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The Effects of Reading and Listening on L2 Incidental Learning and Retention of Different Dimensions of Word Knowledge

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Abstract

The present study compares the effects of the second language (L2) reading and listening on incidental vocabulary learning and retention of three dimensions of word knowledge (i.e., part of speech, syntagmatic association, and form-meaning connection) among EFL learners. The relationship between word exposure frequency and vocabulary learning is also examined in reading versus listening. Sixty-three pre-intermediate EFL learners in four intact classes were randomly assigned to four experimental groups based on the number of target word (TW) exposures (i.e., 1, 3, 5, and 7 exposures) they received in treatment texts. The experimental groups read and listened to four texts with 36 TWs. The scores on the immediate and three-week delayed posttests revealed that reading contributed to a greater amount of vocabulary learning and retention in the three dimensions of word knowledge. The results further revealed that an increase in the word exposure frequency had a significant effect on acquiring form-meaning connection through reading, and on three dimensions through listening. Moreover, frequency improved retention gains in both input sources.

Keywords: exposure frequency, incidental vocabulary learning, listening, reading, word dimension

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1. Introduction

Vocabulary plays an important role in acquiring a language. English language learners need to know around 8,000–9,000-word families for reading, and 6,000–7,000 for listening (Nation, 2006). However, there is a large gap between the number of words learned in the classroom and those necessary for L2 acquisition due to time constraints. Therefore, some learning needs to happen without explicit instructions; learners need to "pick up" new words from context while reading or listening. This picking up, technically known as 'incidental learning', refers to learning new words from reading a text or listening to someone while the focus is on understanding the meaning of the language input rather than learning new words (Derakhshan & Shakki, 2016; Hulstijn, 2013). This type of learning process stands in contrast to intentional learning which involves a deliberate attempt to learn the target material (Hulstijn, 2013).

Given the significance of incidental vocabulary learning in L2 vocabulary growth (R. Ellis, 1994; Derakhshan & Shakki, 2019; Huckin & Coady, 1999), "a vocabulary learning program will require both an explicit teaching component and a component which maximizes repeated exposures to lexical items, such as extensive reading" (Schmitt, 2008, p. 329). Since reading has long been the most common type of L2 exposure for language learning in classrooms, numerous studies have explored incidental vocabulary acquisition through reading (e.g., Chen & Truscott, 2010; Elgort & Warren, 2014; Heidari-Shahreza & Tavakoli, 2016; Horst, 2005; Malone, 2018; Pellicer-Sánchez & Schmitt, 2010; Pigada & Schmitt, 2006; Reynolds, 2020; Teng, 2018, 2019; Webb, 2005, 2007).

Relatively few studies have investigated the extent to which listening in an L2 classroom context might contribute to incidental vocabulary learning (e.g., Brown et al., 2008; Jin & Webb, 2020; Pavia et al., 2019; van Zeeland & Schmitt, 2013a; Vidal, 2003, 2011). Therefore, more studies are needed to examine the effect of listening on L2 incidental vocabulary learning. Moreover, little is known about the comparative effects of reading and listening on incidental vocabulary learning, as well as the variables, such as word exposure frequency, that influence this process (i.e., Brown et al., 2008; Chen & Teng, 2017; Feng & Webb, 2020; Hatami, 2017; Mohsen & Almudawis, 2020; Vidal, 2011). This comparison is "of vital importance as it can help determine how much reading or listening (and what type) needs to be done in foreign language learning" (Brown et al., 2008, p. 139).

Since vocabulary knowledge is multidimensional (Akbarian, 2010; Henriksen, 1999; Janebi Enayat & Derakhshan, 2021; Nation, 2001; Milton, 2009), it is necessary to examine the learning of different types of lexical knowledge (e.g. orthography, syntax, grammatical functions, collocations, and form-meaning connection) (Nation, 2013). In the 'dimensions approach' (Read, 2000), referred to as "the most effective way to assess vocabulary depth" (Nation & Webb, 2011, p. 227), the extent of learning in different dimensions of word knowledge is measured separately. Consequently, it would be useful to examine which aspects of vocabulary knowledge may be learned from reading and listening.

Among the studies comparing the effects of reading and listening on L2 incidental word learning, relatively few studies (i.e., Chen & Teng, 2017; Hatami, 2017) have examined vocabulary knowledge through the dimensions approach. Therefore, further research is needed to examine how these two sources of language input influence incidental learning of different dimensions of word knowledge (e.g., Chen & Teng, 2017; Feng & Webb, 2020; Hatami, 2017), partly addressed in the following research questions (RQs):

1) Is there a significant difference in the L2 incidental learning and retention of three dimensions of word knowledge (i.e., part of speech, syntagmatic association, and form-meaning connection), when word exposure frequency is identical in reading and listening?
2) Is there a significant difference in the L2 incidental learning and retention of three dimensions of word knowledge (i.e., part of speech, syntagmatic association, and form-meaning connection) when word exposure frequency is different in reading and listening?

2. Literature Review

2.1. Incidental Vocabulary Learning from Reading

Early studies have shown that vocabulary is learned incidentally from reading input. However, the pick-up rates are modest with about one word being correctly recognized out of every 12 words tested. Methodological constraints "including very small amounts of reading, insensitive measurement instruments, inadequate control of text difficulty, or small numbers of target words and no delayed posttests" (Schmitt, 2010, p. 29) might be the reason for the small gains in vocabulary acquisition from reading (Horst et al., 1998).

Further studies addressed these constraints by expanding the reading treatment and measuring different aspects of word knowledge through new measurement instruments which allowed partial knowledge to be assessed. These studies have shown higher pick-up rates from reading (e.g. Chen & Truscott, 2010; Hatami, 2017; Pellicer-Sánchez & Schmitt, 2010; Webb, 2007). For instance, Horst (2005) examined vocabulary learning from reading over a six-week extensive reading program. The results showed that learners acquired knowledge of more than half of the unknown words.

On the other hand, Pigada and Schmitt (2006) investigated incidental vocabulary gains from extensive reading through the dimensions approach in a case study. The findings revealed that knowledge of 65% of the TWs was enhanced in some way, with a pickup rate of about one word in every 1.5 words tested. At one encounter, the greatest improvement was found in spelling (48.2%), followed by grammar (14.8%) and meaning (3.4%). It should also be noted that since this was a case study, the findings are not generalizable. Similarly, Webb (2007) found large gains from reading at a single exposure for knowledge of orthography (67%), syntax (40%), associations (48%), meaning and form (58%), and grammatical functions (57%) on the immediate recognition tests.

In a study by Chen and Truscott (2010), the results of the immediate recognition tests showed vocabulary gains of 48% for part of speech, 43% for orthographic

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form, 1.3% for meaning and form, and 40% for associations from reading at a single exposure. The retention rates were 40% for part of speech, 47% for orthographic form, 1.1% for meaning and form, and 31% for associations. On the other hand, at one encounter, Pellicer-Sánchez and Schmitt (2010) found that the meaning and spelling could be recognized from reading for 29% and 30% of the words, respectively.

In the Iranian EFL context, Heidari-Shahreza and Tavakoli (2016) examined incidental vocabulary learning through reading. The results of the immediate recognition tests showed vocabulary gains of 51.8 % for orthographic form, 15.6% for meaning and form, 41.7% for part of speech, and 37.8% for associations from reading at a single exposure. The retention gains were 47.6 % for orthographic form, 6.4% for meaning and form, 41.3% for part of speech, and 13.4% for associations.

