MEDIA & COMMUNICATION STUDIES | RESEARCH ARTICLE

Emphatic assimilation across morpheme boundaries in Jordanian Arabic
Mutasim Al-Deaibes¹*, Marwan Jarrah², Ekab Al-Shawashreh³ and Rami Alsharefeen⁴

Abstract: This study aims to examine emphatic assimilation across morpheme boundaries in Jordanian Arabic (JA). Our research is based on word-list data comprising 86 words uttered by 12 native speakers of JA, recorded and acoustically analyzed in Praat for a total of 1032 tokens. The consonants of the bound morphemes tested include the genitive/accusative suffix-initial consonant /h/, the active participle prefix-final consonant /l/, and the definite article-final consonant /l/, in terms of emphasis. The results firstly show that the phomene /l/ undergoes total emphatic assimilation when followed by a coronal obstruent. Secondly, when the phomene /l/ is followed by any emphatic coronal, it undergoes total emphatic assimilation. Thirdly, the phomene /h/ undergoes total emphatic assimilation when preceded by an emphatic voiceless fricative or an emphatic voiceless plosive. Fourthly, the directionality of assimilation across morpheme boundaries is either progressive with the suffix /h/ or regressive with the prefixes /l-/ and /l-/. Finally, emphasis is found to be an important feature that correlates with assimilation.

Subjects: Theories of Learning; Bilingualism / ESL; Language & Linguistics

Keywords: Linguistics; morphophonology; assimilation; Jordanian Arabic; emphasis

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PUBLIC INTEREST STATEMENT
This study investigates how certain speech sounds change their features or get affected by the neighboring sounds. This change could occur between words or within words. Our focus in this study is on how the sounds of affixes are affected by the neighboring sounds in the stem words. We also show that this effect could be from left to right or right to left depending on the affix (whether it is a prefix or suffix). This research is based on word-list data comprising 86 words produced by twelve native speakers of Jordanian Arabic, for a total of 1032 tokens.
1. Introduction

Assimilation across morpheme boundaries in Arabic has received a fair amount of attention; nonetheless it is for the most part limited to an impressionistic examination of assimilation of the definite article “ئٌل” (Haselwood & Watson, 2013; Elramli, 2012; Alshammiry, 2013; Benyousef & Mahadin, 2013, Al-Deaibes, 2016; Al-Deaibes & Rosen, 2022). This study takes a step further exploring the full extent of assimilation across morpheme boundaries in Jordanian Arabic (JA). More specifically, this study examines assimilation across morpheme boundaries in terms of emphasis which is an important feature that is proven to spread to neighboring sounds in Arabic (Al-Deaibes et al., 2021; Al-Masri, 2009; Jongman et al., 2011). This study is also important as JA is an understudied variety of Arabic, which, as we show in this article, is found to display unique properties as compared to other Arabic varieties investigated in this regard. Additionally, this study uses an acoustic analysis to emphatic assimilation across morpheme boundaries, hence investigating different morphemes rather than the definite article, which was the main target of the ongoing research.

The motivation of the study stems primarily from the obvious observation that many JA speakers tend to use assimilation between consonants across morpheme boundaries in computer-mediated communications on social media in Romanized Arabic. For example, JA speakers assimilate the definite article “ئٌل” to a following fricative phoneme like “s” as in “ئٌل-salaام” “the peace” which is written as “ئٌس-salaام”. In other places, speakers of JA do this when they code-switch between Arabic definite article ئٌل and English lexical words on computer-mediated communications as in a word like “el-security” “the security” which is written down as “essecurity” (Al-Deaibes, 2021b).

This paper is organized as follows. Section one offers a general overview of Jordanian Arabic dialects. It also sheds light on the morphology of bound morphemes that is investigated in the current study. It also provides a summary of the findings of the main studies on the phonetic assimilation of different Arabic dialects. This section also provides an overview of the acoustic parameters for emphasis and explains how the current paper can fill a marked gap in the related literature. In section two, we describe our procedures of data collection and analysis. Sections three and four list the findings of this research article and provide an analysis and discussion of them. Finally, in section five, we conclude the article with a summary of the primary findings and spell out some recommendations for further research.

