**Universität Bielefeld**
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# Issues in the Characterisation of Phonological Speech Impairment vs. Delayed Acquisition in Jordanian Arabic-Speaking Children

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vorgelegt von
Sa'da Salman Issa Bader

Gutachter:
Prof. Dr. Dafydd Gibbon, Universität Bielefeld,
Prof. Dr. Yishai Tobin, Ben Gurion University of the Negev, Israel,
Dr. Petra Jaecks, Mittelbauvertreterin.

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# Dedication

To my family

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## List of Abbreviations

A1-A4: age matched normally developing cases

AFF: affrication

ASHA: the American Speech-Language-Hearing Association

AMN: age-matched normally developing children

B1- B7: cases with phonological impairment

Bac: backing

CCR: consonant cluster reduction

*CODA: “no coda” constraint

*COMPLEX : “no clusters” constraint

C: consonant

CON: constraint

CV: consonant-vowel

DE: de-emphasis

DV: devoicing

EAGLES: Expert Advisory Group on Language Engineering Standards

ELD: early language delay

Epe: epenthesis

ESA: Educated Spoken Arabic

EVAL: evaluator

FCD: final consonant deletion

*FRICATIVES: “no fricatives” constraint

FCD: Final consonant devoicing

Fro: fronting

GL: gliding

GR: glottal replacement

GEN: generator

GP: generative phonology

ICD: initial consonant deletion

ICC: incomplete consonant closure

IDENT-FEATURE: “don’t change manner features” constraint

JA: Jordanian Arabic

Lab: labialization

LAD: language acquisition device

Lat: lateralization

*LIQUIDS: “no liquids” constraint

LIPP: Logical International Phonetics Programs

L2: second language acquisition

MAX: “no deletion” constraint

Met: metathesis

MSA: Modern Standard Arabic

Nas: nasalization

NP: Natural phonology

OSDP: Optimal Sonority Distance Principle

OT: Optimality theory

PHB: Phonology as Human Behaviour

PCC: consonants produced correctly

SA: Standard Arabic

SLI: speech and language impairment

SLI-E: speech-language impairment-expressive

Spi: spirantization

Stop: stopping

SVO: subject-verb order

TBI: traumatic brain injury

V: vowel

V: voicing

Vel: velarization

VN: vowel neutralization

VSO: verb-subject order

WSD: weak syllable deletion

# CHAPTER 1 Introduction

## 1.1 Speech and Language impairment

It is worth noting that there is no common definition which is universally adopted for speech and language impairment (SLI) as Haynes and Naidoo (1991: 1) state:

> "Although a considerable body of knowledge about SLI has been derived from clinical studies, the growth of a precise knowledge has been hampered by the absence of any agreed criteria for defining language impairment. When criteria are defined, they are particular to the study in question rather than universal."

However, the concept of language disorder can be defined, as introduced by ASHA, the American Speech-Language-Hearing Association, (1980: 317-318), as follows:

> "Language disorder is the abnormal acquisition, comprehension or expression of spoken or written language. The disorder may involve all, one or some of the phonologic, morphologic, semantic, or pragmatic components of the linguistic system. Individuals with language disorders frequently have problems in sentence processing or in abstracting information meaningfully for storage and retrieval from short-and long-term memory."

As is clear in this definition, language disorder is a general term including different classifications and diagnoses. In the relevant literature on language disorders, two major classifications have been provided. These classifications include disorders of the language production and perception systems (i.e., speech dimensions and linguistic dimensions) and disorders attributed to certain physical, mental or emotional causes (e.g., aphasia, mental retardation, and autism). A more detailed classification of language disorders has been provided by Bloom and Lahey (1978), accordingly a language disorder is:

> Any disruption in the learning or use of the conventional system of arbitrary signals used by persons in the environment as a code for representing ideas about the world for communication (cf. Bloom & Lahey 1973: 290).

