# Recursion of Phonological Phrase: Views from the Jordanian Arabic dialect of Irbid

https://doi.org/10.33806/ijaes2000.20.1.4

Hadeel Alsaed and Abdulazeez Jaradat
*Applied Science Private University*

**Abstract:** *In the original model of Prosodic Hierarchy (Selkirk 1984, 1986; Nespor &Vogel 1986), the prosodic representation was partly autonomous from the syntactic structure, and prosodic recursion was not possible. Recently, it has been proposed in Match Theory (Selkirk 2011) that each prosodic unit has a corresponding syntactic constituent, and prosodic recursion exists, as proposed in some recent empirical studies (Féry and Truckenbrodt 2005; Wagner 2005, 2010, Selkirk 2009, 2011, Itô &Mester 2012, 2013; Elfner 2012among others).This paper empirically investigates the phonological phrase construction in Jordanian Arabic as spoken in Irbid. The empirical results indicate that phonological phrases match XPs and are marked by low phrase accents and pre-boundary lengthening. They also suggest that syntactic nesting motivates prosodic recursion: a nested XP matches a recursive phonological phrase which is cued by gradient pre-boundary lengthening. However, a recursive phonological phrase is limited to two subcategories, i.e. a minimal and maximal layer. In accord with that, prosodic recursion is neither prohibited as proposed in the early version of Strict Layer Hypothesis (Selkirk 1984, 1986; Nespor &Vogel 1986), nor freely allowed to perfectly mirror syntactic nesting as in Match Theory (Selkirk 2011).*

**Keywords:** phonological phrase, prosodic recursion, syntactic nesting, Match Theory

## 1. Introduction

### 1.1 The phonological phrase: Its syntactic grounds, recursion and diagnostics

In the original model of Prosodic Hierarchy (Selkirk 1984, 1986; Nespor &Vogel 1986), the prosodic hierarchy was not directly mapped from the syntactic structure. Although the formation of prosodic units referred to edges of syntactic constituents, no rules were postulated to match prosodic domains and syntactic constituents. This explained the fact that phonological phrases (Φs) can match syntactic phrases (XPs), but that mismatches are frequent. Beside its autonomy, the prosodic hierarchy was non-recursive in this model: a prosodic level must not include prosodic subcategories. Therefore, the maximal Φ in (1) is impossible in this model due to the fact that it dominates two smaller subcategories of the same prosodic level, i.e. two minimal Φs.

(1) Φmax

Φmin Φmin

Prosodic recursion has been reported in some recent empirical studies (Féry and Truckenbrodt 2005; Wagner 2005, 2010; Elfner 2012; Itô&Mester 2012, 2013 among others). In some of these studies, prosodic recursion mirrors syntactic nesting. Furthermore, Match Theory (Selkirk 2009, 2011), which is the most recent model of the Prosodic Hierarchy, presents prosodic recursion as the output of a set of constraints that require direct correspondence between the syntactic and prosodic structure. For instance, the violable constraints on the syntactic and prosodic structure, i.e. MATCHPHRASE and MATCHΦ, result in the perfect match between Φs match XPs. These constraints require an XP in the syntactic structure to have a corresponding Φ in the prosodic representation, and vice versa. Based on these constraints, a nested syntactic structure should have a recursive prosodic counterpart. In (2), for example, NP1 and NP2 are nested within NP3, and therefore these two minimal NPs have corresponding minimal Φs, and NP3, which is the maximal syntactic projection, matches a maximal Φ in the prosodic representation.

(2) $_{NP3}[\ _{NP1}[\quad ]\quad _{NP2}[\ \ldots\ ]]$
$(\quad (\quad )_{\Phi min}\quad (\ \ldots\ )_{\Phi min})_{\Phi max}$

However, this perfect match between syntax and prosody is not allowed in most languages. It is normally blocked by some markedness constraints that ban or override matching constraints. In Egyptian Arabic, for instance, matching Φs and XPs is overridden by BINMIN, a markedness constraint that requires each Φ to be prosodically heavy (Hellmuth 2004, 2011a, 2011b). Therefore, a light XP is not expected to have a corresponding Φ in this dialect.

The Φ level is considered the domain of some intonational and temporal phenomena. For example, the Φ is the domain of pitch accent alignment in English: each Φ receives a pitch-accent (Adger 2006; Kratzer& Selkirk 2007). Moreover, the right boundaries of Φs are normally marked by high or low right boundary tones and final lengthening (Wagner 2005) and their left boundaries are marked by F0 partial reset (Truckenbrodt 1995, 1999, 2007). As for Φ-recursion diagnostics, Itô and Mester (2012) for example, reported that the minimal Φ is the domain of initial rise (%L-H) in Japanese, and the maximal Φ is the domain of F0 down step. Wagner (2005, 2010) presented pre-boundary syllable lengthening as an additive temporal cue to the recursive Φ in English coordinate structures: the maximal and minimal Φs receive final syllable lengthening, but the maximal Φ is marked by significantly greater amount of lengthening

To sum up, the match between Φs and XPs has been confirmed in several theoretical and empirical studies. Furthermore, the recursive Φ has recently been reported in some languages, such as Irish (Elfner 2012) and made evident by gradient correlates: boundaries of different strengths could have quantitatively different effects on a specific phonetic property (be it intonational or durational). In the remaining part of this section, the previous work on the Φ-formation in Arabic varieties is reviewed.

### 1.2 The phonological phrase in Arabic varieties

The work of Hellmuth (2004, 2007, 2011a&b, 2016) and Yasin (2012) on Egyptian Arabic (EA) and Jordanian Arabic as spoken in Amman (AA) are, as far as the researchers know, the only organized attempts to investigate the construction of the Φ and the role of syntax in the formation of this prosodic domain and explore its correlates in Arabic. The general conclusion of Hellmuth's studies on EA is that the relation between XPs and Φs is governed by restrictions on minimal size. In (2004), Hellmuth argued that a Φ matches a maximal XP if this XP consists of three or four prosodic words (ωs), such as the subject NP in (3). Hellmuth (2004) reported that the right edge of a Φ can be marked by one or more of the following suprasegmental correlates in EA: final lengthening, low phrase accent and partial reset.

(3) **Subject NP** **VP**
(il-muˈhandisl-ma$^{c}$ˈmaːril-muˈhimm)$_{Φ}$ (bijˈkhumm baˈlad-na)$_{Φ}$
DEF-engineer DEF-architectural DEF-important cheats-3SGM.PST country-1PL.POSS
'The important architect is cheating our country'.
(Hellmuth 2004)

In (2011a), Hellmuth relied on sentences that have a VOO structure. The direct object and the indirect object in these sentences are always syntactically complex and prosodically heavy. She observed Φ boundaries at more syntactic edges in VOO sentences than in her previous studies. The most recurring phrasing pattern in her dataset was the one in (4a). In (4b), the final prepositional phrase (PP) is parsed in a Φ if it has a sufficient weight.

(4) a. (V DirectO)$_{Φ}$ (Locative)$_{Φ}$ (IndirectO PP)$_{Φ}$
b. (V DirectO)$_{Φ}$ (Locative)$_{Φ}$ (IndirectO)(PP)$_{Φ}$

Hellmuth, in the same paper, indicated that Φ-recursion is possible and could be cued by a gradient reset of the first pitch accent after a Φ boundary. She identified two types of pitch accent resets in her dataset. In (4), for example, there can be either a strong or a weak pitch accent reset after the locative. This suggests that the Φ boundary at the right edge of the locative can be either of that a maximal or minimal Φ depending on the amount of pitch accent reset. A greater amount of pitch-accent reset would indicate the preceding boundary is that of a maximal Φ and while a smaller amount of pitch accent reset would signal the boundary of a minimal Φ.