1.1. Jordanian Arabic sub-dialects

Modern Standard Arabic (MSA) is a Semitic language that is spoken in the Middle East and North Africa. It is one of the official six languages of the United Nations (United Nations, 2011). Jordanian Arabic (JA) is one of the Arabic dialects spoken in the Levant.1 JA belongs genetically to the Semitic languages family and branches into three basic sub-dialects distributed according to the geographical areas. These sub-dialects include Urban Jordanian Arabic (UJA), Bedouin Jordanian Arabic (BJA), and Rural Jordanian Arabic (RJA; Suleiman, 1985).

UJA is mainly spoken in the big cities and by city dwellers of Palestinian or Syrian origins. Such dwellers immigrated to Jordan in the past two centuries due to regional wars and forced expulsion. It is worth mentioning that UJA is not the whole picture of Jordanian Arabic; rather it consists of one part of it given that its speakers descended from other countries. UJA therefore shares many similarities with several dialects, i.e., Syrian, Palestinian, and Lebanese (Ibrahim, 1984). Bedouin Jordanian Arabic (BJA) is spoken by desert inhabitants (originally nomadic tribes) mainly scattered in the eastern and southern parts of Jordan. According to Sakarna (1999), there are five main Bedouin dialects in Jordan, spoken by five Bedouin tribes such as Bani Hasan, Bani Saker, Al-Huwaitat, Al-Ajaarma, and Al-Abady. On the other hand, Rural Jordanian Arabic (RJA) is spoken by villagers (farmers) who mainly live in the suburbs and countryside of north Jordan. This variety is also spoken by city dwellers who came from the suburbs but moved to the city for work or study.
Table 1. Summary of studies on assimilation in Arabic

| Dialect               | Boundary Affected               | Study Reference          | Main Findings                                                   |
|-----------------------|---------------------------------|--------------------------|-----------------------------------------------------------------|
| Turaij Arabic         | Morpheme Boundary /l/           | Alshammiry (2013)        | * /l/ totally assimilates to a following coronal.               |
| Algerian Arabic      | Morpheme boundary (/W/ and /l/) | Benyacuf and Mahadin     | * /l/ totally assimilates to a following coronal.               |
| Cairene Arabic       | Morpheme boundary (definite article /l/) | Haselwood and Watson (2013) | * /l/, the following coronal undergoes gemination.               |
| Misrata Libyan Arabic| Morpheme boundary (/l/ and prefix /l-/) | Elramli (2012)          | * /l/ totally assimilates to a following coronal                |
| Jordanian Arabic     | Morpheme boundary (/mit-/ and /h-v/) | Al-Deaibes & Rosen, 2022 | * /mit/ undergoes voicing when followed by a voiced obstruent   |
|                       |                                 |                          | * /h/ undergoes devoicing when preceded by a voiceless obstruent|

Although MSA is the official language by constitution in Jordan and is used in newspapers, radios, government issues, official speeches, regulations, Friday sermons, etc., people speak their vernacular dialects in their everyday life conversations. So, Jordan, like other Arab countries, lives in a diglossic situation whereby MSA is exclusively used in formal settings (Ferguson, 1959; El-Hassan, 1977).²

In this study, we refer to these three dialects as mainstream Jordanian Arabic (MJA) which is used by all speakers of these dialects representing the majority of the population in Jordan. Other dialects that are not referred to as MJA include Ghourani and Dorzi dialects, among others, which are spoken by minority groups.

1.2. Previous studies on assimilation

Phonological assimilation has been explored cross-linguistically (Mohanan, 1993; Jun, 1995; Lombardi, 2001, 1999; Hansson, 2001; Rose & Walker, 2004; Al-Deaibes, 2016; Al-Deaibes & Rosen, 2022, among others), especially across word boundaries. However, in spoken Arabic, few studies have dealt with assimilation across morpheme boundaries. In MJA, in particular, no single study, to the best of our knowledge, has investigated assimilation across morpheme boundaries to date. Table 1 summarizes some of the main findings of the related studies that dealt with assimilation across morpheme boundaries in spoken Arabic.