Additionally, Bloom and Lahey (1978) provide five subcategories of language disorders: difficulties with learning linguistic forms involving comprehending and using phonological, morphological and syntactic rules, difficulties with the semantic component, as it will be exhibited in language content, pragmatic difficulties in facing problems in language use in communicative functions, association problems when children have difficulties combining form, content and use of the language, and finally delayed language development when children use the language in a way similar to younger typically developing children. Generally speaking, speech language impairment is known among language theorists, as also derived from the previous definition, as a misrepresentation and a ''false organization'' of the phonemes (sound system) within a language system. In other words, language impairment is a sound production and perception disorder that varies in degree and type from one atypical individual to another.

Oral-verbal communication can also be described as atypical when there is an interference with message transference that does not insure mutual understanding. This communication can be atypical when the method being used causes the communication to be negatively perceived by the listener and disrupts that relevant communication. In other words, speech impairment can be noticed when one aspect or more of the communication system does (or do) not function appropriately. Moreover, Eisenson and Ogilvie (1983: 14) have provided a comprehensive view of the nature of language disorder:

> "A speech language disorder is a serious interference or obstruction of the communicative act that produces or prevents its intended impact on the listener. For example, when the listener can not perceive the intent because so many consonants are deviant or omitted, s/he can not react to the meaning of the message."

As any other similar serious problem, language impairment has been described and explained in the literature since the 19th century. Speech production and perception impairment plays a crucial negative role in the every day conduct of an individual's life, as these disorders may reduce and hinder the effectiveness and the efficiency of the speaker's message transmission and the relevant communication.

Language disorders normally result from a disorder in the linguistic structure of the speaker (phonology, syntax, semantics, or pragmatics), therefore, the role of linguistics has been enhanced and supported in the research and the study of language disorders for the last 40 years. This interaction can partially be related to two developments in linguistics. The first of these is the appearance of Transformational Grammar (TG) with the publication of Noam Chomsky's Syntactic Structures in (1957). This theory has provided a powerful descriptive device for language (e.g., transformation in the domain of syntax and the application of distinctive features in phonology). The concept of distinctive features was originally introduced and discussed by the Prague School linguists Roman Jakobson and Count Nikolai Trubetzkoy who founded the new science of Phonology in 1928 at an international linguistics conference in the Hague. Furthermore, Jakobson (1941/(1968)) was the first to connect developmental and clinical phonology with phonological analysis based on distinctive features and markedness theory which will be discussed later in this dissertation. The second development is through the emphasis in Transformational Grammar [TG] on the need for a linguistic theory to explain how children acquire linguistic structures (cf. Ingram 1976). The influence of linguistics on the study of language impairment has provided new theoretical frameworks and innovative clinical approaches to the field of speech-language pathology. These frameworks, and as will be explained later in this study, include: error analysis, contrastive analysis of the child's phonological system, distinctive feature analysis, as well as the analysis of child speech based on the framework of

Generative Phonology [GP], and currently based on the notions of Natural Phonology [NP]. Basic linguistic units such as phonemes, morphemes, and distinctive features developed by the Prague School mentioned above and other British and European structuralist schools (e.g the British Firthian School, Hjemslev of the Copenhgen School and others), as well as the structuralist-descriptivist school of linguistics in North America (e.g Bloomfield, Hockett, Bloch and others) are now integral concepts for the descriptive and practical study of speech and language disorders. The application of linguistic theories and methodologies has gone beyond the description of the disorder to affect both diagnostic assessment methodologies and therapeutic remediation programs and plans. More specifically, a major change occurred in the 1970s, the time when the field of speech-language pathology adopted the methodologies being used by linguists to analyze and describe the phonological and grammatical aspects of language (cf. Bernhardt and Stoel-Gammon 1994).

