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Morphological Processing of L2 Arabic by Indonesian Speakers

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***Abstract*—In contrast to word formation in stem-based languages, Arabic words are derived through a process of mapping a consonantal root into a vowel pattern. Ample evidence suggests that, during lexical processing of real words in Arabic, native speakers are successful in decomposing words into their roots and patterns such that there is priming between Arabic words that share the same root. In L2 acquisition, however, the question remains whether L2 learners adopt L2 morphological processing mechanisms especially when these are different from L1 processes. The current study explores this question by investigating L2 Arabic learners' sensitivity to the presence of roots when processing auditory speech in Arabic. 38 Indonesian learners of Arabic as a second language and 38 native Arabic speakers rated the word-likeness of auditorily presented nonwords in Arabic. Results reveal that L2 Arabic learners, like native speakers, are sensitive to the presence of roots in the nonwords. These findings are discussed in light of lexical processing models.**

***Index Terms*—word-likeness, root, L2 processing, speech**

I. Introduction

Languages diverge as to the processes they adopt for word-formation. This is particularly factual for languages that belong to different language families. For example, whereas Semitic languages including Arabic are root-based, Indo-European languages such as English adopt concatenative stem-based derivations. In other words, stem-based languages create words by adding prefixes or suffixes to the stem. Consider the English word *killer* for example which is the result of combining the stem *kill* with the suffix *er.*

On the other hand, word formation in Arabic is non-concatenative and is characterized by a process of mapping a consonantal root into a vowel pattern (Holes, 1995). The consonantal root acts as the semantic foundation, whereas the vowel pattern dictates the word's grammatical category and its sound structure. For example, a word like /la:ʕib/ "player" is the result of mapping the root {lʕb} into the nominal pattern for the active participle {fa:ʕil}.

The method of word formation in a language has a direct effect on how words, particularly complex ones, are accessed during lexical processing. Nevertheless, there is hardly an agreement on how derived words are represented and processed in the native language. Models of morphological processing posit different paradigms of lexical processing. Two main models are relevant to the current discussion. First, the full-listing model (Butterworth, 1983) asserts that words are processed as whole units rather than separate morphemes. It is assumed that a word like *unbreakable* has its own whole representation through which it is recognized and that its prefix *un-* and suffix *–able* are not independently processed in the early stages of word recognition. On the other hand, the second model relies on affix-stripping as the main mechanism of lexical processing. It maintains that the word is recognized through its constituent morphemes after an early obligatory morphological decomposition process (Taft, 1979, 2004). For instance, a word like *wreckage* is decomposed into its morphemes (wreck+age) before it is recognized.

II. Literature Review

Some findings in the literature from both L1 and L2 research lend support to the obligatory morphological decomposition hypothesis and evidence for morphological decomposition in L1 from visual word recognition has been well documented recently (Fernandes et al., 2023). Fernandes et al. conducted a meta-analysis to examine the robustness of the masked priming effect in L1 and L2 morphological processing. In the visual masked priming task a forward mask (######) is presented followed by a prime (e.g., killer) that is presented for a short duration (around 50 milliseconds). The prime is then replaced by a presentation of the target (e.g., KILL). The task requires subjects to categorize the target as a word or non-word via button press, prioritizing both speed and accuracy. Reaction times in ms and error rates are recorded. Faster reaction times and better accuracy rates in the morphologically related condition compared to the unrelated conditions is typically interpreted as evidence of morphological decomposition which precedes lexical access. In their meta-analysis, Fernandes et al. found clear priming effect only for native speakers.

Moreover, evidence for morphological decomposition from a non-concatenative language has also been observed. For instance, previous research using priming experiments (mainly visual) has shown that, during lexical processing of real words, native Arabic speakers are successful in decomposing words into their roots and patterns such that there is priming between Arabic words that share the same root (Boudelaa & Marslen-Wilson, 2013, 2015). However, the role of the pattern in morphological processing of non-concatenative languages is less clear. That is, whereas studies investigating Arabic found priming effects for both verbal patterns and nominal ones (e.g., Boudelaa & Marslen-Wilson, 2011), studies on Hebrew failed to find a clear priming effect for nominal patterns (e.g., Deutsch et al., 1998); but see Deutsch and Velan (2016) for nominal pattern effect based on eye-fixation latency using fast-priming paradigm for sentence reading.