All studies that dealt with Jordanian Arabic dialects (mainly MJA) have particularly focused on consonantal assimilation across word boundaries within Optimality Theory (See, Zuraïq & Abu-Joudeh, 2013; Zuraïq & Zhang, 2006). As shown in Table 1, the definite article undergoes total assimilation when it is followed by a coronal consonant.

As far as JA is concerned, Zuraïq and Zhang (2006) investigated consonantal assimilation in UJA. They found that place assimilation is always regressive and alveolars and postalveolars undergo assimilation when the sonority of the consonants already matches. Zuraïq and Zhang (2006) also showed that coronal obstruents assimilate to following coronal obstruents but not velar obstruents. They also asserted that voicing and emphasis take place when the places of the adjacent non-coronal consonants are identical. So, according to them, the similarity in place of articulation plays an important role in accounting for the behavior of voicing and emphatic assimilations.
Table 2. Examples of root and pattern in MJA

| Type | Pattern | Example | Root | Gloss   |
|------|---------|---------|------|---------|
| I.   | fiːːb   | tiːːb   | ʃ-ð-b | “lying” |
| II.  | faʃːal  | tiːːdab | ʃ-ð-b | “liar”  |
| III. | faʃːal  | taʃːːb   | ʃ-ð-b | “to belie” |
| IV.  | faʃːal  | tiːːdab | ʃ-ð-b | “he lied” |
| V.   | mitʃːːl | miʃːːdab | ʃ-ð-b | “to be belied” |

Table 3. Mean formant frequencies at 50% and duration of the vowel /a/

| Vowel /a/ | Mean F1 midpoint (Hz) | Mean F2 midpoint (Hz) | Mean F3 midpoint (Hz) | Mean duration (ms) |
|-----------|-----------------------|-----------------------|-----------------------|--------------------|
| Before emphatic consonants | 596.1964 | 1266.681 | 2983.399 | 0.17617 |
| Before plain consonants     | 591.6385 | 1557.681 | 2724.656 | 0.098051 |

Table 4. Mean formant frequencies at 50% and duration of the vowel /i/.

| Vowel /i/ | Mean F1 midpoint (Hz) | Mean F2 midpoint (Hz) | Mean F3 midpoint (Hz) | Mean duration (ms) |
|-----------|-----------------------|-----------------------|-----------------------|--------------------|
| Before emphatic consonants | 842.2961 | 1610.981 | 3099.689 | 0.214465 |
| Before plain consonants     | 520.026 | 1885.836 | 2846.122 | 0.205082 |

Other studies in the literature of JA assimilation focused on assimilation across word boundaries using Optimality Theory. For example, Abu Abbas et al., (2010) found that the coronal sonorants /n/ and /l/ undergo total assimilation to a following /r/, but not to any other consonant. They considered local conjunction as an appropriate tool for handling voice, emphasis, and continuance assimilation in stem-stem clusters in Arabic.

In a related vein, a number of studies reported that when a vowel is adjacent to an emphatic consonant, F1 and F3 are significantly raised, which is an indication of upper pharyngeal constriction due to the presence of a sound with a secondary pharyngeal constriction. F2 is also found to significantly lower because emphatic consonants drag the adjacent vowels to the low back position due to an enlarged mouth cavity well as a constriction in the back part of the vocal tract. It was also reported that F1, F2 and F3 are the main acoustic cues for emphasis (Al-Deaibes et al., 2021; Al-Masri, 2009; Jongman et al., 2011; Khattab et al., 2006; Wahba, 1993). Card (1983) found that emphasis features spread phonetically to adjacent sounds in the whole word regardless of the directionality, while the duration of the vowel preceding the target consonants was found to be insignificant.

