

An Optimality Analysis of Syllable-based Processes in the Speech of Normal Algerian Arabic-Speaking Children

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Abstract:

The present study aims at identifying the most frequent syllable-based processes in the speech of 80 normally developing Algerian children who are acquiring Jijilian Spoken Arabic (JSA) natively, and accounting for that within an Optimality Theory (OT) framework. The children's ages ranged between 1;2 (year;month) and 5 years and they were divided into four age groups of ten month intervals. Importantly, this study attempts to determine whether those processes are language-universal or language-specific. A thorough analysis of the data at the researchers' disposal revealed that Reduplication, Weak and Unstressed syllable deletion, Cluster Simplification, Vowel Epenthesis, and Final Consonant Deletion are the most common syllable-based processes in the speech of typically developing Algerian children. They emerged at the age of 1;2 and started decreasing in number and frequency at the age of 3 until they completely disappeared at the age of 5. The application of OT so as to account for such phonological processes disclosed that the acquisition process within the OT framework is synonymous with the reranking of constraints in the sense that as the language of the child develops, faithfulness constraints, which are initially low ranked, are promoted and markedness constraints, which are initially high-ranked, are demoted.

Keywords: Constraints, Normal Algerian Children, Jijilian Spoken Arabic, Optimality Theory, Syllable-based processes.

تحليل أمثلي للعمليات الفونولوجية المرتكزة على المقطع لدى الاطفال الجزائريين الطبيعيين الناطقين باللغة العربية

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ملخص:

تهدف هذه الدراسة إلى تحديد العمليات المرتكزة على المقطع، والأكثر شيوعاً في كلام ثمانين (80) طفلاً جزائرياً طبيعياً ممن يكتسبون اللهجة الجبلية بشكل أصلي، وذلك في إطار ما يسمى بالنظرية الأمثلية. تراوحت أعمار الأطفال ضمن عينة الدراسة من أربعة عشر شهراً إلى غاية خمس سنوات، وتم تقسيمهم إلى أربع فئات عمرية بحيث كان الفارق بين كل فئتين متتاليتين عشرة أشهر.

تكمن أهمية الدراسة في محاولتها تحديد ما إذا كانت هذه العمليات قابلة للتعميم على كل أو أغلب اللغات أم أنها تقتصر على لغات معينة. كشف تحليل البيانات أن أكثر العمليات شيوعاً هي: تكرار المقطع الصوتي وحذف المقطع الضعيف وحذف أحد الصوامت المتجاورة وإدخال الصوائت وحذف الصامت في نهاية الكلمة. ظهرت هذه العمليات عند الأطفال في سن الأربعة عشر شهراً وبدأت في الانخفاض من حيث العدد والتكرار في سن الثالثة إلى أن تلاشت تماماً في سن الخامسة.

كما كشف تطبيق النظرية الأمثلية على هذه العمليات الصوتية أن عملية اكتساب اللغة في إطار هذه النظرية مرادف لإعادة ترتيب الضوابط، بمعنى أنه عندما تتطور لغة الطفل فإن ضابط الإخلاص (Faithfulness Constraint) والذي يحتل مرتبة متأخرة في البداية ترتقي مرتبته لاحقاً، مقارنة بضابط الوسم (Markedness Constraint) والذي تتراجع مرتبته بعد أن كان في مرتبة عليا.

الكلمات المفتاحية: الضوابط، الأطفال الجزائريون الطبيعيون، اللهجة العربية الجبلية، النظرية الأمثلية، العمليات المرتكزة على المقطع.

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Introduction:

Language acquisition has attracted the attention of many investigators from a wide array of different scientific, scholarly, and philosophical interests. Interestingly, the received opinion among language acquisition researchers is that first language acquisition "occurs without explicit teaching, on the basis of positive evidence, under varying circumstances, and in a limited amount of time, in identical ways across different languages" (Guasti, 2002, p. 3). This line of reasoning is in conformity with Chomsky's ideas who purports that children are born with an inherited ability to learn any human language and become competent users of their native language in such a short lapse of time and without any significant instruction (McGilvray, 2007, p.50).

The human linguistic agility is underpinned by an innate mechanism termed as the 'Language Acquisition Device' (LAD) which encodes the major principles of a language and its grammatical structures into the child's brain (Wen, 2013, p.151). Nevertheless, "during the first two or three years of development, a child requires interaction with other language-users in order to bring this general language capacity into operation with a particular language such as English" (Yule, 2006, p. 149). Due to the fact that every aspect of human language is extremely complex, "between the earliest cry of hunger or pain and the most complicated spoken word there is often a lengthy, sometimes bumpy, path of development" (Bochner & Jones, 2003, p. 131). Such a path of child phonological development is characterized by the use of the so-called 'phonological processes' which are at the very core of how we understand child phonological development.

