1 A New Word

What It Means to Know a Word

Before we can say a word, we need to know the word. Before we access a word, we need to recall it. Before we can recall a word, we need to have encountered and processed it to the extent that we can recognize and bring it forward (from within our memory) for use at a later time. This is a challenging task. Languages such as English and German have more than 100,000 words (although less than 10 percent of those are used in 90 percent of all written or spoken texts). That means they also have about 100,000 lexemes.

There are many aspects to consider when it comes to how we learn a word, and these considerations are part of a multilevel model developed by Nation (2001). An important distinction must be made between the word's form and meaning as opposed to its multiple usages. For the purpose of investigating word processing from first encounter to long-term memory, I will focus on form and meaning. Once we know how a word is processed and retrieved in our brain, we can look at how it is used in various contexts.

With regard to form and meaning, Nation makes the following distinctions:

- the spoken form of the word (form)
- the written form of the word (form)
- the question of what parts of a word are needed in order to recognize or produce a word (form)
- the relationship of form to meaning (meaning)
- the concept the word expresses (meaning)
- the question of what other words the word is associated with (meaning).

Once the aspects of form and meaning are acquired, we need to learn a word's multiple usages (Nation, 2001): the grammatical patterns of a word, collocations, as well as when and how often we encounter or use a particular word.

We can use Nation's model and link it to phonemes (spoken form), lexemes (written form), and lemmas (concept/the question of what other words the word is associated with). Matching phonemes to lexemes represents the form-to-meaning relationship. Morphemes would be linked to the question of what

parts of a word are needed in order to recognize or produce a word, as well as to grammatical patterns. As was explained earlier, these are identified/attached after the phonemes and lexemes have been processed, even though morphemes can feed information back to that process. The form-to-meaning relationship can be complex. By drawing on Nation's multilevel model, Schmitt (2010a) points out that we need to be exposed to a word several times in order to fully understand a word's form-to-meaning relationship.

In terms of processing, we distinguish between phonemes, lexemes, morphemes, and graphemes. A phoneme is best described as a speech unit expressing a distinct sound; that is, a sound that is different when compared to another sound. Encountering a new word, a number of phonemes need to be identified. They are grouped as syllables. The correct order of phonemes, as well as the syllables, needs to be established. This is done via nodes that keep information on what is called serial order. We will go into more detail regarding nodes and serial order in Chapter 4, "Cognitive Load."

A lexeme is an abstract unit that describes the form-to-meaning relationship of a single word. A lexeme needs to be identified, in particular, the concept of a lexeme that is expressed through a lemma. A lemma is part of a lexeme. In addition to the lemma, a lexeme includes possible morphological markers that indicate if and what type of morpheme can be attached. A concept, the idea behind a word, can sometimes be difficult to define. Let us think about the word "coffee." We have an idea of what coffee is, but what exactly are its features? It is made from beans that grow on plants. When brewed, it is dark. It is usually hot when consumed, but there are many variations on how to consume it. Other features, such as strength and size of the coffee, may also be noted. If we follow this thought pattern, we find that there are often various exceptions to the features of a concept that at first seemed well defined. The easiest way to define a concept may be simply to accept what has been commonly agreed upon, in this case, the accepted understanding of what "coffee" means. It may help to look up the definition in a dictionary.

The lemma matches the concept onto the lexeme. It is necessary to have the lemma as a mediator because, on the one hand, a concept can be difficult to define and, on the other hand, there can be several ways of grammatically coding a concept, and some of those ways might in turn change the concept. The grammatical coding is done with the help of the lexeme, which contains information in its morphological markers as to if and what type of morphemes may be attached. In a sense, a marker allows an actual morpheme to be attached. Most important for the form of a word are bound morphemes. A bound morpheme is a unit that can change the meaning or the form of the word if added to the lexeme. There are two types of bound morphemes: derivational and inflectional. Derivational morphemes such as "-ness" or "un-" change the meaning ("happy" becomes "happiness" or "unhappy") and inflectional morphemes such as Third

Person Singular (3.P.Sg.) Present Tense "-s" change the form. In this process the marker functions like a placeholder; that is, a bound morpheme can be attached later if it has been marked. With a match, the morpheme is attached to the lexeme. For example, the lexeme "to walk" has the inflectional morphemes "-s" (pronoun-verb agreement), "-ed," and "-ing" (verb tense), changing the word to "walks," "walked," "walking." The rules that govern which morphemes are attached to which words are very strict and depend on other words in the sentence, such as the pronoun (for example, 3.P.Sg "he" or "she").