Nevertheless, while investigating morphological processing in Semitic languages, previous investigations have mainly utilized priming experiments with real words as primes and targets. However, investigations in other languages have demonstrated that native speakers process representations (lexical vs. sublexical) differently when recognizing words vs. nonwords (Vitevitch & Luce, 1998; Gor, 2018). Therefore, using nonword stimuli can potentially provide insight whether root-based morphological processing can be replicated when only sublexical representations are accessed. Accordingly, the current investigation seeks to extend earlier investigations by thoroughly analyzing the contribution of morphemic components (root and pattern) to the cognitive processing of auditory stimuli in Arabic as a second language (ASL).

Quite recently, Aljasser (2020) used nonwords in Arabic to examine whether native Arabic speakers are sensitive to the presence of roots in nonwords. Arabic speakers were asked to rate the word-likeness of spoken nonwords in Arabic. Subjects were capable of decomposing the nonwords into roots and patterns and recognizing the real roots. Importantly, they were also sensitive to the statistical properties of the roots. In other words, whereas nonwords that had real Arabic roots were rated as more Arabic-like than those with pseudo roots, nonwords with high frequency real roots were rated as more Arabic like than those with less frequent real roots. This was taken as evidence that morphological processing in Arabic involves a process of decomposing the spoken form and that this process "revolves around the root morpheme and is guided by its distributional features" (Aljasser, 2020, p. 298).

However, there has been a long debate whether L2 speakers manage to acquire and utilize the morphological processing mechanism that is specific to their L2 or continue to adopt L1 processes even though these might be non-conducive in the L2. Masked priming studies investigating different combination of L1(e.g., German, Japanese, Russian, Turkish) and L2 (e.g., English, German) languages have found that whereas L1 speakers show strong facilitation effects for both inflected and derived primes, L2 speakers show significant priming only for derived primes (Jacob et al., 2018; Kirkici & Clahsen, 2013; Neubauer & Clahsen, 2009; Silva & Clahsen, 2008). This contrast has been accounted for by positing that while in derivational priming the base stem is accessed through the use of morpho-lexical representations (i.e., lexical entries), inflectional priming makes the use of grammatical rules representations. Whereas the former representations can be accessed by L1 speakers and L2 speakers alike, grammatical rules representations can only be effectively accessed if the language has been acquired early as an L1 (Reifegerste et al., 2019).

However, findings from priming studies investigating derivational morphology do not always converge. For example, Silva and Clahsen (2008) found out that their L2 English learners from German, Japanese, or Chinese L1 backgrounds showed only reduced priming for derived words (*bitterness*- BITTER). On the other hand, native-like priming for derived words was observed in other studies (Veríssimo et al., 2018). Veríssimo et al. used a masked priming task with a large group of Turkish-German bilinguals to explore the effect of age of acquisition on the processing of both inflected words and derived words in German. What they found was that Turkish subjects regardless of their AoA showed native-like priming effects for derived words only.

Using the same priming paradigm, it was shown that derivational processing is successful even when the L1 and L2 diverge in their mechanisms of morphological decomposition as in the case with Arabic and English. Freynik et al. (2017) used the cross-modal priming paradigm to explore the type of morphological processing non-native Arabic speakers (L1 English) adopt when processing Arabic words. They found out that, comparable to the native control group, the English speaking ASL learners showed priming effects between words that shared the same root. This made Freynik et al. (2017) conclude that L2 Arabic speakers are similar to native Arabic speakers in adopting root-based morphological decomposition of Arabic words.

As was shown in the literature review, studies exploring L2 morphological processing show mixed results. Moreover, there was an overreliance on priming tasks in the literature to explore morphological decomposition. Nevertheless, it was recently shown that morphological priming may be confounded with orthographic priming especially for L2 speakers (Ciaccio & Jacob, 2019). Using a visual priming experiment, Ciaccio and Jacob (2019) explored the role that orthography plays in L1 and L2 processing of German complex words. Their results were interesting. That is, whereas both groups showed morphological priming effects indicating decomposition, the L2 groups also showed signs of orthographic priming. This orthographic priming confound made it difficult to clearly isolate morphological effects in the L2 processing. Similarly, Plaut and Gonnerman (2000) provided an argument that morphological effects in priming tasks are potentially confounded by semantic effects.