Phonological processes are simplifying strategies that allow children to reduce the number of sounds and contrasts between sounds. In this regard, Stampe (as cited in Al-Buainain et al., 2012, p. 26) Asserts that a phonological process is a mental operation which usually applies in speech to substitute for a class of sounds presenting a common difficulty to the speech capacity of the individual. Phonological processes are believed to be "universal to the extent that every child is born with the facility to simplify speech in a consistent fashion" (Ingram, 1986, p. 224). Importantly, child phonological development is considered as a gradual loss of those simplifying processes until the child's words finally match his adult models.

At this juncture, it is worth noting that phonological processes in child language are of different types, an instance of which are 'syllable-based processes'. These are processes in which "the child adds or removes sounds

or alters the structure of the syllable in some way. They reflect a preference by young children for CVCV patterns” (Peccei, 2006, p. 12). In a nutshell, syllable structure processes are based on the fact that the syllable is the unit in terms of which phonological systems are organised. Roach (2009, p. 87) stated that "every language has syllables, and babies learn to produce syllables before they can manage to say a word of their native language. When a person has a speech disorder, their speech will still display syllabic organization, and slips of the tongue also show that syllabic regularity tends to be preserved even in 'faulty' speech". Phonologists have proposed that 'core syllables', or CV structures are the unmarked form of syllable structure and that is why they are preferred by children at the onset of phonological acquisition (Demuth, 1997, p. 57).

In light of the foregoing, one can state that syllable-based processes affect the relative distribution of consonants and vowels within words. Therefore, processes like cluster simplification, vowel epenthesis, the deletion of final consonants or unstressed syllables, and reduplication are brought to the fore. Accordingly, if an English speaking child attempts to say the word 'stand', he is likely to say something like 'tan' in which he drops out the /s/ in the initial /st/ cluster and drops out the /d/ in the final /nd/ cluster, and thus, cluster reduction. At this point, it is prerequisite to point out that syllable structure processes in the speech of normally-developing Algerian children could be accounted for under the banner of OT.

In brief, OT was propounded by Prince and Smolensky in 1991 at the University of Arizona Phonology Conference in Tucson in which they presented a paper entitled ‘Optimality’ (Archangeli, 1997, p. 1). It is the most prevalent perspective being developed in the literature and differs to varying degrees from other proposals, both in terminology and formalism. The core of OT is the notion that Universal Grammar furnishes us with a set of highly general *constraints* (CON) which are universal and violable but whose ranking is language specific (Prince & Smolensky, 2004, p.4). They are divided into two fundamental and often antagonistic types viz: *Markedness Constraints* and *Faithfulness Constraints*. The former are "formulated exclusively in terms of output properties and militate against marked segment types, sequences and structures while the latter "demand identity between corresponding elements in input and output representations” (Dinnsen & Gierut, 2008, p. 5).

These constraints are in a constant conflict that could only be resolved via ranking them (McCarthy, 2007, p.5). In addition to CON, OT grammar consists of other components namely: the lexicon or input, the generator (GEN) which generates output candidates for that input, and the evaluator (EVAL) whose function is to identify the optimal output or the most harmonic one among the set of competing, language-specific ranked constraints (Kager, 1999, p. 19).

It is worth noting that OT has had a colossal impact on the field of child phonological acquisition. Within its framework, the acquisition task consists of detecting the language-specific ranking of universal constraints on the basis of the adult target forms. It is doubtless that the early child productions differ significantly from the forms they hear or the input forms. Therefore, child phonological acquisition researchers are required to examine the child's pronunciations of words as reflecting the child's independent phonological system, while still focusing on the ways that the child's system (and hence the child's pronunciation) matches or differs from the adult's system (and hence from the adult's pronunciations) (Stemberger & Bernhardt, 1997, p.2). What is worth being set to light here is the fact that the way OT tries to account for the discrepancy between the input forms (i.e. the adult output forms) and the child's output forms is different from that of other phonological theories. It suggests that faithfulness constraints are generally ranked low (and are, therefore, allowed to be violated), while markedness constraints are ranked high (preferably unviolated). The gist is that as the phonology of the child develops, the output forms become more and more faithful to the input forms: this is accounted for by the reranking of the constraints: faithfulness constraints are promoted, markedness constraints are demoted (Zamuner, 2003, p.73). Thus, the phonological acquisition process within the OT framework is synonymous with the reranking of constraints.

2. Literature Review

After the circulation of the earliest manuscript in Optimality Theory namely: Prince and Smolensky's *'Optimality Theory: Constraint Interaction in Generative Grammar'* in 1993, some researchers began to investigate its application to normal child phonological development. Importantly, the majority of those studies focused on patterns in child language production data. Nonetheless, taking the fact that OT is a relatively new model of phonological analysis, it is no wonder that prior accounts of child phonological development within its framework in different languages are

not abundantly available. That is, most studies which dealt with phonological processes in child language were coached within linear phonology and the autosegmental approach. However, compared with studies on normal child phonological development in languages such as English, Arabic lags behind. This remains a current gap in the existing research on normal Arab child phonological acquisition in general and syllable-based processes in particular.