As phonology is the main area of interest in this work, Ingram (1976) explains five aspects in which linguists can provide their valuable contribution to the work of the language clinician who deals with children with phonological disabilities:

1. The first contribution is by providing the basic principles of phonological theories needed for non-linguists.
2. Second, the work of linguists is useful for enabling clinicians to have a more comprehensive view of how children acquire phonology in the typical developmental context.
3. Furthermore, linguistics has developed a number of techniques needed for the methodological part of the clinician's work, namely in the aspects of the data collection, recording, transcription and analysis of the speech of children with language impairment. Some of these methods involve ways to elicit speech samples, methods of tape-recording, and phonetic transcription.
4. The fourth contribution would be in characterizing the nature of phonological disabilities in children through illustrating and thus enhancing the understanding of the nature of the processes that exist in the speech of atypical children.

5. Finally, linguists offer several approaches in the area of remediation and speech therapy. These approaches are based on how children would typically acquire theie language. Linguistic remediation methods include the elimination of general processes rather than individual sound substitution. These methods involve teaching the accurate phonemic contrasts within the child's own system rather than just those of the adult language as well as ways to determine which sounds to teach first. These are are just some examples of the possible linguistic remediation methods that can be applied in the speech therapy domain.

Ingram (1976) in his account shows that the contribution of linguistics to the study of SLI covers the three basic concepts in this field. This contribution helps in describing the typical phonological development and speech production, the atypical development, and accordingly the accurate diagnostic assessment and the required therapeutic remediation plans.

## 1.2 Objectives of the study

This study deals with analyzing the phonological processes of a sample of JA-speaking children who have been clinically diagnosed as having speech-language impairment [SLI]. Most of the SLI cases are usually diagnosed by the speech clinicians as having one form or another of language impairment. The majority of these cases are children with delayed or deviant phonological development. Children in Jordan are not exceptional in this respect. It is rather difficult if not impossible to find one kindergarten or an elementary school without language-atypical children which might negatively impact their social behaviours, psychological stability as well as their future careers. Therefore, intensive attention has been invested in the last 40 years to this serious problem in clinical, phonetic and phonological research. Specialized centres have been established all over the world, but concerns about speech-language assessment and pathology in Jordan, as well as in other Arab countries are still in the early stages.

In this study, the developmental phonological processes in atypical children's speech will be assessed and analyzed. The idea that there are a number of universal phonological processes governing children's acquisition of the phonologies of different languages means that these are assumed to be natural innate processes. Furthermore, these universal processes are attested to and considered as characteristics of early typical child phonological development. Therefore, children who fail to typically develop speech in their relevant age group, thus fail to conform to the linguistic universals postulated for human language, would be described as having phonological deviances.

The developmental phonological disability of JA-speaking children is examined in this study. It is their unintelligible speech resulting from a large number of misarticulated sounds along with certain unusual phonological processes that indicate their speech and language disorder. In the diagnostic assessment of those children, articulation and phonological patterns will be identified by comparing them to what are regarded as the typical patterns in the speech development of age-matched normally developing (AMN) JA-speaking children.

Therefore, in this study, phonological speech impairment in JA (JA), which has been also referred to as functional articulation, are to be described and analyzed. The term functional, which is used in both general medical science and speech pathology, implies that the disorder has no readily detectable organic basis. This developmental dimension of the disorder could be simply described as a retardation of the typical process of speech and language learning.

This study describes the phonological system of children with phonological disorders. Therefore, this analysis will summarize the phonological characteristics of their speech to be accounted for and considered as the symptomatology of SLIin JA. Moreover, specifying the phonological characteristics of this disability is intended to help in setting the basis of an informed diagnosis by describing what the child can and can not do in his use of the language. This diagnosis will help later to determine the real needs to be considered in the relevant therapy, the amount and the potential success of the treatment.

The application of linguistic principles in the investigation of atypical speech includes the explanation of the nature of the disability, modifications in the clinical practice, and the medical model of the assessment, diagnosis, and treatment. Therefore, this analysis considers these aspects in reflecting the relevance of the linguistic findings to the examined speech disorder. The relevant assessment in this study includes the necessary distinction between typical immature and deviant phonological systems in JA. The immature systems are generally described as typical developmental inadequacies with a chronologically deviant occurrence.