III. The Present Study

A. *Significance*

The aim of the current study is to realize morphological decomposition in the processing of ASL without the possible confounds that may be involved in the processing of real words in general and in priming tasks in particular. That is, if non-native Arabic speakers do really possess the same root-based processing and decomposition ability that native speakers have then they should be able to show that not only when processing real words in priming tasks where other semantic or orthographic cues may be conducive but, similar to native speakers, they should be able to access real roots embedded in nonwords. In addition, using nonword stimuli, the current design will test the claim whether derivational priming is really the byproduct of accessing lexical entries or stems from a deeper mechanism. Moreover, it will more closely examine the role of pattern type in the processing of Arabic. To address these theoretical and methodological concerns, the present study examines ASL auditory nonword morphological processing.

Furthermore, the present study is original in that it examines ASL learners with an interesting L1 background; that is Indonesian. Indonesian language is particularly suited for the current investigation for a number of reasons. Firstly, it comes from a different language family, namely Austronesian, and it has been rarely studied in the context of L2 acquisition. Secondly, similarly to Arabic, it represents a diglossic situation. In other words, Indonesian native speakers speak two varieties of the language, a regional colloquial Indonesian variety which is used in everyday situations and the standard variety (i.e., Indonesian, also known as Bahasa Indonesia) which is the national language. Importantly, however, Indonesian diverges morphologically from Arabic in that it mainly adopts a stem-based morphology. It uses affixation as a main process of word formation. Like English, prefixes and suffixes are attached to the lexeme to form words. However, notably, infixes are also used in Indonesian as in the examples in Table 1 below.

TABLE 1
AFFIXATION EXAMPLES IN INDONESIAN, ADAPTED FROM KRIDALAKSANA (2014, P. 13)

Type Of Affix	**Affix**	**Lexeme**	**Derived Word**
Prefix	di-	*tulis*	*ditulis* “written”
	ber-	*jalan*	*berjalan* “walk”
Infix	-el-	*gembung*	*gelembung* “bubble”
	-em-	*getar*	*gemetar* “tremble”
Suffix	-kan	*bangun*	*bangunkan* “raise”
	-i	***lempar***	***lempari* “throw repeatedly”**

The current study’s findings when compared to others’ (e.g., Freynik et al., 2017) will provide more evidence whether native language modulates L2 morphological decomposition of derived words (Portin et al., 2008) for evidence of L1 modulation in morphological processing of inflected words). Therefore, taken together, it is important to replicate morphological decomposition in ASL using different paradigms and particularly with much understudied L1 populations.

Against this background the current study is designed to answer the following research questions:

1- Do Indonesian ASL learners show sensitivity to the availability of roots in spoken nonwords in Arabic in a manner similar to native speakers?
2- Is ASL root sensitivity modulated by pattern type?

B. Method

A seven-point word-likeness rating task (henceforth WLRT) was used to examine the effect of root when processing spoken nonwords in Arabic. In this task, Indonesian ASL learners were aurally presented with nonword stimuli. The WLRT requires subjects to rate the nonword for how likely for it to be a real word on a 7-point scale, with 1 indicating “very poor – highly unlikely to be a real word of Arabic” and 7 indicating “very good - a highly prototypical Arabic word”.

The WLRT is well suited for the current investigation for a number of reasons. First, Bailey and Hahn (2001) have argued that given the time this task affords respondents, the ratings are mainly governed by their sensitivity to the word-likeness of the nonword stimuli. Furthermore, the WLRT explicitly hinges on language-specific knowledge and the current goal is to tap into the Arabic knowledge that ASL learners have. Additionally, unlike other online tasks where computer software is used and a more complicated procedure is involved, the current task is simple and therefore ASL subjects, especially lower level ones, are more likely to understand the procedure and be spontaneous in completing the task. More importantly, it has been recognized that “When native speakers are asked to judge made-up (nonce) words, their intuitions are rarely all-or-nothing. In the usual case, novel items fall along a gradient cline of acceptability” (Albright, 2009, p. 9). These advantages of the WLRT have led to its extensive use in the speech recognition literature (Bailey & Hahn, 2001; Frisch et al., 2000; Kirby & Yu, 2007; Vitevitch et al., 1997).

