INSTRUÇÃO DE VOCABULÁRIO EM L2
UMA ANÁLISE DE APLICATIVOS PARA A APRENDIZAGEM DE INGLÊS

L2 VOCABULARY INSTRUCTION
AN ANALYSIS OF SMARTPHONE APPLICATIONS FOR ENGLISH LEARNING

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Smartphones have become more accessible in the last decade, which has promoted the development of numerous applications for language learning and brought increased interest in the field of Mobile Assisted Language Learning (MALL). Considering that most smartphone applications for English learning have activities designed to instruct vocabulary, this study aimed to analyze the instruction of vocabulary in the three most used applications for language learning until the end of 2018. More specifically, it investigated: a) what aspects of word-knowledge the applications develop; b) whether they provide a number of encounters with the target vocabulary and whether they are massed or spaced; and c) the nonverbal representations employed by the applications. The results showed that the applications: a) instruct the spoken and written form of words, but often neglect other aspects of word knowledge such as the lexical and syntactic relations between words; b) provide multiple, massed encounters with the target vocabulary and c) employ images and videos as nonverbal that are not always relevant to the instruction of target vocabulary. Based on our analysis we concluded that, in spite of limitations such as the lack of opportunities for language production and decontextualized instruction, these applications can be used as a tool to assist the instruction of vocabulary.

Keywords: Vocabulary Instruction. Mobile Learning. Second Language Learning. Smartphone Applications.

A popularização dos *smartphones* nas últimas décadas promoveu o desenvolvimento de diversos aplicativos para o aprendizado de línguas e fomentou o interesse no campo da aprendizagem móvel. Considerando que boa parte dos aplicativos de *smartphone* para a aprendizagem de inglês tem atividades para a instrução de vocabulário, este estudo buscou analisar o desenvolvimento de vocabulário nos três aplicativos para a aprendizagem de línguas mais utilizados até o final do ano de 2018. Mais especificamente, buscou-se compreender: a) quais aspectos do conhecimento de palavras os aplicativos desenvolvem; b) se existem múltiplos encontros com as palavras-alvo e se

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esses encontros são espaçados; e c) as representações não-verbais utilizadas pelos aplicativos. Os resultados indicam que os aplicativos: a) instruem a forma oral e escrita das palavras, porém negligenciam outros aspectos do conhecimento de palavras; b) provem, com o auxílio de algoritmos, múltiplos encontros espaçados com as palavras-alvo; e c) utilizam imagens e vídeos que nem sempre são relevantes para a instrução das palavras-alvo. Com base nos resultados deste estudo, entendemos que os aplicativos podem auxiliar o desenvolvimento de vocabulário de língua inglesa, apesar de limitações como a falta de oportunidades para a produção de linguagem e o ensino descontextualizado.

Palavras-chave: Instrução de vocabulário. Aprendizagem móvel. Aprendizagem de segunda língua. Aplicativos de *smartphone*.

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1. Introduction

Once viewed as a neglected aspect of language learning (Meara 1980; Carter 2012), it is now accepted that vocabulary acquisition is an essential aspect of language learning. Chapelle and Jamieson (2008) understand vocabulary as the building blocks of a language. They also point out that when learners encounter unfamiliar words, they need help from a teacher or a computer to properly acquire them. In this regard, computers and mobile devices have been explored as tools to assist language learning and, more specifically, vocabulary acquisition.

Computers have become a valuable tool to second language teachers and students. The field studying the use of computers to enhance language learning is called Computer Assisted Language Learning (hereafter CALL). According to Levy (1997), CALL is the search for and study of applications of computer in language teaching and learning. Since today second language learners can obtain electronic support from not only computers, but also smaller and more portable devices, such as mobile phones, a subset of CALL has recently emerged: MALL. The acronym stands for Mobile Assisted Language Learning and it encompasses the use of mobile technologies to enhance language acquisition (Chinnery 2006).

Although MALL is still emerging, studies have recognized that mobile technology can be a valuable tool for language learning (Andrade 2017; Attewell & Savill-Smith 2003; Naismith *et al.* 2004; Stockwell 2013; Vesselinov & Grego 2012). However, little is known about the instruction of vocabulary in applications for smartphone. Considering the focus on vocabulary present in most applications for English learning (Kim & Kwon 2012), the purpose of this study is to investigate the instruction of vocabulary in the three most used smartphone applications for English learning. A brief review of the literature that guided this study is now provided.

2. Vocabulary knowledge and instruction

What does it mean to know a word? Although linguists do not always agree on the main aspects of word knowledge, they agree that it encompasses more than knowing their meanings. Carter points out that knowing a word involves the understanding of both its syntagmatic and paradigmatic relations. He notes that since words exist in a kind of semantic space, learners have to know what parts of this space they can or cannot occupy. Moreover, he explains that to know a word also means to know its context and argues that the "syntactic and semantic knowledge must also include pragmatic knowledge" (2012, p. 185).

Tumolo (1999) describes a continuum which foreign language learners follow, which goes from a) never having seen the word; b) having encountered the word, but being unable to recall its meaning; c) recognizing the word when linked to some context; d) comprehending the word in the context; to e) knowing various meanings in different contexts. Therefore, at the end of this continuum, learners should have a deeper knowledge of the words, which would include knowing the different meanings a word can have depending on the context, *i.e.* having a pragmatic knowledge of the word (Carter 2012).

Laufer (1997) outlines that knowing a word means knowing: a) its written and spoken form, which means being able to recognize it in written and spoken form and being able to spell and pronounce it; b) its structure, that is, recognizing and understanding its basic free and bound morphemes (*e.g.* knowing that the word *uncomfortable* is made up of *un + comfort + able*); c) its syntactic behavior, that is, knowing the possible combinations of the word (*e.g.* the verb *enjoy* is followed by a verbs in the gerund form); d) its meaning, which involves understanding polysemy as well as affective and pragmatic meanings and e) its lexical relations, its synonyms, antonyms, hyponyms and collocations. Although all these aspects of word-knowledge are important, vocabulary instruction can be successful if some aspects are more developed than others.