Gnanadesikan (1995) is among the first who accounted for child language data within OT in his 'Markedness and Faithfulness Constraints in Child Phonology'. Importantly, the study was dedicated to the phonology of a single child named Gitanjali (G), a 2 year old who was raised in a monolingual Standard American English environment. The researcher reported that G's grammar produced syllables which had at most one consonant in onset position, thus the syllable-based process of 'cluster reduction' is brought to the fore. It revolves around the idea that underlyingly complex onsets must be reduced to a single segment. Accordingly, the unmarked structure of G's onsets emanated from the ranking of the markedness constraint *COMPLEX (no complex onsets) above the faithfulness constraint of MAX (IO) (all the segments in the input should have a corresponding element in the output). The examples clean /kin/, and please /piz/) are a case in point. In OT terms, *COMPLEX dominates MAX (IO), i.e. *COMPLEX >> MAX (IO). Therefore, Gitanjali's grammar enforces the unfaithful outputs to surface.

Ohala (1996) examined the process of cluster reduction in children's speech from an OT perspective. Interestingly, subjects were sixteen English-speaking children ranging in age between twenty-one and thirty-eight months. Two sets of stimuli were used: picture and word stimuli. The researcher explained extensively the way cluster reduction was at work in the children's production of the word /spark/ whose optimal output was /park/. Therefore, he proposed the following constraint hierarchy: *COMPLEX >> FAITH whereby the markedness constraint *COMPLEX (Syllables must not associate more than one C or V to a syllable position node) was high ranked. It forces children to conform onset clusters to singleton consonants. This was done at the expense of the faithfulness constraint FAITH which requires every segment of the input to have a correspondent in the output.

Likewise, Łukaszewicz (2007) discussed four strategies of onset consonantal clusters' reduction employed by Ola (O), 4;0-4;4, a normally-

developing Polish-speaking child. These included deletion, coalescence, metathesis, and gemination. The results showed that deletion and coalescence occurred in word-initial onsets while metathesis and gemination were restricted to word-medial position. The OT account made it possible to envisage the four strategies as different surface responses to the undominated *COMPLEX_{Onset} constraint. The researcher found out that the choice of a particular strategy as well as its restriction to a particular word position followed from the interplay between *COMPLEX_{Onset}, sonority-based syllable structure constraints, context-sensitive markedness constraints, and faithfulness constraints. As for deletion, for instance, the Polish word 'słomy' /swɔmi/ 'straw' was realized as /sɔmi/ and, thus resulting in the simplification of the cluster in the onset.

In a more recent study, Al Qawasmi (2008) dealt with the phonological processes in the speech of normal urban Jordanian children using OT. Accordingly, she analyzed the pronunciations of a list of words by thirty children whose ages ranged between 1.5 and 5 years. In particular, they were asked to name objects and pictures. Therefore, the researcher identified different processes including syllable structure processes like weak syllable deletion, and vowel epenthesis. The results of the study confirmed the existence of continuity between children's and adults' phonological systems and considered phonological development as a re-ranking of constraints. An example of syllable structure processes is 'vowel epenthesis' in the word /kalb/ (dog) which was realized as /kalib/ and it was explained in terms of an interaction between *Complex, DEP and MAX. *Complex was the highest ranked constraint. Thus, /kalib/ was the optimal candidate because it satisfied it.

Analogously, Ragheb (2011) used OT so as to account for the process of final consonant cluster simplification by an Egyptian child (2;8) who was acquiring Cairene Arabic. The data were elicited in a spontaneous picture-naming task and in conversation. Results manifested that the child generally replaced final clusters with a geminate of the final consonant in the cluster as in the case of the word /kalb/ 'dog' which was realized as /kabb/. Interestingly, the researcher accounted for such productions as emanating from the faithfulness constraint MAX MORA (Input moras must be preserved in the output) and the markedness constraint *COMPLEXCODA (Complex codas are banned) being ranked higher than MAX (Segments in the input must have correspondents in the output. No deletion). Hence, /kabb/ is the optimal output candidate because it satisfies the higher ranked

constraints and violates only the lower-ranked constraint MAX as the /l/ of /kalb/ is deleted.

As a matter of fact, syllable-based processes in the speech of normal Arab children have received scant attention in the literature. Moreover, it has become apparent that such processes in the speech of normally developing Algerian children in Jijel have not been subject to previous research neither in the light of OT nor within the framework of other phonological theories. Therefore, the present research work aims at filling that gap by using OT with the hope of accounting for the syllable-based processes that are present in the speech of normal Algerian children aged between 1;2 and 5 years.