To the best of our knowledge, no previous studies have dealt with the assimilation of other bound morphemes, apart from the definite article /i/ and the prefix /ʔin/ to a free morpheme in MJA.
1.3. **MJA bound morphemes under investigation**

The consonants of the bound morphemes examined in the present study include the genitive/accusative suffix-initial consonant /ň/ in the pronouns “hum”, “hin” and “ha”, the active participle prefix-final consonant /y/ in /mity/, and the definite article-final consonant /y/ in /tily/. The phonological assimilation of these consonants in these morphemes to other adjacent consonants in the free morphemes is investigated in terms of emphatic assimilation. The reason why we decided to examine these morphemes is based on our observation of this phenomenon in both written and oral communications (see, section 1).

It is worth mentioning here that the morphological system in all Arabic varieties is called the root-and-pattern system, whereby roots provide the general meaning of the word, and patterns contribute the derived meaning (Elgadi, 1986, p. 85). This can be illustrated in the following Table 2.

Based on Table 2, it can be revealed that the first pattern is the simplest and the commonest in MJA. It functions as a base for the verb. In other words, the verb that carries this pattern should be CVVC. The consonants in this verb are the triconsonantal (trilateral) root, i.e., ( título), and the vowels will be only the high front short vowel /i/. Likewise, the second type /faʕʕa:l/ is the template for any verb that is CVCC:CV, which implicates that the consonants in this verb are ( título) in which the middle consonants are gminated, and the vowels are the low front short vowel /a/ and the low front long vowel /a:/ This equally applies to the other types of patterns.

1.3.1. **The /-hum/, /-hin/ and /-ha/ morphemes**

With regard to the genitive/accusative suffixes “-hum” (3PM), “-hin” (3PF) and “-ha” (3SF) in MJA, they are a third person bound suffix that cannot stand on its own without being attached to the terminal of a verb or a noun. These suffixal pronouns agree in number and gender with the entity that they refer to except for the singular masculine which is vowel-initial (-u) and thus does not participate in the assimilation of interest here. The following examples (adapted from Al-Deaibes & Rosen, 2022) show how these suffixes are used in MJA.

1. Ahmad kasar-ha
   Ahmad broke-3SF
   “Ahmad broke it.”

2. Ahmad kasar-hin
   Ahmad broke-3PF
   “Ahmad broke them.”

3. Ahmad kasar-hum
   Ahmad broke-3PM
   “Ahmad broke them.”

4. Ahmad kasar-u
   Ahmad broke-3SM
   “Ahmad broke it.”

According to the examples above, the third-person masculine pronoun is excluded in this paper because it has a different realization, which is the suffix -uh. Thus, there will be no assimilation between the phoneme /ň/ in uh and the preceding consonants because of the vowel /i/.

1.3.2. **The morpheme /mit-/**

The second morpheme covered by the study is the final consonant of the active participle prefix /mit/. This prefix is a dependent (bound) morpheme that cannot stand by itself, i.e., it has to be
connected to a verb to function. When the active participle prefix /mit-/ in MJA is affixed to a verb, it acts as an adjective in which case it agrees with its subject in number and gender. It is mainly used to describe the state of being, to describe an event that is happening at the moment, and to ascertain that an action is in the state to have been done. The following instances (adapted from Al-Deaibes & Rosen, 2022) exemplify how the active participle in MJA is used.

5. Ali mit-dʒaw.wiz
   Ali AP-marry
   “Ali is married.”

6. Maha mit-dʒawz-e
   Maha AP-marry-FS
   “Maha is married.”

7. Ali w Maha mit-t’alɡ-in
   Ali and Maha AP-divorce-MPL
   “Ali and Maha are divorced.”

8. Maha and Lila mit-t’alɡ-at
    Maha and Lila AP-divorce-FPL
    “Maha and Lila are divorced.”

As shown in the examples above (5–8), the prefix (mit-) is attached to the verbs, resulting in active participles that act as adjectives. It is also clear for the examples in (5–8) that the active participles agree in gender and number with their subjects.