As learning vocabulary is no easy task, its instruction should be guided by sound principles. Sökmen (1997) observes that, throughout the literature, some pedagogical themes seem to be predominant in terms of vocabulary instruction. They are: a) develop a large sight vocabulary, meaning that learners should know a great number of high frequency words while making sure they also learn difficult words; b) integrate new words with the old, that is, learners should be stimulated to build semantic associations between new words and ones already known; c) provide a number of encounters with a word, especially encounters which are arranged in increasingly longer intervals; d) promote a deep level of processing, which acknowledges that there is better learning when there's more depth in processing due to the fact that words are encoded with elaboration; and e) facilitate imaging and concreteness, meaning that instruction with verbal and nonverbal representations is likely to promote better results than instruction with only nonverbal representations, especially if these representations relate to learners' experiences and their real lives.

Studies point out that multiple encounters are necessary for true acquisition of a word. Nation (1990), for example, suggests a range of 5–16 encounters. Sökmen (1997)

explains that if words are encountered in increasingly longer intervals, they are more likely to be stored than if encounters are presented at a single time. This is referred to as the spacing effect, which postulates that "for a given amount of study time, spaced presentations yield substantially better learning than do massed presentations" (Ellis 1995, p. 16).

The validity of the spacing effect has been found to assist in the learning of many contents, including vocabulary in a second language (Bahrick & Phelps 1987; Bloom & Shuell 1981; Goossens *et al.* 2012; Kornell 2009; Ullman & Lovelett 2016). Bloom and Shuell (1981), for instance, carried out a study in which high school students enrolled in a French course learned words under massed or distributed (spaced) practices. The results show that, even though the results were almost identical on a test given right after the completion of study, those who had learned words by distributed practice scored significantly better (35%) on a second test given four days later. The authors suggest that the spacing between repetitions can be more valuable than the number of repetitions.

Nonverbal representations, such as images and videos, can facilitate imagery of vocabulary, which in turn can strengthen memory links (Clark & Paivio 1991; Laufer 1997; Mayer 2009; Sadoski 2005). Research on vocabulary learning has consistently found better retention of vocabulary if it is paired with pictures, showing that Mayer's multimedia learning principle holds true for this type of learning. Nevertheless, for this facilitation to take place, the nonverbal representations must be relevant to the learning goal. According to Mayer, multimedia learning is improved when "interesting but irrelevant words and pictures are excluded from a multimedia presentation" (2009, p. 89). Considering the literature reviewed in this section, vocabulary instruction is enhanced if learners: a) have opportunities to learn and practice the different aspects of word-knowledge outlined by Laufer (1997); b) are provided with multiple, spaced encounters with the target vocabulary; and c) are instructed with aid of nonverbal representations that are relevant to their learning goal. Given that smartphone applications have become very popular, this study sought to look into their instructional design for L2 vocabulary learning.

3. Vocabulary learning in CALL and MALL

Linguists have started to consider how computer and mobile assisted language learning can enhance vocabulary acquisition. Sökmen (1997) argues for the use of computer-assisted learning with software based on principles of vocabulary acquisition theories. She mentions that a significant number of software lacked depth and more varied exercises. Ellis (1995) has also criticized CALL by saying that "CALL programs have too often been driven by enthusiasm for what computers can be made to do and too rarely by an understanding of human cognition" (Ellis 1995, p. 1). In this regard, the author suggests that CALL programs are not being developed with attention to the cognitive aspects, and that the interest for the technology itself is the driving force behind CALL. In spite of such critics, both Sökmen (1997) and Ellis (1995) acknowledge that, with proper development, computers can enhance vocabulary acquisition.

Grace analyzed the effects of "sentence-level L1 translations on the retention of L2 vocabulary presented in a pregnant CALL context for beginning L2 learners" (1998, p. 536). Although the author believes that inferring word meanings promotes better retention due to deeper processing, she acknowledges that incorrect meanings can be retained if wrong inferences are made. The study found that sentence-level translations reduce the chances of incorrect inferences from L2 context and the consequent commitment of wrong meanings to memory. Furthermore, she hypothesizes that "as a result of their verifications of meaning, sentence-level translations may also lead to elaborate, deep and durable encoding" (Grace 1998, p. 534). The results showed that the participants who had access to translations while inferring performed better in a post test. The author points out that such performance is not only due to the availability of the translations, but also because a great number of stimulus from the pregnant context was provided.

Stockwell (2010) carried out a study that aimed at comparing vocabulary acquisition in mobile phones and desktop computers. Participants could choose to do the selected activities in their preferred platform and could alternate between them freely. The results show that the participants obtained similar scores with the two platforms. The results also demonstrated that completing the activities through mobile took significant longer. The author argues that the mobility of these devices can be one of the reasons for this result. As participants could do the activities anywhere and at any time, Stockwell reasons that they did them in environments where it was harder to concentrate such as in trains or coffee shops, which required more time to finish the tasks.

In an attempt to explore the benefits of mobile phone applications for vocabulary learning, Fageeh (2013) conducted a study in which participants from an experimental group were given a list of words based on their textbooks and had to practice them using mobile phones, whereas participants from the control group had to use the textbook for this practice. The post-test scores indicate that the experimental group acquired the target vocabulary significantly better. The author also mentions the use of mobile phones promoted higher motivation to complete the tasks.

Studies suggest that EFL learners are willing to use their mobile devices as language learning tool. As Naismith *et al.* (2004) acknowledge, mobile devices are "finding their way into classrooms in children's pockets, and we must ensure that educational practice can include these technologies in productive ways" (p. 36). An important step in this direction is the analysis of smartphone applications for learning. This study sets out to add discussion to the field of MALL, especially in regard to vocabulary instruction.

4. Method

This study aimed at analyzing the instruction of vocabulary in the most used mobile applications for English learning until the end 2018. Ideally, it would be possible to verify the exact number of downloads/users each application has. Unfortunately, neither of the two largest application stores worldwide (the *Apple Store* and the *Google Play Store*) provide such precise information. However, as the *Google Play Store* allows us to know if applications have reached a certain number of downloads, such as one, five or ten million downloads (Stimac 2014), the platform was used to estimate the most used

applications. The steps adopted to select the applications are the following. First, we conducted a search on the *Google Play Store* using the keywords 'English learning' and 'Language learning'. [1] Then, we selected all the applications that had reached more than 10 million downloads. Five applications met this criterion, namely: *Babbel*, *Busuu*, *Duolingo*, *Hello English* and *Memrise*. As our goal was to analyze only the three most used applications currently available, we looked at the number of reviews each of them had[2], which are shown in table 1.

