Introduction: Real-Time Measurement of Vocabulary Knowledge and Processing

Vocabulary is a key building block of language. As such, measuring vocabulary knowledge in an accurate manner provides crucial information regarding, for example, a learner’s progress towards becoming an expert user of the target language. In studying and measuring vocabulary knowledge, researchers need to consider two inextricably related issues: firstly, how they are measuring vocabulary knowledge, and secondly, what knowledge they are measuring. Traditionally, the field of vocabulary research and teaching has relied on offline measures of vocabulary knowledge, such as multiple choice, translation, fill-in-the-blank, and matching tests. Offline tests are a convenient way of measuring vocabulary knowledge because they provide information about learners’ ability to recognize or retrieve the form or meaning of a word, often with no time restrictions (hence the name offline). More recently, offline measures are increasingly being used in conjunction with a qualitatively different type of measure, known as online measure. Online measures typically involve measuring learners’ lexical knowledge during language processing (hence the name online) when there are real time restrictions.

A daily-life analogy of online and offline measurements would be a case of watching football (or soccer). One could watch a match live (i.e., in real time) in the stadium or on TV. In that case, one would view the detailed happenings of the match as they unfold, such as how a particular player scores a goal, and who has a great shot but misses. In other words, the real-time watching allows the viewer to know the dynamics of the match, similarly to researchers investigating language processing using online measures. In contrast, researchers using offline measures are primarily interested in the overall outcomes or products of vocabulary knowledge and perhaps less in the fine-grained details of the process (or at least, their instruments do not provide this information). In our analogy, this would be someone simply scanning the headlines of the sports section of a newspaper in order to know the result of the football match, and perhaps the standing of a given team in the league after the weekend.

Measuring vocabulary knowledge is an integral part of studying vocabulary. Whether the goal is to compare different teaching methods, or track vocabulary growth over time,
researchers or teachers need to have a measure of their students’ vocabulary knowledge. Most commonly this measure will be a paper-and-pencil or computer-based test that involves word recognition (e.g., multiple choice, matching) or recall or retrieval (e.g., translation, fill-in-the-blank). Therefore, much of what we know about the learning and teaching of vocabulary in another language derives from offline measures of vocabulary knowledge. These tests measure explicit-declarative word knowledge, because learners could declare their vocabulary knowledge out loud (e.g., To drive is to use a car) if they were asked to. Given the predominance of offline measures in vocabulary research and teaching, it is perhaps no surprise that Nation’s (2013) framework of vocabulary knowledge, which is the most comprehensive framework of vocabulary knowledge in second language (L2) studies to date, is also geared heavily towards explicit-declarative knowledge (see Table 28.1). That is, although Nation’s framework greatly broadened the scope of what vocabulary knowledge entails, the default approach to how vocabulary knowledge is measured is still very much offline and declarative. Here, I aim to expand and explore the how dimension, so teachers and researchers may opt for more diverse and comprehensive measures of vocabulary knowledge in their work.

Offline measures of vocabulary knowledge are not without limitations. Most of all, these tests are separate or divorced from actual language performance. Recognizing or being able to recall a word’s meaning or form on a paper-based test is not the same as recognizing or recalling the word during interaction with another speaker. Actual language usage is often characterized by a certain amount of time pressure, which makes the task of word recognition or retrieval more demanding. Language users must access their lexical knowledge rapidly so they can focus their efforts on larger meaning units. This requirement of quick lexical access

Table 28.1 Nation’s (2013) framework of vocabulary knowledge

<table>
<thead>
<tr>
<th>Aspects of vocabulary knowledge</th>
<th>Receptive/ productive</th>
<th>What does it mean to master this aspect?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form Spoken</td>
<td>R</td>
<td>What does the word sound like?</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>How is the word pronounced?</td>
</tr>
<tr>
<td>Written</td>
<td>R</td>
<td>What does the word look like?</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>How is the word written and spelled?</td>
</tr>
<tr>
<td>Word parts</td>
<td>R</td>
<td>What parts are recognizable in this word?</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>What word parts are needed to express the meaning?</td>
</tr>
<tr>
<td>Meaning Form and meaning</td>
<td>R</td>
<td>What meaning does this word form signal?</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>What word form can be used to express this meaning?</td>
</tr>
<tr>
<td>Concept and referents</td>
<td>R</td>
<td>What is included in the concept?</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>What items can the concept refer to?</td>
</tr>
<tr>
<td>Association</td>
<td>R</td>
<td>What other words does this make us think of?</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>What other words could we use instead of this one?</td>
</tr>
<tr>
<td>Use Grammatical functions</td>
<td>R</td>
<td>In what patterns does the word occur?</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>In what patterns must we use this word?</td>
</tr>
<tr>
<td>Collocations</td>
<td>R</td>
<td>What words or types of words occur with this one?</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>What words or types of words must we use with this one?</td>
</tr>
<tr>
<td>Constraints on use</td>
<td>R</td>
<td>Where, when, and how often would we expect to meet this word?</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>Where, when, and how often can we use this word?</td>
</tr>
</tbody>
</table>
could also partly explain why listening, where learners have little control over the speed of the incoming speech stream, is claimed to be the most difficult foreign language skill to acquire (e.g., Vandergrift & Goh, 2012). To capture these aspects of vocabulary knowledge-in-action more fully, researchers can measure not only learners’ explicit-declarative knowledge, but also their automatized explicit, procedural, or implicit knowledge of vocabulary; that is, how easily people can retrieve words from their mental dictionaries and how well the words are connected in their minds. Thanks to the advance of technology, new methods and techniques have made it possible to ask and answer new questions about the non-declarative aspects of vocabulary knowledge. The finer distinctions between these different knowledge types (i.e., automatic knowledge, procedural knowledge, tacit-implicit knowledge) are still being sorted out in the literature. In reviewing different methodologies, I will therefore adopt the same terminology as the authors of primary studies have used, bypassing subtle theoretical distinctions that may exist between the different knowledge types. The overarching idea is that there is a type of non-declarative knowledge of vocabulary – which researchers variously refer to as automatic knowledge, procedural knowledge, or tacit-implicit knowledge – that can be assessed by online measurements.