Teng (2018) examined the effects of reading (as well as reading while listening) on acquiring four dimensions of vocabulary knowledge. At one encounter, vocabulary gains were 33.3%, 10%, 10%, and 6.6% for form recognition, grammar recognition, meaning recall, and collocation recognition, respectively. More recently, Reynolds (2020) compared incidental vocabulary acquisition between reading inside a classroom (in-class) versus reading outside a classroom (out-of-class). The results of the recognition tests showed vocabulary gains of 47.8% for meaning from in-class reading and 51.7% from out-of-class reading. The studies in the brief review above indicate that L2 reading can lead to significant vocabulary gains in different dimensions of word knowledge but not to the same extent.

2.2. Incidental Vocabulary Learning from Listening

Earlier studies suggested that listening was only a way of enhancing the effect of incidental vocabulary acquisition through reading. Later on, research indicated that aural input alone can contribute to L2 incidental vocabulary learning (e.g., Brown et al., 2008; van Zeeland & Schmitt, 2013; Vidal, 2003, 2011). However, studies have shown that listening results in typically much lower vocabulary gains compared to reading (Brown et al., 2008; Hatami, 2017; van Zeeland & Schmitt, 2013a; Vidal, 2003, 2011). For instance, Vidal (2003) examined incidental vocabulary learning and retention through academic listening among EFL learners and reported learning gains of 16.01% immediately after listening, and 8.2% four weeks later.

In a follow-up study, Vidal (2011) investigated incidental vocabulary learning through reading versus listening. The results showed that the immediate and retention gains from listening (15.5% and 7.8%, respectively) were significantly lower than from reading (22.7% and 10.6%, respectively). Similarly, Brown et al. (2008) compared vocabulary learning from reading and listening (as well as from reading-while listening). They found that recognition gains were much lower immediately after listening (29.3%) than reading (44.8%).

On the other hand, van Zeeland and Schmitt (2013a) examined vocabulary gains from listening through the dimensions approach. The results of the immediate recognition tests showed vocabulary gains of 45.8% for word form, and 33.7% for grammar immediately after listening, and retention rates of 25% for word form, and 24.6% for grammar. According to van Zeeland and Schmitt (2013a), the dimensions approach can help measure the smallest gains through listening. In a recent study of vocabulary learning through listening to video-taped teacher talk by Jin and Webb (2020), EFL learners could recall 15.8% of the meaning immediately after listening, and 12% one week later. Vocabulary gains for collocations were modest but significant on the immediate and delayed recognition tests.

Studies of listening were also extended to explore incidental gains from listening to songs. Pavia et al. (2019) examined incidental vocabulary learning through listening to two songs (Song A and Song B). The researchers reported a significant gain of 6.53% for spoken form recognition from Song A and 10.97 % for collocation recognition from Song B immediately after listening. The findings of this study indicated the positive effect of listening on vocabulary acquisition supporting the results of studies on regular texts. The brief review above suggests that listening contributes to rather small but significant vocabulary gains. We might have a better view of the lexical uptake from listening when it is compared directly with the gains made from reading in a single study.

2.3. Incidental Vocabulary Learning from Reading versus Listening

Studies have shown that reading is a more effective input source for incidental vocabulary learning than listening. However, little is known about the difference in the learning gains of different knowledge dimensions in reading and listening. Hatami (2017) was the first to compare the effects of reading and listening on incidental vocabulary learning through the dimensions approach. The results of the immediate recognition tests revealed gains of 75% for written form, 55% for part of speech, 54% for meaning, 53% for spoken form, and 49% for syntagmatic association from reading. The listeners' immediate gains were as follows: spoken form (50%), written form (45%), part of speech (37.3%), meaning (37%), and syntagmatic association (25%). Retention gains were measured only for form-meaning connection three weeks later. On the delayed posttest, readers were able to recognize the meaning of 45.4% of the TWs and listeners could recognize almost all the knowledge of meaning that they had initially acquired.

Similarly, Chen and Teng (2017) compared the effects of reading and listening on incidental vocabulary learning through the dimensions approach. The results of the immediate recognition tests showed vocabulary gains of 48% for form, and 46.6% for meaning from reading and 34% for form, and 26.6% for meaning from listening. The retention rates were 35.3% for form and 33.3% for meaning from reading and 26% for form and 14% for meaning from listening on the delayed recognition tests. The results provided evidence that form recognition was the best acquired word knowledge dimension in both reading and listening followed by meaning recognition.

On the other hand, Feng and Webb (2020) compared vocabulary learning from written and aural input (as well as audiovisual input). The researchers found no significant difference between vocabulary gains from these two input modes. Acquisition of similar amounts of vocabulary from reading and listening corroborates findings from Marefat and Hassanzadeh (2014) in the Iranian EFL context. This finding is in contrast to the prevailing view in the literature where it has been often argued that reading contributes to larger vocabulary gains compared to listening (e.g., Brown,2008; Chen & Teng,2017; Hatami,2017; Mohsen & Almudawis,2020; Vidal,2011).

Likewise, Mohsen and Almudawis (2020) compared vocabulary learning from reading and listening. The results showed significantly larger gains from reading compared to listening in the first exposure. However, the retention gains from listening were significantly higher than those from reading on the delayed posttests. Based on the results of the reviewed studies, except for a few (i.e., Feng & Webb, 2020; Marefat & Hassanzadeh,2014), reading is more conducive to incidental vocabulary learning than listening. However, the precise differential effect of these two input modes on overall learning gains and different dimensions of vocabulary knowledge has not been well studied.

2.4. Word Exposure Frequency

Numerous studies have shown the important role of word frequency in promoting incidental vocabulary learning through reading (Chen & Truscott, 2010; Hatami, 2017; Heidari-Shahreza & Tavakoli, 2016; Horst et al., 1998; Malone, 2018; Pellicer-Sánchez & Schmitt, 2010; Pigada & Schmitt,2006; Rott, 1999; Teng, 2018, 2019; Vidal, 2011; Webb, 2007). However, there is no consensus about the number of exposures necessary for incidental vocabulary learning across studies. For instance, Horst et al. (1998) argued for eight exposures, Rott (1999) for six exposures, and Webb (2007), Pellicer-Sánchez (2010), and Hatami (2017) for more than 10 exposures. Nation (2014) also referred to 12 exposures as a ‘‘moderately safe goal’’.

L2 listening studies have shown that exposure frequency affects L2 vocabulary gains positively. However, a higher frequency of exposures is needed for incidental learning to occur from listening compared to reading. The results of van Zeeland and Schmitt’s (2013a) study indicated that even when TWs were met 15 times, relatively little learning occurred through aural input.

Based on the results of previous studies (e.g., Brown et al., 2008; Hatami, 2017;

Vidal, 2011), it can be argued that frequency has a stronger impact on vocabulary learning from reading than listening. For instance, Brown et al. (2008) suggested that 15 to 20 exposures give only a 3% chance to learn the words in aural input, while 10 to 13 exposures give a 20% chance to learn the words through reading. In sum, different studies have suggested various thresholds of exposure frequency for incidental vocabulary learning to occur. Yet, there is not a certain threshold that can ensure vocabulary learning (Webb, 2020).

2.5. The Present Study

The literature reviewed above indicates that the vast majority of research has focused on incidental vocabulary learning from reading, while less is known about incidental vocabulary learning through listening and the relative advantages of reading or listening contexts for vocabulary learning. Moreover, the number of exposures necessary for acquiring different dimensions of word knowledge has remained unclear.

