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# An Optimality Analysis of the Morphophonemic Development of Triconsonantal Verbs of Normal Jordanian Speaking Children

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**Abstract**

This study carries out an analysis using the framework of Optimality Theory to investigate the acquisition of the morphophonemics of JA triconsonantal verbs. The analyzed data consist of speech samples obtained from a picture/action naming task as well as spontaneous speech collection. The sample of the study consists of 64 normally developing children who are acquiring spoken Jordanian Arabic as their mother tongue. The participants whose ages range from 2;1 to 6 years are selected randomly from different preschools in two Jordanian cities. The major findings of the study suggest that children overcome the morphological complexity of Arabic verbs by applying a number of processes, including: cluster simplification, glottalization, and truncation. The OT analysis indicates that these processes are associated with highly-ranked markedness constraints and lower-ranked faithfulness constraints in child grammar. In addition, the root/affix asymmetry triggers unmarked patterns to emerge in the affix. Finally, the results display that children's morphophonological abilities improve with age and that the majority of children's morphophonological processes disappear at age six years.

**Keywords:** Phonological acquisition, Optimality Theory (OT), Morphophonemics, Triconsonantal verbs, Jordanian Spoken Arabic

## 1. Introduction

This study utilizes the framework of Optimality Theory to investigate a relatively unexplored area in phonological development that is the morphophonemic acquisition of triconsonantal verbs of Jordanian children. With regard to this, the introduction shortly clarifies the field of morphophonemics, provides a brief account of JA triconsonantal verbs, and sheds some light on Optimality Theory as an approach to investigate child language.

Morphophonemics (or morphophonology) is a linguistic field that focuses on the interaction between phonology and morphology in word formation and shows how phonological factors affect the pronunciation of morphemes and how morphemes affect each other's sound structure when they blend to form a word (Árnason, 2012). On the one hand, morphological generalizations may include information about sound patterns affecting the phonetic shape of derived forms. For instance, the English plural morpheme has three different pronunciations, allomorphs, depending on the phonological context of the free morpheme: [-z] after voiced sounds as in 'dogs', [-s] after voiceless sounds as in 'cats', and [-əz] after sibilants as in 'buzzes'. On the other hand, phonological generalizations may contain information about morphology which selects some constructions over others. For example, velar softening (k → s / _ + i) in English applies only across the morpheme boundary. Therefore, velar softening is activated when adding the suffix '-ity' to a word like 'electric'[ɪlektrɪk]→ 'electricity' [ɪlektrɪsəti], but it is not applied within the morpheme boundary as in the word 'kiss' [kis] (Szigetvari, 2013).

Arabic triconsonantal verbs are often analyzed in terms of roots and patterns. The roots which consist of two, three, or four consonants are the most basic semantic units, whereas the patterns specify the phonological structure as well as the lexical and syntactic functions. In Jordanian Arabic (JA), there are ten patterns to derive triconsonantal verbs as demonstrated in Table 1 (Rakhieh 2009; Huneety, 2015).

Table 1. The verbal patterns of triconsonantal verbs in JA

| **Form** | **Imperfect** | | **Perfect** | | **Meaning** |
|---|---|---|---|---|---|
| | **Stem form** | **Example** | **Stem form** | **Example** | |
| **I** | $-C_1C_2VC_{3-}$ | ji**ktib**<br>'he writes' | $C_1aC_2aC_{3-}$<br><br>$C_1iC_2iC_3$- | **katab**<br>'he wrote'<br>**fihim**<br>'he understood | the basic verbal meaning of the root |
| **II** | $-C_1aC_2C_2iC_3$- | j**kattib**<br>'he makes someone | $C_1aC_2C_2aC_3$- | **kattab**<br>'he made someone write' | causative or intensive |

| | | | | | |
|---|---|---|---|---|---|
| | | write' | | | |
| **III** | -$C_1$a:$C_2$i$C_3$- | j**ʔa:tib** 'he admonishes' | $C_1$a:$C_2$a$C_3$- | **ʕa:tab** 'he admonished' | transitive or associative |
| **IV** | -$C_1C_2$i$C_3$- | ji**hmil** 'he neglects' | ʔa$C_1C_2$a$C_3$- | ʔa**hmal** 'he neglected' | causative or transitive of Form I |
| **V** | -t$C_1$a$C_2C_2$a$C_3$- | jits**allam** 'he receives' | -t$C_1$a$C_2C_2$a$C_3$- | ts**allam** 'he received' | reflexive or intensive of Form II |
| **VI** | -t$C_1$a:$C_2$a$C_3$- | jitʕa:**mal** 'he deals with someone mutually' | -t$C_1$a:$C_2$a$C_3$- | tʕa:**mal** 'he dealt with someone mutually' | reflexive or passive of Form III |
| **VII** | -n$C_1$a$C_2$i$C_3$- | jin**katib** 'it is written' | (ʔi)n$C_1$a$C_2$a$C_3$- | (ʔi)n**katab** 'it was written' | reflexive or passive of Form I |
| **VIII** | -$C_1$ta$C_2$i$C_3$- | ji**ʃ**ta**ɣil** 'he works' | (ʔi)$C_1$ta$C_2$a$C_3$- | (ʔi)**ʃ**ta**ɣal** 'he worked' | reflexive intentional of Form I |
| **IX** | -$C_1C_2$a$C_3C_3$- | ji**ħmarr** 'he turns red' | (ʔi)$C_1C_2$a$C_3C_3$- | (ʔi)**ħmarr** 'he turned red' | acquiring a color or a defect |
| **X** | -sta$C_1C_2$i$C_3$- | jsta**ktib** 'he asks someone to write' | (ʔi)sta$C_1C_2$a$C_3$- | (ʔi)sta**ktab** 'he asked (someone) to write' | seeking an action or quality of Form I |

As for the verbal subject paradigm, only suffixes are attached to the perfect stem to mark verbs for person (first, second, or third), number (singular, dual, or plural), and gender

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(masculine or feminine), whereas a combination of prefixes and suffixes marks imperfect verbs (Rakhieh 2009; Huneety, 2015). The table below demonstrates the suffixes attached to perfect and imperfect stems.

