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The relationship between morphological awareness and morphological decomposition among English language learners

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Abstract Morphological awareness facilitates many reading processes. For this reason, L1 and L2 learners of English are often directly taught to use their knowledge of English morphology as a useful reading strategy for determining parts of speech and meaning of novel words. Over time, use of morphological awareness skills while reading develops into an automatic process for L1 readers called morphological decomposition. While the practice of explicitly teaching morphological awareness skills is prevalent in ESL classes, more research is needed to establish what is known about gains in L2 morphological awareness, and its relationship to the development of automatic morphological decomposition processes in English language learners. The present study seeks to shed light on the nature of this relationship across growth in L2 proficiency. Two experimental measures were used: a masked priming paradigm with a lexical decision task to explore priming evidence for morphological decomposition and a paper and pencil test of morphological awareness which required subjects to derive the base of a morphologically complex word. These tasks were administered to L1 (N = 43) and L2 groups (intermediate N = 16, advanced N = 16) of university-aged subjects. Results indicated that all subjects show repetition priming effects. However, despite a significant gain in explicit knowledge of English morphology across proficiency levels, L2 learners don't develop an ability to morphologically decompose words in the unconscious, automatic way that native English speakers do, as evidenced by a lack of morphological priming. Implications for L2 pedagogy and L2 word storage in the mental lexicon are discussed.

Keywords Morphological awareness · Morphological decomposition · English learners · Reading

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Introduction

Morphological awareness facilitates word recognition, reading comprehension, and learning new words (Goodwin, Huggins, Carlo, August, & Calderon, 2013; Kieffer & Lesaux, 2008; Marinova-Todd, Siegel, & Mazabel, 2013). For this reason, L1 and L2 learners of English are often directly taught to use their knowledge of English morphology as a useful reading strategy for determining parts of speech and meaning of novel words. There is substantial evidence (e.g. Murrell & Morton, 1974; Kempley & Morton, 1982; Taft, 1979; Taft & Forster, 1975) that over time, this strategy develops into an unconscious and automatic process for L1 readers called morphological decomposition, which can be defined as the resolution of a word into its individual morphemes (i.e. stems, prefixes and suffixes). Once this has been done, a word is thereby recognized by its root form (Taft, 2004).

While the practice of explicitly teaching morphological awareness skills is prevalent in ESL classes, more research is needed to establish what is known about gains in L2 morphological awareness, and its relationship to the development of automatic morphological decomposition processes in English language learners. With a look into the existing literature, we review what is currently known about morphological awareness and decomposition skills in L2 learners to situate the current study.

Previous literature

L2 morphological awareness

As aforementioned, morphological awareness is crucial for many different reading skills in both L1 and L2. For instance, Kieffer and Lesaux (2008) longitudinally examined the relationship between morphological awareness and Spanish-speaking English learners' reading comprehension in English. By following and testing the same group of students through fourth and fifth grade, Kieffer and Lesaux were able to show that morphological awareness and reading comprehension increase over time. Moreover, the use of an extract-the-base-task (much like the one used in the present study) and a reading comprehension passage indicated that morphological awareness of derived forms in English was a significant predictor of reading comprehension once the students entered fifth grade.

Similar results were obtained in 2012 by the same authors with sixth grade students from Spanish, Filipino, and Vietnamese backgrounds. A battery of assessments to analyze morphological awareness, global and inferential reading comprehension skills, reading vocabulary and silent reading fluency revealed that morphological awareness is crucial for reading vocabulary, which in turn is important for reading comprehension across language groups. Additionally, when effects of reading vocabulary and word reading efficiency were controlled, Kieffer and Lesaux found a significant direct contribution of morphological awareness to reading comprehension among the L2 English learners. Lastly, the results of this

study indicate that morphological awareness significantly predicts word reading efficiency as well.