Previous studies also suffered from several shortcomings such as lack of ecological validity, inadequate control of text difficulty, or insensitive measurement instruments. For example, ecological validity was endangered in studies such as Hatami (2017) and Vidal (2011), using pseudo-words rather than authentic ones. Although Chen and Teng (2017) improved ecological validity in their study using real TWs, they employed very short contexts (i.e.,160 isolated sentences) which were not an accurate representation of incidental learning in naturalistic contexts. On the other hand, the number of TWs used in these studies was few. For instance, Webb (2007) and Chen and Truscott (2010) employed 10 TWs, Chen and Teng (2017) and Teng (2019) employed 15 TWs, and Hatami (2017) employed 16 TWs. Further, the difficulty of the texts was not fully controlled in some studies such as Chen and Truscott (2010).

The present study aims to examine the effects of reading and listening as well as exposure frequency on incidental learning and retention of different dimensions of vocabulary knowledge. Basic assumptions underlying experimental research designs (i.e., random assignment, experimental control, and manipulation) were met in this

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study. A carefully controlled design was chosen to control for the potential effects of the texts' and TWs' difficulty, and the number of TW exposures on vocabulary gains. This study also compensates for the shortcomings of previous studies using a larger number of real TWs in longer contexts (i.e., larger amounts of treatment).

3. Method

3.1. Participants

Eighty-one pre-intermediate EFL learners, with an average age of 20.5, were selected from four intact classes in a private language institute in Tehran. They had formally studied English for seven years at school and attended EFL classes for 1.2 years. None of them had the experience of living in an English-speaking country before. Their vocabulary knowledge was measured using the New Vocabulary Levels Test (NVLT) (McLean & Kramer, 2015) to ensure that they were proficient enough to comprehend the reading and listening materials.

Mastery of at least 50% (out of 24) of the 2,000-word level of the NVLT was selected as the minimum cut-off point for the inclusion of the participants. This cut-off point was determined based on the learners' scores on comprehension questions for the treatment texts in the pilot study. According to Laufer (1989), learners who knew 95% of the words in a text would tend to score at least 55% on comprehension questions for the text. Therefore, learners' scores on comprehension questions for each text were calculated. Based on the results, only learners with 50% mastery of the second 1,000-word level and above were able to score at least 55% on the comprehension questions for each text in the pilot study.

Using the cut-off point, 18 learners were excluded due to their low scores on the NVLT, leaving 63 learners (36 females and 27 males) in the sample. The four intact classes were then randomly assigned to four experimental groups of at least 15 learners to satisfy the minimum participation requirements for each group in an experimental study as suggested by Dornyei (2007) and Fraenkel and Wallen (2003, cited in Mackey & Gass, 2016). Each group received a different number of TW exposures as following: E1-Group (n = 15) was given one exposure, E3-Group (n = 16) three exposures, E5-Group (n = 17) five exposures and E7-Group (n = 15) seven exposures.

We ensured that the participants' vocabulary levels were equivalent across the four groups. To this end, learners were only tested on their knowledge of the 1,000-, 2,000-, and 3,000-word levels of the NVLT as they were unlikely to master any of the subsequent levels based on the results of the pilot study. Subsequently, the sum of means (out of 72) for these three-word levels was compared across the groups: E1-Group: M = 60.47, SD = 2.47, E3-Group: M = 61.75, SD = 1.77, E5-Group: M = 61.06, SD = 3.67, and E7-Group: M = 61.40, SD = 2.56. The groups did not differ significantly in their vocabulary knowledge, as determined by a one-way between-groups ANOVA, $F(3, 59) = 0.62$, $p = .606$.

3.2. Materials

3.2.1. Reading and Listening Materials

Four texts, adapted from the following elementary-level graded readers (from Oxford Bookworms Library), were prepared for reading and listening treatment: *Weddings, London, Scotland* and *Mary, Queen of Scots*. The texts '*Weddings' and 'London'* were used as the reading materials and the texts *'Scotland'* and *'Mary, Queen of Scots'* were used as the listening materials. The texts were approximately of equal length (1800 words). It was not possible to use longer texts due to time constraints.

The exposure frequency of the TWs was operationalized at one, three, five, and seven, and represented by nine TWs within each text. Overall, the four experimental groups were exposed to the same set of 36 target items in two reading and two listening texts. Since the number of exposures to the TWs was different for each group, exposure frequency was manipulated within the texts. As a result, four versions of each text were created: version 1 for E1-Group, version 2 for E3-Group, version 3 for E5-Group, and version 4 for E7-Group. In version 1, E1-Group had one encounter with each target item, Group-E3 had three encounters in version 2, and Group-E5 and Group-E7 had five and seven encounters with the TWs in versions 3 and 4, respectively (see Table 1).

Table 1

Target Words and Materials across Groups

Group	f	Reading material	TW in reading	Listening material	TW in listening
E1-Group	1	Weddings (version 1)	9	Scotland (version 1)	9
	1	London (version 1)	9	Queen of Scots (version 1)	9
E3-Group	3	Weddings (version 2)	9	Scotland (version 2)	9
	3	London (version 2)	9	Queen of Scots (version 2)	9
E5-Group	5	Weddings (version 3)	9	Scotland (version 3)	9
	5	London (version 3)	9	Queen of Scots (version 3)	9
E7-Group	7	Weddings (version 4)	9	Scotland (version 4)	9
	7	London (version 4)	9	Queen of Scots (version 4)	9

f: Target Word Frequency; TW: Target Word

The analysis of texts with the VocabProfile-Compleat, online software available on Tom Cobb's Lextutor website (http://www.lextutor.ca), revealed that except for the TWs all other words in different versions of the texts were either at the first 1,000- or 2,000- word level. Any words beyond these levels were replaced with their synonyms or eliminated. A final frequency analysis confirmed that each text contained approximately 1,800 words, and TWs covered less than 5% of the words in each text. Therefore, a lexical coverage of 95% was achieved. This range of lexical coverage is sufficient for adequate comprehension of written and spoken texts (Hu & Nation, 2000; Laufer & Ravenhorst-Kalovski, 2010; Stæhr, 2009; van Zeeland & Schmitt, 2013b).

Assessing the readability level of the treatment texts ($N = 16$) using a readability analyzer (available at https://datayze.com/readability-analyzer.php) confirmed that the texts were of equivalent difficulty. The readability level was assessed using the Flesch Reading Ease Formula (Flesch,1948). Moreover, the readability level of the texts was compared with the reading passages of the textbook (Flesch Reading Ease Score: 85.74) taught to the participants in EFL classes. The results showed no

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significant difference between the readability levels of the treatment texts and passages of the textbook (Table 2).

Table 2

Readability Scores of the Reading and Listening Materials Used in the Study

Reading Material	FRE	Listening Material	FRE
Weddings (version 1)	86.9	Scotland (version 1)	87.86
London (version 1)	85.88	Queen of Scots (version 1)	89.08
Weddings (version 2)	87.18	Scotland (version 2)	87.91
London (version 2)	85.46	Queen of Scots (version 2)	87.94
Weddings (version 3)	86.4	Scotland (version 3)	87.78
London (version 3)	84.04	Queen of Scots (version 3)	89.11
Weddings (version 4)	85.7	Scotland (version 4)	87.51
London (version 4)	83.81	Queen of Scots (version 4)	88.7

FRE: Flesch Reading Ease Score

Since we were not yet sure that the participants knew all the remaining (i.e., 95%) words, the treatment texts were piloted with 10 pre-intermediate EFL learners in the same language institute. They were instructed to scan the texts and circle any word that seemed unfamiliar to them. Then, the texts were once again modified; unknown words were either replaced with their synonyms or deleted.