In (2011b), Hellmuth's dataset has sentences that contain complex subject NPs and complex VPs, as shown in (5):

(5) **Subject NP** **VP + direct object**

il-mudi:ril-jadi:d min il-yuna:nbiy[c]allim il-tadri:s il-hadi:s
**VP-internal PP- adjunct**
fikulliyyitil-tarbiyih

il-mudi:ril-jadi:d min il-yuna:nbiy[c]allim il-tadri:s il-hadi:s
DEF-manager DEF-new from DEF-Greece teach.3SGM DEF-teaching DEF-modern

fikulliyyitil-tarbiyih
in faculty DEF-pedagogy
'The new headmaster teaches the modern teaching in the Faculty of Pedagogy.'

The VP always included five ωs and the subject NP was made up of three or four ωs. The results showed that Φ boundaries are at the expected syntactic positions: at the right of the subject NP and at the right of the direct object. Again, Hellmuth reported that the cues at the right edge of the subject NP are stronger than those at the right edge of the direct object, and therefore they can argue for Φ-recursion in EA. Specifically, the stronger cues at the right edge of the subject NP can be taken as evidence for the boundary of a large/maximal Φ and the weaker ones at the right of the direct object may indicate the boundary of a smaller/minimal Φ.

To conclude Hellmuth's work on EA, there is an obvious match between XPs and Φs; however, this mapping is affected by prosodic weight. Φ boundaries are marked by various suprasegmental cues, including phrase accents, final lengthening and F0 reset. Moreover, even if Hellmuth is not directly addressing the issue, there is possible evidence of Φ-recursion in this dialect: some syntactic XPs in here 2011a and 2011b datasets are marked by stronger Φ boundaries than others.

With regard to the Φ formation in AA, it has been also reported that maximal XPs project Φs (Hellmuth2016; Yasin 2012). Again, suprasegmental correlates to Φ boundaries in AA include final lengthening, low and high phrase accents and post-boundary F0 reset. In Hellmuth's pilot study, the target sentences were SVO sentences. Subject NPs in her test sentences vary in prosodic complexity. The results indicate that the subject NP, which is a maximal XP, projects a Φ independently of its prosodic weight. Thus, the recurring prosodic pattern in AA is $(S)_{\Phi}(VO)_{\Phi}$. In most of the collected tokens, the Φ boundary at the right of the subject NP is marked by a low phrase accent (L-) that is followed by a pitch reset up to the next word.Like Hellmuth (2016), Yasin (2012) reported that Φs match maximal XPs. According to Yasin, Φ boundaries are marked by high phrase accent and final lengthening. In these studies, unlike Hellmuth's work in 2011 on Φ in EA, there are no indications to Φ-recursion. This is, may be, due to the fact that potential cues at edges of non-maximal XPs were not investigated.

Despite the lack of prior empirical studies on prosodic recursion in Arabic varieties, we assume that it is unlikely that recursive Φs are present in EA. Keeping in mind that the match between maximal XPs and Φs are conditioned by a constraint on the minimal weight of that XP, it is rare to detect cues to Φ boundaries at the edges of subject XPs that are light (i.e. a single-word XP) in EA. Accordingly, it will be much harder to detect cues to smaller/minimal Φ boundaries at the edges of an XP that is embedded in a maximal/complex subject XP. For example, final lengthening at the right of a single-word subject XP should hypothetically be greater than the amount of durational increment added to the last syllable of an embedded XP within a complex subject XP although both of them are single words. This is because the right edge of the embedded XP should match a weaker prosodic boundary: a minimal Φ boundary. Since there is limited evidence of syllable lengthening in simple subject XP-final position in EA, significant syllable lengthening in embedded XP-final position is not expected either. This also applies to intonational phenomena, such as phrase accents at the right edges of these simple XPs: if low or high phrase accents are missing at the right of simple subject XPs, they are likely to be also missing at the right of an embedded XP.

From a perception and acquisition view point, if there is little evidence for small Φ because of the minimality requirement, how would children of EA notice and acquire recursion? In all likelihood, they would have no intonational or temporal evidence for it. The issues of recursion in EA obviously need to be addressed directly, but for the time being, we will assume that EA does not tolerate Φ-recursion.

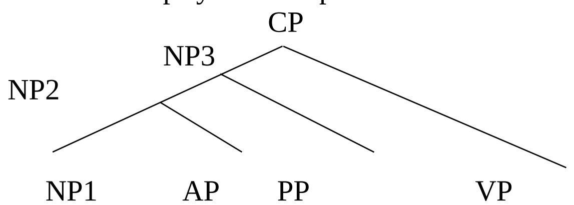
In the following section, we will present an experiment on the formation of the Φ in Jordanian Arabic as spoken in Irbid (IA). This experiment is designed to determine the exact nature of the relation between XPs and Φs in IA: do Φs only match maximal XPs as they do in AA? The other possibility is that Φs can also match low level/minimal XPs, which would be evidence to Φ-recursion. If the second scenario is correct, EA, AA and IA will have different ways of referring to the syntax when forming Φs.Generally speaking, the previously reviewed studies supported matching Φs to XPs; however, none of these studies tested potential recursion at this prosodic level. In the experiment presented in the following section, intonational and durational cues to Φboundaries, i.e. syllable duration and F0 contour, at edges of maximal and embedded XPs are explored to determine if Φs match XPs. This experiment is also conducted to determine whether these cues are gradient and suggest Φ-recursion or not.

## 3. Experiment on the phonological phrase in Irbid Arabic

### 3.1 Hypotheses

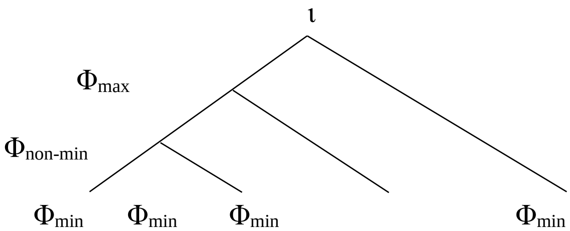
We will start with the strong hypothesis that Φ boundaries, as marked by intonational and durational properties, match XPs and directly reflect syntactic embedding in IA. The choice to assume the direct match hypothesis is a practical one: since there is a large number of possible ways to have mismatching domains, it is easier to make testable predictions for the direct match. If the direct match hypothesis is correct, recursive right-branching and left-branching extra-complex XPs in (6&7) are expected to have different prosodic representations based on their internal syntactic structures, but both of them are expected to trigger prosodic recursion (i.e. three-layer recursive Φ). In the prosodic representation of the right-branching extra-complex NP in (6b), we assume that there are three recursive prosodic layers: NP1 and AP in (6a) form minimal Φs that are dominated by a larger/non-minimal Φ which corresponds to NP2, as shown in (6b). Then, the Φ containing PP joins the Φ of NP2 in a maximal Φ that matches NP3 in the bottom-up syntactic tree in (6a). Finally, the entire sentence is contained in a ι.