Table 1. Applications with more than 10 million downloads on Google Play.

Application	Number of downloads	Number of reviews
Duolingo	More than 10 million	6,763,679
Memrise	More than 10 million	1,157,188
Hello English	More than 10 million	789,652
Babbel	More than 10 million	307,915
Busuu	More than 10 million	229,419

Source: the author.
Note: Data collected on November 2018.

Unlike the number of downloads, the number of reviews is exact and allowed us to select the applications with the most reviews. *Duolingo*, *Memrise* and *Hello English* had more reviews on *Google Play Store* than *Babbel* and *Busuu*, and were therefore the applications analyzed in this study.

Having selected the applications, data was then collected by using these applications. Each application was used for a month, on a daily basis, thus ensuring that all types of activities provided by the applications were done at least once.

After the data collection, a qualitative analysis was carried out with the objective of understanding how the applications incorporate elements from the literature on vocabulary instruction in a second language. More specifically, we analyzed a) what aspects of word-knowledge the applications develop; b) whether they provide a number of encounters with the target vocabulary and whether these encounters are massed or spaced; and c) the nonverbal representations employed by the applications. With this in mind, our research questions were:

RQ1) What aspects of word-knowledge do the applications develop?

RQ2) Do the applications provide a number of encounters with the target vocabulary? Are these encounters massed or spaced?

RQ3) What are the nonverbal representations employed and how can they assist the instruction of vocabulary?

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[1] The search was conducted on November 22nd, 2018.
[2] The number of downloads and of reviews allowed us to infer that these applications are more used worldwide.

5. Results and discussion

The results from the analysis of the three applications are now presented. First, a brief description of the main general characteristics of each application is given. Then, an analysis of the instruction of word-knowledge is provided, followed by the analysis of the number of encounters with target vocabulary. Finally, the nonverbal representations employed by the applications are discussed.

5.1. *Duolingo*

Duolingo is currently the most popular application for language learning designed for mobile devices, offering courses in more than 90 languages. Although its content can be accessed for free, the application offers a premium, ad-free version that can be accessed offline. *Duolingo* also generates revenue through what is called human computation. Garcia explains that human computation has the objective of "combining human and computing power to solve problems neither people nor computers could solve alone" (2013, p. 20). The author argues that, for translating the web, the translation done by computers is not good enough while professional translators are too expensive. *Duolingo* may help with this by offering translation as a by-product of the applications' usage.

One of the websites which uses *Duolingo* learners' translations is *Buzzfeed*, a well-known humor page. According to the website, native speakers of Portuguese, Spanish and French learning English on the application work together to translate *Buzzfeed* articles while an algorithm selects the best translations to create a better translated post (Buzzfeedpress 2017). The sheer amount of *Duolingo* users "guarantees high-speed, high-volume translations, ensuring that *BuzzFeed* content can be translated in a matter of hours" (Buzzfeedpress 2017, p. 1).

The content of *Duolingo* is divided into what it calls sections, which go from basic to advanced. Each section contains up to 11 topics, which are either vocabulary or grammar related. Due to the scope of this study, only the sections related to vocabulary will be considered. Figure 1 shows an example of how *Duolingo* organizes its content in sections.

Figure 1. An example of a section from *Duolingo*.

The section from Figure 1 shows some vocabulary topics, such as *viagem* (traveling) *números* (numbers) and *educação* (education). Each of these topics is further divided into smaller lessons containing a limited number of target words. The lessons are divided into even smaller parts, which work with a small number of target words. For example, in one of the lessons about animals, the target words were *horse*, *bird* and *duck*.

Regarding our first research question, the aspects of word-knowledge instructed by the application, the analysis suggests that *Duolingo* can assist, to different degrees, the learning of written and spoken forms, as well as their meaning. The instruction of the written form takes place in activities that require the spelling of words or sentences, such as the one in Figure 2.

Figure 2. Instruction of the written word form in *Duolingo*.

As seen in Figure 2, learners are asked to write the target word *bird*. The application expects them to know its spelling because they have seen the word in previous translation activities, but in case they make mistakes, the application provides corrective feedback, which can also be considered part of the word form instruction.

Knowledge of the spoken form can be developed with nearly every activity in *Duolingo*, as the application pronounces the sentences learners are translating. If the sentence is translated from the L1 to the L2, then the application pronounces the L2 sentence when a correct translation is provided. If the sentence is translated from L2 to L1, the L2 sentence is pronounced before learners translate it, or when they tap on the words that make it up. The application also offers short listening passages (with no more than 10 words), as well as short sentences for learners to repeat, as is shown in Figure 3.

Figure 3. Two examples of activities involving the spoken form of words.

The first type of activity shown in Figure 3 may help learners connect the spoken to the written form since they listen to sentences and have to choose the answer that corresponds to what they have heard. This connection is an important aspect of word knowledge to be developed, being the second step of the five steps put forth by Brown and Payne (1994, *apud* Hatch & Brown 1995). The second type of activity simply asks learners to repeat sentences and provides feedback on what is been correctly pronounced and what has not. In the case shown in Figure 3, the application noticed that the word *bilingual* was incorrectly pronounced. Although *Duolingo* can identify such mispronunciations, it did tell users why their productions were incorrect or how they can improve them.

Regardless of the type of activity, learners are expected to acquire the spoken form of words by repeating them multiple times, without explicit pronunciation instruction. According to Schmitt (2000), explicit instruction in the L2 phonological system is often necessary because second language learners think and perceive orthography in ways dictated by their Ll, which many times is different in kind from the L2 being taught.

Duolingo provides word meanings mostly by associating the target words in the L2 to a meaning from the L1. As stated, the application gives sentences in the learner's L1 or L2 and asks them for a translation. Learners can access the meanings of the target words by tapping on them, as is shown in Figure 4.

Figure 4. Instruction of word meanings in *Duolingo*.

