true coverage is likely under 90 percent because so many of their words are infrequently used in authentic English. Many EFL teachers working in Asian university environments have recognized that certain obscure English words are widely known amongst their students. Why do high school students in Asia tend to know so many of the same obscure English words? Lexica co-founder Charles Browne's research (2006) identified several hundred seldom used English words that frequently occur in the high-stakes college entrance exams in Japan. Perhaps it is because Japanese high schools and Japanese textbooks are geared toward teaching the English words that will help students get into highly ranked universities.

3. Coverage peroration

English is a remarkably efficient language with which people can easily survive and even thrive with limited vocabularies. Beyond the 5,000 most important high-frequency words, there are many thousands of lower frequency words that can add depth, flexibility and color to one's language. For daily practical communications, however, lower frequency words can be considered optional. If the goal is to excel in a special purpose domain such as TOEIC, or TOEFL, or in a particular academic course, then having knowledge of the most frequently occurring Base Words specific to the domain is essential for better performance and test scores. Above the first 2,000 most frequent words, vocabulary usage is highly domain specific. One sure way to improve comprehension, test scores, and proficiency is to focus on acquiring just the high-frequency words that are specific to a domain.

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