(6) A sentence with a right-branching extra-complex XP:
a. Simplified bottom up syntactic representation:




il-jundi il-iswad min khashabtharrak
DEF-soldier DEF-black from wood move.3SGM.PST
'The black wooden pawn was moved'.

b. Prosodicrepresentation:




il-jundi il-iswad min khashabtharrak

Based on previous studies, we expect that this prosodic representation will be cued by two suprasegmental correlates: F0 and syllable duration. These cues are expected to be correlates of boundary tones and pre-boundary syllable lengthening. We first expect final lengthening, i.e. a longer syllable duration at[1] the end of all Φs projected by simple XPs. Assuming prosodic recursion, this final lengthening (FL) should be gradient and incrementally greater at the right edges of higher XPs, as shown in (6c), such as the NP2-final and NP3-final positions, as they also match recursive Φs. We also predict that the greatest amount of lengthening should be found in sentence-final position where the strongest prosodic boundary, anι boundary, is inserted (the end of the VP in (6c)).

c. Syntactic-prosodic bracketing and expected cues to boundaries:
L- L- L-
L%
Small FL FL Greater FL

Greatest FL

↓ ↓ ↓

↓

((( )$_{\Phi min}$ (( )$_{\Phi min}$)$_{\Phi non\text{-}min}$ ( )$_{\Phi min}$)$_{\Phi max}$ (

)$_{\Phi min}$)$_{ι}$

$_{CP}$[$_{NP3}$[$_{NP2}$[$_{NP1}$[il-jundi] $_{AP}$[il-iswad]] $_{PP}$[min khashab]]

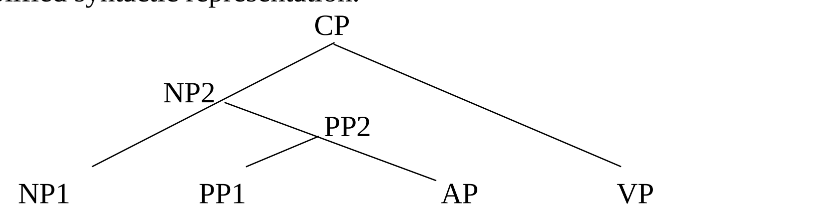
$_{VP}$[tharrak]]

High or low phrase accents (L-) are expected to demarcate the final edge of Φs, as shown in (6c). Assuming a close mirroring of syntax by prosody, they should be realized as F0 movement in XP-final positions. A question that can be raised here is: can F0 raising or lowering demarcate the right edges of more complex XPs in a gradient manner, similar to what we predict for final lengthening? For the time being, there are two theoretically potential ways in which F0 could reflect prosodic recursion: a phrase accent could be more exaggerated at the edges of larger Φs that match more complex XPs; NP2 and NP3. On the other hand, phrase accents realization could be limited to Φs projected by minimal or maximal XPs.

In the prosodic representation of the left-branching extra-complex NP proposed in (7b), the minimal Φs that match PP1 and AP are dominated by a larger Φ that corresponds to PP2 in the syntactic structure in (7a), and then the entire recursive phrase NP2 projects a maximal Φ. Similar to (6b),the entire sentence is contained in an ι.

(7) Sentence with left-branching extra-complex XP:

a. Simplified syntactic representation:

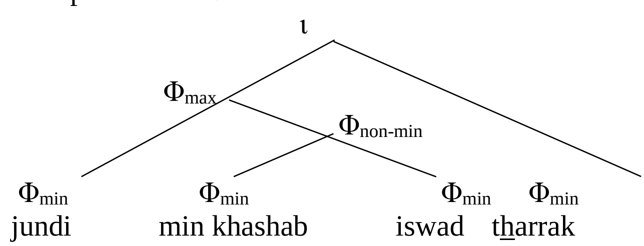



jundi min khashab iswad tharrak

soldier from wood black move.3SGM.PST

'A pawn made of black wood was moved'.

b. Prosodicrepresentation:



Again, final lengthening is expected at all simple XP-final positions that match the right boundaries of small Φs, as shown in (7c), but the final syllable of *iswad* should be the longest of NP2 since it simultaneously occupies PP2-final and NP2-final positions. There should also be phrase-final accents at the end of Φs, but as discussed for the sentence with a right-branching extra-complex XP in (6), it is unclear if these accents will surface at the end of each XP or only at the end of certain types of XPs.

c. Syntactic-prosodic bracketing and expected cues to boundaries:

L- L- L- L%

Small FL Small FL Greater FL Greatest FL

↓ ↓ ↓ ↓

((( $)_{\Phi min}$(( $)_{\Phi min}$ ( $)_{\Phi min})_{\Phi non\text{-}min})_{\Phi max}$ ( $)_{\Phi min})_{\iota}$

$_{CP}$[$_{NP2}$[$_{NP1}$[jundi] $_{PP2}$[$_{PP1}$[min khashab] $_{AP}$[il-iswad]]] $_{VP}$[tharrak]]

### 3.2 Wordlistsand procedures

The current study employed an interactive chess-based task. This task was primarily designed by the researchers in order to elicit semi-spontaneous sentences that contain target syntactic constituents. This interactive semi-spontaneous elicitation technique is more appropriate than spontaneous and text-based techniques. Although Spontaneous techniques come up with natural utterance, the unscripted speech is not predictable (Ito &Speer 2006), and therefore it is too difficult to elicit a relatively large number of the target syntactic structures. Furthermore, the text-based techniques do not fit the current study since the production is more likely to be heavily influenced by laboratory conditions and some of the target tokens may not be found in everyday conversations. The chess-based task in the current study has many resemblances with a previously designed partially scripted game-based task constructed by Speer, Schafer and Warren (2003). This task is mainly to describe an object movement around a game board.

Twenty native speakers (10 male and 10 female speakers) of Jordanian Arabic living in Irbid participated in the task. They are between 18 and 40 years old. They are graduate and undergraduate students at Yarmouk University, an institution located in the city of Irbid. All of them were born and brought up around the city of Irbid. Two speakers participated in each session and sat on opposite sides of a table. Each session was divided into two rounds: the first consisted in gathering utterances containing syntactically right-branching NPs and the second in recording utterances with left-branching NPs, as exemplified in (6a and 7a). The elicited data is based on the description of chess pieces in terms of colors and materials. To record right-branching XPs, one of the experimenters (the authors) introduced some chess pieces, made five moves and described his actions orally using full sentences that contained right-branching extra-complex NPs, as shown in (8).

(8) $_{NP3}$[$_{NP2}$[$_{NP1}$[il-jundi] $_{AP}$[il-iswad]] $_{PP}$[min khashab]] $_{VP}$[t<u>h</u>arrak]
DEF-Soldier DEF-black from wood move.PST
'The black wooden pawn moved.'

After the experimenter completed all five moves while the speakers watched his actions, he gave each speaker a cue card on which a move was described using a sentence with a right-branching extra-complex NP. One of the speakers was asked to start the game and perform the first move after reading the cue card. Roles were then reversed. This was repeated few times to make sure that the speakers could produce natural utterances containing right-branching extra-complex NPs. The speakers were given an opportunity to ask questions or request further instructions about the game, and then the real experiment started. The participants resumed the same round. The round was stopped by the experimenter when each speaker had produced 15 utterances.

In order to record left-branching extra-complex NPs, as shown in (7) above, the experimenter repeated exactly the same procedures that were followed to elicit right-branching extra-complex NPs, but this time he replaced sentences containing right branching extra-complex NPs with sentences embedding left-branching extra-complex NPs: he described his five moves using full utterances that contained left-branching NPs and distributed two cards contained a sentence with a left-branching NP, as exemplified in (9). Then, one of the two participants was asked to read the sentence on the cue card and perform the first move. The experiment started to record after making sure that both speakers could produce natural utterances containing left-branching extra-complex NPs. The round was also stopped once each speaker had produced 15 utterances.