Research by Myers-Scotton and Jake (2000) has gone into more detail regarding morphemes. They use the term "system morphemes" to refer to a more elaborate version of bound morphemes. They distinguish between three types of system morphemes. First, there are early system morphemes that occur at the lemma level – for example, the plural "-s," as the lemma will match a concept of two or more things and not just one. Second, there are late system morphemes that attach at the grammar level, for example 3.P.Sg. Present Tense "-s": "I walk" vs. "He walks." In this case, the verb "walk" is recalled and processed fully until it is put into a sentence obeying a grammatical rule. Third, there are bridge system morphemes marked at the lemma level but put into form at the grammar level, for example the possessive "-'s," as in "Angie's coffee." This classification is very helpful for predicting the process of second language acquisition. We will return to it in Chapter 6, "The Bilingual Lexicon and Speaker."

In addition to the phonemes, lexemes, and morphemes, there are also graphemes. Graphemes are essentially letters representing the written form of a word. Naturally, graphemes also need to be processed, but their processing is relatively uncomplicated compared to phonemes or lexemes. Children process graphemes later in life than phonemes because, at the age of five or six, they learn to read and write and thereby come to acquire the orthographic form of the thousands of words they already know. Interestingly, although most adults learning another language do so in order to be able to have a conversation in that language, they often learn words by looking at the orthographic form. Much of that has to do with the way words are presented in textbooks or learning programs.

There are two things that are quite interesting about graphemes when, in addition to hearing a new word, it is also spelled out. In the first scenario, the pronunciation follows a regular pattern; for example, the English word "though" with the diphthong [ou] in between consonants on each side. In this case, processing the lexeme and its orthographic form requires little energy and attention. In the second scenario, let us consider the words "through" or "plough" or "enough." Here is the same combination of the diphthong to the consonants, yet the pronunciation is different. In this case, the graphemes have actually interfered with the phonemes, requiring more attention and consequently more energy from the speaker.

This shows how truly complex it is to process phonemes. Regardless of whether the graphemes assist or interfere with processing the diphthong [ou], in each of those words this diphthong plays a central role in relation to the lexeme of the word. This interplay between phonemes and the lexeme is at the heart of word processing. The linguistic record of the word that is created consists of the lemma of the lexeme indicating a concept, the morphological markers, and a tag that indicates the combination of the phonemes to the particular lexeme. The word record also contains other information, such as emotions conveyed through the senses at the time of input. When a speaker needs to use a word, s/he recalls the records of several lexemes as well as many phonemes, and rehearses them in the phonological loop. The concept is expressed through the lemma of the lexeme. The tag assists in the brain's process of matching phonemes to lexemes, which in turn allows the speaker to recall the correct combination. Once recalled and matched correctly, the interaction with morphemes takes place through the morphological marker of the lexeme. If a morpheme that fits is found, the word will be uttered properly. If not, the process of rehearsal might start again.

In summary, the form-to-meaning relationship of a word is made up by phonemes and lexemes. The phonemes represent the sounds. The lexeme with its lemma and markers must be matched to the phonemes in order to identify the meaning of the word. Later, morphemes are analyzed in order to process the form. Similarly, when a word needs to be recalled from memory for use in speech, the phonemes need to be matched to a lexeme while the morpheme in question, one of many, is processed later, when the final form is determined. The final form can depend on other words in the sentence. Therefore, a morpheme feeds information back to the lexeme that has been matched to its phonemes because, if it does not fit, either another morpheme is tried or another lexeme with its phonemes is rehearsed.

All this happens in our brain in hundreds of milliseconds. The processes are multidirectional; that is, they influence each other. Information from morphemes is fed back to lexemes, information from lexemes to phonemes, and from phonemes to morphemes. The details of this process are very intriguing, not all of which have been fully explored or understood. However, many advances have recently been made in the fields of neurophysiology, cognitive psychology, and second language acquisition that provide some insight as to what happens in our brain when we process and speak another language.