As seen in Figure 4, the application alerts learners that there is a new word to be learned and that its possible meanings can be accessed by tapping on it. Nonetheless, no further information is given on these meanings. As a result, learners have to decide which of the

meanings is better suited to the translation at hand. For example, in Figure 4, three meanings are offered to the target word *staff: equipe, pessoal* and *empregados*. Although all of them are suitable choices for a Portuguese translation of the sentence, learners may assume that these meanings follow a one-to-one relationship, *e.g.* the word *staff* always means *pessoal*, and *pessoal* always means *staff*, which is not true. In case it is an adjective, *pessoal* should be translated as *personal*, and if it is used in the vocative case, it could be translated as *guys*. Polysemic words may also pose problems in activities such as the one shown in Figure 5, which has learners form word pairs, with one word in the L1 and the other in the L2.
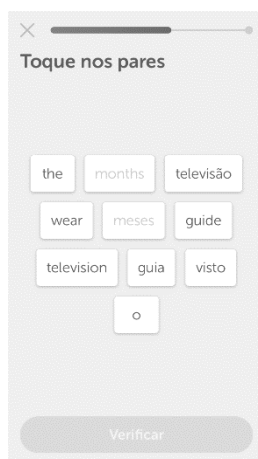

Figure 5. Word pairings in *Duolingo*.

Figure 5 shows that the L2 word *wear* should be paired with *visto*, and the word *guide* with *guia*. However, the words from this activity also have other meanings. For example, if v*isto* is functioning as a noun, it should be translated as *visa* in Portuguese. A learner doing this activity is likely to look at the word *visto* and activate the mental representation of a visa because the first person subject *eu,* required for the understanding that *visto* is actually a verb, is missing. In sum, as the activity presents the words in isolation, it is difficult to know whether *visto* is a verb or a noun. This exemplifies the problems that may arise due to the lack of contextualization in MALL.

Regarding our second research question, *Duolingo* provides multiple encounters with target vocabulary within the lesson they were presented. For instance, the word *boat*, one of the target words from the second lesson in the unit entitled *travelling*, was met from three to five times in the lesson which presented it. Subsequent encounters take place at the last lesson from each unit, entitled *palavras mais fracas* (weaker words). Through its algorithm, *Duolingo* is able to identify the words that have been mistaken more frequently, subsequently adding these words to the lessons entitled *palavras fracas*. This means that vocabulary that caused difficulty to learners is going to be reencountered more often than vocabulary that did not.

Once a unit has been finished, Duolingo assesses the need for practice and review of its content. Settles and Meeder explain how this assessment is done:

> Once a lesson is completed, all the target words being taught in the lesson are added to the student model. This model captures what the student has learned, and estimates how well she can recall this knowledge at any given time. Spaced repetition is a key component of the student model: over time, the strength of a skill will decay in the student's long-term memory, and this model helps the student manage her practice schedule. (2016, p. 1850)

As the authors point out, the application evaluates how much learners have learned from each lesson and how long it has been since they finished it. With this evaluation, strength meters are created to show students how likely they are to remember the content from a given unit. Three or four golden bars indicate that the lesson has been done/reviewed recently, while one or two mean the lesson should be reviewed. The more learners practice the content from the units, the slower the strength bars will decay, which goes in accordance to the forgetting curves presented in Settles and Meeder (2016). Considering this, it is safe to assume that *Duolingo* offers multiple encounters with target vocabulary and that these encounters are spaced in an organized fashion.

With reference to our third research question, *Duolingo* makes use of images to assist the instruction of vocabulary. For some activities, the application introduces concrete words with the aid of images that represent them. When this happens, the images are the nonverbal representations of the target words. Because of them, learners can comprehend the meaning of the written form of words, *i.e.* their signifiers, without resorting to their L1, as Figure 6 illustrates.
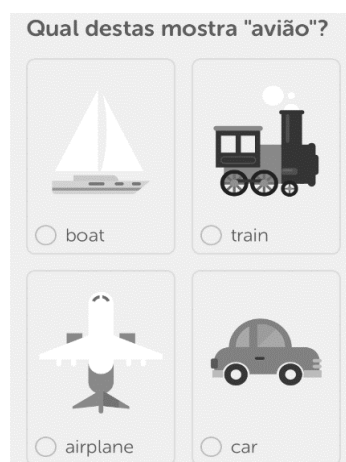

Figure 6. Images used to instruct target words in *Duolingo*.

As Figure 6 shows, upon seeing the image of a boat, learners access their mental representation of the word and associate it with its signifier in English. Therefore, *Duolingo* makes good use of images when it comes to instructing concrete vocabulary. This goes in accordance to Sadoski, who argues that the usefulness of pictures is connected to a number of factors, such as the concreteness value of the word, as "it is easier to picture concrete words such as tree than abstract words such as true" (2005, p. 225).

While images such as the one in Figure 6 can facilitate assist the learning some words, images as the one in Figure 7 are unlikely to have any positive outcome.
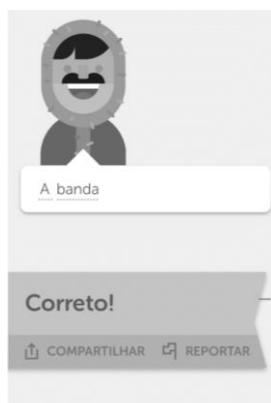
Figure 7. An image from *Duolingo* that can be considered extraneous material.

As Figure 7 shows, the target word *band* was illustrated by the image of what seems to be an Eskimo. The image does not contextualize the target word, nor does it provide does it facilitate its mental imagery. Rather, it seems as if the image is only there so that it feels like someone is pronouncing it. In light of the principles of the multimedia learning, these images would be considered extraneous material as they "compete for cognitive resources in working memory and can divert attention from important material" (Mayer 2009, p. 89). In this sense, it would be more fruitful to have images that helped contextualize the sentences.

All things considered, *Duolingo* is an application which a) presents, reviews and consolidates lexical items with activities that involve translation and repetition, b) can assist the learning of the written and spoken form of words, as well as their meanings; c) offers multiple encounters with target vocabulary, with spaced encounters provided with the aid of an algorithm; and d) uses images as an aid in the instruction of vocabulary, although some of these images are unlikely to have do so.