1.3.3. The morpheme /ʔil-/  
The third morpheme scrutinized in this study is the Arabic definite article ʔil-, which has to be connected to either a noun or a postnominal adjective that is preceded by a noun that is prefixed with ʔil. In Arabic grammar, the sounds are categorized into two groups, namely lunar and solar (concepts that are traditionally used in reference books of Arabic). Only solar sounds can fully assimilate to /ʔil-/ in /ʔil/ where lunar (noncoronal) sounds do not. Consider the following examples for illustration.

9. ʔil-bint  ʔil-dʒamile
    the-girl  the-beautiful
    “The beautiful girl.”

10. ʔis-salame nɪme
     the-peace  blessing
     “Peace is a blessing.”

As shown in examples above, if the first consonant of the stem that the definite article ʔil is attached to is lunar (non-coronal), there is no total assimilation as in (9), whereas in (10) ʔil totally assimilates to the coronal /s/ because it is a solar sound.

2. Methods

2.1. Participants
Participants of the study were six male and six female native speakers of MJA with no known history of either speech or hearing impairment whose L1 is MJA and L2 is English. Their mean age was 34, and they were acquaintances of the researchers. To protect the participants’ confidentiality and to meet research ethics, a consent form was given to the participants prior to collecting
the data to explain the purpose of the study and to seek their permission to record the stimuli of the study.

2.2. Recordings
The participants were provided with a written list of common phrases, where each phrase contains a word followed or preceded by an affix. They were asked to read the phrases in MJA at a normal pace and to read them the way they would use them in everyday-life communications. The participants were not informed about the specific purpose of the study to make the production of phrases more natural and unbiased. The recording was performed with a Marantz PMD-660 solid state recorder and an Audix OM 2 microphone in a quiet room.

2.3. Stimulus material
Although the MJA consonant inventory consists of 29 consonants, the total number of tokens used in the study were 86 (recorded by 12 participants for a grand total of 1032 tokens) because some consonants do not occur in certain environments in MJA. Twenty nine phrases were recorded for the prefix-final consonant /t/ in /imit-t/, 29 phrases for the prefix-final consonant /ʔʔʔʔ/, whereas 28 phrases for the suffix-initial consonant /ʔʔʔʔ/ in /ʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔʔAAC__AAL脱_1.jpg
higher F1 and F3 and lower F2 than the same vowels preceding plain consonants across the board. With regards to vowel duration, it can be noticed that emphatic consonants have longer vowels before them than plain consonants do. It bears pointing out here that the vowel /u/ was only used before plain consonants unpurposefully in the stimuli, and no examples had the vowel /u/ before the target emphatic consonants.

In order to check if there is a statistically significant difference between F1, F2, and F3 as well as the duration of the vowels preceding emphatic and plain consonants, a one-way ANOVA test was used. The results of the ANOVA test show that F1 at the onset of the vowels preceding the emphatic consonants is significantly higher (M = 730 Hz, SD = 345) than those preceding plain consonants (M = 542 Hz, SD = 289), (F(10.33) = 0.0015, p < 0.01. Also, F1 at the midpoint of the vowels preceding emphatic consonants (M = 776 Hz, SD = 380) is significantly higher than those preceding plain consonants (M = 531 Hz, SD = 295), F(16.45) = 6.93e-05, p < 0.001 (see, Figure 1 below). F1 at the offset of the vowels preceding emphatic consonants (M = 797 Hz, SD = 384) is significantly higher than those before plain consonants (M = 462 Hz, SD = 226), F(45.56) = 1.28e-10, p < 0.001.

Similarly, F3 at the onset of the vowels preceding the emphatic consonants (M = 3029 Hz, SD = 468) was significantly higher than that of the vowel preceding plain consonants (M = 2741 Hz, SD = 445) F(10.75) = 0.00121, p < 0.01 (see, Figure 2 below). F3 at the mid of the vowels preceding emphatic consonants (M = 3068 Hz, SD = 396) is significantly higher than those before plain consonants (M = 2813 Hz, SD = 408), F(10.18) = 0.00163, p < 0.01. F3 at the offset of the vowels preceding emphatic consonants (M = 3189 Hz, SD = 408) is significantly higher than those before plain consonants (M = 2707 Hz, SD = 366), F(43.47) = 3.1e-10, p < 0.001.