For the listening experiment, the audio versions of the listening texts (texts ‘Scotland’ and ‘Mary, Queen of Scots’) were prepared; the texts were read aloud by a native speaker of American English, recorded on a CD, and later played for listening. The narration of each text had a duration time of approximately 15 minutes.

3.2. 2. Target Words (TWs)

Thirty-six real English words were used as TWs for the current study (see Appendix A for details): 12 nouns, 12 adjectives, and 12 verbs. In turn, each treatment text

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contained 9 of the 36 TWs including 3 nouns, 3 adjectives, and 3 verbs. To ensure the relative equivalence of the TWs in terms of learning difficulty, the selected target items shared the following characteristics: they had two syllables and six to seven letters in length; only one sense of a TW's meaning appeared in the texts; the target verbs were all regular and in the simple past tense.

Following Webb (2005), TWs were taken from the frequency bands in the Collins COBUILD dictionary. Given that the most frequent first and second 1,000 words are considered high-frequency items (Nation, 2013) likely to be known by the learners, TWs were selected from subsequent frequency bands (i.e., the third, fourth, and fifth bands) of the COBUID. Finally, a vocabulary checklist containing 150 potential TWs was prepared. The checklist was given to the participants before the experiment and they were asked to underline the words they did not know. Based on the responses received, 36 words unknown to at least 98% of the participants were selected and inserted into the treatment texts.

3.3. Instruments

The instruments used in the present study included:

3.3.1. New Vocabulary Levels Test (NVLT)

Vocabulary knowledge was measured through the NVLT (McLean & Kramer, 2015) to ensure that the participants had sufficient lexical knowledge to comprehend the texts used in this study. The test consists of six separate sections: five 24-item levels which assess knowledge of English lexis from the first five 1,000-word frequency levels from Nation's (2012) BNC/COCA lists, and a 30-item part measuring knowledge of the Academic Word List (AWL) (Coxhead, 2000). The test scores indicate the number of words that participants know at each word frequency level. In scoring, each correctly chosen word receives one point.

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3.3.2. Immediate Posttest

Four vocabulary posttests were developed to measure learners' knowledge of three dimensions (i.e., part of speech, syntagmatic association, and form-meaning connection) of the TWs and were administered immediately after reading and listening. Each posttest consisted of three subtests (see Appendix B for examples of the subtests). Subtest 1 measured knowledge of part of speech and subtests 2 and 3 measured knowledge of syntagmatic association and form-meaning connection at the level of recognition, respectively.

Overall, all experimental groups received four treatment texts, which were followed by an immediate posttest (three subtests) measuring three dimensions of nine TWs. The vocabulary posttests were the same for all of the four groups and the subtests in each posttest were sequenced following Webb's (2007) example to avoid any possible learning effect. In scoring, each correct response was awarded one point. The subtests employed a multiple-choice format, based on a modified version of Webb's (2007) recognition tests of grammatical functions, syntax, and meaning and form link.

Since contextualized vocabulary knowledge assessment is a more valid way of vocabulary testing (Read, 2000), a contextualized format of Webb's (2007) tests of syntax, and meaning and form link (as in González-Fernández & Schmitt, 2020) was developed. The reliability index of the subtests (nine items each) was .87, .88, .87, .85, .86, .87, .83, .83, .88, .89, .85, and .86 (Kuder-Richardson formula 20), thereby indicating that the tests were highly reliable.

3.3.3. Delayed Posttest

After a three-week delay, each vocabulary posttest was administered to measure the participants' retention of word knowledge. This posttest was based on the assumption that word retention tends to become relatively stable after three weeks (Schmitt, 2010). The delayed posttests consisted of the same series of vocabulary tests used in the immediate posttests. However, the order in which the test items were presented in each subtest of the delayed posttests was changed to minimize the test-retest memory effect.

3.4. Procedures

Two weeks before the experiment, the learners were given a vocabulary checklist of 150 potential TWs and were instructed to underline the words they knew. Seventy-three words were found to be unknown to the participants; 36 were chosen as TWs and were used in the materials of the study. Before the study was conducted, the materials and instruments were piloted with 10 EFL learners similar to the participants in the main study in respect of their language proficiency level and linguistic and sociocultural background.

Based on the results of the pilot study, the minimum cut-off point for the inclusion of participants (i.e. mastery of at least 50% of the 2,000-word level) was selected. Further, a few implausible distractors of test items were replaced with plausible alternatives, and some unfamiliar words in the materials, except for the TWs, were either replaced with their synonyms or deleted.

The experiment included four phases: NVLT, reading and listening comprehension tasks, immediate posttests, and delayed posttests. The participants were exposed to the intervention over nine sessions. They were not aware that the focus of the study was on vocabulary learning to avoid intentional vocabulary acquisition. They were told that the study focused on reading and listening comprehension and that they were required to answer some comprehension questions after reading or listening to the texts. In the first session, 81 learners agreed to participate in the study and signed a consent form. They were then asked to complete the NVLT. Participants with low scores (below 12 on the 2000-word level) were excluded, and the remaining participants were randomly assigned to four experimental groups. This session took approximately 60 minutes.

During the next four sessions (Sessions 2, 3, 4, and 5), the groups read and listened to four texts (Table 3). In the second and third sessions, they read the texts ‘Weddings’ and ‘London’, and in the fourth and fifth sessions, they listened to the

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texts 'Scotland' and 'Mary, Queen of Scots', respectively. At the end of session 5, participants had been exposed to all the TWs. Each reading or listening was followed by three open-ended comprehension questions. Correct answers to comprehension questions were an indication that the participants had paid attention to the input vocabulary. Immediately after the comprehension questions, an unannounced vocabulary posttest (i.e., an immediate posttest) was administered. The participants were given enough time to complete each task. Each session took approximately 50 minutes. There were four immediate vocabulary posttests in total. After three weeks, in sessions 6, 7, 8, and 9, the four posttests were once again administered as delayed posttests to measure the vocabulary retention of the TWs. In the sixth and seventh sessions, the participants took delayed posttests for the texts 'Weddings' and 'London', and in the eighth and ninth sessions, they took the delayed posttests for the texts 'Scotland' and 'Mary, Queen of Scots', respectively. Each delayed posttest took approximately 13 minutes (see Table 3).