3. Methodology

The sample of the present cross-sectional study is composed of eighty gender-balanced normal Algerian children who were acquiring JSA natively. Such a dialect is spoken in a seaside town named 'Jijel' which is located in the northeast of Algeria. All of the children were normal in the sense that they did not have any speech or language pathological history. Specifically, they were informally screened for their language ability and orofacial mechanism. They also passed a 25 –dB pure-tone hearing screening test conducted by a specialist using a portable audiometer. The children's ages ranged between 1;2 and 5 years old and they were divided into four age groups of ten month intervals namely: (1;2-2;1), (2;2-3;1), (3;2-4;1), and (4;2-5) years of age.

The present study depended on well-known methods for data collection. First, picture-naming, and object-based elicitation were used. In particular, the children were exposed to some familiar pictures of animals, vegetables, and fruits, and they were asked to say what they could see. Moreover, they were asked to name objects which were found in the recording site such as tables, chairs, and toys and they were asked to tell stories or recite songs and to name friends and relatives. The choice of the target words and phrases was primarily motivated by their familiarity to young children. However, a word stimulus which comprised a set of words was also used. In doing so, the entire JSA segmental inventory was represented.

The recordings took place in quiet rooms in the children's homes in the presence of the mother and the investigators and each session lasted for one hour. Interestingly, the researchers tried their best to create a friendly atmosphere with the children before and during the recording process. In

addition to recording, the researchers made recourse to note-taking of the children's spontaneous speech. Eventually, all data were exported from the digital recorder to a laptop, then onto an external hard disk for safe back up. After the completion of the recording process, the collected speeches were carefully transcribed by the first author, a native speaker of JSA, then checked by the second author. That was done in accordance with the International Phonetic Alphabet (IPA). Eventually, syllable-based processes were identified and accounted for within OT.

4. Results and Discussion

In this section, syllable-based processes in the speech of normally developing Algerian Arabic-speaking children are presented, described, exemplified, and analyzed within the framework of OT. These include reduplication, weak and unstressed syllable deletion, cluster simplification, final consonant deletion and vowel epenthesis. This is done in compliance with the aforementioned four age groups to which the children are distributed viz: (1;2-2;1), (2;2-3;1), (3;2-4;1), and (4;2-5) respectively. It will be shown that in the phonological acquisition process, children gradually increase the number of syllables in a word and produce syllables of a greater complexity as their language develops.

4.1. Reduplication

The syllable-based process of reduplication in first language acquisition is a purely phonological phenomenon in which a child takes part of a word and repeats it more than one time. As a matter of fact, the reduplication of syllables is one of the most frequent processes of first language acquisition on the prosodic phonological level and one of the most frequently documented processes too (Al-Qawasmi, 2008; Younis, 2008). It often comes as a means to avoid more difficult sound combinations. Therefore, children's productions are characterized by a constant conflict between the communication factor which requires a large number of maximally distinct phonological units that demand a great deal of effort, and the human factor whose main hallmark is the desire for minimum effort. In more technical terms, this is referred to as 'language synergy' (Tobin, 2000, p.306).

More strikingly, at the onset of language acquisition, the syllabic structure available to the child is rather rudimentary compared with the syllabic structure that is available to adults and his productions as a whole are characterized by the prevalence of unmarked types of structure. Hence, young children's syllables tend to be made up of a consonant and a vowel (Onset and Nucleus), and the result is the 'CV' syllable'. This syllable type,

which is unmarked, is also dubbed 'the core syllable' because it is cross-linguistically preferred and basic in all grammars. Demuth and Fee (1995) call this first stage of prosodic word acquisition "the Sub-Minimal Word stage, where early word forms are generally CV in shape" (as cited in Bensaid, 2006, p.20). In all cases, the reduplications employed by normal Algerian children at the first age group (1;2-2;1) took the form of bi-syllabic words comprising one reduplicated syllable. Data bearing on this situation are presented in (1) (see the Appendix for more examples on reduplication and the other processes that are discussed in this study):

(1)	Adult Form	Child Form	Gloss
	[kalb]	[brbɪ]	'dog'
	[ʔaksɪ]	[θɪθɪ]	'car'
	[luʃba]	[lulu]	'toy'