Table 2. Subject affixes added to JA triconsonantal verbs

| **Person** | **Gender** | **Perfect stem** | | **Imperfect stem** | |
|---|---|---|---|---|---|
| | | **Singular** | **Plural** | **Singular** | **Plural** |
| **3rd** | masculine | -Ø | -u: | j-X- Ø | j-X-u: |
| **3rd** | feminine | -at | -in/u: | t-X- Ø | j-X-in/u: |
| **2nd** | masculine | -t | -tu: | t-X- Ø | t-X-u: |
| **2nd** | feminine | -ti | -tin/u: | t-X-i: | t-X-in/u: |
| **1st** | masculine/ feminine | -t | -na | ʔa-X-Ø | n-X- Ø |

Mapping roots into verbal pattern often creates syllables and clusters of sounds that are prohibited in the language, which triggers major phonological processes such as epenthesis, deletion, and resyllabification. To take JA syllable structure, onsetless syllables which result from joining morphemes are often avoided by a number of repairing strategies, viz., glottal stop epenthesis, and vowel deletion (e.g., Abu Abbas, 2003; Huneety, 2015). For instance, the imperative prefix /i-/ constitutes an onsetless syllable when added to the verb. Hence, to avoid having onsetless syllables, the glottal stop /ʔ/ is added in stressed syllables as /i-ʃrab/ ['ʔiʃ.rab] 'you drink', but the prefix /i-/ is deleted in unstressed syllables as /i-stagi: l/ [sta. 'gi:l] 'you resign' (Abu-Abbas, 2012). Furthermore, the coda /b/ in [katab] 'wrote' is resyllabified when attached to the onsetless suffix /at/ [ka.ta.bat] 'she wrote', ensuring that the last syllable have an onset. Epenthetic vowels, on the other hand, may be opted to avoid illegal clusters. For example, forming the verb /ʃaraħ-t-l-ha/ 'I explained to her' creates a cluster of three consonants which is prohibited in JA, and thus the vowel /i/ is epenthesized as a repairing strategy [ʃa.raħ.til.ha]. However, a number of phonological processes (i.e., resyllabification, epenthesis, and syncope) may occur to prevent three-consonant clusters in the onset or the coda as in the complex verb /gult+laha/ 'I said to her' [qul.til.ha] (Abu Abbas, 2003).

A fast-growing interest has been given to Optimality Theory as an approach to study language acquisition in general and phonological development in particular. The basic motivation behind OT is that it allows us to describe grammar in terms of universal violable constraints instead of ordered, language-specific rules (Feehan, 2016). The constraints suggested by OT are innate and universal. They correspond to the aspects of Chomskyan Universal Grammar and explain why children acquire the target language in such a short period of time (McCarthy, 2007). Since children are born with a universal set of constraints, what they acquire is the language-specific ranking of these constraints (Dinnsen & Gierut, 2008). Optimality Theory reinstates continuity in language acquisition in that the child's and the adult's grammar have the same representational units and organizational principles (Boersma & Levelt, 2004).

Theoretically, OT proposes markedness and faithfulness constraints. Markedness constraints embody universality in referring to the unmarked properties which are basic and present in all languages. They necessitate that output forms meet some criteria of structural well-formedness (McCarthy, 2007). For example, markedness constraints require syllables to have onsets (ONS) and no codas (NoCODA) in the syllable structure. Faithfulness constraints, on the other hand, preserve lexical items from the corrupting power of markedness constraints, requiring output forms to match input forms. For instance, faithfulness of vowels (FAITHV) entails that vowels in the input and the output are identical, while faithfulness of consonants (FAITHC) requires consonants to be identical (Archangeli & Langendoen, 1997). For example, markedness constraints require syllables to have onsets (ONS) and no codas (NoCODA) in the syllable structure. Faithfulness constraints, on the other hand, preserve lexical items from the corrupting power of markedness constraints, requiring output forms to match input forms. For instance, faithfulness of vowels (FAITHV) entails that vowels in the input and the output are identical, while faithfulness of consonants (FAITHC) requires consonants to be identical (Archangeli & Langendoen, 1997). In addition to markedness and faithfulness constraints, McCarthy and Prince (2004) propose alignment family constraints which are concerned with structural relations between grammatical constituents and arrange phonological or morphological constituents relative to each other. For instance, the constraint Align-L (Stem, Syllable) requires the left edge of every stem to end at the left edge of a syllable (McCarthy & Prince, 2004).

Optimality Theory models the grammar as a system that maps linguistic items from inputs to outputs by two formal mechanisms GEN and EVAL (McCarthy, 2008). GEN generates an infinite set of possibilities for the optimal candidate chosen by EVAL. It has the power to add, delete, and reorganize objects. Nonetheless, it is confined as it can only generate linguistic items taken from the universal vocabulary (Prince & Smolensky, 2004). EVAL, on the other hand, is the tool by which the optimal candidate is selected. EVAL approaches the optimal form using a hierarchy of violable constraints. It selects the optimal form based on the best satisfaction of constraints which can be achieved by violating lower-ranked constraints or using them to resolve ties of higher-ranked constraints (Archangeli & Langendoen, 1997).

This study attempts to fill the gap in the literature of morphophonemic acquisition. To the researchers' knowledge, no study has been conducted to investigate the acquisition of JA morphophonemics using the framework of OT, nor any other approach. Moreover, the study tries to give more support to the notions of Universal Grammar (UG) and language universals. Nevertheless, due to space limitation, the study focuses only on three common morphophonemic processes observed in the language of Jordanian-speaking children.

## 2. Literature Review

This section briefly reviews the domain of the developmental research utilizing OT to investigate child morphophonology.

A great deal of OT research questions the nature of the constraints and their ranking in the hierarchy. While the classical version of OT assumes that markedness constraints outrank faithfulness constraints in child grammar, Bernhardt and Stemberger (1998) hold their argument against this. They have carried out an optimal analysis of Stemberger's diary studies of English-speaking children as well as the data of previous studies investigating the acquisition of different languages. The findings of the study suggest that in the onset of morphophonological development children may put some faithfulness constraints very high in the constraint hierarchy. For instance, it is observed that children initially block flapping which reflects phonetic naturalness in words as 'waiter', 'sitting', and 'needed', favoring the more faithful output to the stem, non-flapped coronals. Accordingly, Bernhardt and Stemberger (1998) suggest 'semi-random' hierarchy in which some faithfulness constraints are placed higher than markedness constraints in the beginning of language acquisition.