In contrast, F2 at the onset of the vowels preceding the emphatic consonants (M = 1503 Hz, SD = 346) is significantly lower than those before plain consonants (M = 1875 Hz, SD = 402), F(23.04) = 2.92e-06, p < 0.001(see, Figure 3 below). F2 at the midpoint of the vowels preceding emphatic consonants (M = 1519 Hz, SD = 448) is also significantly lower than those before plain consonants (M = 1815 Hz, SD = 373), F(15.47) = 0.000112, p < 0.001. F2 at the offset of the vowels preceding emphatic consonants (M = 1477 Hz, SD = 359) is significantly lower than those before plain consonants (M = 1756 Hz, SD = 263), F(26.01) = 7.29e-07, p < 0.001.
As for the duration of the vowels preceding the emphatic consonants (M = 204 Ms., SD = 26) and the plain consonants (M = 183 Ms., SD = 23), the ANOVA test results show that duration of the vowels preceding the emphatic consonants is insignificantly higher than those before plain consonants whether the outliers F(0.191) = 0.663, p > 0.5. Vowel duration before emphatic and plain consonants can be observed in (Figure 4).

3.2. Summary of emphatic assimilation results
When the phoneme /t/ is followed by an emphatic coronal obstruent, /t/ undergoes total emphatic assimilation as shown in the examples below (11–14). Therefore, the phoneme /t/ functions as a target rather than a trigger because it changes its phonological properties, emphasis, to pattern with another adjacent segment.

11. mit-s′aːwib  [mis′s′awib] ‘He is injured.’
12. mit-t′allig  [mit′t′allig] ‘He is divorced.’
13. mit-ð′aːhir  [mið′ð′ahir] ‘He is pretending.’

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11. mit-s′aːwib  [mis′s′awib] ‘He is injured.’
12. mit-t′allig  [mit′t′allig] ‘He is divorced.’
13. mit-ð′aːhir  [mið′ð′ahir] ‘He is pretending.’
14. mit-z’ayyir [miz’-z’ayyir] ‘He is looking younger.’

The emphasis process can also be observed in the spectrogram in (Figure 5) below where /t/ undergoes total emphatic assimilation when it is followed by the emphatic fricative /sˤ/. As shown in the spectrogram, there is no appearance of the voiceless plosive /t/ after the vowel /i/ as there is no closure seen, which would indicate the presence of /t/. Rather, the vowel /i/ is followed by the friction of the emphatic /sˤ/, indicating that a total emphatic assimilation is actually taking place. The directionality of emphatic assimilation in the phoneme /t/ is regressive because it spreads leftward.

When the phoneme /h/ is preceded by an emphatic voiceless fricative consonant or an emphatic voiceless plosive consonant, /h/ undergoes total emphatic assimilation as shown in the examples below (15–16).

15. bas’hum [bas’h- s’um] ‘their bus’
16. ballat’hin [ballat’h- tin] ‘he made them tiles’

The directionality of emphatic assimilation is progressive, not regressive as opposed to /t/ because it spreads rightward. Emphatic assimilation can also be observed in the spectrogram in (Figure 6),
which shows how the friction extends from the offset of the vowel /a/ to the onset of the vowel /u/ in the word “bәs-s’um”.

By contrast, when the emphatic voiced fricative consonant /ðˤ/ is preceded by the phoneme /h/, it undergoes a two-process assimilation: /ðˤ/ gets devoiced as a target and then becomes a trigger and undergoes total emphatic assimilation as presented in the following example (17):

17. ɣра:ðˤ-hum [ɣra:θˤ- θˤum] ‘their stuff’

According to example (17) above, /ðˤ/ undergoes devoicing and becomes /θˤ/ and retains the emphasis feature. As far assimilation directionality it is bidirectional; it is regressive (leftward) as a result of devoicing and progressive (rightward) as a result of total emphatic assimilation.