It should be intuitively obvious that each of these words is made up of a consonant and a vowel. In essence, normal Algerian children did not only delete sounds or syllables from the words, but also repeated the remaining sounds or syllables. In terms of OT, this would be captured by having the faithfulness constraint FAITH-BR which requires every segment of the base (B) (adults' form) to have a correspondent in the reduplicant (R) (No deletion). Such a constraint is low-ranked. Therefore, the children deleted some segments and syllables in the reduplicant. Apparently, the children's productions manifested a preference of the monomoraic CV form which is codaless (an open syllable). In aid of this conception, it could be suggested that the unmarked situation is for syllables to lack codas. Hence, the markedness constraint NO-CODA (Syllables are open) is undominated. It remains unranked with regard to the markedness constraint *EFFORT which states that an articulation which requires more effort is disfavored (the children reduplicated only those segments or syllables which required less effort for their production and simplified the structure of words as a whole). A synopsis of the foregoing discussion is encapsulated in the constraint hierarchy in (2) and in Tableau 1 which both demonstrate why [lulu] is the optimal output for /luʃba/ (the optimal candidate is marked by the index ①):

(2) NO-CODA, *EFFORT >> FAITH-BR

Tableau 1: The Optimal Output for [luʃba]

luʃba	NO-CODA	*EFFORT	FAITH-BR
a. luʃba	*!	*!	
b. ① lulu			*

This tableau serves to establish the relative ranking of the two markedness constraints NO-CODA and *EFFORT and the faithfulness constraint FAITH-BR. In line with this relative ranking of constraints, the contest between candidates (a), and (b) is plainly decided in favor of candidate (b) though it incurs a violation of the low-ranked constraint FAITH-BR. The failing candidate (a) averts a violation of the top-ranked constraints NO-CODA and *EFFORT and this excludes it from the competition. A ranking with the markedness constraints above the faithfulness one, therefore, yields the least marked system, with only CV syllables. Clearly also, “domination is strict...no possible degree of satisfaction of lower-ranked constraints can compensate for the violation of a single high-ranked constraint” (Kager, 1999, p. 23).

In the second age group (2;2-3;1), however, the syllables produced by typically developing Algerian children started increasing in complexity, and thus, in markedness. This could be justified by the emergence of some reduplicative forms with codas: CVC syllables, a syllable type which is more marked than the core one (CV syllable). Such a finding seems to be in symbiosis with the so-called 'the implicational hierarchy' which suggests that children acquire the different syllable types in a predictable order. By way of explanation, children start first producing the CV syllable, then the CVC or V syllables, and eventually the VC syllable type (Roca & Johnson, 1999, p. 247).

Clearly, the degree of markedness increases in the children's speech as they gradually grow older. Therefore, if one considers reduplicative forms like /baʃbaʃ/ 'cat', it could be concluded that the coda is allowed and thus, the markedness constraint NO-CODA is low-ranked with regard to the markedness constraint *EFFORT for the instances showing that structure. Yet, it remains unranked with regard to the faithfulness constraint FAITH-BR. Reasonably, markedness constraints have started being demoted. Importantly, it has been found that reduplication was no longer manifested in the productions of children in the two remaining age groups namely: (3;2-4;1), and (4;2-5).

4.2. Weak and Unstressed Syllable Deletion

Weak and unstressed syllable deletion is a well-documented syllable-based process in first language acquisition. Essentially, syllables are the units in terms of which phonological systems are organised. They could be either stressed or unstressed. The former are said to give more

communicative, perceptual and cognitive information than unstressed syllables, and the more syllables in the word, the more effort it takes to pronounce it. Accordingly, in the syllable deletion process, children tend to delete weak syllables from words containing more than one syllable. The fact that weak syllables in JSA are usually the first syllables is worthy of note here. The results of the present study have shown that weak and unstressed syllable deletion was manifested only by children belonging to two consecutive groups namely: (1;2-2;1) and (2;2-3;1). After the age of 3;1, this syllable-based process was eliminated. The data in (3) are a case in point:

(3)	Adult Form	Child Form	Gloss
	[də'bana]	[bana]	'fly'
	[ʒə'dɪ]	['dɪ]	'grandfather'
	[sən'dala]	[dala]	'sandal'

In the examples above, the unstressed syllables were deleted by normal Algerian children. For this reason, three constraints could be suggested. Basically, the markedness constraint **Prominent (Foot, Left)** which prohibits initial unstressed syllables is high ranked since the initial unstressed syllables were deleted. It dominates the faithfulness constraint **DEP-IO** which requires every segment in the Output to have a Correspondent in the Input (No Epenthesis) since no insertion took place. The latter, in turn, dominates the faithfulness constraint **PARSE-SEG** which holds that underlying segments need to be parsed into syllable structure which is the lowest-ranked constraint in the whole hierarchy. This line of reasoning is in conformity with the main assumption that is held in the present study: the initial state of the phonology is one in which constraints against phonological markedness outrank the faithfulness constraints. The constraint ranking in (4), together with tableau 2 account for the interaction between markedness and faithfulness constraints in opting for the optimal output for /də'bana/:

(4) Prominent (Foot, Left) >>DEP-IO >> PARSE-SEG

Tableau 2: The Optimal Output for /də'bana/

də'bana	Prominent(Foot, Left)	DEP-IO	PARSE-SEG
a. də'bana	*!		
b. dəb'bana		*!	
c. ə 'bana			*

Child grammar at this age penalizes the first candidate and eliminates it from consideration due to its fatal violation of the undominated Prominent (Foot, Left). The second candidate is also excluded from the competition because it violated DEP-IO constraint by inserting a new segment. Note that the optimal output /'bana/ avoided any violations of the higher ranked markedness constraint in the sense that it deletes the unwanted unstressed syllable in the word.