5.2. *Memrise*

By the end of 2018, *Memrise* was the second most downloaded application for language learning worldwide. It is available in 25 languages, with the possibility of learning more than 150, including less commonly taught ones such as Catalan, Mongol and Swahili. To start using the app, learners must select their first language (out of the 25 available) and choose the L2 they want to study. It is possible to study multiple languages at the same time. For this analysis, the L1 was Portuguese, and the target language was American English. All of *Memrise*'s units follow a basic structure: first, the application presents the target words and lexical items for the unit, and then it reviews them with a series of activities.

Concerning the aspects of word knowledge considered for this study, *Memrise* can assist the learning of spoken and written forms, structure and meanings. To instruct the spoken form, the application pronounces[3] the target words in all the activities, meaning

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[3] Unlike other applications, which use automated pronunciation, *Memrise* uses human-recorded audio files.

that learners will hear them multiple times within one unit. However, no other resources are employed to develop the spoken form, such as showing stress patterns or phonemic/phonetic transcriptions.

To instruct the word form, the application relies on activities such as the one illustrated in Figure 6, which asks learners to spell out target words.
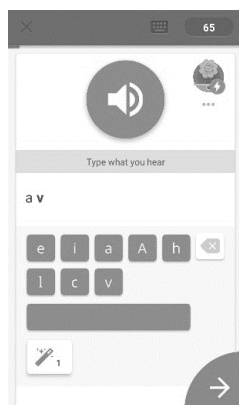

Figure 8. Instruction of word form in *Memrise*.

As shown in Figure 8, the application pronounces the target word *vehicle* and provides the letters that make it up for learners to spell it. If learners are in doubt, they can tap the magic wand button so that the application provides the next letter of the word for them. This type of activity can help learners with their phonetical awareness of the language, allowing them to perceive that the same letter does not always represent the same sound, and vice-versa. For example, the letter *h* in *hospital* is pronounced, whereas it is mute in the target word *vehicle*. However, learners would have to come to this perception by themselves, as the application does not explicitly instruct this.

Translation is the main source for the instruction of word meaning. The lack of contextual clues from texts or illustrations prevents less explicit forms of learning from happening, such as guessing the meaning of words from the context. Nevertheless, the application also allows learners to create their own *mems*, which, according to the developers, are "anything which helps connect what you're learning and bring it to life" (Memrise 2018, p.1). Figure 9 shows an example of a *mem* we created for the verb *to argue*.

Figure 9. *Memrise*'s *mems*.

To instruct the meaning of the verb *to argue*, *Memrise* only offered two possible translations into Portuguese, *discutir* and *argumentar*. Learners can then add information that may help them remember or better understand the word. As can be seen in Figure 9, we added the sentence *I argued with my friend over politics*. Although the *mems* might help with the memorization of vocabulary, they do not compensate for the lack of instruction on the other aspects of word knowledge such as syntactic behavior and lexical relations. For instance, it is of little value to know the meaning of the verb *to argue* without knowing the prepositions that may follow it, such as *for, against, over* and *about*. Without such knowledge, it would not be possible to create the sentence aforementioned.

In regards to our second research question, the developers of *Memrise* claim that "by tracking when you should review and practice material, we do the hard work for you – making your learning as effortless and fun as possible" (Memrise 2018, p. 1). This implies that the application somehow follows the principles of spaced repetition to distribute content review in an appropriate manner.

At first sight, it does not seem to be the case as new words are presented in a rather massed manner. *Memrise* justifies this by saying that "when you first learn a new word your memory is at its most delicate and requires the most love and attention" (2017, p. 1). In light of this, the application tests and reviews new words very frequently so that these words "get a secure root-hold in your brain" (p. 1). However, when the application understands that the target vocabulary has been learned, its algorithm reduces the frequency of the encounters and increases the intervals between them, which is in conformity with the concept of spaced repetition, as discussed in Ellis (1995) and Ullman and Lovelett (2016). Therefore, target vocabulary is encountered multiple times, first in a massed manner, and subsequently in a more spaced fashion.

With respect to our third research question, *Memrise* does not employ any nonverbal representation to assist the instruction of vocabulary. Even though there are some visual representations, such as the growth of flowers to depict vocabulary gain, they do not help instruct vocabulary, but are simply part of the design of the application.

In summary, *Memrise*: a) instructs the spoken and written form of words, as well as their meanings; b) provides multiple, frequent encounters with target vocabulary within

units, with subsequent, less frequent encounters in ones; and c) does not employ nonverbal representations to assist the instruction of vocabulary.

5.3. *Hello English*

Hello English is an application for English learning developed by *Culture Alley*, an Indian technology startup. Although the application can be downloaded free of charge, each lesson costs a number of coins to be accessed. These coins can be obtained in two ways: by purchasing them with real money or by doing exercises that give them as a prize for successful completion. This makes *Hello English* a type of freemium application.

The first activities of every lesson from *Hello English* seem to focus on the instruction of meaning. To do this, the application divides sentences into smaller chunks of language and translates each of these chunks into the users' L1.

To Laufer (1997), knowing what a word means involves knowing its written and spoken form, its structure, its syntactic behavior, its meaning and its lexical relations. Concerning the first research question, *Hello English* can serve as a tool to assist the learning of all of these aspects.

In *Hello English*, the knowledge of the spoken form of words can be developed by hearing the artificially language chunks and by taking part in dialogues with the application, as depicted in Figure 10.
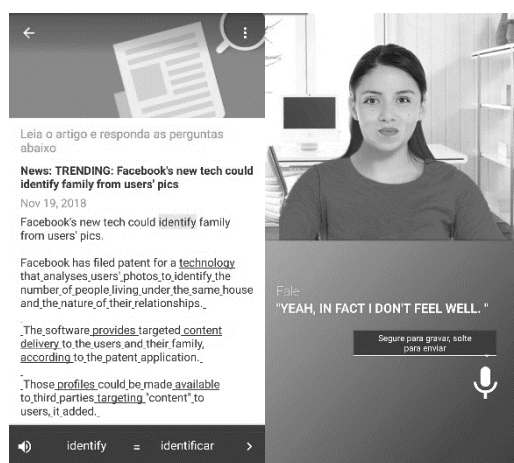

Figure 10. Instruction of the spoken form in *Hello English*.