First Encounter

It is quite exciting for the brain to learn a new word. Phonemes, lexemes, morphemes, and graphemes are all components of a new word that the brain must

analyze. The process of identifying those '–emes' requires the activation of several regions in the brain. Information necessary to process the new word is transported through neuroanatomical circuits that connect language faculties, memory faculties, and emotions via the senses. The brain lights up, so to speak, as neurons fire simultaneously in communication with each other (Singer, 2006). If the process is successful, a synapse is created to connect the neurons (nerve cells able to transmit information) and store the record of the word. These synapses create permanent access to the information in the form of a bridge or path (Kandel, 2006). Yet nothing is permanent when it comes to memory. The strength of the synaptic connection – which we might compare figuratively to a bridge in the form of an eight-lane highway overpass, a rural covered trestle, or a tree trunk over a wilderness creek bed – depends on how the word is encountered. The following factors influence this result:

- situation (modalities: audio, visual, example)
- word group (length, similarity, emotional connotation)
- word category (content vs. function words)
- spacing (uniform vs. expanded)
- timing (number of repetitions, time frame).

Depending on the given situation, a new word can be encountered in spoken conversation; by listening or overhearing other people talking; or by reading, whether in a text on your cell phone, in an email, or in a newspaper or book. In any case, the brain's challenge is to match the phonemes to a lexeme. When talking to someone, the listener relies on audible sounds. When reading, that person must decipher the sounds by looking at the graphemes. Ideally, the learner both hears and reads the word simultaneously, in order to receive both verbal and written information cues. This also depends on the type of learner: some people prefer to hear sounds in order to identify a word, while others require the visual input. Recent studies have shown that non-linguistic information, in particular pictures, plays a key role when processing a new word (Jones and Plass, 2002; Kim and Gilman, 2008). That is, the likelihood of a strong word record is higher when a corresponding image is processed.

Situational factors also refer to where the word is encountered. A major factor is whether or not you are in the country where the language you are learning is predominantly spoken. Imagine you are learning German. In Germany, Austria, or some other parts of Europe where German is spoken, you will not only be surrounded by the sounds of German, you will also pick up extra non-linguistic information beyond the new words, such as the taste and smell of the coffee you drink, the colorful arrangement of tiles on the table at which you sit, and the hairstyle and outfit of the waiter who brings you the coffee. All of these sensory cues are examples of non-linguistic information that may be encoded through cortices in your brain and fed via emotional responses to

the hippocampus, in order to strengthen the record of the word. It is difficult to create such a rich, sensory situation when we study a second language within the classroom. Some language programs try to use information technology to immerse the learner into an online environment to compensate for the lack of actually being immersed in the foreign country. The problem is that our brain is capable of processing highly specific nuance, and can determine at once that the locations do not correspond. In such a situation, it is as if our brain could ask: "Why am I sitting in front of a computer and not in a café in Vienna?"

In terms of word groups, it is important to consider the length and similarity of the word encountered. Words with many syllables have many phonemes that need to be identified and matched onto a lexeme. The main problem when processing is the time available to digest the incoming information. In conversation or reading, we encounter many words in a short period of time. All of those, including the ones we know, are rehearsed in the phonological loop (Baddeley, 2007). If a new word is not identified within two seconds, it might not be processed. We will go into more detail in Chapter 4, "Cognitive Load." An additional problem occurs when we encounter words that have similar phonemes because, due to the discrimination process, the brain will need more time to distinguish between the phonemes that overlap. For the success of second language learners, we must account for the predictability of how such phonemes are pronounced. If the word has an unusual pronunciation pattern, a learner needs to rehearse it more often. Sometimes, similarity across languages can be an advantage to the language learner. If words in both the native tongue and the language to be acquired have similar lexemes, the brain will match the new lexeme to the existing with greater ease.

When analyzing word groups, we should also consider the phenomenon of words that have an emotional connotation, such as "love," "cry," or "happy." This emotional information – which is fed through cortices connecting the senses to the hippocampus – is stored in long-term memory along with the lexemes of those words. This creates a strong connection through the synapse. The record will be even more powerful if an emotional word is learned in an emotional situation. For example, if you fall off your bicycle while vacationing in the Rhine Valley, the German word for "to hurt" [verletzen], will be more easily remembered.