4.3. Cluster Simplification

There are a number of ways for reducing the complexity of polysyllabic words, an instance of which is cluster simplification. In fact, the reduction of a consonant cluster to a single segment is a common phenomenon in child language. This phenomenon could be attributed to the fact that articulating a consonant cluster requires more articulatory control of the muscles than articulating a single consonant followed by a vowel, thus less effort would be needed. This process means losing some aspects of the communicative distinctions as consonants are more communicative than vowels, as Tobin (2000, p.309) puts it: “a consonant cluster requires greater effort than a consonant-vowel sequence and may be reduced or replaced at the expense of maximum communication; in addition,...phonemes of constriction give clearer communicative distinctions than phonemes of aperture..., but they require more articulatory control”. Obviously, normally developing Algerian children are no exception in this regard. The researchers have found that the children manifested this process in all of the age categories being considered. Yet, it is important to note that its occurrence was greatly reduced at the beginning of the last age group (4;2-5), and it was completely eliminated around the age of five. Consider (5) for illustration:

(5)	Adult Form	Child Form	Gloss
	[ʃtɪmɪ]	[θɪmɪ]	'give me'
	[lma]	[ma]	'water'
	[hə'znɪ]	[hə'zɪ]	'carry me'

Generally speaking, singletons are acquired before onset clusters across developing systems. Therefore, passing through a stage in which target clusters are produced incorrectly is unavoidable for all children, and thus universal. An OT description of this pattern requires that a markedness constraint against consonant clusters, ***COMPLEX**, be the superordinate one. It immediately dominates the faithfulness constraint **MAX-C-IO** which

demands that every consonant of the input has a correspondent in the output (no phonological deletion). Note that if we take the input /lma/ 'water' and we consider just the two aforementioned constraints, two output optimal candidates will be available namely: /ma/ and /la/. Therefore, in cluster simplification, the sonority of the segments determines which consonant is deleted: children retain 'the least sonorous' member of the cluster. Intriguingly, Prince and Smolensky (1993, p.148) put forth the 'Universal Margin Hierarchy' which suggests that the less sonorous a consonant is, the more harmonic it is as a margin. Therefore, the following markedness constraint was introduced: ***M/C**: C must not be parsed as a syllable Margin (i.e., associated to Ons or Cod). Hence, this markedness constraint which appeals to the relative sonority of sounds is required to determine if /ma/ is more harmonic than /la/. It is dominated by the markedness constraint ***COMPLEX**. Nevertheless, it is higher-ranked than the faithfulness constraint **MAX-C-IO**. The result is the following constraint hierarchy in (6):

(6) ***COMPLEX >> *M/C >> MAX-C-IO**

Tableau 3 for the input /lma/ nicely captures the interaction between the previously mentioned two markedness constraints and the faithfulness constraint:

Tableau 3: The Optimal Output for /lma/

lma	*COMPLEX	*M/C	MAX-C-IO
a.lma	*!		
b.la		*!	*
c. ma			*

The unacceptability and exclusion of the first two candidates is due to their explosive breaching of the essence of two undominated constraints: candidate (a) incurs a fatal violation of ***COMPLEX** because of the target-appropriate [lm] cluster. Candidate (b) also incurs a fatal violation of ***M/C** coupled with the violation of **MAX-C-IO** because it deletes one segment and keeps the most sonorous one (nasals and liquids are both sonorants but liquids are more sonorous than nasals). In contrast, Candidate (c) only incurs a violation of the lowest ranked **MAX-C-IO** because it does not segmentally correspond to the input. Therefore, it is chosen as the most harmonic candidate. This sonority-driven account of cluster reduction is in conformity with those of several child phonologists who found that children would reduce clusters to whichever consonant would result in the least complex syllable as defined by sonority (Gnanadesikan, 1995; Ohala, 1996;

Barlow, 2005). Therefore, the present study supplies further evidence for universal sonority mechanisms for cluster simplification.