One downside of using artificially produced sentences is that the pronunciation of the words may sound artificial. On the bright side, however, this enables *Hello English* to provide the pronunciation for an unlimited number of words, making it possible for learners to hear the spoken form of every word from the books and articles that the application offers. As can be seen in Figure 10, learners can hear the pronunciation of any word they tap on, not only the target ones. Without the computerized voices, a human being would have to read and record every word from these books, which would probably increase the cost of the application.

Some activities also allow learners to practice the spoken form of words by having conversations with the application. As can be seen in Figure 10, the conversations consist in the learning pronouncing the sentences provided by application, which itself assesses and replies. Although the assessment of the pronunciation is still faulty, this is a good opportunity for learners to practice the spoken form of words.

By doing the activities and reading the articles and books available in the application, learners will probably become able to recognize the target words in print. The application also has a game called *jogo de soletração* (spelling game), designed to consolidate the written form of lexical items, specially their spellings, as shown in Figure 11.

Figure 11. A spelling game from *Hello English*.

As seen in Figure 11, the application provides a sentence in the L1 and the letters that make up this same sentence in the L2. The game has learners spell not only single words, but whole sentences. This goes in accordance to the conception of lexical item proposed by Lewis (1993), which understands that fixed expressions and idioms are also lexical items. Like in the other games from the app, learners are awarded coins for completing the game, and the faster and more accurately they do it, the more coins they get.

Hello English also has a game that can help develop the knowledge of the lexical relations of words, called *Being succinct.* As the name suggests, learners are expected to make sentences shorter by using single words synonyms for the highlighted phrases.
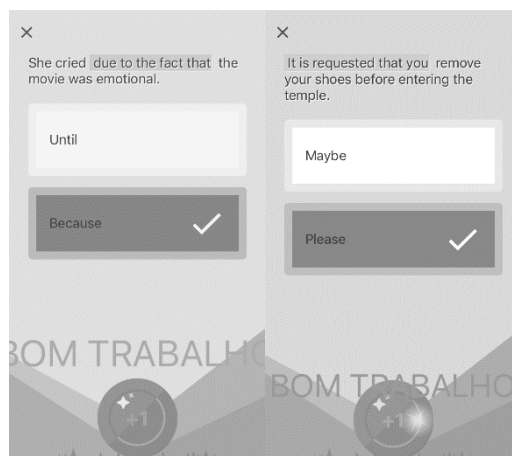
Figure 12. A game from *Hello English* for the instruction of lexical relations.

As evidenced in Figure 12, a part of the sentence is highlighted, and learners have to choose a word that can replace it. In the case of Figure 12, the lexical item *due to the fact that* could be replaced by *because* and *it is requested that you* by *please.* With this game, learners are given opportunities to develop their knowledge of the lexical relations of words with other words, an important aspect of word knowledge (Laufer 1997; Nation, 2001).

With regards to the research question two "Do the applications provide a number of encounters with the target vocabulary?", target vocabulary is encountered multiple times within the same lesson in *Hello English*, but it is not reencountered in subsequent lessons. Therefore, encounters with target vocabulary are not spaced, which are likely to have better learning outcomes than massed ones (Bloom & Shuell 1981; Goossens *et al.* 2012; Ullman & Lovele 2016). Often, identical sentences are part of the presentation phase and of the review phase too, with the only difference being that in the review phase learners must build the sentences with the lexical items provided. The application does not seem to provide multiple encounters in a spaced manner. Learners may incidentally reencounter vocabulary instructed in the readings and the videos, but these are not promoted or organized by the application.

To assist the instruction of vocabulary, *Hello English* makes use of images and videos. Images are sometimes used to illustrate the target words of activities such as the ones shown in Figure 13.
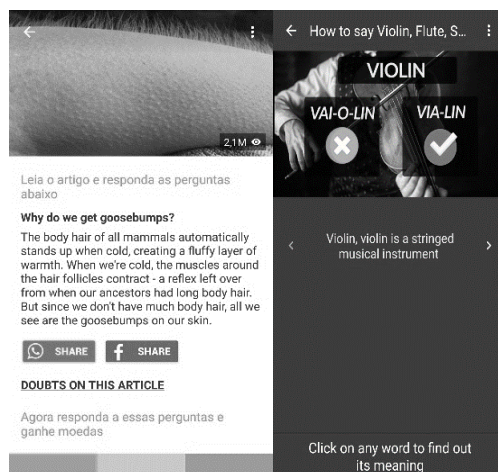
Figure 13. Illustration of target words in *Hello English*.

As seen in Figure 13, one of the target words from the reading activity is *goosebumps*. Its learning is facilitated by the use of an image of someone's body hair raised. In similar fashion, an image of someone playing a violin can assist learners as they carry out this pronunciation activity. Even though the activity does not have the primary goal of instructing vocabulary, the image allows learners to quickly access the meaning of the word, allowing them to focus on the pronunciation of the words. This goes in accordance with Vekiri (2002), which posits that graphical representations enables us to process information more efficiently than verbal ones, ultimately reducing the demand on working memory.

Images are also employed to illustrate vocabulary lists, such as the ones shown in Figure 14.
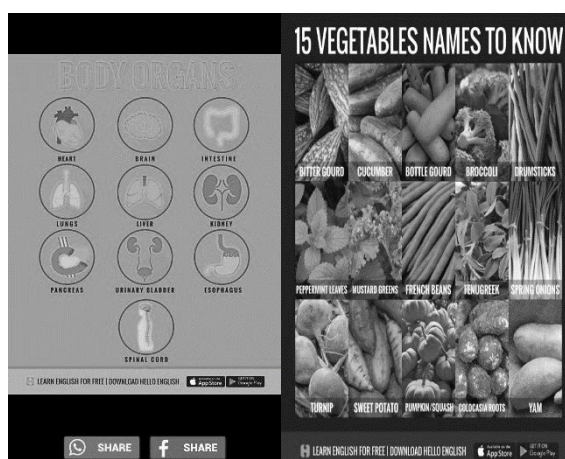

Figure 14. Vocabulary lists from *Hello English*.

Two vocabulary lists are shown in Figure 14, one containing the names of body organs and the other the names of vegetables. The nonverbal representations for the words from the body organs are illustrations whereas the ones for the vegetables are actually pictures.