With regards to the phoneme /l/, when it is followed by an emphatic coronal, it undergoes total emphatic assimilation as presented in examples (18–22). This can also be illustrated in the spectrogram in (Figure 7) below, where /l/ fully assimilates to /tˤ/. Therefore, the phoneme /l/ is a target rather than a trigger because it changes its phonological properties to pattern with another adjacent segment.

18. ʔil-s’a:ħib [ʔiðˤ-s’a:ħib] ‘the friend’
19. ʔil- t’alag [ʔiðˤ-t’alag] ‘the divorce’
20. ʔil-ð’ahir [ʔiðˤ-ð’ahir] ‘the appearance’
21. ʔil-z’ayi:reh [ʔiðˤ-z’ayi:reh] ‘the little one’
22. ʔil-le:l [ʔiðˤ-le:l] “the night”

Figure 6. Illustration of emphatic total assimilation of /sˤ/ and /h/.

Figure 7. Illustration of total assimilation of /l/ and /tˤ/ in the word “ʔitˤ- t’alag”. 
The directionality of emphatic assimilation is regressive, not progressive because it spreads leftward.

4. Discussion

The results of the present study show clearly that emphasis is an important feature in MJA because it spreads to the adjacent sounds, and that the directionality of emphasis across morpheme boundaries is either progressive as is the case with the suffix /h/ or regressive as is the case with the prefixes /t/ and /l/. The interesting part of this study is that it deals with spreading the emphasis feature from one consonant to another, not just investigating the effect of the emphatic consonants on the adjacent vowels. This study also reports that the phoneme /t/ is a target rather than a trigger for emphasis when it is followed by an emphatic coronal obstruent.

The phoneme /l/ in the definite article becomes emphatic and undergoes total assimilation when followed by an emphatic coronal. On the other hand, the phoneme /h/ picks up the emphasis feature when followed by an emphatic voiceless fricative or an emphatic voiceless plosive. Thus, emphatic assimilation occurs as a result of place assimilation. This finding disagrees with Zuraiq and Zhang (2006) and Zuraiq and Abu-Joudeh (2013) who propose that in order for emphatic assimilation to take place across word boundaries in UJA, the two adjacent consonants have to obtain the same place of articulation. This finding indicates that emphatic assimilation across morpheme boundaries does not require the two adjacent sounds to share the same place of articulation. Thus, emphatic assimilation does not behave similarly in both across morpheme boundaries as well as across word boundaries.

Further, when investigating the acoustic correlates of the vowels preceding the affected (emphatic) consonants, the results of the present study agree with the other studies that dealt with emphasis. For example, F1, F2 and F3 have been found as significant acoustic cues of emphasis, whereas the duration of the vowel was less salient, a finding that concurs with other studies like (Wahba, 1993; Khattab et al., 2006; Al-Masri, 2009; Jongman et al., 2011; Al-Deaibes, 2016; Al-Deaibes et al., 2021). This can also be observed through investigating the emphatic assimilation of the phoneme /l/ in the definite article when it undergoes total emphatic assimilation. Therefore, we propose that emphatic assimilation takes place after place assimilation or because of place assimilation, which contradicts Heselwood and Watson, (2013)’s assumption that the definite article in Arabic does not assimilate. Rather, it undergoes gemination. Since /l/ assimilates in place to other consonants and then picks up the emphasis feature, then /l/ undergoes assimilation, but the assimilated form may become longer in duration, but still, it undergoes assimilation. These results corroborate those of Alshammary (2013), Benyoucef and Mahadin (2013), Elramli (2012), and Zuraiq and Zhang (2006), who reported that the phoneme /l/ totally assimilates to the following coronal consonant.