4.4. Final Consonant Deletion

The results of the present study point to the fact that Algerian children with typical phonological development realized target-syllable structure of the shape CVC as the unmarked CV structure by deleting the coda consonant (final-consonant deletion). Deleting the syllable final consonant is logical in the sense that the syllable final position is less communicative than the initial position. This process also reduces the articulatory efforts as vowels are easier and more preferred than consonants. Therefore, in a sequence like CVC, it is the final consonant that would most likely be deleted, resulting in a CV sequence, which is the canonical preferred syllable structure for a closed and open jaw to produce the best contrast. This syllable-based process was manifested only by children belonging to the first age group: (1;2- 2;1). The following data in (7) are in order here:

(7)

Adult Form	Child Form	Gloss
[mu:h]	[mu:]	'cow'
[gazu:z]	[dazu]	'fizzy drink'
[ʔamal]	[ʔama]	'girl's name'

Seemingly, the final consonants in the CVC syllables did not surface in the grammar of normal Algerian children. This line of thought necessitates bringing two constraints into prominence. The first one is the markedness constraint ***CODA**: a syllable must not have a coda. The second one is the faithfulness constraint **MAX-C-IO**: input consonants must have output correspondents; no consonant deletion. At this juncture, it could be concluded that since the children's productions are in favor of codaless syllables, ***CODA** is ranked higher than **MAX-C-IO**. Hence, in this grammar, it is better for an open syllable to surface than it is for the segments to be parsed. Tableau 4 below illustrates this state of mind and is consistent with the constraint hierarchy in (8) which both clarify how the optimal output for /gazu:z/ is selected:

(8) ***CODA >> MAX-C-IO**

Tableau 4: The Optimal Output for /gazu:z/

gazu:z	*CODA	MAX-C-IO
a. gazu:z	*!	
b. ^ɪ dazu		*

In attempting to avoid incurring a violation of the dominated MAX-C-IO, candidate (a) incurs a violation of a pitiless constraint namely: *CODA. Hence, it fails to survive. However, candidate (b) wins the race by satisfying the top constraint in spite of incurring a violation of the lowest ranked faithfulness constraint. It appears that in the grammar of normally-developing Algerian children aged between 1;2 and 2;1, the supremacy is still for markedness constraints.

4.5. Vowel Epenthesis

Normal Algerian children employed another strategy so as to break consonant clusters and to keep the CV syllable pattern. This process is called 'Vowel Epenthesis'. In point of fact, the additional vowel often eases the transition to more difficult consonants or clusters. The clusters then may be reduced at the expense of communication. The results of the study have shown that typically developing Algerian children manifested this syllable-structure process only during the age period ranging between 1;2 and 2;1. It was absent in the remaining age groups. The items in (9) illustrate the process:

(9)	Adult Form	Child Form	Gloss
	[bħar]	[baħal]	'sea'
	[bəʃmaqa]	[ʃamaqa]	'a type of shoes'
	[sθɪlu]	[saθɪlu]	'pen'

The relative ranking of the constraints *COMPLEX, DEP-IO, MAX-C-IO could perfectly account for the 'vowel epenthesis' pattern. This pattern requires that the markedness constraint *COMPLEX be high-ranked due to the fact that the children under scrutiny avoid the production of clusters at this age. Additionally, since deletion is not an option for dealing with illicit structures in the grammar of normal Algerian children at this stage, the faithfulness constraint MAX-C-IO must be higher-ranked than the second faithfulness constraint DEP-IO. The possible ranking of constraints is shown in (10) and illustrated in tableau (5) which shows why [baħa] is the optimal output candidate of /bħar/:

(10) *COMPLEX, MAX-C-IO, UNIFORMITY >> DEP-IO

Tableau 5: The Optimal Output for /bħar/

bħar	*COMPLEX	MAX-C-IO	UNIFORMITY	DEP-IO
a. bħar	*!			
b. bar		*!		
c. far			*!	
d. baħal				*

Among the candidates provided in Tableau 5, candidate (a) is eliminated because it incurs a fatal violation of high-ranked *COMPLEX (the [b \hbar] output sequence). Candidate (b) also incurs a fatal violation of MAX-C-IO because all segments of the input are not present in the output, and Candidate (c) incurs a fatal violation of high-ranked UNIFORMITY because of the [f] in the output. Candidate (d) is deemed optimal because it conforms with *COMPLEX in that there is no onset cluster, with MAX-C-IO in that all segments of the input match the output, and with UNIFORMITY in that there is no coalescence. The only constraint violation that Candidate (c) incurs is for lowest ranked DEP because there is insertion of a vowel in the output form.

At this juncture, one can state that the process of acquisition is one of promoting the faithfulness constraints to approximate more and more closely the adult grammar, and produce more and more marked forms. When normally developing Algerian children manifested each of reduplication, weak and unstressed syllable deletion, cluster simplification, final consonant deletion, and vowel epenthesis, markedness constraints were ranked higher than faithfulness constraints. However, as soon as those processes were eliminated, markedness constraints were demoted and faithfulness constraints were promoted.