Hayes (2004), on the other hand, proposes a different model to account for morphophonological acquisition. Providing empirical evidence from previous studies (e.g., Berko, 1958; Jusczyk et al., 1994; Smith, 1973), Hayes (2004) shows that children acquire some phonological knowledge before acquiring morphophonemics explaining some highly-ranked faithfulness constraints at the beginning of morphophonological development. Thus, morphophonemic acquisition is a continuation of previous phonological knowledge in which the selection of an optimal alternation is governed by some phonotactic knowledge. To demonstrate, the allomorphs of the English plural 's' are associated with structural constraints that prohibit sequences of heterovoiced obstruent (i.e., *[kætz] 'cats') and sibilant sequences (i.e., *[edʒz] 'edges') in final position. Interestingly, these phonotactic constraints govern the phonological structure of English word in general and are not limited to morphophonemics as there is no word in English ending with *[dʒz] or *[tz]. Accordingly, children do not need to learn new rules or constraints to acquire allomorphs, instead they identify the faithfulness constraints which must be placed low in the constraint hierarchy to allow morphophonemic alternations to fit the phonotactics of adult language.

Nevertheless, there are some linguists who stand critical to OT model. For example, Menn (2004) reviews the classic literature of language acquisition to create an annotated inventory within which he mentions some linguistic phenomena which can be explained using OT, and others which constitute a challenge to the model. Among the things that are problematic to OT model are the U-shaped curve behavioral pattern and the development of abstract underlying forms while acquiring morphophonemics.

OT model proposes that children's ranking of phonological constraints makes their pronunciation more similar to adults' production as they grow up, which leaves little room to the analysis of the U-shaped behavioral pattern. Menn speculates how OT can explain children's behavior who start out able to say a word or an allomorph correctly and then regress in their linguistic ability before acquiring the correct linguistic form again. According to Menn, this can only be achieved in OT by assuming interesting manipulation of the constraint re-ranking. Another challenge, the acquisition of morphophonological alternations requires children to recognize a single abstract underlying representation of different surface allomorphs and at the same time to analyze adults' speech into morphemes and words.

Unfortunately, OT does not clearly differentiate between inputs which are the adult's speech production that children try to imitate from inputs which are an abstract sequence of morphemes that they attempt to discover.

On the positive side, Lloret and Pons-Moll (2016) test three possible hypotheses which may solve the problem of morphophonological inputs: the Richness of the Base hypothesis (RotB), the Lexicon Optimization hypothesis (LO), and the Free-Ride hypothesis (FRML). To test the explanatory power of the three hypotheses, Lloret and Pons-Moll examine the problematic UR of the <esC> Catalan morpheme (i.e., escriure 'to write', estona 'while', espot 'spot'). As these researchers explain, the underlying nature of the initial vowel in Catalan <esC>- is not clear or transparent to language learners: it can be part of the morpheme or an epenthetic vowel to avoid consonant cluster /sC/. During analysis, the study first provides evidence from the underapplication of vowel reduction and the productivity of word-initial epenthetic vowels to show that the initial vowel in <esC>- is not part of the morpheme and thus is not present in UR. The study then demonstrates based on empirical results the superiority of the 'free ride hypothesis' over the other two approaches in accounting for the nature of underlying forms as well as their construction, learning, and acquisition. The study hypothesizes that learners of Majorcan Catalan often take a "free ride" when acquiring UR: 1- in the beginning they learn phonotactics and have little or no knowledge of morphological alternations. 2- they observe that the input /sC/ corresponds to the outputs *[sC] and [əsC] indistinctively. 3- Based on phonotactic learning and list of unfaithful mapping (Ø > ə) alternations, learners re-rank faithfulness constraints and take a "free ride" to the unfaithful /Ø/ → [ə] map even to non-alternating cases. 4- Majorcan Catalan learners obtain a "more restrictive" grammar with a higher "r-measure" which gives more power to markedness constraints.

Adam (2002) focuses on the development of Hebrew prosodic structure in child language; and stop-fricative alternations in Modern Hebrew due to historical change. For the purpose of examining morphophonological interaction in child grammar, Adam gathers data from various published and unpublished corpora where he observes repetitive patterns in child speech. He focuses on the acquisition of prosodic structures of words out of their morphological context as well as the acquisition of Hebrew inflectional verbal paradigms with regular morphophonological alternations.

The acquisition path of single words exhibits a gradual development in prosodic structures (e.g., the number and type of syllables) and prosodic contrasts (e.g., diverse stress patterns). Children also reveal a gradual loss of phonological generalizations (e.g., PRWD=FTBIN) in favor of input-output faithfulness up until they master the phonology of adult language. These findings can be accounted by OT model as a gradual re-ranking of constraints, within which markedness constraints are demoted below faithfulness constraints.

In the acquisition path of alternating paradigms, Adam (2002) investigates morphophonological relations between child-adult speech and between verbs in the paradigm (e.g., 'to grow' gadal – 'she grew' gadl-a– 'I grew' gadal-ta). The findings of the study reveal that morphological knowledge precedes knowledge of morphophonemics. Also, the findings indicate that variation in child speech is attributed to the development of lexical contrasts, rather than phonological restrictions. Thus, Adam suggests a partial ranking of constraints where only some markedness constraints are demoted below faithfulness constraints.

The problematic nature of the singular- plural alternation of Dutch triggers Kerkhoff (2007) to discuss its morphophonological development within different linguistic models, including Optimality Theory. The Dutch plural stands between regular and irregular forms as it is associated with a final voicing neutralization process (i.e., 'bed' [bɛt] 'beds' [bɛdən], and 'hand' [hɛnt]-'hands' [hɛndən]). The study initially hypothesizes that the acquisition of the Dutch singular-plural alternation requires the interaction between a number of constraints: 1) the markedness constraint *VOICED-CODA prohibiting [+voice] in the coda, (2) the faithfulness constraint IDENT-IO(VOICE) demanding correspondence in the voicing feature between the output and the input, and the markedness constraint INTER-V-VOICE (IVV) requiring obstruents to be voiced between vowels.

Nevertheless, Kerkhoff (2007) argues that the acquisition of voicing alternation may not be that simple, children may commit linguistic errors in which they produce a non-alternating paradigm (i.e., 'bed' [bɛt]- 'beds' *[bɛtən] 'beds'). Such errors suggest an output-to-output relation (i.e., faithfulness between different surface forms of a morpheme). After reviewing previous research, examining longitudinal data, and conducting a number of elicitation tasks on normal children, SLI children, and adults, Kerkhoff (2007) gives support to Output-to-Output correspondence constraints. Children's generalizations are initially surface-true disregarding the need for an abstract underlying representations such as 'bed' /bɛd/ and 'hand' /hɛnd/.