Online measures are often about how long it takes a participant to do something. Consequently, most online measures used in the field of Second Language Acquisition (SLA) offer some kind of reaction time data. The processes that are studied with these reaction time measures tend to be very fast, in the order of tenths and hundredths of a second, and therefore their length is normally measured in milliseconds (msec). For example, the average time it takes to retrieve the meaning of a word is one-fourth of a second, or 250 msec (e.g., Inhoff & Rayner, 1986). Consequently, the fine-grained details offered by online measurements can reveal the dynamics of language processing as in watching a football match live. Furthermore, these online measures add a new dimension to our understanding of vocabulary knowledge, by illuminating how well learners can access their knowledge of different aspects of a word. In the following overview, I will therefore link the different methodologies back to Nation’s (2013) framework and, in so doing, expand it by adding a whole new dimension (see Table 28.2 later in the chapter). As such, this chapter does not only serve as an introduction to new methods and techniques which could tap into a learner’s implicit, automatized explicit, or procedural vocabulary knowledge; it also invites readers and researchers to see new meanings of vocabulary knowledge. This could potentially inform a more usage-focused teaching practice and, I hope, inspire more research that examines the lexical iceberg in full – that is, both conscious knowledge (the tip) and unconscious knowledge (the part underwater).

In the second section of the chapter, I will review three key online methodologies in the context of vocabulary knowledge and processing. These methodologies are, first, general reaction time measures in, for example, a lexical decision task, where the participant decides whether a letter string (or a spoken item) forms a word or not; second, the coefficient of variability, a measure derived from reaction times; and, third, eye-movement registration or eye tracking, which tracks the eyes’ dwell times in different locations. For each method, the discussion will start with introducing how it works and what type of information researchers can obtain from it, followed by a general overview of vocabulary studies that have used the methodology. A couple of representative studies will be highlighted and reviewed. In the third section of the chapter, I present an extension of Nation’s framework and provide directions for future research to measure new dimensions of vocabulary knowledge. Interested readers will be pointed to some further reading and related topics in the fourth section.
Aline Godfroid

Critical Issues and Topics

Measures from psychology have found their way into L2 vocabulary research in the form of various reaction time methodologies and, to some extent, neurocognitive measures. These sensitive measures of vocabulary knowledge generally fall into two categories (also see Leow, 2015):

1. Measures of vocabulary knowledge as a product capture how well words or phrases are known.
2. Measures of vocabulary learning and knowledge as a process capture the incremental learning of vocabulary over time, as L2 learners are engaged in processing new words or phrases.

Online product measures supplement traditional, offline measures and are often used to shed new light onto well-established, well-studied research questions. The best-known example is the primed lexical decision task. Another prototypical example of an online processing measure is eye tracking (Conklin, Pellicer-Sánchez, & Carroll, 2018; Godfroid, 2019a), the filming of participants’ eye movements, although eye tracking can also be used to study the product or outcome, rather than the process, of vocabulary acquisition (Godfroid, 2019b). The introduction of eye tracking in L2 vocabulary research has been an important source of innovation in the field, making it possible to study new questions in a detailed and fine-grained manner (Godfroid & Winke, 2015).

Priming Tasks and Other Reaction Time Tasks

How It Works

Primed lexical decision tasks are lexical decision tasks with an additional priming component. For the lexical decision part, participants are asked to judge whether a string of letters or a sound sequence forms a real word in a given language. This is the lexical decision. For instance, CAT is a word in English, and therefore requires a yes response, but CAX is a non-word that requires a no response. Participants are asked to hit the “yes” or “no” key on a response box or a keyboard as quickly and accurately as possible when they see or hear a stimulus (called the target). Of interest are their reaction times for correct yes responses, because these reflect the participants’ knowledge of the target language (the non-words are not a part of the target language and are, therefore, less informative). Reaction times are recorded on a computer running special software, such as E-Prime (Psychology Software Tools Inc., 2012), DMDX (Forster & Forster, 2003), PsychoPy (Peirce, 2007), Inquisit (Inquisit 5.0.9, 2017), or SuperLab (Cedrus Corporation, 2017).

Lexical decision tasks afford a measure of speed of lexical access (the retrieval of a word’s form or meaning). The assumption is that to judge a word correctly as a word, participants must access the form in their mental lexicon, much like looking up a word in a dictionary. Whether this requires looking up a word’s meaning or whether lexical decisions could be purely form based remains a matter of debate. Favoring a form-based explanation, Grainger, Dufau, Montant, Ziegler, and Fagot (2012) showed, in an article published in Science, that even baboons can be trained to do lexical decision tasks! For this reason, some researchers prefer semantic categorization tasks to lexical decision tasks (Lim & Godfroid, 2015; Phillips, Segalowitz, O’Brien, & Yamasak, 2004; Segalowitz & de Almeida, 2002; Segalowitz &
Frenkiel-Fishman, 2005). Semantic categorization tasks are similar to lexical decisions, except all the items are real words (there are no non-words). A participant’s task is to judge whether the word is a member of a predetermined semantic category or not. For instance, if participants are asked to judge whether or not a word refers to a living being, BOY should elicit a yes response and BOOK a no response.

Responding yes or no to word and non-word stimuli is the lexical decision part; now what about the priming component? In a primed lexical decision task, a prime appears shortly before the target word. For instance, the prime dog may precede the target CAT (dog → CAT), potentially leading to faster response times to CAT because dog and cat are semantically related. This is known as positive priming or facilitation. The opposite, negative priming or inhibition, also exists and will result in slower reaction times. By manipulating the relationship between the prime and the target, researchers can probe whether a word is a part of someone’s mental lexicon (whether it has its own lexical entry) and, if so, how well connected the word is to others. There are orthographic priming experiments, phonological priming experiments, semantic priming experiments, and others (see examples below). Priming experiments are thus quite useful to address a range of questions about the mental lexicon, conceptualized here as a giant interconnected network of words and phrases (e.g., Meara, 2009).

Furthermore, researchers can vary the interval between the prime and target, so participants may be more or less likely to perceive the prime consciously. In unmasked priming, participants can see both the prime and the target. In masked priming, the prime is flashed only briefly on the screen so most participants remain unaware of it (they report seeing only a flicker). The masked priming technique allows researchers to study connections in the mental lexicon outside of participants’ awareness; that is, with masked priming, researchers can explore parts of the lexical iceberg that are deeply buried under water.