Conclusion

Immersion in the present cross-sectional study for a period of time has demonstrated that the speech of normal Algerian Arabic-speaking children in Jijel, and whose ages ranged between 1;2 and 5 years was characterized by five syllable-based processes viz: reduplication, weak and unstressed syllable deletion, final consonant deletion, cluster simplification, and vowel epenthesis. Such processes reached their peak between the ages of 1;2 and 2;1, but they started decreasing in number and frequency until they completely disappeared at the age of 5. Similar findings were documented in previously conducted studies on normal children (Al Qawasmi, 2008; Ayyad, 2011; Al-Buainain, et.al, 2012, among others). OT accounted neatly for this fact by proving that the initial state of the phonology is one in which constraints against phonological markedness outrank the faithfulness constraints. As the phonology develops, the faithfulness constraints move upward as required to approximate the adult language.

It is well-known that children acquiring their first language proceed in remarkably similar ways, going through developmental stages that are independent of the language being learnt. This contention is supported by

the fact that normal Algerian children, like all the children of the world, started producing syllables of the unmarked CV type. As they grew older, they produced more marked syllables. Therefore, it could be stated that the innateness of Universal Grammar is what causes these observed developmental similarities (the universally recurring patterns of first language acquisition). Hopefully, this study, which can capture neither the breadth nor the depth of normal Algerian child phonological development will pave the road for subsequent studies in which other types of processes will be identified and accounted for within OT. Specifically, this will give more support to the claim that language acquisition in general and phonological acquisition in particular are universal.

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APPENDIX

Syllable-based Processes for Normal Algerian Children in Jijel

1. Reduplication

Adult Form	Child Form	Gloss
[ħli:b]	[bɔbɔ]	'milk'
[bɪbɪ]	[mɔ'mɔ]	'baby'
[rqad]	[nɪnɪ]	'sleep'
[qə'ta]	[baʃbaʃ]	'cat'
[luʃba]	[lulu]	'toy'
[ħəlwa]	[qaqa]	'candy'
[zərħ]	[dudu]	'wound'
[pɔrɔabl]	[wɪwɪ]	'mobile'
[taksɪ]	[θɪθɪ]	'car'
[susaθa]	[θaθa]	'a child's dummy'
[kalb]	[hawhaw]	'dog'
[ħli:b]	[θaʃθaʃ]	'milk'
[maʃrubat]	[bɪbɪ]	'drinks'
[pupɪja]	[juju]	'doll'

2. Weak and Unstressed Syllable Deletion

Adult Form	Child Form	Gloss
[də'bana]	[bana]	'fly'
[zə'dɪ]	['dɪ]	'grandfather'
[ħəz'nɪ]	[nɪ]	'carry me'
[sə'ba:t]	['ba:θ]	'shoe'
[məʃ'raf]	[laf]	'spoon'
[ʃəzra]	[zla]	'tree'
[zər'biʃa]	[biʃa]	'carpet'
[ħəlwa]	['wa]	'candy'
[məs'ʕu:d]	['ʕud]	'male's name'
[zɪ'da]	['da]	'grandmother'
[də'laʃ]	['llaʃ]	'watermelon'
[ʕə'mɪ]	['mɪ]	'uncle'
[sən'dala]	[dala]	'sandal'
[qə'ta]	['θa]	'cat'

3. Cluster Simplification

Adult Form	Child Form	Gloss
[ftaħ]	[θaħ]	'open'
[lma]	[ma]	'water'
[ħmama]	[mama]	'dove'
[zrudija]	[zudija]	'carrot'
[hnaja]	[naja]	'here'
[ħəlwa]	[ħə'wa]	'candy'
[kalb]	[θab]	'dog'
[ħsan]	[san]	'horse'
[sθilu]	[θilu]	'pen'
[lʕars]	[lʕas]	'wedding'
[tqafira]	[qasila]	'sock'
[sabrına]	[sabına]	'female's name'
[ləktab]	[ləθab]	'book'
[taksı]	[tasi]	'car'
[ntaʕı]	[θaʕı]	'mine'
[qnuna]	[quna]	'rabbit'
[qard]	[qad]	'monkey'
[ħanʃ]	[ħas]	'snake'
[ʃambra]	[ʃabla]	'room'

4. Final-Consonant Deletion

Adult Form	Child Form	Gloss
[mu:h]	[mu:]	'cow'
[gazu:z]	[dazu]	'fizzy drink'
[ʔamal]	[ʔama]	'girl's name'
[ʃu:f]	[su:]	'look'
[θilıfun]	[lıfu]	'phone'
[xabz]	[bax]	'bread'
[pɔrtabl]	[pu'θab]	'mobile'

5. Vowel Epenthesis

Adult Form	Child Form	Gloss
[bħar]	[baħal]	'sea'
[bəʃmaqa]	[ʃamaqa]	'a type of shoes'
[sθilu]	[saθilu]	'pen'
[nwaɖar]	[nawadal]	'glasses'