(9) $_{NP2}$[$_{NP1}$[il-jundi] $_{PP2}$[$_{PP1}$[min khashab] $_{AP}$[iswad]]] $_{VP}$[t<u>h</u>arrak]
DEF-soldier from wood black move.PST step
'The pawn made of black wood was moved.'

Each session lasted about 30 minutes per pair of participants. Thirty utterances were collected from each speaker: 15 right-branching and 15 left-branching extra-complex NPs (30 utterances X 20 speakers = 600 collected tokens). It is worth noting that each speaker was free to choose any piece and describe his/her action based on the descriptions of the piece he/she picked. The pieces were either black or white and were either made of wood or plastic.

### 3.3 Measurements

Six types of information were labeled in Praattextgrids by the researchers. First, target utterances were segmented into syllables based on auditory impression, an inspection of the pitch trace and the spectrogram, and were labeled using IPA symbols for Arabic phonemes, as shown in the following figure:

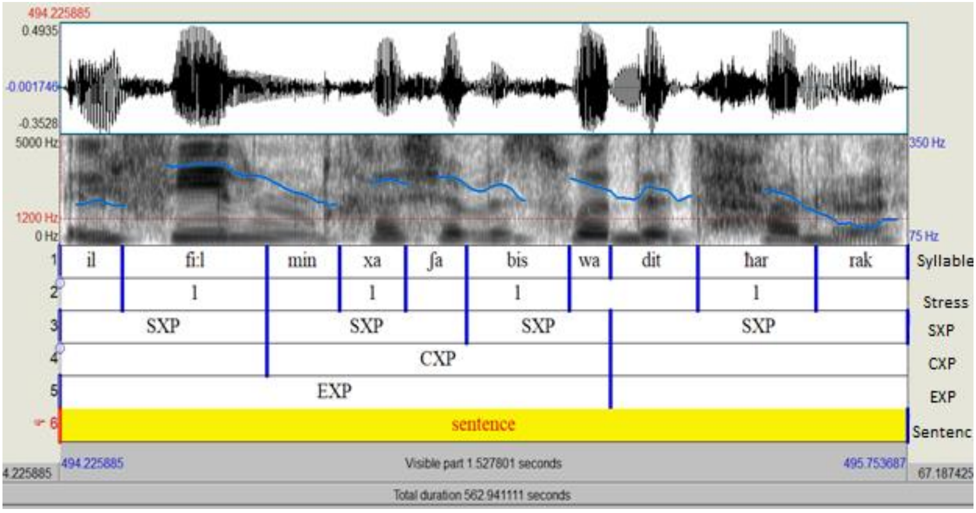



Figure 1: A spectrogram and labeled textgrid for a sentence embedding a left-branching extra-complex XP.$_{\text{NP2}}$[$_{\text{NP1}}$[il-fi:l] $_{\text{PP2}}$[$_{\text{PP1}}$[min khashab] $_{\text{AP}}$[iswad]]] $_{\text{VP}}$[tharrak] 'The bishop made of black wood was moved.'

Stressed syllables were marked. Boundaries, as indicated by arrows in (10&11), were labeled at the edges of the target constituents: simple XP (SXP), complex XP (CXP), extra-complex XP (EXP) and sentence. Note that these final edges are not necessarily mutually exclusive, as the edge of a low level XP can also be the edge of a larger XP encompassing it.

(10) Right-branching extra-complex NP:

| | | | | |
|---|---|---|---|---|
| | CXP-final | | EXP-final | Sentence-final |
| SXP-final | SXP-final | SXP-final | | SXP-final |
| ↓ | ↓ | | ↓ | ↓ |
| $_{\text{NP3}}$[$_{\text{NP2}}$[$_{\text{NP1}}$[jundi] | $_{\text{AP}}$[iswad]] | $_{\text{PP}}$[min khashab]] | | $_{\text{VP}}$[tharrak] |
| Soldier | black | from wood | | move.PST |

'A black wooden pawn moved.'

(11) Left-branching extra-complex NP:

| | | | |
|---|---|---|---|
| | | EXP-final | |
| | | CXP-final | Sentence-final |
| SXP-final | SXP-final | SXP-final | SXP-final |
| ↓ | ↓ | ↓ | ↓ |
| [$_{\text{NP2}}$[$_{\text{NP1}}$[jundi] | $_{\text{PP1}}$[$_{\text{PP2}}$[min khashab] | $_{\text{AP}}$[aswad]]] | $_{\text{VP}}$[tharrak] |
| minister | from wood | black | move.PST |

'A pawn made of black wood was moved.'

The first acoustic property used to diagnose prosodic boundaries is the duration of syllables in (10&11). In the related literature (e.g. Turk (1999)), it is either the final syllable or its nucleus that is normally measured to determine if a syllable or a vowel gains non-phonemic pre-boundary lengthening. From a physiological perspective, pre-boundary lengthening should influence not only the final vowel, but also the entire syllable since this lengthening is a result of slowing down of articulators when they reach the target position of a sound and return to their original position before a boundary. In addition, measuring the duration of the entire syllable is more consistent as some vowels in a pre-boundary position do not seem to show significant lengthening in closed syllables. Therefore, the duration of syllables in final positions are measured.

Significant increments in syllable duration in these final positions, if any, will be interpreted as pre-boundary syllable lengthening. The second acoustic property used as a diagnostic is F0. Maximum, mean and minimum F0 were measured on each syllable to determine the presence of high or low phrase accents. These acoustic properties were measured automatically with a Praat script.

The statistical significance of the factors of interest was investigated using linear mixed effects models[2]. The dependent variables were mean F0, minimum F0 and maximum F0 and syllable duration. F0 values for all male and female speakers were normalized using z-scores to control for F0 range variation between speakers (and especially between genders). The fixed effects were stress (two levels: stressed and unstressed) and a number of relevant syntactic positions: simple XP, complex XP, extra-complex XP and sentence (each had two levels: final syllable and non-final syllable). Speaker and syllable were specified as random intercepts to control for variation based on speaker and the segmental structure of syllables, respectively. As for pitch tracking errors, they were identified by finding outliers and manually corrected if needed.

It is expected that syllables in word-final position are significantly different. The prediction is that word-final syllables that match the right edge of a higher or larger syntactic phrase should be significantly longer than those syllables that match lower syntactic phrases. Furthermore, syllables at the right edges of higher syntactic phrases are expected to have more pronounceable high or low phrase accent. To determine whether syllables in final positions of higher syntactic phrases are significantly longer and they have more pronounceable phrase accents, the length of syllables was measured in milliseconds and the acoustic correlate of phrase accents which is F0 raising or lowering was measured in Hz. The results in the following tables indicate whether syllables in final position are significantly longer in milliseconds and have significantly higher F0 values (high phrase accent) or lower F0 values (low phrase accent) as we go higher in the syntactic structure.

### 3.4 Results

### 3.4.1 Duration

The fitted model for syllable duration (Table 1) shows that syllables in simple XP-final position are significantly lengthened by 13ms compared to non-final syllables ($p = .014$). In left-branching complex XP-final position, syllables are lengthened by an additional 24ms. It is important to note that right-branching complex XP-final position exhibits syllable lengthening (17ms), which almost reaches significance (p=.062): if the dataset had been larger, it is very probable that this position would have a significant positive impact on syllable duration. The results however show that right-branching and left-branching extra-complex XP-final positions do not have an impact on syllable duration. The duration of stressed syllables is longer than the duration of unstressed syllables by a weak but significant 9ms, and the duration of syllables in sentence-final position is significantly lengthened by 96ms.