Table 3
Order and Timing of Task Administration

Sessions	Tasks		Time
Session 1 (week 1)		NVLT	60 min
Session 2 (week 2)	Tasks and immediate posttests	Reading (Weddings)	50 min
Session 3 (week 2)		Reading (London)	50 min
Session 4 (week 3)		Listening (Scotland)	50 min
Session 5 (week 3)		Listening (Queen of Scots)	50 min
Session 6 (week 4)	Delayed posttests	Weddings	13 min
Session 7 (week 4)		London	13 min
Session 8 (week 5)		Scotland	13 min
Session 9 (week 5)		Queen of Scots	13 min

4. Results

4.1. Investigating the Effects of Reading and Listening on Incidental Learning and Retention of the Dimensions of Word Knowledge

Research question one investigated the effect of reading and listening on L2 incidental learning and retention of three dimensions of word knowledge when word exposure frequency is identical. Since we aimed to measure vocabulary gains without considering any probable effects of word exposure frequency for this question, only the vocabulary scores for the group with one exposure to the TWs (E1-Group) were used for data analysis. To this end, first, a one-way repeated measures ANOVA was performed to compare learning scores on part of speech, syntagmatic association, and form-meaning connection for the immediate posttest results through reading. Table 4 presents the means and standard deviations of the immediate and delayed posttests administered to the E1-Group after reading. The ANOVAs revealed that reading had a significant effect on learning vocabulary dimensions when word exposure frequency was identical, Wilks' Lambda = .57, F (2, 13) = 4.92, p = .026, multivariate partial eta squared = .43 (Table 5).

Pairwise comparisons revealed that the mean score on syntagmatic association (M = 7.60, SD = 2.59) was significantly different from form-meaning connection (M = 9.27, SD = 2.34). However, the mean score on part of speech (M = 9, SD = 2.24) did not differ significantly from the form-meaning connection (Table 6).

Next, one-way repeated measures ANOVA was run to compare retention scores on vocabulary dimensions for the delayed posttest results through reading (Table 4). The ANOVA results revealed that reading did not have a significant effect on retaining vocabulary dimensions when word exposure frequency was identical, Wilks' Lambda = .77, F (2, 13) = 1.94, p = .184, multivariate partial eta squared = .23; large effect sizes need more attention (Table 5). Pairwise comparisons revealed that the mean scores on part of speech (M = 7.47, SD = 2), syntagmatic association (M = 6.20, SD = 1.74), and form-meaning connection (M = 7.20, SD = 2.24) did not differ significantly from one another (Table 6).

Table 4

Descriptive Statistics of Learning and Retention through Reading

	Learning		Retention		
	Mean	*SD*	*Mean*	*SD*	*N*
Part of speech	9.00	2.24	7.47	2	15
Syntagmatic association	7.60	2.59	6.20	1.74	15

Form-meaning connection	9.27	2.34	7.20	2.24	15

Maximum score =18.

Table 5

Multivariate Tests of Learning and Retention through Reading

Effect			Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Vocabulary dimension	Learning	Wilks' Lambda	.57	4.92	2.00	13.00	.026	.43
	Retention		.77	1.94	2.00	13.00	.184	.23

Table 6

Pairwise Comparisons of Learning and Retention through Reading

Posttest	(I) Vocabulary dimension	(J) Vocabulary dimension	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference Lower Bound	Upper Bound
Learning	1	2	1.40	.54	.065	-.07	2.87
		3	-.27	.37	1.000	-1.28	.74
	2	1	-1.40	.54	.065	-2.87	.07
		3	-1.67*	.51	.018	-3.06	-.27
	3	1	.27	.37	1.000	-.74	1.28
		2	1.67*	.51	.018	.27	3.06
Retention	1	2	1.27	.64	.207	-.48	3.02
		3	.27	.82	1.000	-1.96	2.49
	2	1	-1.27	.64	.207	-3.02	.48
		3	-1.00	.81	.703	-3.19	1.19
	3	1	-.27	.82	1.000	-2.49	1.96
		2	1.00	.81	.703	-1.19	3.19

A one-way repeated measures ANOVA compared learning scores on vocabulary dimensions through listening (i.e., part of speech, syntagmatic association, and form-meaning connection). The mean scores and standard deviations of the immediate and delayed posttests administered to the E1-Group after listening are shown in Table 7. Although the means for learning vocabulary dimensions through listening are lower in comparison to those through reading, the ANOVAs revealed that listening had a significant effect on learning vocabulary dimensions when word exposure frequency was identical, Wilks' Lambda = .52, F (2, 13) = 5.95, p = .015, multivariate partial eta squared = .48 (Table 8). Based on pairwise comparisons, the mean score for syntagmatic association (M = 1.87, SD = 1.41) was significantly different from part of speech (*M* = 3.67, *SD* = 1.99) and form-meaning connection (*M* = 3.80, *SD* = 1.47). However, part of speech (*M* = 3.67, *SD* = 1.99) did not differ significantly from form-meaning connection.

Table 7

Descriptive Statistics of Learning and Retention through Listening

	Learning		Retention		
	Mean	*SD*	*Mean*	*SD*	*N*
Part of speech	3.67	1.99	2.47	1.30	15
Syntagmatic association	1.87	1.41	1.60	1.18	15
Form-meaning connection	3.80	1.47	3.33	1.59	15

Maximum score =18

Table 8

Multivariate Tests of Learning and Retention through Listening

Effect			Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Vocabulary dimension	Learning	Wilks' Lambda	.52	5.95	2.00	13.00	.015	.48
	Retention		.59	4.61	2.00	13.00	.031	.42

A one-way repeated measures ANOVA was run to compare retention scores through listening. Unlike retention through reading, listening had a significant effect on retaining vocabulary dimensions when word exposure frequency was identical, Wilks' Lambda = .59, *F* (2, 13) = 4.61, *p* = .031, multivariate partial eta squared = .42; large effect sizes need more attention (Table 8). In spite of that, pairwise comparisons revealed that only the mean for syntagmatic association (*M* = 1.60, *SD* = 1.18) differed significantly from that of form-meaning connection (*M* = 3.33, *SD* = 1.59).

Table 9

Pairwise Comparisons of Learning and Retention through Listening

Posttest	(I) Vocabulary dimension	(J) Vocabulary dimension	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference Lower Bound	95% Confidence Interval for Difference Upper Bound
	1	2	1.80*	.55	.016	.32	3.28

		3	-.13	.38	1.000	-1.16	.89
	2	1	-1.80*	.55	.016	-3.28	-.32
		3	-1.93*	.57	.012	-3.47	-.40
	3	1	.13	.38	1.000	-.89	1.16
		2	1.93*	.57	.012	.40	3.47
Retention	1	2	.87	.49	.290	-.46	2.19
		3	-.87	.39	.128	-1.92	.19
	2	1	-.87	.49	.290	-2.19	.46
		3	-1.73*	.57	.025	-3.27	-.20
	3	1	.87	.39	.128	-.19	1.92
		2	1.73*	.57	.025	.20	3.27

4.2. Investigating the Effect of Exposure Frequency on Incidental Learning and Retention of the Dimensions of Word Knowledge from Reading and Listening

Research question two investigated the effect of word exposure frequency on L2 incidental learning and retention of three dimensions of word knowledge from reading and listening. A one-way between-groups ANOVA was run to determine the effect of different frequencies on learning and retention of part of speech, syntagmatic association, and form-meaning connection through reading and listening measured by immediate and delayed posttests. Participants were divided into four experimental groups based on the number of word exposure frequency (i.e., 1, 3, 5, and 7). Levene's test showed that the assumption of homogeneity of variance was not violated for the analyses on reading but it was violated for those on listening. Therefore, we consulted robust tests of equality of means (Welch and Brown-Forsythe) for listening.