Marinova-Todd et al. (2013) expand what is known about L2 morphological awareness by conducting a study with sixth grade students from a myriad of language backgrounds including 7 Germanic languages, 2 Chinese languages, 2 Filipino languages, 3 Romance languages, 7 Slavic languages, as well as Korean and Persian. Through such a diverse subject pool, the researchers were able to investigate possible effects of L1 transfer in morphological awareness and the way in which this manifests itself in reading comprehension and spelling in L2 English. A series of multiple regression analyses show that across L1 backgrounds (excluding the Slavic languages), "morphological awareness made an independent contribution to reading comprehension and spelling tasks over and beyond that of phonological awareness skills" (p. 102). While significant contributions were found in all language groups, effects of morphological awareness on reading comprehension were strongest among students from L1 backgrounds with more transparent or agglutinative morphology, such as Korean, Filipino and Persian, thus indicating a possible role of L1 transfer in morphological awareness.

L2 morphological knowledge and automaticity

While findings from the literature about the importance of morphological awareness in offline L2 reading tasks are largely consistent, those investigating the online use of such knowledge vary substantially. Some studies report evidence for automatic morphological decomposition among L2 learners in online word processing, but others argue otherwise. A number of these studies are discussed below.

Jiang (2004) conducted a study with a group of Chinese L2 learners of English to investigate whether or not cases of morphological difficulty among L2 speakers are due to issues of competence or performance. Three online, self-paced reading experiments were implemented to explore this question. Participant reading times were measured, with longer reading times indicating processing difficulties likely due to morphological disagreement. In the first experiment, inflectional plural morphemes were manipulated to either agree (e.g. The key to *the cabinet was rusty* from many years of disuse.) or disagree (e.g. The key to *the cabinets was rusty* from many years of disuse.) with a corresponding verb. The second and third experiments used a similar procedure, but manipulated subject-verb agreement with the head noun of the sentence and subject agreement in number and subcategorization (e.g. The bridges to the island were about ten miles away vs. *The bridge to the island were about ten miles away.). Results of these three experiments show that L2 learners of English's reading times were not affected by number disagreement. However, they are sensitive to disagreement in subcategorization structure. Jiang stated that this implies that L2 learners' morphological knowledge of English "is not an integrated part of their *automatic* second language competence."

Using the same materials and procedure in 2011, Jiang et al. explore the idea of L1 transfer in online use of L2 morphological awareness with advanced groups of Russian and Japanese L2 English learners. In Russian, plurals are morphemically marked while in Japanese, plural marking is "highly optional or restricted" (p. 942).

An analysis of participant reading times revealed that Russian speakers showed sensitivity to grammatical errors with the plural morpheme while Japanese speakers did not. Thus, the data show support for the morphological congruency hypothesis, or the idea of positive L1 transfer in online L2 morphological processing.

Yielding slightly different results, Silva and Clahsen (2008) explored the question of whether or not differences in morphological decomposition abilities among Chinese, German and Japanese L2 learners of English exist between inflected and derived word forms. Firstly, Silva and Clahsen conducted a masked priming experiment with native speakers to replicate the results of others showing that native speakers show evidence for morphological decomposition of both inflected and derived word forms during the early stages of recognition. Following the first experiment was a series of three more masked priming experiments with the aforementioned L2 speakers as participants. Experiment items were constructed to test for evidence of morphological decomposition in regular past tense verbs (inflectional morphemes) and nominalizing suffixes -ness and -ity (derivational morphemes). The data produced by these experiments demonstrate that repetition priming effects can be seen across items for both L1 and L2 speakers of English, but that L2 speakers only show "reducing priming" for derived items and no priming for inflected items.

Gor and Jackson (2013) sought to shed light on the roles of verb frequency and regularity in morphological decomposition among 3 proficiency levels of advanced English learners of Russian. Using a masked priming paradigm, the researchers' results suggest that advanced English learners of Russian show priming effects for regularly inflected Russian -aj- class verbs (e.g. rabot -aj-, *work*). However, priming effects for semi-regular -i- class verbs (e.g. xod-i-, *go*) and irregular -ø- class verbs (e.g. moj-ø-, wash) were only observed among the 2 highest proficiency levels (advanced high and superior on the ACTFL scale) for the former and only the highest proficiency level for the latter. These results suggest that morphological decomposition for inflected verbs in Russian, a highly inflectional language, is a skill that L2 learners acquire over time.