This makes sense as our organs are not easy to recognize through pictures because we do not see them in our lives, unlike vegetables.

The application also makes use of videos, which contain narration and text that explains the words in English, with images representing the target vocabulary on the background, and tips of how to pronounce the words, as exemplified in Figure 15.

Figure 15. An example of a video for vocabulary instruction from *Hello English*.

For example, the target word *onion*. The images in the background assist the instruction of the target vocabulary because they allow learners to understand the meaning without having to read anything. According to Mayer, this is optimal as "people learn better from graphics and narration than from graphics, narration, and printed text" (2009, p. 118). There are also videos taken from *YouTube*, serving as sources for incidental learning.

In sum, *Hello English*: a) can help develop all aspects of word knowledge proposed by Laufer (1997); b) provides multiple encounters with the target lexical items, but only with within the lessons the were instructed and c) employs videos and images that are likely to assist in the instruction of target vocabulary.

5.4. Readdressing and discussing the research questions

Having presented the results from our analysis, we proceed now to readdress and discuss the research questions of this study.

RQ1) What aspects of word-knowledge do the applications develop?

All the applications instruct the word form, both spoken and written. Nation points out that knowing the spoken form of a word implies the ability to recognize the word when it is heard and, at the other end of the receptive-productive scale, "being able to produce the spoken form in order to express meaning" (2001, p. 55). In addition, the author says knowing the spoken form of a word also includes knowing its stress. All the applications analyzed have sources to help with the recognition of words, most of them being audio recordings of words or short sentences, repeated numerous times throughout

the lessons. In *Duolingo* and *Hello English*, learners can record their pronunciation for the application to give feedback, which provides an opportunity for the productive use of language, and to get feedback from the app. In reality, however, the applications often fail to understand the pronunciation of learners. For instance, sometimes the target words were carefully pronounced by the researcher and still negative feedback was given. Other times, they were mispronounced on purpose and positive feedback was given.

It is worth noting that spoken output is limited to repeating words and sentences in almost all the applications, meaning that learners are not provided with chances to produce their own sentences. Taking into consideration the five essential steps proposed in Hatch and Brown (1995), this means that the last step, which involves using the word, is not often developed. According to Hatch and Brown the use of the word allows "learners to see if the knowledge gained in the other steps is correct." (1995, p. 390).

Considering the aspects of word-knowledge proposed by Laufer (1997), *Hello English* was the only application analyzed that had activities with the explicit goal of developing the syntactic behavior of words and their lexical relations. As shown in Figures 12 and 13, the application provides activities allowing learners to understand that words are combined with other words and that they can replaced by others according to the context. On the other hand, *Duolingo* and *Memrise* favor the recognition of the written and spoken form of isolated vocabulary but do not explicitly work with the lexical and syntactic relations that exist between words. Thus, these two applications should help learners recognize a large number of words if they are encountered in contexts that resemble the instruction from the apps but are unlikely to help learners become and versatile users of the language instructed.

RQ2) Do the applications provide a number of encounters with the target vocabulary? Are encounters massed or spaced?

All of the applications analyzed provide multiple encounters with the target vocabulary. These encounters were mostly massed within the units which presented the target words. This means that, after introducing a word, the applications provide additional encounters in quick succession until the unit is over.

Although the amount of time required to complete a unit varies, they are not designed to require a lot of time. This can be problematic because if learners are exposed to the target vocabulary only in the unit that presented it, chances are this vocabulary will not be consolidated into memory. In order to avoid this, some designers of applications have come up with algorithms to promote spaced encounters with vocabulary, namely *Duolingo* and *Memrise*. These applications reintroduce the words presented previously based on how long it has been since the learner last encountered it. The algorithms also take into consideration the number of mistakes with the target words, which means that words causing difficulty will be reencountered more often that those that are not. Even though these algorithms can be flawed, their goal is sound and is in accordance to the spacing effect, which has been found to have to have positive effects on vocabulary instruction (Bloom & Shuell 1981; Goossens *et al.* 2012; Kornell 2009; Ullman & Lovele 2016).

It is relevant to point out that, in the end, multiple encounters with target vocabulary also depend on the learners themselves. Even if the applications do provide opportunities for multiple, spaced encoúnters, they will not take place unless learners use the applications. This is a challenge faced by any distance education course that lets learners make their own decisions regarding when and how to study, a challenge that has to be addressed if the quality of distance education is to be improved.

RQ3) What are the nonverbal representations employed and how can they assist the instruction of vocabulary?

Duolingo employs images to assist in the instruction of the target words, while *Hello English* makes use of both images and videos to do so. *Memrise*, on the other hand, does not seem to use nonverbal representations with the objective of instructing vocabulary.

Under the light of the principles for multimedia learning stated by Mayer (2009), some images from *Duolingo* can be understood as extraneous because they are not needed for the instructional goal and end up having an aesthetic role rather than an instructional one. However, the videos and images employed by *Hello E*nglish allow learners to understand the meaning of new lexical items without having to read any printed text, which is in accordance to Mayer, which claims that "people learn better from graphics and narration than from graphics, narration, and printed text" (2009, p .118). Moreover, they may also reduce the cognitive load of some of the activities.

Considering the affordances of modern smartphones, nonverbal representations can be better explored to assist language learning, including images, videos, animations, simulations, interactive charts, infographics and so on. The current levels of technology certainly allow for the implementation of other types of media and interactions in MALL.

6. Conclusions

It is no longer a novelty that mobile devices such as smartphones are used to assist second language learning. However, as the applications run by these smartphones are constantly changing and evolving, constant research is necessary to understand and assess their instructional value, especially considering the number of people who use them nowadays. Thus, the present study sought to investigate current and popular applications for learning English via smartphone, with the goal of understanding how these applications instruct vocabulary.

According to the literature, learning vocabulary involves learning different aspects of word knowledge. Nonetheless, the applications analyzed develop primarily the spoken/written forms of the words as well as their meanings. Because of this, we understand that even though these apps can be used as a tool to assist vocabulary development, they do so with certain limitations. These limitations include a lack of chances for language production, a lack of context for presenting new words and insufficient instruction on some aspects of word knowledge, especially knowledge of lexical relations and syntactic behavior. Considering this, it is our understanding that

these applications work best as a complement to other types of language learning, such as regular language classes in elementary or high school.