Table 10

Descriptive Statistics for Four Groups in Learning and Retention through Reading and Listening

	N	*Mean*	*SD*	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max

			N	*Mean*	*SD*	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
Reading	Parts of speech (Learning)	1 F	15	9.00	2.24	.58	7.76	10.24	5.00	14.00
		3 F	16	11.38	3.26	.82	9.64	13.11	5.00	18.00
		5 F	17	11.41	3.54	.86	9.59	13.23	5.00	18.00
		7 F	15	12.07	3.39	.88	10.19	13.94	7.00	18.00
	Part of speech (Retention)	1 F	15	7.47	1.20	.52	6.36	8.57	5.00	12.00
		3 F	16	10.25	3.00	.75	8.65	11.85	6.00	18.00
		5 F	17	10.24	3.36	.82	8.56	11.97	5.00	17.00
		7 F	15	12.00	3.30	.85	10.18	13.82	7.00	18.00
	Syntagmatic association (Learning)	1 F	15	7.60	2.59	.67	6.17	9.03	5.00	15.00
		3 F	16	9.19	3.06	.76	7.56	10.81	5.00	16.00
		5 F	17	9.06	3.63	.88	7.19	10.93	5.00	16.00
		7 F	15	10.53	2.56	.66	9.12	11.95	8.00	16.00
	Syntagmatic association (Retention)	1 F	15	6.20	1.74	.45	5.24	7.16	4.00	9.00
		3 F	16	7.00	2.50	.683	5.67	8.33	4.00	11.00
		5 F	17	7.41	2.60	.63	6.08	8.75	3.00	12.00
		7 F	15	9.87	2.95	.76	8.23	11.50	6.00	17.00
		Total	63	7.60	2.78	.35	6.90	8.30	3.00	17.00
	Form-meaning connection (Learning)	1 F	15	9.27	2.34	.61	7.97	10.57	6.00	16.00
		3 F	16	10.13	2.36	.59	8.87	11.38	6.00	16.00
		5 F	17	9.77	2.68	.65	8.39	11.14	7.00	15.00
		7 F	15	12.00	2.48	.64	10.63	13.37	9.00	18.00
	Form-meaning connection (Retention)	1 F	15	7.20	2.24	.58	5.96	8.44	4.00	10.00
		3 F	16	8.00	2.92	.73	6.44	9.57	4.00	14.00
		5 F	17	8.94	2.61	.63	7.60	10.28	5.00	14.00
		7 F	15	11.47	3.40	.88	9.58	13.35	6.00	18.00
Listening	Part of speech (Learning)	1 F	15	3.67	1.99	.51	2.57	4.77	1.00	8.00
		3 F	16	4.44	2.31	.58	3.21	5.67	1.00	9.00
		5 F	17	7.18	3.70	.90	5.28	9.08	.00	14.00
		7 F	15	8.40	4.44	1.15	5.94	10.86	2.00	17.00
	Part of speech (Retention)	1 F	15	2.47	1.30	.34	1.75	3.19	1.00	5.00
		3 F	16	3.06	1.98	.50	2.01	4.12	.00	6.00
		5 F	17	5.18	3.66	.89	3.29	7.06	.00	14.00
		7 F	15	7.00	4.11	1.07	4.73	9.27	3.00	17.00
	Syntagmatic association (Learning)	1 F	15	1.87	1.41	.36	1.09	2.65	.00	5.00
		3 F	16	2.81	1.83	.46	1.84	3.79	.00	7.00
		5 F	17	5.06	3.73	.91	3.14	6.98	1.00	13.00
		7 F	15	6.73	3.69	.95	4.69	8.78	2.00	15.00

		N	Mean	SD	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max
Syntagmatic association (Retention)	1 F	15	1.60	1.18	.31	.9448	2.26	.00	3.00
	3 F	16	2.25	1.57	.39	1.4131	3.09	.00	6.00
	5 F	17	4.77	2.93	.71	3.2599	6.27	.00	11.00
	7 F	15	5.87	3.29	.85	4.0435	7.69	.00	13.00
Form-meaning connection (Learning)	1 F	15	3.80	1.47	.38	2.9840	4.62	2.00	7.00
	3 F	16	3.56	1.20	.50	2.4973	4.63	1.00	7.00
	5 F	17	6.35	4.44	1.08	4.0684	8.64	1.00	15.00
	7 F	15	7.33	3.56	.92	5.3624	9.30	4.00	16.00
Form-meaning connection (Retention)	1 F	15	3.33	1.59	.41	2.4536	4.21	.00	6.00
	3 F	16	3.81	2.81	.70	2.3152	5.31	.00	10.00
	5 F	17	5.59	4.46	1.08	3.2956	7.88	.00	14.00
	7 F	15	6.93	4.03	1.04	4.7038	9.16	1.00	16.00

F= exposure frequency, Min = minimum score, Max = maximum score

The results (Table 11) did not show a statistically significant difference at the $p <$ .05 level, for the four different word exposure frequencies in reading, in learning part of speech, F (3, 59) = 2.74, p = .052, and syntagmatic association, F (3, 59) = 2.37, p = .079, except for form-meaning connection, F (3, 59) = 3.52, p = .020, eta squared = 0.12, 0.11, and 0.15, respectively. However, there is a statistically significant difference for the four different word exposure frequencies in retaining part of speech, F (3, 59) = 5.94, p = .001, syntagmatic association, F (3, 59) = 6.06, p = .001, and form-meaning connection, F (3, 59) = 6.51, p = .001, eta squared = 0.23, 0.24, and 0.25, respectively.

Table 11
ANOVA Results for Four Groups in Learning and Retention through Reading and Listening

			Sum of Squares	df	Mean Square	F	Sig.
Reading	Part of Speech (Learning)	Between Groups	82.18	3	27.39	2.74	.052
		Within Groups	590.80	59	10.01		
		Total	672.98	62			
	Part of Speech (Retention)	Between Groups	158.21	3	52.74	5.94	.001
		Within Groups	523.79	59	8.88		
		Total	682.00	62			
	Syntagmatic association	Between Groups	64.71	3	21.57	2.37	.079

			Sum of Squares	df	Mean Square	F	Sig.
	(Learning)	Within Groups	536.71	59	9.10		
		Total	601.43	62			
	Syntagmatic association (Retention)	Between Groups	112.83	3	37.61	6.06	.001
		Within Groups	366.25	59	6.21		
		Total	479.08	62			
	Form-meaning connection (Learning)	Between Groups	64.67	3	21.56	3.52	.020
		Within Groups	361.74	59	6.13		
		Total	426.41	62			
	Form-meaning connection (Retention)	Between Groups	155.15	3	51.72	6.51	.001
		Within Groups	469.08	59	7.95		
		Total	624.22	62			
Listening	Part of Speech (Learning)	Between Groups	230.41	3	76.80	7.20	.000
		Within Groups	629.34	59	10.67		
		Total	859.75	62			
	Part of Speech (Retention)	Between Groups	196.29	3	65.43	7.24	.000
		Within Groups	533.14	59	9.04		
		Total	729.43	62			
	Syntagmatic association (Learning)	Between Groups	220.94	3	73.65	8.83	.000
		Within Groups	492.05	59	8.34		
		Total	712.98	62			
	Syntagmatic association (Retention)	Between Groups	189.21	3	63.0	10.77	.000
		Within Groups	345.39	59	5.854		
		Total	534.60	62			
	Form-meaning connection (Learning)	Between Groups	162.86	3	54.29	5.49	.002
		Within Groups	583.55	59	9.89		
		Total	746.41	62			
	Form-meaning connection (Retention)	Between Groups	125.78	3	41.93	3.54	.020
		Within Groups	698.82	59	11.84		
		Total	824.60	62			

Unlike reading, the four different exposure frequencies in listening had a significant effect on learning part of speech, $F(3, 59) = 7.20$, $p = .000$, syntagmatic association, $F(3, 59) = 8.83$, $p = .000$, and form-meaning connection, $F(3, 59) = 5.49$, $p = .002$, eta squared = 0.27, 0.31, and 0.22, respectively. A similar effect was observed in retaining part of speech, $F\ (3, 59) = 7.24$, $p = .000$, syntagmatic association, $F\ (3, 59) = 10, 77$, $p = .000$, and form-meaning connection, $F\ (3, 59) = 3.54$, $p = .020$, eta squared = 0.27, 0.35, and 0.15, respectively. Most of the effect sizes either in significant or non-significant differences in Table 11 are larger than .14 in Cohen's (1988, pp. 284–7) terms, hence worth considering for study with a larger sample size.