Another distinction, in terms of processing, can be made between content and function words. The criteria to distinguish between word groups – length, similarity, emotional connotation – mostly apply to content words such as nouns, verbs, adjectives, and some adverbs. These words have an independent meaning. Other types of words, called function words, such as prepositions, conjunctions, fillers, and some adverbs, carry meaning only in connection with content words. For example, imagine you order a coffee with milk. You know what "coffee" is, but what is the preposition

"with"? Meaning is only assigned by asking "with what?" In other words, "with milk." In any language, there are few function words compared to the number of content words. In general, function words tend to be short, having three syllables or less. The likelihood of their similarity is not high, as they are few in number. Naturally, function words do not have an emotional connotation, because they do not have independent meaning. This poses an interesting question: does the fact that a function word is short and not similar to another function word indicate that it can be readily processed to long-term memory, or does the fact that it lacks independent meaning – that is, the lexeme is weak – indicate that it needs to be rehearsed often? In research on second language acquisition, this question has only been investigated recently (Schütze, 2015). We will return to this in Chapter 8, "Word Analysis."

We have known for some time that processing is linked to spacing – the repetition of certain words at certain intervals. Spacing, in turn, can be linked to working memory. We will learn more about working memory in the following chapter, "Memory, Language, and the Brain." Research testing different spacing techniques has been carried out since the 1970s (for an overview, see Balota, Duchek, and Logan, 2007). It has been shown that, in order to recall a word successfully, that word must be repeated several times with an intermittent pause between the repetitions. This pause gives the phonological loop a chance to process the word, while it allows the hippocampus to create a record of that word. However, there has been some controversy with regard to the ideal duration of these pauses. For example, should a word be repeated using a uniform interval (repeat – pause – repeat – pause – repeat), or an expanded interval (repeat – repeat – pause – repeat – pause – pause – pause – repeat)? Also related to the question of the ideal type of spacing is the question of timing. Should a new word be acquired in one learning session, where the word is repeated after seconds or minutes, or from one learning session to the next? Or should a word be learned through the process of repetition over a whole day or several days? How many times does a word need to be repeated? This is something cognitive psychologists as well as second language specialists continue to investigate, but the goal of the learner is commonly overlooked. Is the word acquired to be used right away (short-term gain) or to be used later on, whenever needed (long-term memory)? Ideally, it is acquired for both scenarios. However, this can present complications (Roediger and Karpicke, 2010; Schütze and Weimer-Stuckmann, 2011), as we will see in Chapter 7, "Spacing."

In summary, the strength of the synapse depends on the learning situation, word group and category, spacing interval, and overall timing. Synapses form connections that bring pieces of information together across several brain regions. Some such pieces serve language processing and production, such as

the phonological loop, Wernicke's area, and Broca's area. Some pieces serve to process sensory information through the cortices and the amygdala, while some pieces, such as the hippocampus, serve to assist with memory. From a psycholinguistic point of view, a new word has been successfully identified when it reaches the hippocampus: a deep, well-protected brain region that creates a record of the word and stores it in the adjacent non-mesial region. We will go into more detail on the brain in Chapter 3, "Synaptic Connections."

Maintenance of a Word

Each time we encounter a word – either new or familiar – and each time we say a word, it is rehearsed in the phonological loop within Broca's area. Back in the early 1970s, when research on the phonological loop was in its infancy, Craik and Lockhart (1972) proposed two types of rehearsal: maintenance rehearsal and elaborate rehearsal. Maintenance rehearsal refers to the simple maintenance of words already known; for example, the repetition of a word, like a street name, to oneself in order not to forget. In contrast, elaborate rehearsal refers to the recitation of new words. In this case the brain must process new information, such as phonemes and lexemes, in connection with other sensory-emotional data in order to create a new word record.

The maintenance of a word should not be underestimated. We need to use it often enough to refresh our memory and to reinforce the synapse-bridge created at the time of recording a word. Any bridge, without proper maintenance, will eventually crumble. Researchers debate the length of time a word record can be stored in our long-term memory. If we attempt to recall a word that has not been thought of for some time, at what point will the attempt fail? The answer depends on how the record of the word was created. If the record is strong, it can be recalled even years later. The strength of the record depends:

- on the type of information recorded; for example, to what degree the senses were activated, and
- on how the word was encountered; for example, if the learner used spacing techniques for repetition.

How does all this play out when learning another language? In first language acquisition, the process of identifying phonemes, lexemes, and lemmas, via the form-to-meaning relationship, is largely automatic. The first few thousand words are learned around the age of three. A native speaker has the full repertoire of phonemes at her or his disposal. A large number of concepts have been developed to help identify the lemma. The rules of morphology to grammatically code a word are learned as early as age three and should be automatic by the age of six to eight.