Priming and Reaction Time Research in L2 Vocabulary Studies

Priming research has been gaining popularity among L2 vocabulary researchers, who are now also using the technique to study the effects of vocabulary instruction on word knowledge (for other applications, see Carroll & Conklin, 2014; Frenck-Mestre & Prince, 1997; Wolter & Gyllstad, 2011). To my knowledge, Elgort (2011) introduced priming into L2 vocabulary teaching research, in an oft-cited study on the effectiveness of deliberate word learning from word cards. In the study, 48 advanced L2 English learners were presented with 48 English pseudowords in the lab (e.g., prolley, defined as “a large strong beam, often of steel or iron, forming a main supporting element in a framework of buildings or bridges”, p. 409). They were given a set of word cards to study for a week, before returning to take part in three priming experiments. On average, the participants had spent four hours studying the words at home when they returned for the main experiments. In three priming experiments, Elgort measured both representational and functional aspects of vocabulary knowledge. To do so, she compared participants’ responses to the newly learned pseudowords vs. (1) real, low-frequency words (established in the lexicon) and (2) non-words (not established in the lexicon). The goal was to investigate whether pseudowords would behave similarly to the real words or the non-words in the priming experiments. In all three experiments, the pseudowords patterned with the real, low-frequency words; that is, they elicited priming effects when the real words did and no priming effects when the real words did not either. This suggested L2 participants had created formal-lexical representations of the newly learned pseudowords in their lexicons (form priming, Experiments 1 and 2) and begun to integrate the pseudowords semantically (semantic priming, Experiment 3). These findings, along with Elgort’s findings for the coefficient of variability (reportd below) showed that deliberate learning activities,
such as learning from flash cards, can generate word knowledge that can be used online, in real time, and thus potentially in spontaneous communication. Interestingly, in a follow-up study with a similar group of L2 English participants, Elgort and Warren (2014) did not find robust priming effects for pseudowords that learners encountered between 6 and 88 times (median: 12 times) when reading multiple chapters from a nonfiction book for pleasure. This may suggest, then, that the massive amounts of word repetition and focused practice that are typical of deliberate vocabulary learning are difficult to match in more naturalistic tasks.

Amount of exposure may also be a factor in Sonbul and Schmitt’s (2013) results for the teaching and learning of medical collocations. In this study, adult native and advanced non-native English speakers learned 15 medical collocations using a combination of input flood (collocations embedded in a story context), input flood with input enhancement (collocations in red and boldface), and decontextualized presentation (no story context). Participants learned five collocations in each condition and each collocation occurred three times during training. After the learning phase, the participants completed two measures of explicit collocational knowledge (form recall and form recognition) and a novel measure of implicit knowledge, called automatic collocation priming. The rationale behind the priming test was that if participants had gained implicit knowledge of the medical collocations (e.g., vanishing lung), the first word (e.g., vanishing) would prime the second word (e.g., lung), causing participants to respond faster to LUNG in vanishing → LUNG than in the matched control pair decaying → LUNG (decaying lung is not a medical collocation). Although participants demonstrated significant explicit knowledge of the newly taught collocations on the immediate and delayed posttests, neither native nor non-native speakers showed a significant priming effect. This finding differed from Elgort (2011), who used 48 single words (English pseudowords), form priming and semantic priming, and several hours of decontextualized study over a one-week time period as instruction. Sonbul and Schmitt (2013) argued their results showed “a clear dissociation between explicit and implicit lexical knowledge” (p. 151).

Paciorek and Williams (2015a) also focused on the acquisition of collocational knowledge, but different from all other researchers, they adopted a pure reaction time methodology. In Experiment 2, Paciorek and Williams trained native and non-native English speakers on four novel verbs embedded in 20 verb phrases each. Participants were informed that two of the verbs (powter and mouten) meant “increase” and the other two (gouble and conell) meant “decrease”. Critically, they were not told that one verb in each pair only took abstract collocates (e.g., powter “increase” the significance) and the other required concrete collocates (e.g., mouten “increase” the calcium). This hidden regularity was the object for learning in the study. The participants saw verb phrases word-by-word and were tasked to decide whether the collocate in each verb phrase had a positive, negative, or neutral connotation and whether the verb in the phrase meant “increase” or “decrease”. Results showed that in trials where the semantic preferences of the verb were violated (e.g., powter the calcium), native speakers made slower increase-decrease decisions. The non-native speakers did not slow down. Because none of the participants commented on the role of concreteness in the collocations, Paciorek and Williams argued native speakers had learned the collocational information implicitly; that is, unintentionally and without being aware of it (for further evidence, see Paciorek & Williams, 2015b).

Taken together, these four studies demonstrate how priming experiments and reaction time tasks can be used to measure aspects of implicit vocabulary knowledge, which are normally hidden below water. In particular, these methods can reveal whether or not a learner has established a lexical entry for new words (form priming), acquired the meaning of a word and integrated it into a larger semantic network (semantic priming), and learned patterns
Vocabulary Knowledge and Processing

of co-occurrence (collocation priming, reaction times to semantic-violation trials). All examples used visual priming, but auditory and cross-modal priming are also available (see “Future Directions”). Similarly, cross-linguistic priming (Carrol & Conklin, 2014; Wolter & Gyllstad, 2011) could be used to address additional research questions about the L1-L2 relationship. The key contribution of all these methods is that they can probe the unconscious (tacit-implicit) dimensions of vocabulary knowledge, which might not be assessed using traditional vocabulary tests, such as the Vocabulary Knowledge Scale, the Vocabulary Size Test, the Vocabulary Levels Test, the yes/no test, and many other examples.

Coefficient of Variability

How It Works

The coefficient of variability, or $CV_{RT}$, is a measure that can be calculated for any type of task (lexical decision, semantic judgment, eye tracking) that produces reaction times as an outcome measure (for sample tasks, see the previous section and next section). Computation of $CV_{RT}$ is straightforward: $CV_{RT} = \frac{SD_{RT}}{M_{RT}}$; in other words, $CV_{RT}$ is the standard deviation of all of an individual’s reaction times divided by his or her mean reaction time (Segalowitz & Segalowitz, 1993). The resulting value provides a measure of processing stability. Processing stability is one of three hallmarks of automaticity of knowledge (for reviews, see Lim & Godfroid, 2015; Segalowitz, 2010; Segalowitz & Hulstijn, 2005); that is, knowledge that can be retrieved rapidly and with little conscious effort.