Table 1: Estimates of fixed effects in a mixed-effects model for syllable duration ($r^2$=0.67). Reference level of the intercept: unstressed, non-final syllables. Estimates are given in msec.

| Parameter | Estimate | Std. Error | df | t | Sig. |
|---|---|---|---|---|---|
| Intercept | 175.839 | .007380 | 93.395 | 23.828 | .000 |
| Stress | 9.343 | .004116 | 2138.745 | 2.270 | .023 |
| Simple XP-final | 13.144 | .005340 | 2081.152 | 2.461 | .014 |
| Right branching complex XP-final | 17.324 | .009277 | 2235.966 | 1.868 | .062 |
| Left branching complex XP-final | 23.869 | .006375 | 2324.297 | 3.744 | .000 |
| Right branching extra-complex XP-final | 2.541 | .009625 | 2238.644 | .264 | .792 |
| Left branching extra-complex XP-final | -4.298 | .008177 | 2319.049 | -.526 | .599 |
| Sentence-final | 95.597 | .007034 | 2274.054 | 13.590 | .000 |

### 3.4.2 Mean F0

The fitted model for mean F0 (Table 2) shows that none of the final positions has a significant effect on mean F0 of syllables. Stress significantly raises mean F0 by .12 SD (standard deviation) and sentence-final position significantly lowers it by .58SD.

Table 2: Estimates of fixed effects in a mixed-effects model for mean F0 ($r^2$=.721).
Reference level of the intercept: unstressed, non-final syllables. Estimated are given in standard deviation (SD).

| Parameter | Estimate | Std. Error | df | t | Sig. |
|---|---|---|---|---|---|
| Intercept | .228018 | .218729 | 17.462 | 1.042 | .311 |
| Stress | .117664 | .043668 | 397.877 | 2.695 | .007 |
| Simple XP-final | .028374 | .055557 | 409.470 | .511 | .610 |
| Right branching complex XP-final | -.133528 | .116910 | 2293.365 | -1.142 | .254 |
| Left branching complex XP-final | -.052026 | .075754 | 1456.841 | -.687 | .492 |
| Right branching extra-complex XP-final | .114767 | .121287 | 2294.313 | .946 | .344 |
| Left branching extra-complex XP-final | -.066799 | .094830 | 791.508 | -.704 | .481 |

| | | | | | |
|---|---|---|---|---|---|
| Sentence-final | -.581939 | .077102 | 562.977 | -7.548 | .000 |

### 3.4.3 Maximum F0

The fitted model for maximum F0 (Table 3) shows that the maximum F0 over syllables in simple, complex and extra-complex XP-final positions is very similar to the results of the mean F0 in that none of these positions have a significant effect on maximum F0. The maximum F0 of stressed syllables is significantly raised by .2SD and maximum F0 significantly drops by .48 SD in sentence-final position.

Table 3: Estimates of fixed effects in a mixed-effects model for F0 maximum (r2=.638). Reference level of the intercept: unstressed, non-final syllables. Estimates are given in SD.

| Parameter | Estimate | Std. Error | df | t | Sig. |
|---|---|---|---|---|---|
| Intercept | .132868 | .201264 | 18.400 | .660 | .517 |
| Stress | .196978 | .050781 | 524.476 | 3.879 | .000 |
| Simple XP-final | .127230 | .065265 | 505.707 | 1.949 | .052 |
| Right branching complex XP-final | -.192144 | .133369 | 2325.950 | -1.441 | .150 |
| Left branching complex XP-final | -.056741 | .087309 | 1692.373 | -.650 | .516 |
| Right branching extra-complex XP-final | .115898 | .138344 | 2326.078 | .838 | .402 |
| Left branching extra-complex XP-final | -.103095 | .110176 | 1085.968 | -.936 | .350 |
| Sentence-final | -.481732 | .089889 | 711.534 | -5.359 | .000 |

### 3.4.4 Minimum F0

The fitted model for minimum F0 (Table 4) shows that the minimum F0 of syllables in simple XP-final position is significantly lowered by .2 SD. There is also a drop of .37 SD in sentence-final position. None of the complex and extra-complex XP-final positions has a significant effect on minimum F0. Stress does not either.

Table 4: Estimates of Fixed Effects in a mixed-effects model for F0 minimum ($r^2$=.438). Reference level of the intercept: unstressed, non-final syllables. Estimates are given in SD.

| Parameter | Estimate | Std. Error | df | t | Sig. |
|---|---|---|---|---|---|
| Intercept | .228873 | .152518 | 26.057 | 1.501 | .145 |
| Stress | .023481 | .068741 | 1306.351 | .342 | .733 |
| Simple XP-final | -.203024 | .088647 | 1226.921 | -2.290 | .022 |
| Right branching complex XP-final | -.118450 | .167455 | 2307.537 | -.707 | .479 |
| Left branching complex XP-final | .009236 | .112291 | 2223.283 | .082 | .934 |

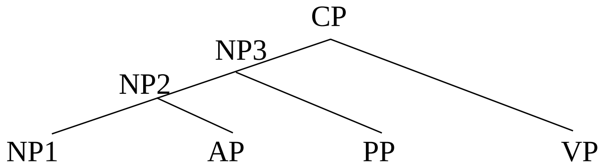
| | | | | | |
|---|---|---|---|---|---|
| Right branching extra-complex XP-final | .169099 | .173717 | 2309.204 | .973 | .330 |
| Left branching extra-complex XP-final | .033255 | .143630 | 2107.689 | .232 | .817 |
| Sentence-final | -.373540 | .119783 | 1616.306 | -3.118 | .002 |

### 3.4.5 Summary and interpretation of the results

The results of the experiment first show that syllable duration increases in the final position of simple XPs (the lowest syntactic level). Syllable duration further increases in left-branching complex XP-final position, and it has been noted in the results that the right-branching complex XP-final position shows a non-significant, but similarly large effect (which would most probably have a significant impact given a larger dataset). On the other hand, left-branching and right-branching extra-complex XP-final positions do not have an effect on syllable duration. Expectedly, it is in sentence-final position that syllables gain the greatest amount of lengthening. These results indicate that pre-boundary syllable lengthening is, to a certain extent, a gradient marker: syllables in simple XP-final position are lengthened, and an even greater amount of lengthening is found in syllables at the right edges of complex XPs. However, this does not extend to extra-complex XPs, suggesting that only two levels of recursion are possible. These results of duration are summarized in (12).

(12) a. A sentence with a right branching extra-complex NP:

Syntactic level:




$_{CP}$[$_{NP3}$[$_{NP2}$[$_{NP1}$[il-jundi] $_{AP}$[il-iswad]] $_{PP}$[min khashab]] $_{VP}$[tharrak]]

↑ ↑ ↑ ↑

SXP-final: 13ms 13ms 13ms 13ms

CXP-final: 17ms

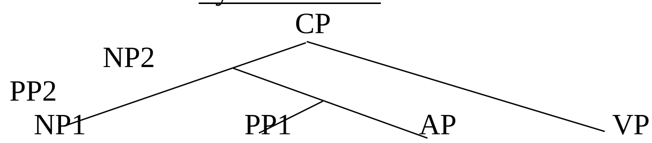
Sentence-final : 95ms (ι effect)

DEF-soldier DEF-black from wood
move.3SGM.PST

'The black wooden pawn was moved'.

b. A sentence with a left branching extra-complex NP:

Syntactic level:




$_{CP}$[$_{NP3}$[$_{NP1}$[jundi] $_{PP2}$[$_{PP1}$[min khashab] $_{AP}$[iswad]]]

VP[tharrak]]

↑ ↑ ↑ ↑

SXP-final: 13ms 13ms13ms13ms
CXP-final: 24ms
Sentence-final:
95ms (ι effect)

soldier from wood black
move.3SGM.PST
'A pawn made of black wood was moved'.