## 3. Method

### *3.1 The Sample*

This study investigates normally developing children who are acquiring Jordanian Arabic as their mother tongue. The sample of the study consists of 64 children who belong to middle class families. The participants are chosen randomly from different nurseries and kindergartens. All the participants live in two Jordanian cities (Zarqa or Amman) and range in age from 2;1 to 6 (month; year). Based on the Table 3, the participants are divided into eight age groups of six-month intervals:

Table 3. The classification of participants in terms of age

| **Group** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| **Age** | 2;1-2;6 | 2;7-3;0 | 3;1-3;6 | 3;7-4;0 | 4;1-4;6 | 4;7-5;0 | 5;1-5;6 | 5;7-6;0 |

To avoid gender-bias research, the sample of the study includes an equal number of boys and girls in each age group. Also, to make sure that the participants have normal language development and normal-functioning oral mechanism, they have been given a 25-dB pure-tone hearing screening test conducted by a speech-language pathologist using a portable audiometer. Anyone who failed to pass this test has been eliminated from this study.

*3.2 Data Collection*

The picture- or action-naming task is designed to target the production of JA triconsonantal verbs. It elicits the Arabic verbal paradigm with different suffixes and prefixes which mark the verbs for person; number; tense; and gender. The task also tests children's production of Arabic triconsonantal verbs with different phonological properties (e.g., weak and strong roots). To expand data collection, spontaneous speech samples are also collected by means of observation and note-taking.

*3.3 Procedure*

In the picture- or action-naming task, the participants are visited at their preschools and individually experimented in a quiet room. The number of the visits and the duration of the sessions depend on the cooperation of the participants. Older preschoolers are more cooperative than younger ones and thus require fewer visits and shorter sessions. During sessions, the participants are shown pictures representing different actions and then asked to name these actions. The researcher utilizes video- or audio- recording to collect the participants' responses. The pictures in the task are presented on a screen of a portable computer because this is more appealing for children and often confines children's movement in the room, allowing the recording of fine-quality audios or videos. The participants are also rewarded and given some candy or toy to increase their interest in the task.

When the participants do not comprehend the task and give the target word, they are given some hints, including: multiple-choice and fill-the-blank questions, story-retelling, or indirect imitation. Furthermore, spontaneous speech samples are obtained to increase the size of the collected data. In each visit to the preschools, the participants are observed for about an hour while playing with their classmates. They are also asked to name actions observed or performed around them.

*3.4 Data Analysis*

A corpus of 1743 verbs is built. The verbs are transcribed using the International Phonetic Alphabet (IPA), arranged in tables, and annotated for the type of the phonological process they carry and the morpheme which is affected by the phonological process. Information about the verbal form, word syllable structure, and the type of the stem is also given. The data of each age group are kept in separate Microsoft Office documents to facilitate the analysis. Then, the researcher identifies the frequently-occurring morphophonemic operations and analyzes them using the OT model. In addition, she calculates their occurrences within each age group to reveal the connection between the participant's age and these morphophonological operations.

## 4. Results and Discussion

The findings of the study reveal an interesting interaction between morphology and phonology during language development and identify a number of morphophonological processes.

Nevertheless, due to space limitation, this study focuses on three morphophonological phenomena: cluster simplification, glottalization, and truncation.

*4.1 Cluster Simplification Verb-Initially*

Although Jordanian Arabic allows consonant clusters verb-initially (i.e., [jɣas.sil] ‘he washes’), verb-finally (i.e., [ʕadd] ‘counted’ and [ka.tabt] ‘I wrote’), and verb-medially across the syllable boundary (i.e., [jil.ʕab] ‘he plays’), the study finds that children omit a consonant from a sequence in the initial position of the verb more than they do in the medial or final positions. The data analysis reveals 156 instances of cluster simplification in verb-initial positions, whereas it does not detect any instance of cluster simplification in verb-final positions. As for cluster simplification verb-medially across the syllable boundary, the study exhibits only 40 cases of coda deletion (e.g., /bir.su.mu / [bi.su.mu] ‘they draw’) and 20 cases of onset deletion (e.g., / bil.ʕab/ [ʔa.lab] ‘he plays’). Cluster simplification in verb-initial position displays an interesting interaction between phonology and morphology in child grammar. It usually occurs across morphological boundaries and aims to simplify the morphophonological structure. To investigate this phenomenon further, Table 4 provides some examples of cluster simplification in verb-initial position.

Table 4. Examples of cluster’s simplification in the participant’s speech

| **Adult production** | **Child production** | **Gloss** | **Age group** | **Measure** | **The deleted consonant** |
|---|---|---|---|---|---|
| jsall.mu | samm.mi | They shake hands | 2;1-2;6 | II strong j-CaC$_2$C$_2$iC-u: | Subject prefix /j-/ |
| jsa:ʕ.do | sa:ʕ.do | He helps him | 2;7-3;0 | III strong j-Ca:CaC-o: | Subject prefix /j-/ |
| xta.fat | xa.fat | She disappeared | 3;1-3;6 | VIII weak CtaCaC-at | Verbal infix /-t-/ |
| tʕa:.wa.nu | ʕa:w.nu | They collaborated | 3;7-4;0 | VI weak tCa:CVC-u: | Verbal prefix /t-/ |
| ʤtamaʕ | ʤamaʕ | He met | 4;1-4;6 | VIII strong CtaCaC-at | Verbal infix /t-/ |
| staʔ. ðan | taʔ.da:n | He asked permission | 4;7-5;0 | X glottalized staCCaC | Part of the verbal prefix /st-/ |
| tħam.ma.mu | ham.ma.mu | They took a bath | 5;1-5;6 | V geminated tCaC$_2$C$_2$aC-u: | Verbal prefix /t-/ |

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As Table 4 shows, the child handles consonant clusters in adults' utterances by deleting the affix and maintaining the consonant in the stem. There are two scenarios to explain this phenomenon: (1) Children may not acquire these affixes, and so they do not produce them in onset clusters. (2) Children acquire these bound morphemes. However, due to prosodic limitations prohibiting complex onsets, they delete the prefix and keep the first radical. Optimality Theory blurs this distinction between phonology and morphology and explains cluster simplification across the morpheme boundary using a set of universal constraints.

1) Align L-(Stem, PrWd): Align every stem with the left edge of a prosodic word (McCarthy & Prince, 2004).