5. Discussion

5.1. The Effects of Reading and Listening on Incidental Vocabulary Learning

The results showed that when exposure frequency is identical in reading and listening, reading contributes to a greater amount of L2 incidental vocabulary learning in different dimensions of word knowledge compared to listening. The notably advantageous effect of reading over listening on vocabulary learning corroborates findings from previous research (e.g., Brown et al., 2008; Chen & Teng, 2017; Hatami, 2017; Mohsen & Almudawis, 2020; Vidal, 2011). This could be largely due to the nature of written language which provides readers with repeated access to unknown words on the page. In other words, readers can "dwell upon words they cannot understand and backtrack if necessary" (Vidal, 2011, p. 243). In contrast, listeners cannot attend to the words repeatedly because auditory signals fade quickly. Also, listeners tend to experience difficulty with speech segmentation (Vidal, 2011). This suggests that it is difficult for L2 learners to recognize the boundaries between spoken forms in connected speech (Brown et al, 2008; Chen & Teng, 2017; Hatami, 2017; Vidal, 2011).

Based on the findings, we can argue that learning gains were not consistent across the three dimensions. At one encounter, reading yielded sizeable vocabulary gains for form-meaning connection (51.5%), part of speech (50%), and syntagmatic association (42. 22%). Through listening, learning gains were less remarkable standing at 21.11% for form-meaning connection, 20.38% for part of speech, and 10.38% for syntagmatic association. No significant differences were found between the amounts of learning gains for form-meaning connection and part of speech through both input sources; the gains for syntagmatic association were significantly lower than the other two dimensions. Yet it should be noted that these learning percentages are not considered complete knowledge of the words, but rather imply

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that the recognition of different dimensions of word knowledge started to develop (van Zeeland & Schmitt, 2013a).

The learning gains from reading corresponded with previous research. For example, at one encounter, the readers' gains for form-meaning connection were 40% in Chen and Teng (2017), and 58% in Webb (2007), compared with 51.5% in this study. Learning gains for part of speech, at one encounter, were 57% in Webb (2007), and 47.9% in Chen and Truscott (2010), compared with 50% in the present study. In Webb (2007), learning gains for syntagmatic association were 40% at a single exposure, compared with 42.22% here.

Overall, the form-meaning connection was the best acquired word knowledge dimension at the recognition level in both reading and listening, also shown earlier (e.g., González Fernandez & Schmitt, 2020; Henriksen, 1999; Pellicer-Sánchez & Schmitt, 2010). This is perhaps not surprising as learners typically read and listen for meaning; learners appear to primarily attend to the meaning of the TWs as they are important for text comprehension. However, other previous research (e.g., Chen & Teng, 2017; Chen & Truscott, 2010; Hatami, 2017; Heidari-Shahreza & Tavakoli, 2016; Teng, 2018; Webb, 2007) suggests that acquiring the form-meaning connection is preceded by other dimensions.

Based on the findings, syntagmatic association is acquired late in both modalities. This is shown in earlier studies indicating that learning syntagmatic association may be more difficult than meaning and part of speech (e.g., Hatami, 2017; Jin & Webb, 2020; Teng, 2018; Webb, 2007; Webb et al., 2013). An important reason for the relatively slow uptake of syntagmatic association is that L2 learners tend to pay attention to just individual words, rather than associations and therefore they acquire individual words instead of chunks (Wray, 2002). Moreover, it is more difficult to pay attention to the formal properties of two or more words compared to one (Peters, 2014).

5.2. The Effects of Reading and Listening on Vocabulary Retention

The results of the delayed posttests showed that scores for all three dimensions

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decreased in both input sources. No significant differences were found between the retention gains for the three dimensions through reading. Learners retained knowledge of 41.5% (out of 50%) of part of speech, 40% (out of 51.5%) of meaning, and 34.44% (out of 42.22%) of syntagmatic association through reading after three weeks; Unlike reading, the results for listening demonstrated a significant difference between the retention gains for syntagmatic association and the other two dimensions. Overall, through listening, learners were able to retain 13.72% (out of 20.38%) of part of speech, 18.5% (out of 21.11%) of form-meaning connection, and 8.88% (out of 10.38%) of syntagmatic association three weeks later.

The comparison of the retention results indicates that although reading leads to higher retention rates than does listening, learners had retained knowledge of the form-meaning connection and syntagmatic association, initially acquired through listening. However, they lost some of their initial gains (loss of 11.5% in form-meaning connection and 8% in syntagmatic association) from reading after three weeks. The finding that the knowledge of the form-meaning connection acquired through reading appeared to decay more easily than that acquired through listening is in line with previous studies (i.e., Brown et al., 2008; Hatami, 2017; Vidal, 2011).

According to Vidal (2011), lower decay rates for the meaning acquired through listening is due to the direct access of aural input to the phonological storage in the working memory, which might result in long-term word retention. Unlike auditory material, visually presented input is transformed into phonological code by subvocal articulation and then gains access to the phonological store. This process may be unsuccessful due to the acoustic confusion that might happen when subjects recall input during reading (Baddeley, 2007). Thus, despite the lower rate of learning compared to reading, listening is a valuable source for retaining the form-meaning connection and syntagmatic association because learners forget them less after three weeks.

5.3. The Effect of Exposure Frequency on Incidental Vocabulary Learning

The results showed that the more frequent the exposures, the larger the gains for different dimensions of vocabulary knowledge. The positive effect of exposure frequency on vocabulary learning through reading and listening corroborates findings from previous studies (e.g., Chen & Teng, 2017; Chen & Truscott, 2010; Hatami, 2017; Heidari-Shahreza & Tavakoli, 2016; Pellicer-Sánchez & Schmitt, 2010; Teng, 2018, 2020; van Zeeland & Schmitt, 2013; Vidal, 2011; Webb, 2007). However, it is difficult to compare the frequency effects on vocabulary learning across studies, as different studies used a different number of exposures.

According to Vidal (2011), repeated exposures to a vocabulary item seem to draw learners' attention to the TW and make them perceive it as an important concept that they should understand and learn. Knowledge of different word dimensions showed different patterns of development with increasing exposure. This suggests that not every dimension of word knowledge needs the same number of exposures.

In reading, most gains occurred between one and three exposures for part of speech and syntagmatic association, indicating that frequency does not have a strong effect on these two dimensions. For form-meaning connection, the largest gains occurred between five and seven exposures (Table 10). This suggests that an increase in the number of exposures has a significant effect on acquiring word meaning. Thus, in line with previous research (e.g., Chen &Truscott, 2010; Chen & Teng, 2017; Hatami, 2017; Pellicer-Sánchez & Schmitt, 2010; Webb 2007), a larger number of exposures is needed for acquiring meaning. On the other hand, there was no significant difference in vocabulary gains between the words encountered three times and those encountered five times for all three dimensions. Syntagmatic association showed a steady growth between five and seven exposures. For part of speech, no real learning gains were found beyond three exposures, suggesting that three exposures might suffice to develop knowledge of part of speech through reading.