(a). Participants

38 Indonesian ASL learners took part in the current study. They were all students at a Saudi university taking ASL courses. They were granted meal vouchers in exchange for their participation in the experiment. They came from three different ASL proficiency levels: 11 students from level 2, 14 subjects from level 3, and 13 subjects from level 4. Thirty-eight Saudi native Arabic speakers from the same university comprised the native control group. Participants were all male (mean age for native speakers = 19 years; and for non-native speakers =20 years).

(b). Materials

The nonword stimuli were created by using 40 real Arabic triconsonantal roots. These were mapped into two different types of patterns, namely the verbal pattern {tafaʕlal} and the nominal pattern {tafaʕlul}. In Arabic, these two patterns do typically carry quadriconsonantal roots such as {dħrdʒ} (e.g., /tadaħrudʒ/). They have four consonant slots where consonant three in the root (i.e., /r/) and consonant four (i.e., /dʒ/) are mapped into consonant slot number three (i.e., the first /l/) and four (i.e., the last /l/), respectively in the pattern.

However, in order to be able to create the real root nonword stimuli we mapped the triconsonantal roots (e.g., {qtl}) into the quadriconsonantal verbal pattern {tafaʕlal} and the quadriconsonantal nominal pattern {tafaʕlul}. This was achieved through mapping root consonant number three in the root {qtl} (i.e., /l/) twice. The first is in consonant slot number three (i.e., the first /l/ in the pattern) and the second is in consonant slot number four (i.e., the last /l/). This produced the two nonwords: the pseudo verb /taqatlal/ and the pseudo noun /taqatlul/. Other stimuli used for comparison were created using 20 unreal (i.e., nonexistent) Arabic roots (e.g., {qdb}) mapped into the same verbal and nominal patterns and using the same method.

Similar to Aljasser (2020), four conditions were created by mapping the 40 real roots and 20 nonexistent roots into the verbal pattern {tafaʕlal} and in the nominal pattern {tafaʕlul}. In condition 1, 40 Nonwords were produced by interweaving real Arabic roots into the verbal pattern. For instance, the root {qtl} was interwoven into the verbal pattern {tafaʕlal} producing the nonword /taqatlal/; hereafter this condition will be referred to as real root in a verbal pattern (RRVP) condition. In condition 2, 40 other nonwords were produced by interweaving the same roots used in condition 1 into the nominal pattern {tafaʕlul} (e.g., the root {qtl} was interwoven into the nominal pattern {tafaʕlul} producing the nonword /taqatlul/; hereafter this condition will be referred to as real root in a nominal pattern (RRNP) condition.

Two other control conditions were produced. In condition 3, 20 nonwords were created by interweaving unreal Arabic roots into the verbal pattern utilized in condition 1. For instance, the unreal root {nfb} was interwoven into the verbal pattern {tafaʕlal} producing the nonword /tanafbab/; hereafter this condition will be referred to as non-root in a verbal pattern (NRVP) condition. Lastly, in condition 4, 20 nonwords were produced by interweaving the same unreal roots utilized in condition 3 into the same nominal pattern utilized in condition 2 (e.g., the unreal root {nfb} was interwoven into the nominal pattern {tafaʕlul} creating the nonword /tanafbub/); hereafter this condition will be referred to as non-root in a nominal pattern (NRNP). Although this design is similar to the one adopted by Aljasser (2020), all the stimuli items in the present study are new. This was to ensure that any observed effects are condition effects rather than specific stimuli effects.

Adopting this design allowed the control of two important variables. The first is the number of phonemes as all items had eight phonemes. The second is the number of syllables as all nonwords in all conditions had three syllables. Every single stimulus item was spoken in isolation and recorded by a male native Arabic speaker using a high-quality microphone on to digital-audio-tape at a sampling rate of 44.1 kHz. The recordings were then saved as digital 16- bit files on a computer disk.