2) Align L-(Affix, PrWd): Align every affix with the left edge of a prosodic word (McCarthy & Prince, 2004).

3) *COMPLEX(ONS): A syllable must not have more than one onset segment (Prince & Smolensky, 2008).

4) MAX-IO: Input segments should have correspondents in the output (against deletion) (Prince & Smolensky, 2008).

Since the participants tend to delete the affix in the cluster and keep the first consonant in the stem, the study supports Beckman (1998) and McCarthy and Prince (1995) who argue that roots and stems are more marked than affixes and that unmarked patterns often emerge in the affix. Furthermore, it suggests that Align L-(Stem, PrWd) is ranked higher than Align L-(Affix, PrWd) in child grammar. To account for cluster simplification, the study proposes that *COMPLEX (ONS) and Align L-(Stem, PrWd) are placed very high in child grammar, whereas MAX- IO and Align L-(Affix, PrWd) are placed very low. Table 5 exhibits the ranking of these constraints and explains the selection of the optimal output [sa:ʕdo] at age 2;7-to-3;0 years.

Table 5. The selection of the optimal output [sa:ʕdo]

| /jsa:ʕdo/<br>//j-sa:ʕd-o://<br>He helps him | ***COMPLEX (ONS)** | **Align L-(Stem, PrWd)** | **Align L-(j, PrWd)** | **MAX-IO** |
|---|---|---|---|---|
| a) jsa:ʕ.do | *! | * | | |
| b) ja:ʕdo | | *! | | * |
| c) sa:ʕdo | | | * | * |

*Complex(ONS)>> Align L-(Stem, PrWd) >> Align L-(j, PrWd), MAX-IO

As shown in Table 5, *COMPLEX(ONS) requires only one segment in the onset position, and thus it excludes the adult's optimal output in (a). The constraint L-(Stem, PrWd), on the other hand, demands the stem to coincide with the left edge of the prosodic word. Accordingly, candidate (b) is excluded for violating L-(Stem, PrWd). Hence, the winner is

International Journal of Linguistics
ISSN 1948-5425
2020, Vol. 12, No. 1

candidate (c) which violates the lower-ranked constraints Align L-(j, PrWd) requiring the prefix /j-/ to correspond with the left edge of the prosodic word and MAX-IO prohibiting segment deletion. Hence, in order to acquire the morphology of triconsonantal verbs, children have to place the constraint Align L-(Affix, PrWd) above *COMPLEX(ONS) and Align L-(Stem, PrWd) in their constraint hierarchy.

The OT treatment given above can also account for the reduction of verbal infixes. For example, Form VIII /CtaCVC/ requires the infix /-t-/ to be added after the first radical leading to complex onsets as in [xtafat] ‘she disappeared’ and [ʤtamaʕ] ‘he met’. Some children, however, face difficulty in pronouncing the initial cluster [consonant+t] in Form VIII and utter these verbs without the infix /-t-/: [xafat] at age 3;1-to-3;6 years and [ʤamaʕ] at age 4;1-to-4;6 years. Such observation can be explained by using the constraints mentioned above, yet we may need in our analysis DEP-IO, a constraint against insertion (McCarthy & Prince,1995).

Table 6. The selection of the optimal output [xafat]

| /xta.fat/ <br> //x-t-afa:-at// <br> She disappeared | *COMPLEX (ONS) | Align L-(Stem, PrWd) | DEP-IO | Align L-($t_{infix}$, PrWd) | MAX-IO |
|---|---|---|---|---|---|
| a) xta.fat | *! | | | * | |
| b) ta.fat | | *! | | | * |
| c) xi.ta.fat | | | *! | * | |
| d) xa.fat | | | | * | * |

*Complex(ONS)>>Align L-(Stem, PrWd) >>DEP-IO>>Align L-(tinfix, PrWd), MAX-IO

Table 6 shows that the most faithful candidate to adults’ output in (a) sustains a fatal violation of the highly-ranked *COMPLEX(ONS). Whereas the candidate in (b) incurs a fatal violation of Align L-(Stem, PrWd), the candidate in (c) fatally violates DEP-IO. Accordingly, the output in (d) is optimal as it incurs violations of the least ranked constraints Align L-(t, PrWd) and MAX-IO.

The OT analysis given here suggests that the difference between prefixes and infixes is in the constraint ranking after acquisition. To clarify, Align L-($t_{infix}$, PrWd) of Form VIII /CtaCVC/ (e.g., [ktaʃaf] ‘he discovered’) remains below Align L-(Stem, PrWd) after acquisition, whereas Align L-($t_{prefix}$, PrWd) of Form V /tCa$C_2C_2$aC/ (e.g., [tfarraʤ] ‘he watched’) and VI /tCa:CaC/ (e.g., [tʕa:wan] ‘he collaborated’) outranks Align L-(Stem, PrWd). The process of ranking constraints during morphophonological acquisition is gradual and difficult as it depends on factors like the frequency of a given form and semantic complexity. Nevertheless, the present study suggests the following constraint ranking to account for the acquisition of verbal affixes:

- **MAX-IO, DEP-IO**>> Align L-(ʔa, PrWd), Align L-( $t_{prefix}$, PrWd), Align L-(n, PrWd), Align L-(st, PrWd)>> **Align L-(Stem, PrWd)**>> Align L-( $t_{infix}$, PrWd)>> ***COMPLEX(ONS)**

Concerning the relation between cluster simplification and the child's age, Table 7 displays the frequency of cluster simplification in verb-initial position for each age group of this study.

Table 7. The frequency of cluster simplification in verb-initial position for each age group

| **Group** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| **Age** | 2;1-2;6 | 2;7-3;0 | 3;1-3;6 | 3;7-4;0 | 4;1-4;6 | 4;7-5;0 | 5;1-5;6 | 5;7-6;0 |
| **Frequency** | 51 | 52 | 21 | 13 | 6 | 4 | 9 | 0 |

Table 7 indicates that most participants do not tolerate onset clusters at age two years since the frequencies in the first (2;1-2;6 years) and the second (2;7-3;0 years) age groups equal 51 and 52, respectively. Nevertheless, children's morphophonological skills seem to improve after age two years. The frequency of cluster simplification decreases significantly among three-year-old participants. The analysis exhibits 21 cases of cluster simplification in the third age group representing the ages between 3;1 and 3;6 years and 13 cases in the fourth age group representing the ages between 3;7 and 4 years. Furthermore, the majority of four-year-old children do not reduce consonant clusters in verb-initial positions. Only 10 instances are detected in the fifth (4;1-4;6 years) and the sixth (4;7-5 years) age groups combined. Finally, by age six years, children learn to handle complex onsets and become more faithful to verbal and inflectional affixes. Only nine cases of cluster simplification are observed in the seventh age group representing the ages between 5;1 and 5;6 years, while no case is observed after this age.