This study aims to characterize this disorder by:

1. Assessing and indicating the aspects of the child system that are atypical by comparing them with AMN phonologies in JA.
2. Moreover, this assessment will offer contributions at the procedural level, as the linguistic framework provides a clinically relevant basis for the assessment.
3. Finally, this linguistic framework will form the assessment tool through the comparison with the patterns in the typical development in JA, thus the disabling symptoms of the disorder can accurately be identified.

The assessment implications of this comparative diagnosis can be speculative and substantive as this study is based on a rather small sample that can not be taken to be a comprehensive representation of both the typical and the atypical phonological development in JA. This is also very expected, as the clinical population is usually diverse and could lead to the establishment of a typological sub-classification of the phonological disability, as each subject exhibits different characteristics of developmental phonological deviances. Each subject might show a different constellation of the phonological patterns presented in his speech. Therefore, these deviances in the phonological patterns consequently differ with one common diagnostic factor among these different cases that is evident in their apparent communicative inadequacy. Such an assessment is of considerable diagnostic importance involving different diagnoses within the general category of the phonological disability, thus this description can present a general characterization of this disorder in its diverse characteristics.

More specifically, this study is an analysis of the speech of JA-speaking children who exhibit phonological disorders that are obvious in their sound production. This study aims at assessing and describing the developmental status of the phonological processes in the child’s atypical speech. Moreover, the primary purposes of this study can be summarized as follows:

1. This study aims to describe the natural phonological processes in the speech of a sample of JA-speaking children with SLI. As young children's limited articulatory abilities would enable, and in certain cases would enforce them normally to employ many substitutions and to apply them quite generally. This study shows and explains the differences in the phonological development between the SLI and their age-matched typically developing children in JA. These differences in the phonological development will characterize phonological disability in JA.
2. This study aims at providing a diagnostic test, assessment procedures and the criteria to detect the phonological developmental deviances in JA. Therefore, this study presents a basis for differentiating typical from atypical development in JA, then to differentiate the delayed from the deviant phonological development in JA.

## 1.3 Overview

The present contribution is concerned with studying the empirical issues in the analysis of SLI in the speech of a sample of JA-speaking children. The study has the further aim of developing diagnostic tools for assessing the developmental status of the phonological processes in the child’s atypical speech based on the chronology of their development in AMN children. This study also aims at providing a sound linguistic basis for this development. Therefore, this analysis will extend this comparison with the main focus on the phonological differences between AMN and SLI children in JA.

The theoretical linguistic basis for the study is taken from Natural Phonology (NP) and Phonology as Human Behaviour (PHB). Additionally, one of the theoretical goals is to provide a description of applying the principles of NP and PHB into the domain of distinguishing delayed from atypical development in JA.

The work in this dissertation has been organized in the following order. The theoretical part starts with a brief account of the contribution of different phonological theories in CHAPTER 2 . This chapter illustrates how these theories explain the child's own phonological system. The chapter concludes by comparing the frameworks of NP and PHB to the framework of Optimality Theory (OT). CHAPTER 3 is concerned with explaining the theoretical framework of this analysis; NP and PHB and their treatment of SLI. The chapter explains the differences between processes and rules. The chapter provides a detailed overview of the phonological processes and their constraints established by NP, therefore, it explains the natural application of these processes and the constrains on this application based on empirical phonological principles found in PHB. Additionally, the types of the phonological processes and the distinction between the fortitive (strengthening) and the lenitive (weakening) phonological processes and their functions in increasing or decreasing the phonetic properties of the segments are explained according to NP and PHB principles. Donegan and Stampe (2009: 2) explain that fortitions make sounds more like themselves and less like adjacent sounds, thus they enhance the clarity of speech sounds. On the contrary, lenitions make sounds more like their adjacent sounds, sometimes to the point of identity, thus they enhance the fluency of speech sounds. These important NP processes will be discussed at greater length later in this dissertation. Finally, CHAPTER 3 explains NP as a preference theory as well as the theoretical and methodological conclusions provided by the theory of PHB.