In second language acquisition, however, the process differs according to the learner's phase of development. Ideally, another language is acquired in childhood, when the development of L1 and L2 go hand in hand. However, most of us learn a second language after the age of six, which means when we go through the language-development phases all the way to the mid-twenties, only some will overlap between L1 and L2. We will discuss this in more detail in Chapter 5, "First and Second Language Acquisition." Let us keep in mind that learning another language is an ongoing process, as Singleton (1995, 2007) points out. Each phase is as important as the one before. For a learner who first encounters the new language at age six, one of the next phases occurs around age eight, when children develop strategies to infer meaning from a word. This widens around the age of twelve or thirteen, when we begin to develop concepts of an abstract nature. Consequently, lemmas change and influence the formation of lexemes. On the plus side, children who learn a language after the age of six to eight have already acquired substantial grammar skills. To acquire grammar rules in another language, although very different than those of the first language, is relatively uncomplicated because we have a general knowledge of how grammar works. With regard to morphemes, sometimes there is a problem in that the L2 morphemes interfere with the L1 morphemes. For example, German verbs add a late system morpheme for every person in Present Tense (First Person Singular to Third Person Plural), not just Third Person Singular, as with English. Beginning German-language students who are native English speakers therefore often forget to add the late system morpheme. While it is not complicated to add morphemes, it must nevertheless be remembered, in particular since late system morphemes already come late to the process of rehearsal in the phonological loop. Some workings of the loop are not refined until about sixteen years of age, which marks another phase.

Naturally, the biggest challenge for an adult language learner is vocabulary: how to remember the multitude of new words? But learning another language successfully should be possible even if that language is not encountered as a child or youth, since the hippocampus, responsible for creating a record of a new word, develops its full potential well into our mid-twenties (Korte, 2009). This is important for university students who enroll in beginners' German, Spanish, and other language courses. Although it might take more effort and time to process thousands of new words, it is possible to learn a language in one's early twenties. We will return to learning words throughout life in Chapter 5, "First and Second Language Acquisition."

In second language acquisition, much of processing words depends on the environment in which these words are encountered. The host country of any language provides more opportunity to process words along with sensory information, as well as to encounter them frequently in order to build and maintain a strong record. Immersion in the L2 environment also assists pronunciation,

as the learner is able to hear native pronunciation and prosody (stress, rhythm, intonation). Children develop a repertoire of phonemes in the first year of life and continue to constantly practice pronunciation. By the time they come to school, most children have generally refined their pronunciation of familiar words, though they still make mistakes with new words, especially those that have an unusual pattern of syllables. A child growing up in England with English as his or her L1 will very likely mispronounce the word "plough" the first time s/he reads it aloud. However, once s/he hears the correct pronunciation, s/he will be able to repeat it quickly. If the child learns another language after the age of six to eight, it will take additional time to get the pronunciation right. S/he must not only identify the phonemes, but must also learn the prosody of the word, and train her or his vocal cords and tongue to reproduce those sounds. For most of us, the older we are, the longer it will take to achieve correct pronunciation. There are exceptions, such as with people who have a good ear, like musicians, because they are able to hear the differences between phonemes in L1 and phonemes in L2. Again, a short cut to a good pronunciation is to be in the country where the language is predominantly spoken, as this increases one's opportunity to hear many variations of the word. This in turn helps to fine-tune the ear.

In order to get an idea of how complex it is to process words, as well as of the differences between two languages, Figure 1 shows what is involved when a word is processed in English as well as in German.

All of the linguistic features – phonemes, lexemes, morphemes, graphemes – need to be processed for each word. While there can be agreement in

	phonenes	lexeme/compounds	morphemes	graphemes	other info	word type
to run	[' rʌn]	run/runaway	-s -ing	r-u-n	ran – run (irregular)	verb
laufen	[' laufn]	lauf/Laufweg	-e/-st/-t/-en	l-a-u-f-e-n	lief - gelaufen (irregular)	verb
the chair	[' tʃ eə]	chair/chairlift	-s	c-h-a-i-r	sitting chair head of a committee	noun
der Stuhl	[ʃ tu:1]	Stuhl/Lehrstuhl	-e plus vowel change: ü	S-t-u-h-l	sitting chair stool (med)	noun
crazy	[' kreɪ zɪ]	crazy	-	c-r-a-z-y	craziness	adjective
verrückt	[fɛə ' ry kt]	verrückt	- (behind noun) - e/ -en/ -er/ -es - em (before noun)	v-e-r-r-ü-c-k-t	Verrücktheit	adjective

Figure 1. Word Complexity English/German.