With slightly mixed results in L2 online use of morphological knowledge, one may ask the question of what determines whether or not L2 readers of English, a morphologically impoverished language, develop the ability over time to automatically decompose words during word recognition as native speakers do. The majority of studies investigating online morphological decomposition abilities among non-native speakers, including the aforementioned, shed light on the processing of L2 *inflectional* morphology, while studies of offline morphological awareness mostly focus on *derivational* morphology. Moreover, investigations of offline morphological knowledge have largely been conducted with children, while online experiments have mostly been done with adults. In an attempt to more directly investigate the relationship between offline morphological awareness and online morphological decomposition as well as add to the small number of online studies focusing on derivational morphology, the current study utilizes only derived forms and will use the same group of adult L2 learners in one offline and one online experiment.

The following experiments set out to investigate these research questions:

1. Do L2 learners of English morphologically decompose words into their morphological constituents in the automatic way that native speakers do?
2. Is there significant development in this skill over time as proficiency increases?
3. Do increases in L2 morphological awareness over time correspond with increases in automatic morphological decomposition skills?

The researchers aim to answer these questions by first, using a masked priming paradigm to test a group of native English speakers, who will serve as a baseline and confirm the results of prior studies. Second, it will add to the existing knowledge of morphological decomposition and L2 speakers by testing two groups of L2 English learners at intermediate and advanced proficiency levels. To explore the relationship between L2 morphological awareness and decomposition abilities, the results of a morphological awareness test will be discussed as well.

Experiment 1: Native speakers

Method

Participants

To investigate this research question, a total of 43 native English-speaking undergraduate students from the University of Arizona participated in this experiment (mean age = 20; age range = 18–24). They received credit for an introductory psychology class at the university. Informed consent was obtained from all individual participants included in the study.

Materials and design

Target words consisted of 60 words and 60 non-words ranging from 3 to 8 letters in length (mean length = 5.1 letters). The word targets selected for the study needed to be moderately frequent to ensure that the non-native participants in the intermediate proficiency group would not be presented with words unfamiliar to them. For this reason, the average CELEX frequency value of word targets was 54.1. Non-word targets were created by changing 2 letters of each word target. For each target, three primes were used (a) morphologically derived or inflected versions of the target (e.g. winner-WIN); (b) repetition primes and (c) unrelated word primes. Rather than having only morphological and control prime conditions, the repetition prime condition was included to show that in the case of no morphological priming, priming effects of some kind could still be achieved. Evidence for priming in the repetition condition and not the morphological condition would show that the effect is indeed not present and that this was not due to some issue with the items themselves. The full set of primes and targets can be found in the Appendix 1.

Three sets of prime-target lists (files A, B, and C) each consisting of 3 blocks with 20 targets each for a total of 60 targets were used in the experiment. Targets remained the same on all three lists while items in the three prime conditions were counterbalanced. In other words, each target appeared once in every list across subjects, but in one of the three prime conditions. In the native speaker group, 15 participants were tested on file A, 14 on file B and 14 on file C.

Procedure

The experiment items were presented as black letters on a white background (Courier New12 pt font. Each trial the participants saw consisted of three stimuli: (1) a row of hash marks (####) displayed for 500 ms; (2) the prime in lowercase letters displayed for 50 ms; and (3) the target in uppercase letters displayed for 500 ms. The experiment was run on a Pentium PC using K. Forster and J. Forster's DMASTR DMDX software program using a color monitor with a refresh cycle of 10 ms. This program synchronizes timing of the display with the video raster of the computer on which it runs. The participants' task was to make a lexical decision on the string of uppercase letters in each trial. If the string of letters was a word in English, they were to answer 'yes,' and if the string of letters was not a word in English, they were to answer 'no.' All participants were instructed to make answers as quickly as possible but not so quickly that they would make mistakes. After each trial, a feedback message reading whether or not the response was correct in addition to their reaction time. Participants selected their 'yes' or 'no' answers through the use of two response keys. They were able to move through the trials of the experiment at their own pace by using a foot pedal to advance to the next trial. The items were presented in a different order for each participant.