An interesting result that came up in the study is the way the phoneme /ð/ behaves when it is followed by the phoneme /h/. As mentioned earlier, it undergoes a two-way process assimilation. It, first, loses its voicing feature (gets devoiced) because it is affected by the voicelessness of the phoneme /h/, which results in a regressive assimilation. Second, it becomes a trigger and undergoes total emphatic assimilation, which changes the directionality of assimilation to progressive, resulting in a new emphatic consonant, /ð/, which does not exist in unconnected speech. This result has not been found in previous studies to date. This might be taken as evidence that this feature is dialect-specific. Thus, voicing and emphasis features act separately and in different directions, and this is limited to the coronal /ð/ when followed by the placeless /h/ (see, Al-Deaibes & Rosen, 2022 for more information about devoicing of obstruents across morpheme boundaries).

Phonologically, the directionality of emphasis in coronals at the coda position is regressive. This regressive directionality has to do with the position of the phoneme in the syllable and whether it is in the affix position or the stem position in the word. Since the coronals /t/ and /l/ occur in the coda position, and at the same time at the affix position, then they are more vulnerable to change their phonological properties than the emphatic coronals that are at the onset of the syllable and at the stem position of the word. Codas are weaker than onsets, and the preceding phoneme is weak as compared with following
phoneme, which affects the preceding phoneme and causes it to change its phonological properties to pattern with it. Also, emphatic assimilation of this kind is triggered by the Obligatory Contour Principle, which prohibits two adjacent identical elements at the melodic level, and this violation is resolved by delinking the leftmost place feature. On the other hand, emphatic assimilation may have a progressive directionality if the emphatic coronal occurs at the coda position of the stem position of the word. This kind of directionality is triggered by having the obstruent phoneme /h/ at the onset position of the affix position. This leads us to conclude that the position of the phoneme -whether at the stem or affix position- is stronger than the position of the phoneme in the syllable-whether at the coda or onset- to account for the assimilation directionality.

5. Conclusion
In this acoustic study, we investigated the full extent of assimilation across morpheme boundaries in an understudied variety of Arabic, Mainstream Jordanian Arabic. The consonants of the bound morphemes examined in the present study are the genitive/accusative suffix-initial consonant /h/, the active particle prefix-final consonant /t/, and the definite article-final consonant /l/. The assimilation of these three affixes is examined in terms of emphasis. The results of the study unveil several generalizations that are related to the behavior of certain morphemes in MJA. First, the phoneme /h/ undergoes total emphatic assimilation when it is followed by a coronal obstructant. Second, the phoneme /l/ undergoes total emphatic assimilation when followed by any emphatic coronal. Third, and more interestingly, the phoneme /h/ undergoes total emphatic assimilation when followed by an emphatic voiceless fricative or an emphatic voiceless plosive. The results of the study also show that the directionality of assimilation across morpheme boundaries is either progressive with the suffix /h/ or regressive with the prefixes /t/ and /l/. Furthermore, the results show that emphasis is a key feature when investigating assimilation as it greatly affects the adjacent consonants. Lastly, it was also found that F1, F2, and F3 are significant cues for scrutinizing emphasis in MJA. The results show that F1 and F3 of the vowels before emphatic consonants are significantly higher than those before plain consonants at the onset, midpoint, and offset of the vowel. Also, F2 was found significantly lowered in the vowels preceding the emphatic consonants at the onset, midpoint, and offset of the vowel.

The authors recommend further research on assimilation across morpheme boundaries in terms of voicing/devoicing, especially the phoneme /h/ as it may lead to interesting results based on what we found in this paper. This investigation would help us better understand the differences with respect to the behavior of assimilation across morpheme boundaries and across word boundaries. In addition, it is worth checking out how assimilation across morpheme boundaries may result in fake geminates as is the case with the phonemes explored in this study and compare them with true geminates that appear word-medially and word-finally.

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Notes
1. For more information about Jordanian Arabic sub-dialects and their classification, see, (Al-Deaibes, 2021a,b,c).
2. Ferguson (1959: 336) defines diglossia as a relatively stable language situation in which, in addition to the primary dialects of the language (which may include a standard or regional standard), there exists a divergent highly codified (often grammatically more
complex superposed variety. This latter variety is the vehicle of a large and respected body of written literature, either of an earlier period or of another speech community, which is learned largely by state education and is used for most written and formal purposes.

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