### *4.2 Glottalization*

In JA, glottalization which refers to the insertion or replacement of a glottal segment is a common morphophonological operation. A sequence of the glottal stop /ʔ/ and a vowel marks a number of morphological units such as the first-person singular pronoun (i.e., [ʔaktub] 'I write') and the imperative prefix (i.e., [ʔiʃ.rab] 'you drink'). Nonetheless, it has been argued that in these contexts the glottal stop is not part of the prefix, but it is added to avoid onsetless syllables which are prohibited in Arabic (Abu-Abbas, 2012: 45; Jaber & Mahadin, 2017; McCarthy, 1989). Glottalization has been also noted in phonological research investigating the acquisition of Arabic. For instance, Alqattan (2015) finds that Kuwaiti Arabic-speaking children replace the voiced pharyngeal /ʕ/ and the voiceless glottal fricative /h/ with the golattal stop /ʔ/ (e.g., /jxa.riʕ/ [jxa.riʔ] 'it is scary', and /ka:.hi/ [ˈka:.ʔi] 'here-it-is (f.)'). Nonetheless, this study reveals an interesting case of glottalization which is different from the ones previously reported. The findings exhibit 157 instances where the glottal stop /ʔ/ substitutes inflectional prefixes. Examples of this type of glottalization is given in Table 8.

Table 8. Examples of glottalization in the participant’s speech

| Adult production | Child production | Gloss | Age group | Measure | The replaced segment |
|---|---|---|---|---|---|
| biʃ.wi | ʔiʃ.ʃi | He grills | 2;1-2;6 | I weak b-CCVC | Imperfect marker |
| tiʤ.li | ʔiz.zi | She washes | 2;7-3;0 | I weak t-CCVC | Subject prefix |
| tuk.tub | ʔut.tub | She writes | 3;1-3;6 | I strong t-CCVC | Subject prefix |
| nil.ʕab | ʔal.lab | We play | 3;7-4;0 | I strong n-CCVC | Subject marker |
| btis.taʕ.mil | ʔis.taʔ.mil | She uses | 4;1-4;6 | X strong t-staCCiC | Imperfect marker and Subject prefix |
| bidʒa:w.bu | ʔi.za:w.bu | They answer | 4;7-5;0 | III weak b-Ca:CiC-u: | Imperfect marker |
| buk.tu.bu | ʔuk.tu.bu | They write | 5;1-5;6 | I strong b-CCVC-u: | Imperfect marker |

Table 8 shows the participants replace subject prefixes and the imperfect marker /b/ with the glottal stop. Since the first person singular prefix has the glottal stop followed by a vowel /ʔa/ (i.e., [ʔak.tub] ‘I write’), glottal replacement may suggest that the participants have acquired a default or unmark form representing the inflectional prefixes of the imperfect. However, the presence of the glottal stop /ʔ/ followed by a vowel can be a phonological requirement to avoid marked constructions (i.e., VC and CCV) if the inflectional prefixes of the imperfect are not acquired. For instance, in the verb /b-ktub-u:/ [buk.tu.bu] ‘they write’ the deletion of the subject prefix /b/ with the epenthetic vowel /u/ leads to a complex onset [ktu.bu], while the deletion of the subject prefix /b/ without the epenthetic vowel /u/ leads to an onsetless syllable [uk.tu.bu]. Consequently, a sequence of a glottal stop and a vowel breaks the complex onset and helps to avoid onsetless syllables when the participants do not learn the inflectional prefixes of the imperfect.

Optimality theory can provide a satisfactory explanation of this phenomenon lying at the phonology-morphology interface. Glottalization can be accounted for in terms of an interaction between markedness, faithfulness, and alignment constraints. To provide an example, Table 9 explains the child's selection of [ʔuktubu] instead of the adult's optimal output [buk.tu.bu] at age 5;1-to-5;6 years. As observed in Table 9, the selection of the child's optimal output involves an interaction between the constraints *COMPLEX(ONS), Align L-(Stem, PrWd), and Align L-(b, PrWd) in addition to other constraints such as :

1) ONS: requires onsets in syllables (Prince & Smolensky, 2008).

2) CONTIGUITY-IO: rejects medial epenthesis or deletion of segments (McCarthy & Prince, 1995).

3) GLOTTAL (STOP): encourages the use of the glottal stop /ʔ/ (Yaseen, 2018: 75)

4) IDENT-AFFIX: demands identity correspondences between inputs and outputs in the affix positions (Beckman, 1998).

Table 9. The selection of the optimal output [ʔuktubu]

| /buktubu/<br>//b-ktub-u://<br>They write | ***COMPLEX (ONS)** | **ONS** | **CONTIGUITY-IO** | **Align L-(Stem, PrWd)** | **GLOTTAL (STOP)** | **Align L-(b, PrWd)** | **MAX-IO** | **IDENT-AFFIX** |
|---|---|---|---|---|---|---|---|---|
| a) buk.tu.bu | | | | *! | * | | | |
| b) ktu.bu | *! | | | | * | * | * | |
| c) uk.tu.bu | | *! | | * | * | * | * | |
| d) ku.tu.bu | | | *! | | * | * | * | |
| e) ʔuk.tu.bu | | | | * | | | | * |

*COMPLEX(ONS), ONS>> CONTIGUITY-IO>> Align L-(Stem, PrWd)>> GLOTTAL (STOP)>> Align L-(b, PrWd), MAX- IO, IDENT-AFFIX

Table 9 suggests that candidate (a) is dismissed due to a serious violation Align L-(Stem, PrWd). The candidates (b) and (c) are excluded because they incur fatal violations of *COMPLEX(ONS) and ONS, respectively. Nevertheless, candidate (d) severely violates the faithfulness constraint CONTIGUITY-IO as it has a medial-epenthetic vowel. Although candidate (e) breaks the constraint Align L-(Stem, PrWd), it is the optimal output as it sustains satisfactions of the higher-ranked markedness constraints *COMPLEX(ONS) and ONS. Furthermore, the affix /b/ surfaces as /ʔ/ due to the high ranking of the markedness constraint GLOTTAL (STOP) and the low ranking of the faithfulness constraint IDENT-AFFIX.