Results

Before data analysis, participants with final error rates of 21 % or higher were excluded from the analysis as a standard procedure. However, in this experiment, no participants had an error rate of 21 % or higher. The data were analyzed using linear mixed-effects modeling in R (Baayen, 2008; Baayen, Davidson, & Bates, 2008). This was done as opposed to using the traditional method of analysis using F_1 and F_2 in by-subjects and by-items ANOVAs because linear mixed-effects modeling allows for the analysis of subjects, items, and reaction times, without aggregating over subjects or items. The data from any trials which included an error were excluded from the analysis. Next, reaction times were transformed using a reciprocal transformation to correct for the violation of normal distribution (i.e. the positive skew in the data) before a model was fit to the data. In this experiment, priming was both a within-subjects and fixed effect factor. Subjects and items were analyzed as random effect factors.

The simplest model including fixed effect factors and random factor intercepts for subjects and items was applied to the data in this analysis. Next, an additional more complex model was also applied to the data including random slopes for both subjects and items. To evaluate whether or not the data justified the use of random

slopes, a likelihood ratio test was conducted. These random slopes analyses are only be reported if they significantly improved the fit of the model (in fact, none did), and altered the conclusions. The probability of the resulting t value was estimated for models without random slopes using a Markov Chain Monte Carlo procedure (MCMC) using 10,000 iterations.

The mean RTs for each condition of the word target trials are shown in Table 1. The mixed-effects model analysis revealed significant priming effects in the morphological prime condition ($t = 7.13$, $p < .001$) and the repetition prime condition ($t = 8.74$, $p < .001$).

Discussion

The significant priming effects found in the morphological priming condition show that native English speakers decompose words into their morphological constituents during the early stages of word recognition. For example, one prime-target pair in this condition was contract-CONTRACTOR. The reaction times suggest that to recognize CONTRACTOR, native English speakers break this word into its root, CONTRACT, and its suffix, -OR. This process of morphological decomposition allows for more efficient lexical storage among native speakers because CONTRACT and CONTRACTOR are not necessarily stored as two separate lexical items. These results are in accordance with other research which has also reported evidence for morphological decomposition by native speakers (e.g. Feldman, O'Connor, & Moscoso del Prado Martín, 2009; Rastle, Davis, & New, 2004; Silva & Clahsen, 2008; Stanners, Neiser, Hernon, & Hall, 1979) (Table 2).

Experiment 2: Non-native speakers

Method

Participants

32 non-native English-speaking students studying at a nearby intensive English program in the United States participated in this experiment (mean age = 21; age range = 18–32). Half of the non-native English speakers were enrolled in advanced proficiency English courses (identified as B2 level speakers on the Common European Framework Reference for Languages (CEFR) scale) in their intensive English program (N = 16) and the other half were enrolled in intermediate proficiency courses (identified as A2 level speakers on the CEFR scale) (N = 16). Placement in these proficiency levels is determined either one of two ways: (1) direct placement into the level by means of an entry test in general English abilities (reading, writing, speaking,

Table 1 Mean reaction times across conditions to word targets for native speakers

Control prime (ms)	Morphological prime (ms)	Repetition prime (ms)
496	469	462

Table 2 Mean reaction times across conditions to word targets for non-native speakers

Prime condition	Intermediate proficiency (ms)	Advanced proficiency (ms)
Control condition	611	662
Morphological condition	596	668
Repetition condition	586	621

Table 3 Number of speakers in each L1 background by proficiency

Proficiency	Chinese	Spanish	Portuguese	Arabic
Intermediate	4	1	7	4
Advanced	4	1	3	8

and listening) at the start of a student's first semester in the program or (2) by passing all of their English courses with a grade of 70 or above and progressing to the next proficiency level courses. In the former case, the intensive English program (IEP) administrators determine the proficiency level through a grading process involving multiple IEP faculty and pre-constructed rubrics for evaluation. Subjects in the intermediate proficiency group had studied English for an average of 3 years and 9 months while those in the advanced proficiency group had studied English for an average of 6 years and 8 months. Within each group, four different L1 backgrounds were represented: Chinese, Portuguese, Arabic, and Spanish. Table 3 contains the number of speakers for each L1 by proficiency level. For their participation in the masked priming as well as the test of morphological awareness, all non-native subjects were entered into a raffle to win one of six $50 cash prizes.