The results also show that minimum F0 is lowered at the right edges of simple XPs. This suggests that the presence of a low phrase accent (L-) at the end of Φs corresponds to simple XPs. A further lowering of mean F0, maximum F0 and minimum F0 in sentence-final position also suggests the presence of a low boundary tone (L%) that marks an intonational phrase boundary in this position. Finally, syllables are lengthened and have higher mean F0 and maximum F0 when they are stressed, suggesting that they receive H* pitch accents.

Finally, collinearity between fixed factors was assessed by dummy coding the categorical variables as ordered gradient values and by measuring their variance inflation factors (VIF) in regressions. The VIF were all below 2, suggesting low collinearity (as a rule of thumb, collinearity is considered significant from 5 and problematic from 10).

## 4. Discussion

The initial hypothesis in this paper is that Φs match XPs and are marked by phrase accents and pre-boundary syllable lengthening. Given the assumption of a strong match between syntax and prosody, one would expect a type of Φ-recursion in which final lengthening and phrase accents are cumulative so that they are more conspicuous in more complex XPs that match higher Φs.

The results of the experiment indicate, partially consistent with my hypothesis, that final lengthening is gradient, but limited to two levels of Φ-recursion. Syllables in simple XP-final position are lengthened and those in complex XP-final position gain further lengthening, but no further lengthening is found in extra-complex XP-final position. This suggests that there is a maximal limit to the number of levels in the recursive Φ: the first level contains minimal Φs that match simple XPs and the larger or maximal Φs of the second level match complex XPs, but there is no motivation to posit a third level projected by extra-complex XPs.

The F0 results indicate that phrase accents are assigned to Φs, but that this type of phonological unit does not reflect syntactic nesting: F0 minimum lowering has been found only in simple XP-final position, and this means that each simple XP matches a minimal Φ and is marked by L- accent. No further lowering has been observed in complex and extra-complex XP-final positions. Thus, phrase accents are not realized cumulatively at the right edges of larger XPs.

The prosodic representations of sentences containing right-branching and left-branching extra-complex XPs and their cues can be formalized as in (13 and 14). In (13a and 14a), we show the prosodic bottom-up representations of the right-branching and left-branching extra-complex XPs, and in (13b and 14b), the syntactic-prosodic bracketing for these XPs is provided.

(13) A sentence embedding right-branching extra-complex XP:

a. <u>Bottom-up prosodic representation:</u> <u>Cues:</u>

ι → Sentence-final ι marked by L% and further FL

$\Phi_{max}$ → marked by further FL

$\Phi_{min}$ $\Phi_{min}$ $\Phi_{min}$ $\Phi_{min}$ → marked by FL and L-

il-jundi il-iswad min khashab t<u>h</u>arrak

b. Syntactic and prosodic bracketing:

(( $)_{\Phi min}$(( $)_{\Phi min})_{\Phi max}$ ( $)_{\Phi min}$( $)_{\Phi min})_{\iota}$

$_{CP}$[$_{NP3}$[$_{NP2}$[$_{NP1}$[il-jundi] $_{AP}$[il-iswad]] $_{PP}$[min khashab]] $_{VP}$[t<u>h</u>arrak]]

(14) A sentence embedding a left-branching extra-complex XP:

a. <u>Bottom-up prosodic representation:</u> <u>Cues</u>:

ι → Sentence-final ι marked by L% and further FL

$\Phi_{max}$ → marked by further FL

$\Phi_{min}$ $\Phi_{min}$ $\Phi_{min}$ $\Phi_{min}$ → marked by FL and L-

jundi min khashabiswadt<u>h</u>arrak

b. Syntactic and prosodic bracketing:

(( $)_{\Phi min}$(( $)_{\Phi min}$ ( $)_{\Phi min})_{\Phi max}$ ( $)_{\Phi min})_{\iota}$

$_{CP}$[$_{NP2}$[$_{NP1}$[jundi] $_{PP2}$[$_{PP1}$[min khashab] $_{AP}$[il-iswad]]] $_{VP}$[t<u>h</u>arrak]]

In a nutshell, the results of the experiment indicate that Φ in IA is recursive, but it is limited to two levels. Minimal Φs match simple/small XPs and are marked by final lengthening and L- accents. In right-branching extra-complex XPs (Figure 2) and in left-branching extra-complex XPs (Figure 3), for example, L- accents are assigned by IA Phonology to all minimal Φs and final lengthening, which is treated as a diagnostic to Φ-recursion, reflects a maximum of two levels of syntactic embedding: minimal Φs are mapped from simple XPs and maximal Φs are mapped from the next level of XP recursion.

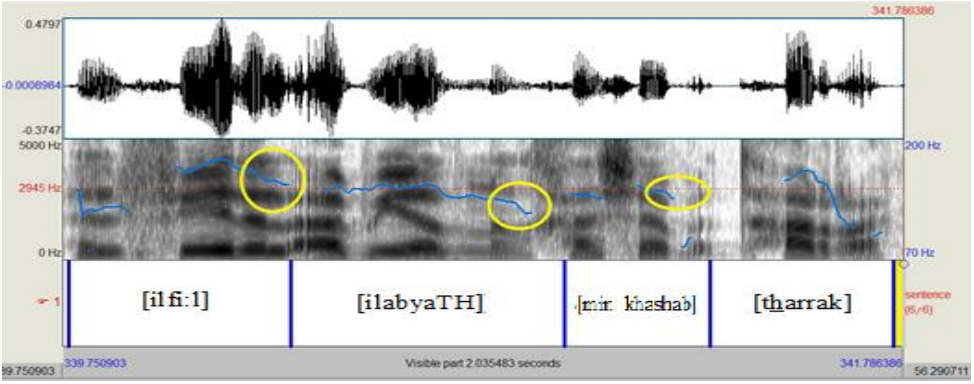



Figure 2: L- phrase accents in the final position of each simple XP and L% tone in sentence-final position in a right-branching sentence $_{\text{NP3}}$[$_{\text{NP2}}$[$_{\text{NP1}}$[ilfi:l] $_{\text{AP}}$[ilabyaTH]] $_{\text{PP}}$[min khashab]] $_{\text{VP}}$[tharrak] 'The black wooden bishop moved'.

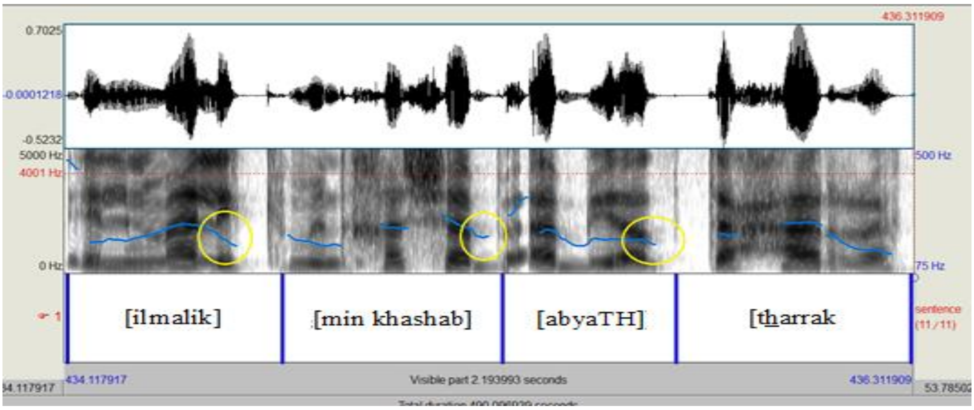



Figure 3:L- phrase accents in the final position of each simple XP and L% tone in sentence-final position in a left-branching sentence [$_{\text{NP2}}$[$_{\text{NP1}}$[ilmalik] $_{\text{PP1}}$[$_{\text{PP2}}$[min khashab] $_{\text{AP}}$[abyaTH]]] $_{\text{VP}}$[tharrak] ‘The king made from white wood was moved’.