The application of OT here is appealing and comprehensive as it captures the link between cluster simplification and glottalization. According to OT analysis, the two processes are carried out in order to avoid complex onsets and prefixes in the beginning of the verb. The OT analysis provided for cluster simplification shows that affix deletion satisfies the higher-ranked constraints *COMPLEX(ONS) and Align L-(Stem, PrWd). Nevertheless, The OT analysis in Table 9 favors the use of the glottal sop /ʔ/ over affix deletion in order to avoid breaking the higher-ranked constraints *COMPLEX(ONS) and ONS.

An important remark remains concerning the significance of glottalization during age development. The analysis given in Table 10 exhibits the frequency of glottalization of prefixes for each age group.

Table 10. The frequency of glottalization for each age group

| **Group** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| **Age** | 2;1-2;6 | 2;7-3;0 | 3;1-3;6 | 3;7-4;0 | 4;1-4;6 | 4;7-5;0 | 5;1-5;6 | 5;7-6;0 |
| **Frequency** | 47 | 43 | 34 | 18 | 6 | 6 | 3 | 0 |

As observed in Table (10), the substitute of inflectional morphemes with the glottal stop /ʔ/ is very common during the second year of life. The highest scores are (47) and (43) representing the ages from 2;1 to 2;6 years and 2;7 to 3 years, respectively. Glottalization continues to exist during age three years. The frequency of glottal replacement equals 34 in the third age group (3;1-to-3;6 years). Nevertheless, glottal replacement decreases significantly during the second half of the third year of life. The occurrences of glottalization are 18 between the ages 3;7 and 4 years. Glottalization becomes less notable after age three years and disappears during the second half of the fifth year. There are only 12 instances of glottal replacement in the fifth (4;1-4;6 years) and sixth (4;7-5;0 years) age groups combined, and only 3 instances in the seventh age group (5;1-5;6 years).

### *4.3 Truncation*

Truncation or syllable deletion patterns are the most common morphophonological operations observed among JA-speaking children. During data analysis, the study observes 399 truncation processes where the participants delete some syllable to simplify complex morphophonological constructions. Furthermore, despite children’s truncated forms seem accidental and disordered to the hearers, they are strikingly systematic and abided by some universal constraints. The analysis reveals two patterns of truncation depending on the type of the deleted syllables (stressed or unstressed syllables). Nevertheless, the truncation of stressed syllables is rarely found among the participants. Children seem to place the constraint IDENT('σ) which demands faithfulness to stressed syllables very high in their grammar. This in turn affects the choice of the deleted syllables. The study also finds that children associate truncation with morphological complex verbs which are often mapped into minimal words with some prosodic shape. Table 11 provides some examples of the participants’ truncated forms which are characterized by the deletion of unstressed syllables.

Table 11. Examples of truncation in the participant’s speech

| Adult production | Child production | Gloss | Age group | Measure | The deleted syllable |
|---|---|---|---|---|---|
| bit.kan.nis | tan.nis | She sweeps | 2;7-3;0 | 1I strong<br>b-t-$CaC_2C_2iC$ | The first syllable [bit] |
| 'bik.ta.ʃif | 'bik.fiʃ | He discovers | 2;7-3;0 | VIII strong<br>b-CtaCiC | The second syllable [ta] |
| 'tiʤ.bi.ro | 'tiz.bil | She forces him | 3;1-3;6 | IV strong<br>t-CCiC-o: | The last syllable [ro] |
| jit.'far.ra.ʤu | 'far.riʤ | They watch | 3;7-4;0 | V strong<br>j-t$CaC_2C_2aC$-u: | The first syllable [jit] and the last one [ʤu] |
| bis.'tas.lim | 'tas.lim | He surrenders | 4;1-4;6 | X strong<br>b-staCCiC | The first syllable [bis] |
| 'wal.la.ʕat | 'wal.laʕ | It(f.) flamed | 4;7-5;0 | II weak<br>$CaC_2C_2aC$-at | The last syllable [ʕat] |

Table 11 suggests that the truncation of triconsonantal verbs is driven by some output constraints on children’s speech production. Morphophonologically complex verbs are mapped into templates of trochaic binary feet, whereas stressed syllables are preserved at the left edge of the reduced verbs. Interestingly, this phenomenon has been documented by a number of researchers. To mention but a few, Allen and Hawkins (1980) find that disyllabic trochaic feet characterize the early words of English-speaking children. Demuth (2007) reveals that children produce morphemes only when they are part of trochaic binary feet. Ota (1998), on the other hand, accounts for Japanese-speaking children’s truncated words which are trochaic binary feet.

Since the participants’ truncated forms follow some universal pattern of language development, the present study utilizes Ota’s OT model of Japanese children’s initial prosodic words. In doing so, the study approves this model and supports the universality of OT constraints.

- Ota's OT model of children's initial prosodic shape (as cited in Boersma & Levelt, 2004: 7):

**- Markedness and alignment constraints:**

1) ALIGN-FT-L/ Align (Ft, L, PrWd, L): Align the left edge of every foot with the left edge of the Prosodic Word (σσ); *(σσ)(σσ)

2) FTBIN: Feet must be binary on moras or syllables (σσ); (σμμ); *(σσσ); *(σμ)

3) PARSE-σ: Every syllable must belong to a foot (σσ); *(σσ)σ

4) TROCH/ Align (Ft, L, H(Ft), L): Feet are left headed

**- Faithfulness constraints:**

5) MAX-BT: Every element in the base has a correspondent in the truncated output

6) IDENT('σ): Every output correspondent of an accented syllable in the input must be accented.

An important point has been taken into account in Ota's (1998) model is that children's truncated forms appear with their untruncated ones for the same target word. To explain this variability in children's speech production, truncation is observed as an output-to-output phenomenon. MAX-BT, an output-to-output constraint, mediates the relation between a base (the adult's output) and surface form (the child's output), demanding every element in the base to have a correspondent in the truncated output. Table 12 verifies Ota's model and explains the selection of the child's truncated form ['tas.lim] between the ages 4; 1 and 4;6 years.