In listening, increasing the number of exposures had a strong effect on learning gains for all dimensions of word knowledge (Table 10). The greatest increase occurred between three and five exposures for the three aspects. Therefore, in line

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with Vidal (2011), it can be argued that at least three exposures are needed for different dimensions of vocabulary knowledge to improve significantly through listening.

Moreover, the findings revealed that seven exposures resulted in significant learning gains across all word dimensions through reading. However, it seems that this number of exposures may have been insufficient for acquiring substantial word knowledge through listening. Therefore, in line with previous studies (e.g., Brown, 2008, Chen &Teng, 2017, Hatami, 2017, Mohsen & Almudawis, 2020, Vidal, 2011, van Zeeland & Schmitt, 2013), we can conclude that L2 listeners might need a higher number of exposures than L2 readers for successful incidental vocabulary learning. In fact, listeners do not seem to take advantage of repeated exposures as much as readers do unless they can segment speech properly and consequently identify the TW (Vidal, 2011).

5.4. The Effect of Exposure Frequency on Vocabulary Retention

The results of the delayed posttests showed that exposure frequency had a significant effect on retention gains for the three dimensions through reading and listening. Thus, the effect of frequency on word knowledge is durable. The long-term benefit of repeated exposures has been shown in previous research (e.g., Chen & Truscott, 2010; Teng 2019, 2020; Peters, 2014). According to N. Ellis (2002), repeated exposures are crucial for the long-term retention of vocabulary.

The overall strength of the effect of frequency varied across different dimensions. The greatest retention gains through reading occurred between one and three exposures for part of speech and between five and seven exposures for form-meaning connection and syntagmatic association. This finding suggests that form-meaning connection and syntagmatic association need a larger number of exposures than part of speech to be retained through reading. Thus, meaning appears to be significantly vulnerable to the lapse of time. Research suggests that 8–10 reading exposures are needed to learn single words (Schmitt, 2010) and 15 exposures to learn syntagmatic association (Webb et al., 2013) at a recognition level.

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In listening, the greatest retention gains occurred between three and five exposures for all dimensions. From five to seven exposures, gains kept increasing to a large extent in the three aspects. Therefore, retention gains tend to enhance greatly between three and seven exposures for the three dimensions. This finding shows the benefits of repeated exposures for retaining and consolidating fragile initial learning through listening. Although the immediate knowledge of a word starts developing with a few exposures through listening, considerably more than 15 exposures are needed to fully develop and retain this knowledge (van Zeeland & Schmitt, 2013).

6. Conclusion

The findings of this study provided evidence for learning and retention of three dimensions of word knowledge at the level of recognition from exposure to written and spoken input. While reading resulted in greater vocabulary gains in terms of learning and retention, listening led to lower decay rates for vocabulary knowledge weeks after exposure. However, the effects of reading and listening varied across different dimensions of vocabulary knowledge. Meaning and part of speech are acquired to a greater extent compared to the syntagmatic association through reading and listening.

This study also suggests that increased exposures to the TWs lead to larger amounts of vocabulary gains; findings indicate that the exposure frequency necessary for acquiring each word dimension differs. Interesting contrasts were found in the pattern of development for each knowledge dimension in both input sources. Through reading, three exposures might suffice to develop and retain the knowledge of part of speech. However, meaning and syntagmatic association require a higher frequency of exposures for acquisition and retention. Through listening, at least three exposures are required to develop and retain the TW knowledge in the three dimensions.

Based on the findings, the development of syntagmatic association requires a greater amount of exposure and more deliberate attention. Therefore, materials

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writers should consider the frequency of target lexical words when developing pedagogical materials and graded written and spoken texts. Since increasing the number of exposures would be impossible without increasing the length of a text, longer texts might offer more opportunities for repeated exposure to the same TW. Therefore, teachers are recommended to include extensive reading and listening into the language learning program with weekly attainable word-targets in classroom settings (Siyanova-Chanturia & Webb, 2016). For long-term word retention, it is necessary to recycle the newly acquired words which otherwise will be forgotten (Nation, 1990). According to Nation, consolidating newly learned words is more important than teaching novel words because it saves time spent on vocabulary learning. Teachers and materials writers thus need to consider incidental vocabulary learning in longitudinal terms where TWs are effectively recycled over time.

The present study has some limitations: First, the sample size was small, and limited to the Iranian EFL context, hence affecting the generalizability of the results. Future studies should choose larger and contextually different samples. Second, since proficiency level has a significant impact on L2 incidental vocabulary learning through reading and listening (Vidal, 2011), replications at other proficiency levels are recommended. Third, due to practical constraints, participants in the present study were exposed to audio input, but their vocabulary gains were measured using written vocabulary posttests; the use of written tests for listening purposes might underestimate learners' knowledge (Alali & Schmitt, 2012). Future research could use an aural version of the NVLT. Fourth, this study only used recognition tests to measure different dimensions of word knowledge. Therefore, it could not be determined the extent to which incidental exposure resulted in productive ability in language learners. Future research should also consider production tests. Fifth, our attempts at manipulation of word exposure frequency might result in the creation of texts offering more exposures to the TWs than normally available in natural input or lacking natural redundancy found in authentic texts. This raises concerns about input authenticity, especially regarding whether these texts would behave in the same way as real-world contexts do. Finally, on a methodological level, testing effects were inevitable due to the research design, assessing learners' word knowledge after each reading and listening session (Nation & Webb, 2011), and the type of vocabulary posttests used; a control group is needed to compare any probable testing effects.

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Appendix A

The 36 Target Words in the Reading and Listening Texts by Part of Speech

"Weddings"	*POS*	"London"	*POS*	"Scotland"	*POS*	"Queen of Scots"	*POS*
capture	V.	acquire	V.	commence	V.	condemn	V.
declare	V.	explore	V.	conquer	V.	confine	V.
fulfill	V.	restore	V.	preserve	V.	perceive	V.
blossom	N.	carriage	N.	dweller	N.	chamber	N.
passion	N.	display	N.	pasture	N.	refuge	N.
presence	N.	monarch	N.	shallows	N.	dispute	N.
ancient	Adj.	precious	Adj.	fertile	Adj.	content	Adj.
fragrant	Adj.	stunning	Adj.	renowned	Adj.	jealous	Adj.
wealthy	Adj.	thriving	Adj.	splendid	Adj.	widowed	Adj.

POS: Part of Speech

Appendix B

Sample subtest items used in the vocabulary posttests

Subtest 1: Part of speech

Example: Which sentence is correct? Please check (✓) the box.

monarch A☐ He is a **monarch**.

B☐ It is very **monarch**.

C☐ She **monarched**.

Subtest 2: Syntagmatic association

Example: Which word is more likely to be used with the underlined word in each sentence? Please check (✓) the box.

He ……... **refuge** in France in 1954.

A☐ made B☐ asked C☐ took D☐ worked

Subtest 3: Form-meaning connection

Example: Which is the correct meaning of the underlined word in each sentence? Please check (✓) the box.

John is a **wealthy** man.

A☐ kind B☐ handsome C☐ rich D☐ young

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