Our analysis also found that the applications make little and sometimes inefficient use of non-verbal representations to assist vocabulary instruction. Given that current smartphones have great computing power, the instruction of vocabulary can benefit from the use of more dynamic, engaging multimedia materials such as interactive animations and augmented reality.

Finally, we understand the field of MALL is still an emerging one and still has plenty of room for improvement. The advances in mobile technology allow for the growth of MALL. However, this growth must be guided by current research on SLA so that this technology serves educational purposes.

References

Attewell, J. & Savill-Smith, C. (2003). M-learning and social inclusion – focusing on learners and learning. *Proceedings of MLEARN 2003: Learning with Mobile Devices*, 3–12. London: Learning and Skills Development Agency.

Andrade, I. R. (2017). *Aprendizagem de língua assistida por Dispositivos móveis (ALADIM): uma proposta a*lternativa para o ensino da língua espanhola (Unpublished PhD thesis, Unicamp, Campinas, Brasil).

Bahrick, H. P. & Phelps, E. (1987). Retention of Spanish vocabulary over 8 years. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *4,* 316–321.

Bloom, K. C. & Shuell, T. J. (1981). Effects of massed and distributed practice on the learning and retention of second-language vocabulary. *Journal of Educational Research*. *74,* 245–248.

BuzzFeedPress. (2017). *BuzzFeed expands internationally in partnership with Duolingo*. <https://www.buzzfeed.com/buzzfeedpress/buzzfeed-expands-internationally-in-partnership-with-duoling?utm_term=.koE4Kq0Z#.eoXw6nk8>. Consulted on: 6th Mar. 2017.

Carter, R. (2012). *Vocabulary: applied linguistic perspectives*. Abingdon, Oxon: Routledge.

Chapelle, C. & Jamieson, J. (2008). *Tips for teaching with CALL: Practical approaches to computer-assisted language learning*. New York: Pearson Education.

Chinnery, G. M. (2006). Going to the mall: mobile assisted language learning. *Language Learning & Technology, 10,* 9–16.

Clark, J. & Paivio, A. (1991). Dual Coding Theory and Education. *Educational Psychology Review*, *3* (3), 149–210.

Garcia, I. (2013). Learning a language for free while translating the Web. Does Duoliongo work? *International Journal of English Linguistics*, *3*, 19–25.

Goossens, N., Camp, G., Verkoeijen, P., Tabbers, H. & Zwaan, R. (2012). Spreading the words: A spacing effect in vocabulary learning. *Journal of Cognitive Psychology*, *24*. 965-971.

Hatch, E. & Brown, C. (1995). *Vocabulary, Semantics and Language Education*. New York: Cambridge University Press.

Kim, H. & Kwon, Y. (2012). Exploring smartphone applications for effective mobile-assisted language learning. *Multimedia-Assisted Language Learning*, *15 (1)*, 31–57.

Laufer, B. (1997). What's in a word that makes it hard or easy: some intralexical factors that affect the learning of words. In N. Schmidtt & M. McCarthy (Eds.), *Vocabulary*

Description, Acquisition and Pedagogy (pp. 154–160). Cambridge: Cambridge University Press.

Laufer, B. (2017). The Three 'I's of second language vocabulary learning: Input, instruction, involvement. In E. Hinkel (Ed.), *Handbook of research in second language teaching and learning*, *3,* (pp. 343–354). London: Routledge.

Levy, M. (1997). *Computer-assisted language learning: context and contextualization*. Oxford: Oxford University Press.

Lewis, M. (1993). *The lexical approach*. Hove and London: Language teaching publications.

Mayer, R. (2009). *Multimedia Learning.* New York: Cambridge University Press.

Meara, P. (1980). Vocabulary acquisition: A neglected aspect of language learning. *Language Teaching and Linguistics Abstracts, 13*, 221–246.

Naismith, L. (2004). *Literature review in mobile technologies and learning*. Bristol: Nesta Futurelab.

Nation, I. S. P. (1990). *Teaching and learning vocabulary*. Boston: Heinle & Heinle Publishers.

Nation, I. (2001). *Learning Vocabulary in Another Language*. Cambridge: Cambridge University Press.

Sadoski, M. (2005). A Dual Coding View of Vocabulary Learning. *Reading & Writing Quarterly: Overcoming Learning Difficulties*, *21*, 221–238. <http://dx.doi.org/10.1080/10573560590949359>. Consulted on: 16th Dec. 2018.

Settles, B. & Meeder, B. (2016). A Trainable Spaced Repetition Model for Language Learning. *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics*. 1848–1858.

Schmitt, N. (2000). *Vocabulary in language teaching*. Cambridge: Cambridge University Press

Sökmen, A. J. (1997). Current trends in teaching second language vocabulary. In N. Schimitt & M. McCarthy (Eds.), *Vocabulary: Description, Acquisition and Pedagogy* (pp. 237–257). Cambridge: Cambridge University Press.

Stimac, B. (2014). *Google Play Store now showcases app download numbers with new badges*. <https://www.greenbot.com/article/2463910/google-play-store-now-showcases-app-download-numbers-with-new-badges.html>. Consulted on: 22nd Nov. 2018.

Stockwell, G. (2010). Using mobile phones for vocabulary activities: examining the effect of the platform. *Language Learning & Technology, 14*, 95–110.

Stockwell, G. & Hubbard, P. (2013). Some emerging principles for mobile-assisted language learning. *The International Research Foundation for English Language Education.* <http://www.tirfonline.org/english-in-the-workforce/mobile-assisted-language-learning>. Consulted on: 22nd Nov. 2018.

Ullman, M. & Lovelett, J. T. (2016). Implications of the declarative/procedural model for improving second language learning: The role of memory enhancement techniques. *Second language research*, *1,* 1–27.

Vesselinov, R. & Grego, J. (2012). *Duolingo effectiveness study*. <http://comparelanguageapps.com/documentation/DuolingoReport_Final.pdf>. Consulted on: 15th Dec. 2018.

Vekiri, I. (2002). What Is the Value of Graphical Displays in Learning? *Educational Psychology Review,* 14 (3), 261–312.