Table 12. The selection of the optimal output [‘taslim]

| /bis.'tas.lim/ <br> //b-sta-slim// <br> He surrenders | PARSE-σ | TROCH | ALIGN-FT-L | FTBIN | IDENT('σ) | MAX- BT |
|---|---|---|---|---|---|---|
| a) (bis.'tas) lim | *! | *! | | | | |
| b) (bis) ('tas.lim) | | | *! | | | |
| c) (bis.'tas.lim) | | | | *! | | |
| d) ('bis.lim) | | | | | *! | |
| e) ('tas.lim) | | | | | | * |

Parse- σ, Trochaic, Alignft-L, Ftbin, Ident('σ) >> Max-BT

In Table 12, candidate (a) incurs serious violations of the highly-ranked markedness constraints: PARSE-σ which demands syllables to belong to a foot, and TROCHAIC which requires the stress to be on the left. Candidate (b) fatally violates ALIGNFT-L requiring a

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2020, Vol. 12, No. 1

single foot, while candidate (c) fatally violates FTBIN which necessitates feet to be binary. Moreover, candidate (d) cannot be the winner as it breaks IDENT('σ). As a result, candidate (e) is selected as the optimal output as it violates the lower-ranked MAX-BT.

Although Ota's model works perfectly in Table 12, it does not account for the choice of the syllables or the segments that are truncated. The analysis of the data shows that children delete segments or syllables based on their morphological categories. For instance, in the truncated form ['wal.laʕ] (uttered between age 4;7 and 5;0 years) of the verb /'wal.la.ʕat / 'It(f.) flamed', the last syllable is truncated, yet the root consonant /ʕ/ is kept and resyllabified. The verb /'bik.ta.ʃif/ 'he discovers' is often truncated as [bik.fiʃ] (uttered between age 2;7 and 3;0 years) where the truncated syllable is an infix. Hence, the study hypothesizes that children are faithful to the root when they map the base or the adult's form into a binary trochaic foot. Consequently, the study utilizes the root-affix asymmetry as suggested by McCarthy and Prince (1995), Beckman (1998), and Urbanczyk (2000).

**Root/affix asymmetry (as cited in Urbanczyk, 2000: 111)**

Rt>>Afx roots are more marked than affixes

FAITHROOT >> FAITHAFFIX

The root/affix asymmetry suggests that children's unmarked structure appears in the affix. Children operate truncation with reference to root-affix relation, and they do not merely depend on an output-to-output relation. To demonstrate, Table (13) displays the child's optimal output ['wal.laʕ] at age 4;7-to-5;0 years based on Ota's model and the root/affix asymmetry.

Table 13. The selection of the optimal output ['wallaʕ]

| /'wal.la.ʕat/ //wallaʕ-at// It(f.) flamed | TROCH | ALIGN-FT-L | PARSE-σ | FTBIN | IDENT('σ) | FAITH-ROOT | FAITH-AFFIX | MAX-BT |
|---|---|---|---|---|---|---|---|---|
| a) ('wal.la) (ʕat) | | *! | | | | | | |
| b) ('wal.la) ʕat | | | *! | | | | | |
| c) ('wal.la.ʕat) | | | | *! | | | | |
| d) ('la.ʕat) | | | | | *! | * | | * |
| e) ('wal.la) | | | | | | *! | * | * |
| f) ('wal.laʕ) | | | | | | | * | * |

Trochaic, Alignft-L, Parse-σ, Ftbin, Ident('σ)>>Faith-Root>>Max-BT, Faith-Affix

Adopting the root/affix asymmetry besides Ota's model successfully accounts for unstressed-syllable deletion patterns in the speech production of JA-speaking children. In Table 13, candidate (a) is excluded as it incurs a violation of ALIGN-FT-L, while candidate (b) is dispensed because it violates PARSE-σ. Similarly, candidate (c) cannot be the winner for violating FTBIN. With regard to candidate (d), it is rejected because it breaks the highly-ranked constraints IDENT('σ) and FAITH-ROOT. The contest then is between candidate (e) and (f). Candidate (e) loses since it incurs a serious violation of the highly-ranked FAITH-ROOT, letting candidate (f) which breaks MAX-BT and FAITH-AFFIX be the winner.

Concerning the relation between truncation and age development, Table 14 detects the occurrences of the participants' truncated forms relative to their age group.

Table 14. The frequency of truncation for each age group

| **Group** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| **Age** | 2;1-2;6 | 2;7-3;0 | 3;1-3;6 | 3;7-4;0 | 4;1-4;6 | 4;7-5;0 | 5;1-5;6 | 5;7-6;0 |
| **Frequency** | 163 | 131 | 45 | 31 | 11 | 9 | 7 | 2 |

According to Table 14, truncation patterns seem to be a feature that distinguishes the speech production of two-year-old children. Of the 399 truncated forms detected in this study, 163 forms are uttered by 2;1-to-2;6-year-old children, and 131 are produced by 2;7-to-3-year-olds. Although truncated forms continue to exist in the participants' speech, it decreases significantly after the second year of life. The participants truncate 45 verbs between the ages 3;1 and 3;6 years, whereas they delete syllables from 31 verbs between the ages 3;7 and 4;0 years. At age four years, on the other hand, truncation is no longer notable since only 20 truncated verbs are found in the fifth (4;1-4;6 years) and the sixth (4;7-5;0 years) age groups. Similarly, only 9 cases of truncated forms are observed at age five years as shown in the seventh (5;1-5;6 years) and the eighth (5;7-6;0 years) age groups.

## 5. Conclusion

This study addresses key issues related to the morphophonemic acquisition of JA triconsonantal verbs. It detects a number of phenomena associated with morphophonological development, namely: cluster simplification, glottalization, and truncation. The study suggests that OT model captures the interplay between segmental, prosodic, and morphological properties during the acquisition of JA triconsonantal verbs. The key findings of the study indicate that phonological complexity (e.g., *COMPLEX(ONS)) triggers children's glottalization and cluster simplification targeting bound morphemes. Furthermore, the position of the morpheme (alignment constraints), morphological architecture (e.g., ROOT-AFFIX asymmetry), and prosodic information (e.g., IDENT-σ') play significant roles in the acquisition of Arabic morphophonemics. The study also gives support to some claims concerning language universals and language acquisition such as children's early prosodic words. However, children from a very early age develop some knowledge of the adult's language (i.e., IDENT('σ)) and use it in subsequent morphophonological learning. Finally, children seem to face great difficulty in acquiring the morphophonemics of JA verbs during the second year of life. However, children resolve the majority of the morphophonological problems after that until they almost disappear by age 6 years.

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