Prosodic recursion is one of the important theoretical issue that is related to the universality of the prosodic hierarchy. While it had been strictly prohibited by the early version of Strict Layer Hypothesis (Nespor&Vogel 1986, Selkirk 1986), it is now built-in as a direct consequence of the universal correspondence constraints of Match Theory (Selkirk 2009, 2011). In this paper, it has been shown that prosodic recursion at the phonological phrase level is neither prohibited, not unconstrained in IA. This restricted version of recursive phonological phrase, contrary to the theoretically infinitely recursive nature of the syntactic constituents to which they are anchored, is diagnosed by restrictions on final lengthening. Final lengthening is presented as evidence that there are only two possible recursive layers (minimal and maximal Φ), even in the presence of more complex syntactic nesting: when the role of ɩs is carefully controlled for, only two degrees of final lengthening are detected at the edges of Φ's.

This binary prosodic recursion, we propose, is a language-specific constraint on the formation of phonological phrases imposed by restrictions on performance rather than a universal constraint that is part of Universal Grammar. Even if full recursion was allowed in terms of competence, it would be very difficult for speakers to realize several gradient levels of phrase-final lengthening at Φ right boundaries. It is also expected to find larger amounts of final lengthening at the right of embedded clauses that match intonational phrases. Hence, it would be too difficult to produce more than two levels of final lengthening at the right of Φ subcategories. This way, learners (i.e. children) are likely to internalize this restriction on final lengthening as a language-specific constraint. This scenario could explain why some dialects/languages have no prosodic recursion (e.g. I assume that EA has a non-recursive Φ) and others have more than two recursive levels, such as English (Wagner 2005, 2010). As for AA, although prosodic recursion at the Φ level has not been reported in previous work on this dialect, the match between XPs and Φs, unlike EA, is not conditioned by a prosodic weight requirement. Therefore, it is possible that cues to a recursive Φ could be found if prosodic recursion is systematically explored in this dialect.

Finally, an important question that has been raised by one of the reviewers is whether extra-complex NPs that have only either embedded APs or PPs, as shown in (15), have the same prosodic partition found in (13). Will the Φs of the first two embedded phrases be lumped together in one maximal Φ? To answer this question, we have composed six sentences that contain extra-complex NPs following the specifications in (15a&b): 3 sentences containing a NP followed by two APs and 3 sentences containing a NP followed by two PPs. The target sentences are listed in (16&17). 4 native speakers of Jordanian Arabic as spoken in Irbid were asked to read these sentences. In the elicited 24 sentences, the final syllable of each word was measured. The measured syllables in AP1 and AP2 final position, as shown in Table 5, indicate that the syllables that occupy the final position of AP1 are general longer than syllables in NP1 and AP2 final position. This conclusion emphasizes on our experimental results that indicate that the first two elements in an extra-complex NP is parsed in a maximal Φ and its right boundary is marked by greater amount of final lengthening when the post-modified elements (i.e. the two APs) non-recursively modify NP1. One the other hand, the measured syllables in PP1-final and PP2-final position indicate that there is no a clear and systematic difference in duration between these syllables. At the first glance, it seems that both PPs in (17a-c) iteratively modify the head noun NP1, and therefore this extra-complex NP should have the same prosodic representation in (13). However, the relation between NP1 and PP1 is strong, and PP2 is an adjunct. This entails that we should come up with new hypotheses/predictions about the possible prosodic phrasing of this syntactic structure. We think that this can be tackled in more details in future research to find out the prosodic behavior of different types of PPs.

(15) a. $_{NP3}[\ _{NP2}[\ _{NP1}[\quad]\ _{AP1}[\quad]]\ _{AP2}[\quad]]$
b. $_{NP3}[\ _{NP2}[\ _{NP1}[\quad]\ _{PP1}[\quad]]\ _{PP2}[\quad]]$

(16) a. $_{NP3}$[$_{NP2}$[$_{NP1}$[il-galam] $_{AP}$[il-azrag]] $_{AP}$[il-saa.'il]] $_{VP}$[inkasar]
DEF-pen DEF-blue DEF-liquid broken
'The blue liquid pen is broken'.
b. $_{NP3}$[$_{NP2}$[$_{NP1}$[il-sahin] $_{AP}$[il-asfar]] $_{AP}$[il-mxat.tat]] $_{VP}$[wigi$^{c}$]
DEF-dish DEF-yellow DEF-striped fell
'The yellow striped dish fell down'.
c. $_{NP3}$[$_{NP2}$[$_{NP1}$[il-maktab] $_{AP}$[il-asfar]] $_{AP}$[il-taalif]] $_{VP}$[inrama]
DEF-office DEF-yellow DEF-damged thrown
'The damaged yellow office has been thrown away.'

(17) a. $_{NP3}$[$_{NP2}$[ $_{NP1}$[sahin] $_{PP1}$[min blastik]] $_{PP2}$[ʕalail-maktab]] $_{VP}$[inkasar]
dish from plastic on DEF-office broken
'A dish made form plastic on the table was broken'.
b. $_{NP3}$[ $_{NP2}$[ $_{NP1}$[daftar] $_{PP1}$[$^{c}$alail-maktab]] $_{PP2}$[la mhammad]] $_{VP}$[insarag]
notebook on DEF-office
toMohammadstolen
'Mohammad's notebook that was on the office was stolen.'
c. $_{NP3}$[ $_{NP2}$[ $_{NP1}$[kutub] $_{PP1}$[$^{c}$alail-raff]] $_{PP2}$[la il-maktabih]] $_{VP}$[in$^{c}$a:rin]
DEF-notebook on DEF-office to Mohammad loaned
'Books of the library on the shelf have been loaned'.

Table 5: Duration measurements of syllables in final positions within extra-complex NPs (NP+AP+AP). Duration is in milliseconds.

| NP1-final | AP1-final | AP2-final | Speaker |
|---|---|---|---|
| 162 | 211 | 176 | MA |
| 171 | 198 | 168 | MA |
| 167 | 191 | 172 | MA |
| 174 | 176 | 182 | MA |
| 181 | 184 | 191 | BK |
| 162 | 197 | 172 | BK |
| 157 | 188 | 161 | BK |
| 156 | 184 | 172 | BK |
| 163 | 190 | 171 | SJ |
| 152 | 188 | 179 | SJ |
| 167 | 189 | 162 | SJ |
| 177 | 191 | 172 | SJ |
| 154 | 187 | 160 | SA |
| 156 | 163 | 184 | SA |
| 166 | 189 | 165 | SA |
| 163 | 192 | 170 | SA |

Table 6: Duration measurements of syllables in final positions within extra-complex NPs (NP+PP+PP).

| NP1-final | PP1-final | PP2-final | Speaker |
|---|---|---|---|
| 155 | 176 | 165 | MA |
| 162 | 175 | 179 | MA |
| 177 | 189 | 187 | MA |
| 173 | 214 | 181 | MA |
| 167 | 182 | 194 | BK |
| 163 | 187 | 186 | BK |
| 152 | 189 | 168 | BK |
| 166 | 183 | 192 | BK |
| 160 | 202 | 171 | SJ |
| 172 | 191 | 189 | SJ |
| 177 | 197 | 192 | SJ |
| 171 | 186 | 187 | SJ |
| 152 | 183 | 179 | SA |
| 149 | 173 | 192 | SA |
| 176 | 201 | 181 | SA |
| 151 | 187 | 178 | SA |

## 5. Conclusion

In this paper, the construction of the Φ, its correlates and potential recursion in IA have been investigated. The initial hypothesis in this paper was that Φs should match syntactic phrases and should recursively match embedded syntactic constituents. The results confirmed on XP-to-Φ match in this dialect and their right edges are marked by low phrase accents (L-) and pre-boundary syllable lengthening. As for syntactically based recursion, the results confirmed on the existence of a two-level recursive Φ in IA. This recursive Φ matches a nested XP in the syntactic structure. This recursion is made evident by gradient pre-boundary syllable lengthening: maximal XPs are marked by a greater amount of final lengthening.