Smaller $CV_{RT}$ values are generally better; however, they are specific to the task at hand. This means $CV_{RT}$ must be compared for different individuals doing the same task or for the same individual repeating a task at different time points. A smaller $CV_{RT}$ value suggests that someone can perform the same task (e.g., lexical decision) with roughly the same speed over and over again, assumedly because it takes them little effort or controlled attention to do so. The knowledge they use is predominantly automatic, much like experienced drivers can execute many of the actions involved in driving a car without conscious thought. The distinction between controlled and automatic processing is central to skill acquisition theory (for a review, see DeKeyser, 2015). The idea is that, across a range of different tasks, linguistic and otherwise, controlled processes tend to be slow, effortful, and variable, whereas automatic processes are fast, effortless, and reliable. A decrease in $CV_{RT}$ suggests a qualitative change in underlying processes: from more controlled to more automatic.

Use of $CV_{RT}$ in L2 Vocabulary Studies

Applications of $CV_{RT}$ in L2 vocabulary studies are diverse. Researchers have used $CV_{RT}$ (1) as a pretest/posttest measure of lexical fluency or automaticity coupled with vocabulary training or instruction (Akamatsu, 2008; Elgort, 2011; Fukkink, Hulstijn, & Simis, 2005; Segalowitz, Segalowitz, & Wood, 1998; Segalowitz, Watson, & Segalowitz, 1995), (2) as an individual difference measure (Elgort & Warren, 2014; Segalowitz & Freed, 2004), and most recently (3) as a measure of novel word learning (Solovyeva & DeKeyser, 2018). These different approaches attest to researchers’ ongoing experimentation with what $CV_{RT}$ means and how it can be used to enrich our understanding of L2 vocabulary acquisition.
Following the introduction of $CV_{RT}$ into L2 research (Segalowitz & Segalowitz, 1993), Segalowitz and his colleagues focused on measuring the effects of instruction or exposure on lexical fluency (Segalowitz et al., 1995; Segalowitz et al., 1998). The idea was later taken up in training studies with middle school EFL learners in the Netherlands (Fukink et al., 2005), college-level EFL learners in Japan (Akamatsu, 2008) and a deliberate learning study with adult ESL learners in New Zealand (Elgort, 2011). A representative study of this kind is Segalowitz, Segalowitz and Wood (1998). The researchers tracked Canadian-English-speaking university students over two semesters of French instruction. The students took part in multiple French lexical decision tasks over the year, for which their $RT$s and $CV_{RTs}$ were calculated. Segalowitz and colleagues identified two subgroups within the Year 1 students: those with comparatively slow and those with comparatively fast word recognition skills at the outset of the study. Differences in processing speed ($RT$s) correlated with differences in automaticity ($CV_{RT}$) in the comparatively fast group only. This suggested it is only at more advanced levels that students differ among themselves in terms of processing efficiency. At lower levels, students may well differ in terms of what they know of the language only (Segalowitz et al., 1998, p. 63). Importantly, both subgroups showed improvements in automaticity over the year, suggesting that incidental exposure to words in a year-long French course results in significant automaticity gains.

Taking a somewhat different approach, Elgort and Warren (2014) studied how individual differences in lexical proficiency (as well as many other variables) might influence gains in vocabulary from reading several chapters from a nonfiction book. The authors measured two dimensions of lexical proficiency: explicit lexical knowledge, using the Vocabulary Size Test (Nation & Beglar, 2007), and implicit lexical knowledge, using $CV_{RT}$ derived from an English lexical decision task performed prior to the reading. Results showed that learners with more automatized lexical processing skills (lower $CV_{RT}$ values) picked up more word meanings from the text. A learner’s vocabulary size, on the other hand, enhanced the benefits of repeated exposure: those with larger vocabularies benefited more from seeing a word repeatedly in the text, as shown in their higher test scores. These results show that $CV_{RT}$ and the Vocabulary Size Test were related, yet distinct measures of lexical proficiency, which contributed to vocabulary learning in different ways.

Although the use of $CV_{RT}$ has spread and now also includes sentence processing research (Hulstijn, Van Gelderen, & Schoonen, 2009; Lim & Godfroid, 2015), it is unlikely that applications of $CV_{RT}$ will end here. Solovyeva and DeKeyser (2018) reported data to suggest that increases in $CV_{RT}$ may also be informative, specifically in the early stages of word learning. The authors administered a primed lexical decision task before and after deliberate study of 40 Swahili-English word pairs. They found an increase in $CV_{RT}$ on the second lexical decision task (after word learning) even though mean $RT$s went down. This response signature – faster, but less stable performance – is not consistent with automatization, where speed and automaticity are expected to go together (Segalowitz, 2010). Rather, the authors argued that the $CV_{RT}$ increase may reflect learners adding new knowledge to their lexicons. The idea is that as new information is added to memory, it cannot yet be called upon reliably and will thus give rise to variable performance and a large $CV_{RT}$. If Solovyeva and DeKeyser’s results can be replicated by other researchers, future use of $CV_{RT}$ may well cover the whole learning spectrum: from adding new information to memory ($CV_{RT}$ increase), to simple speed up of retrieval of existing knowledge (no change in $CV_{RT}$), to automatization of well-established, highly practiced routines ($CV_{RT}$ decrease).
**Eye Tracking**

**How It Works**

Eye-movement recordings can offer a window into participants’ cognition because in complex tasks such as reading, watching a video, or listening to a picture-based story, there is a link between what a participant looks at and what he or she is currently processing. This phenomenon is termed the *eye-mind link* (Just & Carpenter, 1980; Reichle, Pollatsek, & Rayner, 2006). It is the reason eye-movement recordings have found their way into many areas of research, including aviation and driving, human expertise in chess and medical diagnosis, problem solving, scene perception, as well as gaming and consumer research. Researchers believe that by filming and analyzing their participants’ eye movements, they can learn something about the cognitive mechanisms that are at play in these various domains.

In the majority of eye-tracking studies with language, the participants perform a language-related task on a computer. The eye tracker records participants’ looks to the screen. Language researchers are primarily interested in two types of eye behavior, namely fixations and saccades. *Fixations* are periods (typically measured in msec) during which a participant’s eyes pause in a specific location (e.g., on a word on the screen). Fixations tell us something about the where and when of eye movements. Per the eye-mind link, *where* a participant is currently looking is an indication of what the participant is currently processing, although the relationship is by no means perfect. In contrast, *when* a participant moves their eyes determines the duration of the fixation. Importantly, eye fixation durations are susceptible to linguistic influences, such as how easy or difficult it is for a participant to process a word (for reviews, see Rayner, 1998, 2009). Processing difficulty, therefore, often gives rise to longer and more fixations in the same area.