(c). Procedure

The total of 120 nonword stimuli items were put in three randomized lists with each including all 120 items. ASL participants were divided into three equal groups and each group was assigned one randomized list. The same division was followed for native speakers. A language computer lab was used for the experiment presentation. Each group was tested one at a time. Each participant was seated in a computer booth equipped with headphones. Participants were instructed that they will listen to nonwords and that their task is to rate the nonword item for its word-likeness in Arabic on a 7-point scale, with 1 indicating "very poor – highly unlikely to be a real word of Arabic" and 7 indicating "very good - a highly prototypical Arabic word".

Participants received five practice trials for familiarization prior to the stimuli presentation. These trials were not included in the final data analysis. Two 3-minute breaks were provided in each list for each group.

IV. RESULTS

The four conditions the experiment involved are as follow: Real root in a verbal pattern (RRVP), Real root in a nominal pattern (RRNP), Non-root in a verbal pattern (NRVP) and Non-root in a nominal pattern (NRNP). Mean ratings and standard deviations for each of the four conditions for both groups are shown in Table 2.

TABLE 2
MEAN RATINGS AND STANDARD DEVIATIONS BY LANGUAGE GROUP AND CONDITION

Language Group	RRVP	RRNP	NRVP	NRNP
NASs	4.30 (.55)	4.37 (.54)	2.99 (.68)	3.01 (.74)
NNASs	4.15 (.87)	4.33 (.85)	3.38 (.87)	3.69 (.77)

A set of repeated measures ANOVAs were run with Root availability (available, not available) and pattern type (noun pattern, verb pattern) as within-subjects factors, and Language group (native, non-native) as the between-subjects factor.

A. Root Effects

The ANOVAs results showed a significant two-way interaction effect of language group and root availability on ratings (F (1, 74) = 26.87, p < .0001, η_p^2= .266). Pairwise Post hoc analysis showed that both groups rated nonwords in the available root conditions significantly higher than those in the unavailable root conditions (NASs, MD = 1.334, p < .0001;

NNASs, MD=.74, $p < .0001$). Results also showed a lack of a language group effect indicating that both groups showed root sensitivity to a similar degree (F (1, 74) = 2.09, p = 0.152, η_p^2= .028).

B. Pattern Type Effects

The ANOVAs results showed a significant two-way interaction effect of language group and pattern type on ratings (F (1, 74) = 5.02, p = .028, η_p^2= .066). A significant effect of pattern type was only found for the NNASs (F (1, 37) = 10.32, p = .003, η_p^2= .218). Pairwise Post hoc comparisons showed that only NNASs rated nonwords in the noun pattern significantly higher than those in the verb pattern (MD = .243, p = .003).

V. Discussion

The current study set out to determine whether ASL learners process Arabic language using the same method of morphological decomposition that native Arabic speakers adopt; that is, decomposing words into roots and patterns. English speaking ASL learners seem to be sensitive to roots and patterns when processing Arabic words (Freynik et al., 2017). The current study sought to examine whether ASL learners from a totally different L1 background show the same sensitivity especially when a different paradigm other than the widely adopted priming task is used.

The current investigation is original in a number of ways: First, it examines ASL learners' processing of nonwords rather than real words. This is particularly important as priming effects reported in the widely used priming experiments may be attributed to the cofounding orthographic (Ciaccio & Jacob, 2019) or semantic effects (Gonnerman et al., 2007) rather than pure morphological ones. Second, not only is it an important contribution to the scarce L2 Arabic morphological investigations but also the L1 background of the ASL learners in the present study is interesting. Indonesian language has been rarely studied in the context of SLA compared to other Indo-European or Semitic languages.

Unequivocally, similar to native Arabic speakers, Indonesian ASL learners have shown a processing pattern that is shaped by the morphological structure of L2 Arabic in that they decompose nonwords into roots and pattern. Nonwords with real Arabic roots were judged as more Arabic-like than nonwords with no real Arabic roots.