Moreover, CHAPTER 4 presents an overview of Arabic language phonology, and the acquisition of the Arabic consonants. The chapter explains the distinguishing features between Modern Standard Arabic (MSA) and JA (JA). More specifically, this chapter illustrates the differences between MSA and JA with regard to verb morphology, agreement paradigms, and negation particles.

CHAPTER 5 explains the phonological processes in children's speech and presents an account of the nature of the atypical language systems, thus explaining patterns in delayed and deviant phonology cross-linguistically. More specifically, this chapter presents an account of the phonological representations in AMN and SLI children cross-linguistically. CHAPTER 6 describes the previous studies on sound changes and the phonological development in AMN and SLI in JA, performed in frameworks other than NP and PHB. Moreover, the methodological design of this study; the participants and the methods of data collecting, recording, saving, transcribing and annotating is explained in this chapter.

Furthermore, CHAPTER 7 presents the analysis of the speech recordings of the AMN children, and compares these results with the previous studies in JA. This chapter describes the phonetic inventory and the substitution patterns in four AMN children. It also presents the major results regarding the chronology of the phonological processes in AMN (Table 31). The explanation of the occurrences of these processes in SLI speech recordings (as will be observed in the examples in Table 1) is presented in CHAPTER 8 . This chapter analyzes all the different substitution processes, the processes influencing syllable structure, as well as the assimilation processes in the SLI speech data in this study. The major findings in this analysis are compared to the previous studies in JA. The thesis concludes with characterizing the developmental phonological disability found in JA in CHAPTER 9 . This chapter summarizes the features and characteristics distinguishing typical from atypical phonology, as well as the deviant from the delayed phonological development in JA. More specifically, this chapter concludes with characterizing the SLI within Arabic-specific rules, NP constraints, and PHB principles to meet the aims of this study as have been stated earlier in CHAPTER 1 of this dissertation. The conclusion chapter presents the contributions of this study to the investigation of SLIin JA and suggest relevant aspects for further research.

Table 1 exemplifies of the phonological processes found in the articulation errors in the speech of the SLI children in JA in our study:

*Table 1: Representative examples of SLI articulations in JA*

| *typical articulation* | *SLI articulation* | *English gloss* | *Phonological Process*[1] |
|---|---|---|---|
| [ɻuz] | [ʁudʒ] | rice | Affrication of [z] & frication of [ɻ] |
| [ˈkfuuf] | [ˈku.faf] | gloves | Vowel neutralization & consonant cluster reduction |
| [ˈχu.biz] | [ˈʔu.biz] | bread | Glottal replacement, stopping & backing |
| [na.ˈðˤiij.fiin] | [naðˤ.ˈðˤaa.fiin] | they are clean | Vowel neutralization |
| [ˈʁa.na.mih] | [ˈkʰa.ma.mih] | a goat | Velarization |
| [χa.ˈzaa.nih] | [ˈnaa.nih] | a closet | Weak syllable deletion & nasalization |
| [ˈli.saan] | [ˈtil.saan] | a tongue | Epenthesis |
| [naðˤ.ˈðˤaa.ɻaat] | [dan.ˈdaa.laat] | glasses | Stopping, de-emphasis & metathesis of [ðˤ] Lateralization of [ɻ] |
| [ˈmaɻ.wa.ħah] | [ˈmaħ.la.wah] | a fan | Metathesis of [ħ,l,w] Lateralization of [ɻ] |
| [ˈfatˤ.buwl] | [ˈfad.buwl] | a football | De-emphasis and voicing of [tˤ] |

1 These processes will be defined, and illustrated with more examples in chapter 8 where the phonological processes in SLI children will be analyzed.