The movements that occur in between two fixations are called *saccades*, after the French word for “twist” or “jerk” (Wade & Tatler, 2005). Indeed, with peak velocities of 600°/s to 1000°/s (Wright & Ward, 2008), saccades are the fastest displacements of which the human body is capable (Holmqvist et al., 2011). Saccades bring the eyes from one location to the next to provide the brain with fresh, quality visual input. In reading, saccades to an earlier part of the text (i.e., right to left eye movements in English) are called *regressions*. Regressions during reading are another sign the participant may be experiencing processing difficulty. Saccades are also interesting in the context of multimodal input (e.g., captioned video or spoken text plus images). In these cases, how often participants visit the different elements on the screen may signal their relative importance or salience and reveal to what extent participants are attempting to integrate multiple sources of information during processing.

**Eye-Tracking Research in L2 Vocabulary Studies**

Eye tracking has been adopted in many areas of SLA, including vocabulary studies (for a synthetic review, see Godfroid, 2019a). For one, researchers use eye tracking to document, in fine detail, the real-time process of learning words from reading (Elgort, Brysbaert, Stevens, & Van Assche, 2018; Godfroid, Boers, & Housen, 2013; Godfroid et al., 2018; Mohamed, 2018; Pellicer-Sánchez, 2015), watching captioned video (e.g., Montero Perez, Peters, & Desmet, 2015), or looking-while-listening to short stories read aloud (Kohlstedt & Mani, 2018). Additionally, researchers use eye tracking to study the processing and representation of multiword sequences such as idioms (e.g., *spill the beans*) and collocations (e.g., *a fatal mistake*). The focus here is on how multiword units are represented in L2 speakers’
lexicon, specifically whether these sequences show stronger internal connections, and are therefore processed more easily than random word combinations are (Carrol & Conklin, 2017; Carrol, Conklin, & Gyllstad, 2016; Siyanova-Chanturia, Conklin, & Schmitt, 2011; Sonbul, 2015; Yi, Lu, & Ma, 2017). Finally, eye tracking has also played an important role in demonstrating that words from a bilingual’s two languages are jointly activated, even when the task requires use of a single language only (e.g., Balling, 2013). Research on the bilingual lexicon can advance our understanding of bilingual cognition, which carries clear societal implications (see Kroll & Bialystok, 2013), but is further removed from L2 vocabulary learning and instruction. Therefore, in the remainder of this section we will focus on what eye-tracking research has revealed about vocabulary learning and the representation of multiword sequences in L2 speakers’ mind.

In one of the first learning studies with eye tracking, Godfroid et al. (2013) recorded the eye gaze as a measure of learner attention in the context of incidental L2 vocabulary acquisition (for a similar study on grammar, see Godfroid & Uggen, 2013). In the study, L1 Dutch – advanced L2 English speakers read short texts (about 100 words each) embedded with English-like pseudowords, which served as targets for word learning. The authors found that the length of time (total eye gaze duration) readers spent on the target words related positively to their performance on a surprise vocabulary posttest: learners who looked longer at individual target words during reading had a better chance of recognizing them on the test. This was important because it suggested that incidental vocabulary learning (understood as learning from a meaning-focused task) is in a fundamental sense not incidental (also see Gass, 1999; Paribakht & Wesche, 1999): those who spend more attention to language form – in this case, novel words – are more likely to learn. In subsequent studies, vocabulary researchers have progressively moved towards the use of longer reading materials, including short stories (Pellicer-Sánchez, 2015), graded readers (Mohamed, 2018), five chapters from a novel (Godfroid et al., 2018), or a general-academic textbook (Elgort et al., 2018). Studies with longer readings have found both L1 and L2 readers become faster as they encounter the same target words repeatedly in the text (Elgort et al., 2018; Godfroid et al., 2018; Mohamed, 2018; Pellicer-Sánchez, 2015). This speed up may reflect a type of implicit or procedural learning, different from what is measured by traditional vocabulary posttests (Elgort et al., 2018; Godfroid et al., 2018). Another noteworthy finding is that prolonged attention (longer looks) may be especially important for the acquisition of word meaning (Godfroid et al., 2018; Montero Perez et al., 2015; Pellicer-Sánchez, 2015) relative to the acquisition of word form (but see Mohamed, 2018).

A second major strand of eye-tracking research concerns the processing and representation of formulaic language. It is well known that formulaic language brings cognitive and communicative advantages (Wray, 2002, 2008) by lowering the processing burden on language users. This is because language users can essentially pull up a whole string of words from their lexicon to express an idea (compare bang for the buck, which is one multiword unit, with value for one’s efforts, which is four lexical units). This advantage presupposes, however, that language users have deeply entrenched knowledge of fixed and semi-fixed expressions in the language (Boers & Lindstromberg, 2012), an assumption that is not to be taken for granted in the case of lower-input L2 speakers.

To study the status of formulaic language for L2 learners, Carrol and Conklin (2017) examined L1 Chinese – intermediate L2 English students’ processing of idioms presented in short English sentence contexts (see also Carrol et al., 2016, for a similar study with Swedish and English). There were two kinds of idioms in the study: English idioms (e.g., spill the beans) and translated Chinese idioms, such as draw a snake and add feet (画蛇添足), which
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means “to ruin something by adding unnecessary detail” in Chinese (Carrol & Conklin, 2017, p. 300). Like previous researchers, Carrol and Conklin observed an idiom advantage in L1 processing: English native speakers read beans in spill the beans (i.e., an idiom, meaning “reveal a secret”) faster than chips in spill the chips (a literal phrase). The Chinese speakers did not show this effect for English idioms, but quite interestingly, they did for the translated Chinese idioms (an effect the authors explained in terms of cross-linguistic priming). When taken together with previous studies (Carrol et al., 2016; Siyanova-Chanturia et al., 2011), these results suggest that real-time advantages for L2-specific formulaic language may only emerge at advanced proficiency levels. Simply knowing the meaning of an L2 idiom (as is often the case at intermediate proficiency levels) does not guarantee that the idiom will be processed more easily during authentic language tasks.