Materials and design

The same items used to test the native English speakers were also used to test the non-native speakers. This consistency allowed the researchers to use the results from the native English speakers as a true baseline for comparison. Likewise, the same three sets of prime-target lists (files A, B, and C) each consisting of 3 blocks with 20 targets each for a total of 60 targets were used in this experiment. Targets remained the same on all three lists while items in the three prime conditions were counterbalanced. In the non-native speaker group, 6 from the advanced proficiency level and 6 from the intermediate proficiency level were tested on file A, 4 from the intermediate and 4 from the advanced proficiency groups were tested on file B, and 4 from the advanced proficiency level and 5 from the intermediate proficiency level were tested on file C. Informed consent was obtained from all individual participants included in the study.

Procedure

The same procedure in experiment 1 was used for the non-native speaker experiment.

Results

Like the native speaker data, reaction times were transformed using a reciprocal transformation to correct for the skewed distribution before a model was fit to the data. Priming was both a within-subjects and fixed effect factor. Subjects and items were analyzed as random effects. The non-native speaker data were analyzed using linear mixed-effects modeling in R However, rather than using a 21 % cutoff rate for errors, the researchers felt justified in using a 31 % error rate cutoff for the non-native speakers as they would be more likely to make errors than the native speaker group. The data from 2 non-native speakers in the intermediate proficiency group as well as 2 in the advanced group were rejected due to final error rates of 31 % or greater.

As in the analysis of the native speaker data, the simplest model including fixed effect factors and random factor intercepts for subjects and items was applied to the non-native speaker data in the analysis. Random slopes were not used as analysis did not justify the use of such a model. The mean RTs for each condition of the word target trials are shown in Table 2. The mixed-effects model analysis revealed that the repetition priming condition was significant across proficiency levels ($t = 2.57$, $p < .01$), but the morphological prime condition was not ($t = 0.16$). Moreover, the model analysis showed that there was no significant difference in reaction times between proficiency levels ($t = 1.62$). At first glance, the table of mean reaction times below would appear to be out of line with this result. However, a closer look into the mean reaction times under each condition of the individual participants in each proficiency level revealed that the near 50 ms difference in mean reaction time across proficiency levels came from approximately three subjects in the advanced proficiency group who had exceptionally longer RTs than the rest of the participants in that group.

Discussion

The data show that while priming effects were present in the repetition condition for both intermediate and advanced proficiency participants, they were not present in the morphological condition. This would suggest that like native speakers, the use of a repetition prime increases the probability that the target will be accessed for L2 speakers. However, the analysis shows that unlike native speakers of English, morphological decomposition is not a part of the early stages of word recognition for both intermediate and advanced proficiency L2 speakers. These results are in agreement with others who have reported evidence of repetition effects for L2 speakers (e.g. Silva & Clahsen, 2008) and those who have reported no evidence for morphological decomposition among L2 speakers of English (e.g. Jiang, 2004).

Morphological awareness test

Participants

The same 32 non-native speakers who participated in the masked priming experiment took the paper and pencil test of morphological awareness.

Materials and design

The test of morphological awareness was developed using the format and items of the Derived Forms and Base Forms tests from Carlisle (1988) and is similar to those used in Carlisle (2000) and Kieffer and Lesaux (2008). Half of the items tested the participants' ability to produce the correct derived form of a given base word to complete a sentence [e.g. My sister is an excellent _____ (swim)]. The other half of items tested participants' ability to produce the correct base form of a given derived form [e.g. Americans across the _____ (national) will vote in the election next year]. These particular items were chosen because the words selected by Carlisle (1988) control for four different types of changes in morphological derivations: no change (in either spelling or phonology) (e.g. enjoy → enjoyment), orthographic change (e.g. rely → reliable), phonological change (e.g. heal → health), and both orthographic and phonological change (e.g. deep → depth). Carlisle showed that the complexity of such spelling and phonological changes interact with participants' abilities to correctly produce the target form. Moreover, the words used were frequent enough that they would be known and easily recognized by participants in the intermediate proficiency group. A few questions soliciting biographical information were added to the beginning of the test to ascertain how long the subjects had studied English. See Appendix 2 for the complete test of morphological awareness.

Procedure

Immediately after completing the masked priming lexical decision task, non-native participants were administered the morphological awareness test. The test was given after the masked priming experiment to avoid any possible instances of unwanted priming.