Recall that significant priming effects in other languages (Jacob et al., 2018; Kirkici & Clahsen, 2013; Neubauer & Clahsen, 2009; Silva & Clahsen, 2008) were accounted for by positing that in derivational priming the base stem is accessed through the use of morpho-lexical representations (i.e., lexical entries). However, given the non-concatenative nature of Arabic morphology and that test items were all nonwords, one cannot attribute L2 subjects' root sensitivity in the current experiment to their ability to access lexical entries. On the contrary, the current findings are supportive of a root-based processing of Arabic morphology (e.g., Boudelaa & Marslen-Wilson, 2011). Moreover, the difference between concatenative stem-based word formation processes in Indonesian and those non-concatenative root-based processes in Arabic makes it unlikely for L1 morphological information to assist in ASL morphological decomposition. Instead, the current findings clearly demonstrate that ASL learners have acquired sensitivity to Arabic roots in that they were able to extract the discontinuous root consonants. This enabled ASL learners to morphologically decompose the nonwords into roots and patterns without accessing a specific lexical entry in memory. In other words, we agree with Freynik et al. (2017, p. 39) who concluded that "combinatorial entries account is not a viable model of L2 derivational processing of Semitic languages such as Arabic".

The combinatorial entry account was posited by Silva and Clahsen (2008). This account was based on their findings that whereas only L1 English speakers show priming for inflected forms, both L1 English speakers and L2 English learners show priming for derived forms. This account relies heavily on Ullman's Declarative/Procedural (DP) model of processing (Ullman, 2005). Under this model, two systems govern native language processing: a declarative system and a procedural system. The declarative system is said to be dealing with morpho-lexical representations (i.e., lexical entries) and that the procedural system is concerned with grammatical rules representations. The difference between successful priming for derived forms in the L2 and the generally reduced priming for inflected forms is explained in terms of overreliance of L2 learners on the declarative system. Decomposing inflected forms, on the other hand, is achieved by the procedural system through grammatical rules representations. This ability is argued to be absent in L2 processing. Such a proposal may explain priming effects for derived forms in a concatenative language like English where the stems and affix morphemes are serially attached (e.g., builder- BUILD). However, this model fails to account for the current findings in the non-concatenative forms in Arabic language. In other words, how does accessing a lexical representation in the declarative system explain our subjects' sensitivity to the availability of a discontinuous root embedded in a nonword? Alternatively, we argue that an obligatory morphological decomposition process (Boudelaa, 2014) proposed for native Arabic language processing seems to be applied in ASL morphological processing. This suggests that L2 speakers can share the same morphological processing mechanisms as L1 speakers of the target language.

An interesting result, however, is that only non-native speakers showed an effect of pattern type. That is, they rated nonwords in the nominal pattern as more Arabic-like than those in the verbal pattern. This cannot be an item effect because identical roots were used in the two patterns conditions. Furthermore, if it were the case, it would show a similar pattern in native speakers' results. One possible explanation for this finding might be that ASL learners are exposed to and use more nouns than verbs making nonwords with nominal patterns more likely to be perceived as Arabic-like than nonwords in verbal patterns. This is in line with recent findings that Arabic children produce more nouns than verbs in their early years of acquisition (Shalhoub-Awwad & Khamis-Jubran, 2021). This may indicate that ASL follows a similar path to the L1 acquisition of the nominal system in Arabic. On the other hand, our adult native speakers may not have shown an effect of pattern type because their identification of the root morpheme seems to be earlier and more robust than the identification of the pattern morpheme (Boudelaa & Marslen-Wilson, 2005). Whether ASL learners can reach such processing efficiency with high proficiency levels remains an open question for future research.

VI. Conclusion

The current research has demonstrated that L1 Indonesian ASL learners have acquired a native-like morphological decomposition in that they can access the root embedded in a pattern and use it as the main unit of lexical processing. Clearly, this cannot be the outcome of accessing a lexical entry in memory as has been posited for languages with concatenative morphology. Future research should aim to provide answers that can help develop a derivational morphology model which can account for findings in different language types particularly those with non-concatenative morphology. One limitation remains to be addressed in future research. That is, although the current non-word rating task shows that ASL learners utilize morphological decomposition it does not reveal how automated this L2 morphological decomposition process is. Future research should aim to utilize online tasks that exclude semantic and orthographic confounds and at the same time tap into more automatic lexical processing.

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