Future Directions: How Can We Measure Knowledge of Form, Meaning, and Use in Real Time?

The goal of this chapter has been to introduce three sensitive measures of vocabulary knowledge and processing: (1) lexical decision, priming, and other reaction time tasks; (2) the coefficient of variability; and (3) eye tracking. A recurring theme is that these newer temporal measures assess different dimensions of vocabulary knowledge compared to more traditional vocabulary tests. As a result, the time is now ripe to revisit Nation’s seminal framework of vocabulary knowledge and consider how these newer methods could contribute to a fuller understanding of what it means to know a word (see Table 28.2). Doing so can help advance the field of vocabulary studies theoretically. Expanding Nation’s framework also carries practical implications, because it might raise awareness of whether different types of input and instruction are effective in moving learners along a path towards fluent language use.

As with any type of assessment, real-time measures are not without limitations. One area that is currently underdeveloped is the use of real-time measures to gauge productive aspects of vocabulary knowledge. Although picture naming or word reading tasks are two sample production tasks that can supply reaction time data (e.g., Ellis, Simpson-Vlach, & Maynard, 2008), their use in L2 vocabulary research is still fairly limited. Given small changes in task instructions and materials, however, picture or word naming tasks (and indeed many other behavioral tasks) with reaction time measurement could tap into most dimensions of productive vocabulary knowledge. As such, the limit is the creativity of researchers, who are free to experiment with and build new tasks to suit their research needs. In the following, I revisit Nation’s framework with an aim to elaborate on how different aspects of word knowledge can be assessed in real time.

Assessing Form

Primed and unprimed lexical decision tasks can add new layers of understanding to traditional measures of form knowledge, such as dictation, yes/no tests, or reading aloud. To date, primed and unprimed lexical decision tasks have predominantly been used with visual stimuli; however, auditory and cross-modal priming and reaction time experiments also exist, so that this family of tasks lends itself to measuring both spoken and written form. Another type of priming, called morphological priming (e.g., walkable → WALK), would be suited to assess knowledge of word parts (for a recent review, see Clahsen & Veríssimo, 2016).

One advantage of priming and related techniques is that they afford a relatively pure measure of formal-lexical knowledge, with little to no interference from knowledge of word
<table>
<thead>
<tr>
<th>Aspects of vocabulary knowledge</th>
<th>Receptive/ productive</th>
<th>What does it mean to master this aspect?</th>
<th>Example of offline measures</th>
<th>Example of online measures</th>
<th>Fluency of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Spoken</td>
<td>R  What does the word sound like? Does the learner have a formal-lexical representation (spoken form) of the new word in memory?</td>
<td>Auditory yes/no tests</td>
<td>Auditory lexical decision tasks; auditory priming</td>
<td>Automaticity</td>
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<tr>
<td></td>
<td></td>
<td>P  How is the word pronounced? How rapidly can the learner produce word forms?</td>
<td>Reading aloud exercises</td>
<td>Naming tasks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Written</td>
<td>R  What does the word look like? Does the learner have a formal-lexical representation (written form) of the new word in memory?</td>
<td>Proofreading exercises (identifying spelling errors)</td>
<td>Visual lexical decision tasks; form priming; masked repetition priming</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P  How is the word written and spelled? How rapidly can the learner produce word forms?</td>
<td>Dictation exercises</td>
<td>Written naming (typing) tasks</td>
<td></td>
</tr>
<tr>
<td>Word parts</td>
<td>R</td>
<td>What parts are recognizable in this word? Does the learner use morphological information to recognize a word?</td>
<td>Word segmentation tasks</td>
<td>Morphological priming</td>
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<td></td>
<td></td>
<td>P  What word parts are needed to express the meaning? Does the learner put together word parts to produce complex words?</td>
<td>Generating word derivations</td>
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<tr>
<td>Meaning</td>
<td>Form and meaning</td>
<td>R  What meaning does this word form signal? How rapidly can the meaning of the word be accessed in the lexicon?</td>
<td>Meaning recognition/recall; translation tasks</td>
<td>Lexical decision tasks; semantic categorization tasks; eye tracking</td>
<td>Naming tasks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P  What word form can be used to express this meaning? How rapidly can the word form for a given meaning be retrieved from the lexicon?</td>
<td>Translation tasks</td>
<td></td>
<td>Naming tasks</td>
</tr>
<tr>
<td>Concepts and referents</td>
<td>R</td>
<td>What is included in the concept? How rapidly can the learner access the concept and referents of the word?</td>
<td>Picture-based vocabulary tests</td>
<td>Visual world eye-tracking paradigm</td>
<td>Naming tasks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P  What items can the concept refer to? How rapidly can the learner produce a word form for a given concept?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Association</td>
<td>R</td>
<td>What other words does this make us think of? Has the new word been integrated into an existing semantic network in memory?</td>
<td>Word Associates Test</td>
<td>Semantic priming</td>
<td>Automaticity</td>
</tr>
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<td>--------------------------------------------------</td>
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<tr>
<td>Grammatical functions</td>
<td>R</td>
<td>What other words could we use instead of this one? How rapidly can the learner produce word associations?</td>
<td>Synonyms tests</td>
<td>Naming tasks</td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td>P</td>
<td>In what patterns does the word occur? Is the learner sensitive to ungrammatical uses of words?</td>
<td>Grammaticality judgment tasks</td>
<td>Grammaticality judgment tasks with online measures (self-paced reading, eye tracking, or event-related potentials)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>In what patterns must we use this word? Can the learner use the word correctly in real-time conversation?</td>
<td>Guided, untimed writing or speaking tasks (e.g., picture description)</td>
<td>Free, real-time writing or speaking tasks (e.g., story retelling)</td>
<td></td>
</tr>
<tr>
<td>Collocations</td>
<td>R</td>
<td>What words or types of words occur with this one? Do collocations and idioms enjoy a special status in L2 learners’ lexicons? How are L2 idioms and L1 idioms in the lexicon related?</td>
<td>Collocation matching tasks</td>
<td>Collocation priming; crosslinguistic priming; eye tracking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>What words or types of words must we use with this one? Do collocations and idioms enjoy a special status in L2 learners’ lexicons?</td>
<td>Fill-in the-blank exercises</td>
<td>Naming tasks</td>
<td></td>
</tr>
<tr>
<td>Constraints on use</td>
<td>R</td>
<td>Where, when, and how often would we expect to meet this word? Is the learner sensitive to how often words occur and co-occur in the language</td>
<td>Lexical decision tasks; eye tracking</td>
<td>Guided, untimed writing or speaking tasks (e.g., picture description)</td>
<td>Free, real-time writing or speaking tasks (e.g., story retelling)</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>Where, when, and how often can we use this word? Does the learner use words appropriately in context?</td>
<td>Guided, untimed writing or speaking tasks (e.g., picture description)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
meaning. For instance, in Elgort’s (2011) form priming experiment, participants had to make a decision on a familiar English word, which was primed by the newly learned target word with a similar form (e.g., 

**prolley** → TROLLEY). For form priming to occur, learners needed to have added **prolley** to their lexicon (i.e., created a new lexical entry for **prolley**), but beyond that no semantic knowledge of **prolley** was required.