# CHAPTER 2 The contribution of phonological theories

## 2.1 Introduction

Phonological theories are basic and prerequisite in describing and understanding the structure of speech sound patterns in languages. There are different theoretical frameworks and approaches to analyze the phonological patterns in typical and atypical language development. These different theories can provide diverse procedures for studying SLI, but as (Bauman-Waengler 2000: 11) states:

> Only knowledge of the speech sound's production features secures firm basis for utilizing such procedures. Without this knowledge, phonological process analysis, for example is impossible.

Therefore, it is necessary that the concept of phonology be explained before considering the clinical applications of these diverse phonological theories and their analytical procedures. Grunwell (1986: 12) states that it is possible that the real nature of some speech and language disorders might be misinterpreted and mis-assessed as a result of not having a clear and a basic distinction between the phonetic and the phonological description of speech. Grunwell (1986) explains that this phonetic vs. phonological distinction would normally lead to the proper diagnosis and characterization of varied speech and language disorders and consequently helps in the relevant clinical practice in the therapy plan in these cases.

Grunwell (1986: 13) clearly explains the phonetic and the phonological descriptions. She states that the phonetic analysis describes the types of sounds the humans are capable of producing. This description includes both the segmental and the suprasegmental aspects of speech. The phonological analysis describes and classifies the phonemic sound differences in speech based on their communicative function and their organization in the spoken language. This distinction is primarily based on Jakobson and Trubetzkoy describing the difference between phonetics and phonology from the end of the 1920s and 1930s during the Prague School era and thereafter. (Jakobson 1978: 42) states:

> "And in spite of the numerous contradictions in the teachings of Saussure, it is to him and his school that we owe the second idea crucial for the functional study of sounds, the idea of the phonological system. Once the point of departure for the study of the relation between sounds and meaning has been indicated ... it was a matter of drawing out all the implications of this and actually developing the new discipline, the systematic study of the sounds of a language from the point of view of their linguistic functions."

Moreover, Trubetzkoy ([1939] 1969: 10) explains phonology:

> "It is the task of phonology to study which differences in sound are related to differences in meaning in a given language, in which way the discriminative elements...are related to each other, and the rules according to which they may be combined into words and sentences."

Based on these differences between phonetics and phonology, and whether the patterns in the deviant and the typical speech represent phonetic or phonological deviations, the treatment procedures will be planned and executed differently. Therefore, Grunwell (1986: 15) states that in the case of the phonetic deviations, it would be important to attract the child's attention to his misarticulations and then to help him to learn the normative/typical articulatory gestures. In the case of having phonological deviations, which is the case in the atypical speech in this study, the attention should be drawn to the communicative inadequacy of these atypical articulations and the phonological contrast between the two forms, before teaching the child the relevant articulatory gestures for his/her language specific system.

Therefore, this chapter will present a brief theoretical account of the contribution of different phonological theories. This chapter illustrates the clinical applications of these theories in explaining and assessing the child's individual phonological system. Therefore, the procedures of the analysis in each framework will be presented and evaluated. More specifically, this chapter compares and contrasts six distinct linguistic theories; namely: error analysis, contrastive analysis, distinctive features, generative phonology (GP), Natural Phonology (NP) and finally Optimality Theory (OT). The chapter concludes by comparing the frameworks of NP and Phonology as Human Behaviour (PHB), which will be used as the analytical frameworks of this thesis, with the framework of OT.

## 2.2 Speech assessment as error analysis

In the simplest types of language disability, a non-specialist can usually identify certain specific deficits in the articulation based on the behavioural symptoms that characterize the difference between the child's atypical speech and the typical speech of his/her peers. Specific theoretical and practical studies in phonetics will enable the clinician to precisely understand and assess the nature of this atypical speech. Grunwell (1986: 50) explains that in the framework of error analysis, speech disorders are described as errors and deviations from the norms of the community speech. Emerick & Hatten (1979: 158) describe this framework as being basic in its classification approach:

> ...an articulation error, or disorder, is a non-standard production of one or more of speech sounds. There are three basic types of articulatory defects: omissions ... substitution ... and distortions.