## Endnotes

[1]The most affected element by such non-contrastive lengthening within a syllable is the vowel. Generally speaking, Arabic varieties contrast between long and short monophthongs (Kalaldeh 2018). In this study, non-contrastive lengthening in Jordanian Arabic affects both long and short monophthongs.

[2]The full model structure used in SPSS is:
DATASET ACTIVATE DataSetX.
MIXED (Y) BY stress SXPfinalCXPfinalEXPfinalsentencefinal speaker syllable
/CRITERIA=CIN(95) MXITER(100) MXSTEP(10) SCORING(1)
SINGULAR(0.000000000001) HCONVERGE(0,

ABSOLUTE) LCONVERGE(0, ABSOLUTE) PCONVERGE(0.000001, ABSOLUTE)
/FIXED=stress SXPfinalCXPfinalEXPfinalsentencefinal | SSTYPE(3)
/METHOD=REML
/PRINT=SOLUTION TESTCOV
/RANDOM= INTERCEPT sentencefinal | SUBJECT(speaker) COVTYPE(VC)
/RANDOM= INTERCEPT sentencefinal | SUBJECT(syllable) COVTYPE(VC).
/SAVE=PRED(XXX_TotPred).

Hadeel Al-Saed
Department of English Language and Literature
Applied Science Private University
Amman, Jordan
Email: h_alsaed@asu.edu.jo

Abdul AzeezJaradat
Department of English Language and Literature
Applied Science Private University
Amman, Jordan
Email: ajara084@uottawa.ca

## Reference

**Adger, David.**(2006). 'Stress and phasal syntax'.*Linguistic Analysis*, 33: 238-266.

**Elfner, Emily.**(2012). Syntax-prosody interactions in Irish.Unpublished PhDDissertation, University of Massachusetts, Amherst, USA.

**Féry, C. and Hubert Truckenbrodt.** (2005). 'Sisterhood and tonal scaling'. *Studia Linguistica*, 59(2): 223-243.

**Hellmuth, Sam.**(2004). 'Prosodic weight and phonological phrasing in Cairene Arabic'.*Proceedings of the 40th Meeting of the Chicago Linguistics Society*, 97-111.

**Hellmuth, Sam.** (2007). 'Therelationship between prosodic structure and pitch accent distribution: evidence from Egyptian Arabic'. *The Linguistic Review*, 24: 289-314.

**Hellmuth, Sam.**(2011a). 'How many levels of phrasing?Empirical questions and typological implications'.*Proceedings of the 28th West Coast Conference on Formal Linguistics*.USA: Cascadilla Press, 258-266.

**Hellmuth, Sam.** (2011b). ‘Variable cues to phrasing: finding edges in Egyptian Arabic’. In Toni Borowsky, Shigeto Kawahara and Mariko Sugahara. (eds.), *Prosody Matters: Essays in Honor of Lisa Selkirk*, 238-279. London: Equinox.

**Hellmuth, Sam.** (2016). Exploring the syntax-phonology interface in Arabic. In S. Davies, & O. Soltan (Eds.), *Perspectives on Arabic Linguistics XXVII*

(Studies in Arabic Linguistics). (pp. 75-97). Amsterdam: John Benjamins.

**Ito, Kiwako and Shari Speer**. (2006). 'Using interactive tasks to elicit natural dialogue'. In Petra Augurzky and Danisa Lenertova (eds.) *Methods in empirical prosody research*, 229-258. USA:Boston. Mouton de Gruyter.

**Itô, Junko and Armin Mester.** (2013). 'Prosodic Subcategories in Japanese'. *Lingua*, 124: 20-40.

**Itô, Junko and Metser.** (2012). 'Recursive Prosodic Phrasing in Japanese'. In Toni Borowsky,Shigeto Kawahara and Mariko Sugahara(eds.). *Prosody matters:Essays in Honor of Elisabith Selkirk*, 280-303. London. Equinox.

**Kalaldeh, Raya. (2018)**. 'Acoustic Analaysis of Modern Standard Arabic Vowels by Jordanain Speakers'. *International Journal of Arabic-English Studies*, 18 (1): 23-48.

**Kratzer, Angelika and Elisabeth Selkirk.** (2007). 'Phase theory and prosodic spellout: The case of verbs'. *TheLinguistic Review*, 24 (3): 93-135.

**Marina, Nespor and Irene Vogel.** (1986). *Prosodic Phonology*. Dordrecht: Foris Publications.

**Selkirk, Elisabeth.** (1986). 'On derived domains in sentence phonology'. *Phonology Yearbook*, 3: 371-405.

**Selkirk, Elisabeth.**(1984). *Phonology and Syntax: The Relation between Sound and Structure*. Cambridge, MA: MIT Press.

**Selkirk, Elisabeth.** (1996). 'The Prosodic structure of function words'. *Occasional Papers in Linguistics 18: Papers on Optimality Theory*, 439-469. Univeristy of Massacausetts, Amherst: Graduate Linguistics Student Association.

**Selkirk, Elisabeth.** (2009). 'On clause and intonation phrase in Japanese: The syntactic grounding of prosodic constituent structure'. *Gengo Kenkyu*, 136: 1-39.

**Selkirk, Elisabeth.**(2011). 'The syntax-phonology interface'. In John Goldsmith, Jason Riggle and Alan Yu (eds.) *The Handbook of Phonological Theory*.2nd edition: 435–484.Oxford: Blackwell

**Truckenbrodt, Hubert.** (2007). 'The syntax–phonology interface'. In Paul de Lacy (ed). *The Cambridge Handbook of Phonology*, 435-456. Cambridge, MA: Cambridge Univeristy Press.

**Truckenbrodt, Hubert.** (1995). Phonological Phrases: Their Relation to Syntax, Focus, and Prominence. Unpublished PhD Dissertation. Massachusetts Institute of Technology, USA.

**Truckenbrodt, Hubert.** (1999). 'On the relation between syntactic phrases and phonological phrases'. *Linguistic Inquiry*, 30(2): 219-255.

**Wagner, Michael.** (2005). Prosody and recursion. Published PhD Dissertation. Massachusetts Institute of Technology. USA.

**Wagner, Michael.** (2010). 'Prosody and recursion in coordinate structures and beyond'. *Natural Language and Linguistic Theory*, 28(1): 183-237.

**Yasin, Ayman.** (2012). 'Syntax-prosody interface: Evidence from wh movement in Jordanian Arabic'. PhDDissertation. Purdue Univeristy, Purdue, USA.