Form knowledge is also central to eye-tracking research on incidental vocabulary acquisition from reading long texts. These studies have consistently shown that L1 and L2 readers gradually speed up their reading as they encounter a new word repeatedly in the text (Elgort et al., 2018; Godfroid et al., 2018, Mohamed, 2018; Pellicer-Sánchez, 2015). This indicates a growing familiarity with the word form and, presumably, less effort to integrate the new word into the surrounding sentence context. What is interesting is that these substantial gains in reading fluency do not necessarily coincide with similar gains in offline word knowledge or, for that matter, other measures of online word knowledge. For instance, Elgort et al. (2018) found that L2 English readers slowed down again (indicative of non-fluent reading) when they encountered target words in new (unsupportive) sentence contexts. This suggested that their participants could not apply their knowledge of word meaning to new contexts yet, even though they had become more fluent reading the words in familiar (supportive) contexts. That vocabulary learning proceeds incrementally was also central to Godfroid et al.’s (2018) findings. The authors found that gains in reading speed followed an S-shaped learning curve, meaning every encounter with the unknown words helped readers build up vocabulary knowledge, but some repetitions led to higher gains than others.

**Assessing Meaning**

Similar to measures of word form, online measures of word meaning include the unprimed and primed lexical decision task, but in this case semantic rather than form priming is used (Elgort, 2011; Elgort & Warren, 2014). New in this area is the semantic categorization task, a variant of the lexical decision task that has been developed specifically so that participants retrieve the meaning of a word (Lim & Godfroid, 2015; Phillips et al., 2004; Segalowitz & de Almeida, 2002; Segalowitz & Frenkiel-Fishman, 2005). Compared with offline measures such as translation and meaning recognition, online measures provide a more indirect measure of word meaning that is able to capture partial word knowledge. In a semantic categorization task, for instance, the participant may be able to respond “yes” that a **badger** is a living being (correct yes response) without knowing what kind of animal it is. The same answer (i.e., **badger** = *an animal*) on a meaning recall test might receive a partial score or no credit depending on the teacher’s or researcher’s scoring rubric. The semantic categorization task therefore can measure breadth of knowledge and, if a reaction time component is included, it can also measure lexical fluency or automaticity (e.g., Lim & Godfroid, 2015; Segalowitz & de Almeida, 2002).

Other online measures of word meaning come from eye tracking, primarily from the visual world paradigm, where spoken words in context are presented alongside their possible referents on the screen (see Dussias, Valdés Kroff, & Gerfen, 2014, and Godfroid, 2019a, for L2-specific reviews). For instance, in a recent visual world study Kohlstedt and Mani (2018) found that L1 and L2 speakers can make use of the discourse context to infer the meaning of new (pseudo) words in a short story. They found participants looked at target pictures on the screen that represented the new nouns (e.g., a picture of a cane, representing a German pseudoword for “cane”) before the nouns had occurred in the spoken story, based on semantic associations with other nouns in the story (e.g., **Opa**, “grandpa”). Bolger and Zapata (2011), using a variant...
of visual-world eye tracking, uncovered subtle semantic interference effects in the retrieval of word meaning, which occurred after participants had studied new vocabulary in semantically related sets.

In reading research, eye movements reflect the fluency with which participants can access a new word in context, but the data do not speak to the question of acquisition of meaning directly. This is why researchers have triangulated their eye-movement data with offline meaning recognition and meaning recall tests (Godfroid et al., 2018; Mohamed, 2018; Montero Perez et al., 2015; Pellicer-Sánchez, 2015) or other online measures of word meaning (Elgort et al., 2018). For both listening and reading, therefore, eye-movement recordings can offer insight into learners’ knowledge of word form and meaning. For word meaning, recording eye movements can reveal developmental trajectories or learning curves, bring semantic relationships to light, and probe how robust the knowledge is that learners have acquired.

Assessing Use

Assessing word use oftentimes involves gathering writing and/or speaking samples with a view to identifying errors and classifying and describing them. Of the different types of errors, lexical errors are especially difficult to code reliably (e.g., Polio, 1997; Polio & Shea, 2014), in part because of uncertainty as to “whether or not a native speaker would produce the word or structure in the context” (Polio & Shea, 2014, p. 20). With technology, researchers have turned to corpora to help compare and contrast how learners and native speakers use a particular word structure. For example, Altenberg and Granger (2001) compared two learner corpus databases (one of French learners of English and one of Swedish learners of English) against a native English speaker corpus to investigate the use of MAKE in writing. The authors found that learners have difficulty in mastering native-like use of this highly frequent verb. Importantly, in this type of research the distinction between vocabulary and grammar is often blurred, as particular lexical items tend to call for particular syntactic constructions.

Another area that blurs the distinction between grammar and vocabulary is collocations and idioms. Also using corpus data, Yi and his colleagues (2017) identified how native Chinese speakers tend to combine monosyllabic adverbs. For example, some combinations as a whole are more common (e.g., 仍不, literally “still did not”), while some are grammatical but not so common (e.g., 仍沒, literally “still had not”). With this information, the researchers were able to test learners of Chinese to see if they had acquired this knowledge of word co-occurrence (i.e., these statistical properties of Chinese adverbials) using eye tracking. Eye-movement data from reading showed that the L2 speakers were as sensitive as the L1 speakers to the statistical properties of Chinese adverbials (for similar findings for English, see Sonbul, 2015). This was an important finding because it suggests that L2 learners may draw on the same general learning mechanisms (statistical learning) as L1 speakers do. Yi et al.’s and Sonbul’s eye-tracking research complements the collocation and idiom priming literature (e.g., Carrol & Conklin, 2017; Sonbul & Schmitt, 2013; Wolter & Gyllstad, 2011). Researchers, then, have a number of options to choose from when the goal is to gain a real-time perspective on language users’ knowledge of word patterns.