Results

The test of morphological awareness was found to be reliable ($\alpha = .73$). Tests were scored as a percentage out of 16 possible correct answers. The mean score for the intermediate proficiency group was 68 % while the advanced group achieved a mean score of 88 %. A one-way analysis of variance indicated that the increase in scores on the morphological awareness test between intermediate and advanced proficiency groups was statistically significant ($F(1,15) = 21.402$, $p < .05$). The range of scores for the non-native participants can be found below in Table 4. No significant difference in scores on the morphological awareness test was found between different L1 s within the low proficiency level or in the high proficiency level ($p > .05$).

Table 4 Range of morphological awareness scores by proficiency level

Intermediate proficiency (%)	Advanced proficiency (%)
37–93	56–100

Discussion

The significant difference in scores on the morphological awareness test between proficiency levels demonstrates that the ability to make explicit use of morphological knowledge in English improves over time with practice. These findings are in line those previously discussed by Kieffer and Lesaux (2008).

General discussion

The results of this study suggest that while L2 speakers of English improve in explicit morphological awareness from intermediate to advanced proficiency levels (identified as levels A2 and B2, respectively, on the CEFR scale), neither group is able to morphologically decompose words into their roots and affixes during the early stages of word recognition as native speakers of English do. According to the CEFR, there is a difference of approximately 220–400 practice hours required for mastery between speakers at level A2 and B2 (Council of Europe, 2001). In this particular group, a difference of 2 years and 11 months studying English was noted between the intermediate and advanced groups. These data show that learners progressing through these levels of English proficiency are not acquiring morphological decomposition as an automatic skill in word recognition even after some 200+ h or a few years of additional practice time.

The results of this study differ from those previously discussed of Gor and Jackson (2013) who reported evidence in favor of morphological decomposition among English learners of Russian. However, primes included in the morphological condition favoring morphological decomposition for this study were inflected rather than derived. Moreover, the participants in their study were identified as either being advanced, advanced high, or superior on the ACTFL scale, approximately equating to B2, B2+ and C1 on the CEFR scale (Goldfield, 2010). This potentially suggests that over time and gains in proficiency, English learners of Russian at a rather advanced proficiency level may gradually acquire the ability to decompose inflected words in Russian, but not derived words. Because Russian is much more morphologically rich than English, this discrepancy in results could also imply potential differences in morphological decomposition abilities among language learners depending on both the L1 and the target language.

Like Silva and Clahsen (2008), effects of repetition priming were found among L2 learners of English in the current study. They also report no evidence for morphological priming in an inflectional condition among advanced L2 learners, but report "reduced" or "partial" priming for derivational forms. However, further examination of the paper reveals that reduced priming in derivational conditions was *not* found for regular past tense forms, but was only found when derivational primes ended with *-ness* or *-ity*. Out of all 60 primes in the morphological condition in the current study, only three had the *-ness* suffix and one had the *-ity* suffix. In English, *-ness* is thought of as a productive and transparent affix while *-ity* is seen as less productive and less transparent (Silva and Clahsen, 2008). The current study used a variety of derivational affixes so as to investigate the morphological

decomposition abilities of L2 English speakers across a broader spectrum. This could point to a possible effect of affix productivity and transparency in morphological decomposition. Lastly, Silva and Clahsen's participants came from three L1 backgrounds: German, Chinese and Japanese. As reported, the participants in this study came from L1 backgrounds of Arabic, Portuguese, Spanish, and Chinese. As previously suggested, this discrepancy in results, too, points toward the need for more investigation into possible effects of the L1 and L2 in morphological decomposition.

Implications for language pedagogy

Morphological awareness is a skill that develops in language learners over time and with many hours of practice. Studies such as those done by Ramirez, Esther Geva, and Luo (2011) and Marinova-Todd et al. (2013) demonstrate the important link between morphological awareness and abilities in word reading and spelling for L2 learners of English in that increased levels of morphological awareness lead to increases in word reading and spelling abilities. However, it could be argued that while morphological awareness is certainly correlated with reading and spelling, the speed or level of automaticity with which an L2 learner of English is able to use their knowledge of English morphology matters for reading speed. In other words, the ability to morphologically decompose a word into its constituents for recognition automatically as native speakers do likely leads to faster reading times. This is evidenced by the 200 ms difference on average in RTs between native and non-native speakers of English in the current study.