For constraints on word use, offline grammaticality judgment tasks and proofreading exercises to spot ungrammatical forms can reveal learners’ receptive knowledge, while guided production (e.g., picture description) can tap into the productive aspects of word
usage. A nice feature is that these tasks can be extended with an online component to bring the temporal factor into the assessment. For instance, in my own collaborative work, I have replicated the grammaticality judgment tasks from R. Ellis’ influential study (Ellis, 2005) but with the addition of eye tracking (Godfroid et al., 2015). Eye tracking is valuable here because it affords insight into how L1 and L2 speakers process grammaticality judgments under different testing conditions (e.g., timed and untimed grammaticality judgments). Because the sentence grammaticality depended crucially on the individual lexical items used in some of the structures (i.e., verb complements, indefinite article, dative alternation, and ergative verbs), this was partially a test of word usage, in addition to grammar. Godfroid and colleagues found that when L2 participants were asked to make grammaticality judgments under time pressure, they were more likely to read the sentence straight through, without making any regressions. They argued that the drop in regressions signaled a reduction in controlled processing that marks the retrieval (successful or not) of explicit-declarative knowledge (Ellis, 2005). Adding time pressure to a grammaticality judgment test may thus make it more difficult for L2 speakers to access their explicit-declarative knowledge base. More generally, eye-tracking research with lexical/grammatical violations can tell us about L1 and L2 speakers’ knowledge of word use when they have little time for conscious reflection, mimicking how a lot of real-time language exchanges take place.

Assessing Automaticity

The previous sections have highlighted how different reaction time methodologies and eye tracking can enrich teachers’ and researchers’ understanding of what it means to know a word. The icing on the cake is that all of these measures can also yield a $CV_{RT}$ value for each study participant, as long as there are multiple observations for each person. Once researchers have obtained reaction time data, they basically get the $CV_{RT}$ measure for free. $CV_{RT}$ provides a measure of automaticity of lexical knowledge, which cuts across the three primary dimensions of word knowledge (i.e., form, meaning, use). Researchers can assess how automatically a learner can retrieve formal-lexical information, how easily they can map the form to meaning, and how consistently they react to word pattern violations. This is why automaticity spans all rows in Table 28.2. It is a crucial component of lexical competence that underpins all aspects of vocabulary knowledge. Automatic lexical knowledge is also essential for skilled language use more generally, because fast, automatic retrieval of words is at the basis of listening and reading comprehension (Grabe & Stoller, 2013; Vandergrift & Goh, 2012) and speaking and writing fluency (Segalowitz, 2010; Galbraith, 2009). Thus, $CV_{RT}$ has a place both in and outside of the language laboratory, as it can document growth in classroom learning and study abroad contexts (Akamatsu, 2008; Fukkink et al., 2005; Segalowitz & Freed, 2004; Segalowitz et al., 1998; Serafini, 2013).

Concluding Remarks

Nation’s seminal framework (Nation, 2013), which dates back to his 1990 book, raised awareness of the need for researchers and teachers to espouse a broader view of vocabulary learning than creating new form-meaning links. The impact of his ideas is shown in the fact that there are now numerous tasks available that tap into the form and usage dimensions of lexical knowledge. Indeed, there is no doubt that the field of L2 vocabulary studies has seen tremendous growth over the last 30 years. In this chapter, I have argued that such development could be propelled even further if researchers focused not only on lexical knowledge (in all its dimensions) but also on the command speakers have over that knowledge – that
is, measure both the tip of the iceberg and the submerged part. This question is commonly framed in terms of tacit-implicit, automatized explicit, or procedural knowledge, which is to be contrasted with explicit-declarative knowledge, the object of most offline vocabulary tests. Three sensitive measures – reaction times in primed and unprimed lexical decision tasks, eye tracking, and $CV_{RT}$ – all lend themselves to studying these hidden dimensions of vocabulary knowledge. Many studies reviewed in this chapter show that researchers have successfully triangulated these online measures with offline tests to gain a more complete understanding of vocabulary learning and knowledge. Indeed, online methods and offline methods can go together in research. As reaction time and eye-tracking methodologies become increasingly accessible, the use and impact of these measures is likely to continue to rise in the coming years (Sanz, Morales-Front, Zalbidea, & Zárate-Sández, 2015). Vocabulary researchers are invited to adopt an online mindset and secure a front-row seat for the game by observing vocabulary learning and use as they are happening.

**Further Reading**


This book provides an overview of eye-tracking research in applied linguistics, including reading, listening, corpus linguistics, and translation research. Exemplary studies in each subdomain are used to introduce basic methodological facts and practical considerations in eye tracking. Research on vocabulary learning and use is well represented in the book.


This book provides foundational knowledge about eye tracking for language researchers. It provides a synthetic review of existing eye-tracking research in L2 and bilingual reading, listening, speaking, and multimodal language processing. It also provides a systematic treatment of topics in the design, execution, and analysis of eye-tracking research. Research on vocabulary learning and use is well represented in the book.


This accessible guide to reaction time research details the steps for collecting accurate reaction time data and includes a tutorial for DMDX, a piece of experimental software. The chapters on lexical and phonological tasks as well as that on semantic tasks are most relevant to measuring vocabulary knowledge.


This book represents the culmination of Segalowitz’s empirical work on automatization and $CV_{RT}$ up until 2010. The book also has a comprehensive review of empirical work on speech production, automaticity, and lexical access, all of which are germane to the discussion of online measures of vocabulary.

**Related Topics**

Different aspects of vocabulary knowledge, learning single-word and multiword items, processing single-word and multiword items, measuring knowledge of single-word items, measuring knowledge of multiword items, measuring vocabulary learning progress, incidental vocabulary learning, deliberate vocabulary learning, developing fluency with words

**Note**

1 This chapter benefited a great deal from the skilled assistance and thoughtful input of Bronson Hui, a PhD candidate in second language studies at Michigan State University.
References


Aline Godfroid