For L2 learners of English desiring to earn an education in an English-speaking country, like the L2 participants in this study, the ability to read efficiently in English is arguably a necessary skill. The data suggest that the ability to morphologically decompose words into their constituents automatically leads to faster recognition time and thus faster reading time. Therefore, more explicit teaching of English morphological word families and practice composing and decomposing words into their morphological constituents and various forms may be needed as part of a strategy for L2 learners of English to develop the ability to read quickly and efficiently in English. Moreover, because no significant difference in RTs was found between intermediate proficiency and advanced proficiency learners in the present study, one could argue that these kinds of morphology education and practice should extend past the beginning and intermediate levels of English language education and continue even into the advanced high levels.

Implications for L2 word storage

The results of studies, such as the present, exploring morphological decomposition abilities in non-native speakers can provide unique insight into the possible ways in which L2 words are stored in the mental lexicon. For native speakers, it has been argued that words are recognized via a dual-route system which consists of (1)

whole-word storage route for irregularly inflected words and (2) a route involving morphological decomposition to recognize regularly inflected words (e.g. reviews in Diependaele, Duñabeitia, Morris, & Keuleers, 2011; Gor & Cook, 2010). Citing evidence from many studies of second language learners, two popular models exist which tout that adult L2 learners store L2 words quite differently than those in L1. Namely, the declarative/procedural model (Ullman, 2012) and the shallow structure hypothesis (Clahsen & Felser, 2006) suggest that adult L2 learners do not decompose words in the way that native speakers do until a superior level of proficiency is achieved. Thus, both models argue for whole-word representations of L2 words in the mental lexicon. The findings of the present study lend support to these models in that no significant priming effects in the derivational conditions were found in either the intermediate or advanced L2 learner groups.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Appendix 1: Primes across three conditions for word and non-word targets

Morphological	Repetition	Control	TARGET
contractor	contract	picture	CONTRACT
amazing	amaze	television	AMAZE
equally	equal	sleep	EQUAL
creation	create	eat	CREATE
excited	excite	floor	EXCITE
meaningful	meaning	cup	MEANING
patience	patient	husband	PATIENT
retirer	retire	painting	RETIRE
happiness	happy	window	HAPPY
rider	ride	desk	RIDE
studier	study	dog	STUDY
attraction	attract	game	ATTRACT
surprising	surprise	fruit	SURPRISE
gladly	glad	shop	GLAD
believer	believe	stereo	BELIEVE
sleepily	sleepy	agent	SLEEPY
horrific	horror	update	HORROR
argument	argue	sweater	ARGUE
chemistry	chemist	cabinet	CHEMIST
winner	win	buy	WIN

Morphological	Repetition	Control	TARGET
hiker	hike	chair	HIKE
successful	success	imagine	SUCCESS
separation	separate	inside	SEPARATE
resistance	resist	beautiful	RESIST
freedom	free	wood	FREE
wrongly	wrong	double	WRONG
graduation	graduate	kitchen	GRADUATE
continuity	continue	dinner	CONTINUE
dreamer	dream	forest	DREAM
beautiful	beauty	sky	BEAUTY
privacy	private	tree	PRIVATE
drawing	draw	son	DRAW
relaxer	relax	mouth	RELAX
prettiness	pretty	career	PRETTY
smartness	smart	glasses	SMART
boredom	bored	paste	BORED
assistant	assist	pillow	ASSIST
realism	real	surface	RELAX
director	direct	remote	DIRECT
original	origin	hammer	ORIGIN
toucher	touch	fire	TOUCH
storage	store	kill	STORE
musical	music	grass	MUSIC
approval	approve	river	APPROVE
magical	magic	hill	MAGIC
historian	history	sun	HISTORY
swimmer	swim	peace	SWIM
curiosity	curious	story	CURIOUS
exhaustion	exhaust	count	EXHAUST
medication	medicate	vote	MEDICATE
hopeful	hope	sick	HOPE
engager	engage	original	ENGAGE
wealthy	wealth	paper	WEALTH
frightened	frighten	everyone	FRIGHTEN
removal	remove	secret	REMOVE
endless	end	fish	END
terrify	terror	lotion	TERROR
regional	region	progress	REGION
stressor	stress	drive	STRESS
brightly	bright	search	BRIGHT
cantraptual	cantrapt	donsible	CANTRAPT
abamely	abame	zelchent	ABAME
eheality	eheal	lonplute	EHEAL

Morphological	Repetition	Control	TARGET
greamer	greame	bertrate	GREAME
obcitiful	obcite	gembling	OBCITE
bealing	bealing	trutican	BEAL
katiancy	katiant	documert	KATIANT
gotirical	gotire	embation	GOTIRE
bampy	bamp	biblital	BAMP
cadish	cade	cluthong	CADE
stidest	stide	aoboromy	STIDE
altranty	altrant	athretic	ALTRANT
staprisen	staprise	neribate	STAPRISE
platty	plat	emoterate	PLAT
paliever	palieve	granmit	PALIEVE
sloapiness	sloapy	palisher	SLOAPY
moaroric	moaror	cubardy	MOAROR
platted	plat	nelth	PLAT
nirly	nir	hoest	NIR
tiper	tipe	fruze	TIPE
knoper	knope	fluik	KNOPE
croser	crose	crube	CROSE
anoker	anoke	sreem	ANOKE
filttest	filtt	tunt	FILTT
reackly	reack	zlot	REACK
morgiven	morgave	betrak	MORGAVE
leamt	leam	pruvit	LEAM
sackessful	sackess	progstil	SACKESS
regarater	regarate	sleaprom	REGARATE
repustful	repust	thoraph	REPUST
fleppy	flep	haftange	FLEP
wrinky	wrink	edinmar	WRINK
galkish	galk	rusliz	GALK
tukely	tuke	cublire	TUKE
pimer	pime	strin	PIME
bramly	bram	splondet	BRAM
rolagish	rolag	proctian	ROLAG
pralty	pralt	lespasal	PRALT
skarmy	skarm	tenasive	SKARM
toathed	toath	debolten	TOATH
choocker	choock	sormuten	CHOOCK
blapped	blap	etan	BLAP
leaty	leat	vitropen	LEAT
measer	mease	mertagot	MEASE
continery	continer	wokindy	CONTINER
greemy	greem	mahoufet	GREEM

Morphological	Repetition	Control	TARGET
seartiness	searty	largiard	SEARTY
krimater	krimate	scotfry	KRIMATE
bramful	bram	homdram	BRAM
alked	alk	jelopran	ALK
srammy	sram	crolotan	SRAM
gupiousity	gupious	noritarn	GUPIOUS
echarstful	echarst	mibasior	ECHARST
merigated	merigate	singulat	MERIGATE
rokeish	roke	borriton	ROKE
enraked	enrake	wanifold	ENRAKE
weelchy	weelch	sclupant	WEELCH
strags	strag	urkle	STRAG
klights	klight	spail	KLIGHT
ramival	ramive	chekiny	RAMIVE

Appendix 2: Test of Morphological Awareness

Name:

How many years have you studied English (in the U.S. + in your country)?:

What is your native language?:

Complete the following sentences with the correct form of the word:

1. You should _____ (continuous) to study hard to enter graduate school.
2. He has a neat and clean _____ (appear).
3. There are _____ (extremely) changes in temperature from morning to night in the desert.
4. My sister is an excellent _____ (swim).
5. Americans across the _____ (national) will vote in the election next year.
6. Because of our love for technology, it would be difficult to live without _____ (electric).
7. In my free time, I like to listen to _____ (musician).
8. The two teachers _____ (difference) greatly in their teaching styles.
9. Where would you like to eat dinner? Please make a _____ (decide).
10. The company is working to _____ (reduction) the amount of waste it produces.
11. You should be _____ (care) when you go to that city; it's dangerous.

12. Please _____ (description) your plan to finish the research project.
13. Iman has never studied English before, he's a _____ (begin).
14. The _____ (major) of students at the university want to have a longer vacation.
15. She's a great teacher because she gives very clear _____ (explain).
16. Wow! The movie theater is totally _____ (emptiness)! We can sit anywhere!

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