Grunwell (1986: 51) states that this articulatory disorder analysis using the error analysis approach is considered a traditional framework, as well as a fundamental model in clinical speech assessment practice. Error analysis had been used to describe the immature articulations of typically developing children(e.g. Snow 1963). This model analyzes both speech atypical with specific organic aetiology and those with functional origins. On the other hand, the disadvantage of this model lies in the possibility of providing an inadequate descriptive assessment as a basis for the subsequent remedial practices and prescriptions. Thus, it is important that in applying this approach a clear definition of what is considered to be correct or acceptable in the language speech production is needed to assess what should be considered as an error, thus a phonemic description of the language system is required.

The assessment proceeds by considering and testing the speaker's production of each speech sound separately and comparing it with its typical production. This model analyzes the syntagmatic and the paradigmatic dimensions of the speaker's sound production patterns as they occur in words in different structural distributions. The sample for error analysis is usually collected using an articulation test, like in a picture-naming technique, to produce a list of pre-selected words containing all the consonant phonemes to be assessed in word initial, medial and final positions in the relevant language system. This approach to data collection has been found to be impractical in trying to collect a sample representing all the possible structural possibilities and consonant sequences in the language system (cf. Grunwell 1986: 52-53).

The question of to what extent are these single-word-responses representative and realistic of the child's habitual speech patterns, and whether they are different from the spontaneous speech patterns, is another question to be considered in applying error analysis as a tool of studying speech and language disorders. Generally speaking, for both typical and atypical speakers, an utterance consists of more than one word and is not a mere naming act. This could be considered among the shortcomings of data collection in the method of error analysis providing an artificial representation of the child's speech patterns, as the child might perform well in this naming task, but might face speech problems and show disability in more spontaneous natural settings (cf. Grunwell 1986: 59). Thus to ensure having more accurate representative data to be analyzed and to assess the intelligibility of the child's speech, it is advisable, when possible, to combine this method with others, like reading aloud or recording naturally occurring speech samples depending on the child's age and his linguistic oral competence as in many atypical cases, children might be able to produce only single-word utterances.

Additionally, Grunwell (1986: 54) refers to another structural dimension to be considered. She explained that in the error analysis approach, the word is the traditional descriptive unit, and in phonological analysis the word is not the primary unit of analysis. Instead phonology uses units of analysis which are based on concepts of hierarchical relationship, so it uses the syllable as the basic normalizing unit of the phonological patterns based on segment-sized descriptive units "phones". Grunwell (1986:61) summarizes the criteria that an adequate sample must fulfil:

1. The speech sample should be a representation of the normal pronunciation patterns in both forms:
    1. system: by representing the full phonemic inventory of the contrastive consonant sounds,
    2. structure: by representing all the possible combinations of speech sounds clusters and sequences in a particular language;
2. This sample should consider the normal range of both:
    1. The stylistic and contextual factors in connected speech
    2. Sociolinguistic variation and the accent differences in that language
3. The sample should be collected from a variety of 'talking situations' in order to assess:
    1. any differences in the pronunciation of individual words in isolation and the pronunciation patterns in spontaneous conversation,
    2. the amount (if any) of variability in pronunciation patterns,
    3. the adequacy of the pronunciation patterns for normal communication (intelligibility of speech),
    4. the effect (if any) of providing a 'model for imitation'.

Moreover and according to (Grunwell 1986: 62), speech errors in this approach are classified into four types, (Michel 1978: 425-6) defines these types as follows:

1. Omission: the target phoneme is not articulated, it is omitted.
2. Substitution: the target phoneme is replaced by another recognizable phoneme.
3. Distortion: the phoneme is replaced by a production that is slightly to severely off the target, or by a sound not found in that language.

4. Addition: an extra phoneme is inserted into the word.

Therefore, classifying speech errors using these categorical terms is easy and could be achieved without a deep phonetic knowledge and training. Grunwell (1986: 63) referrs to the flaws of this system: firstly, that this classification does not make reference to the functional load of the phoneme nor to the frequency of its occurrence in the typical speech in the relevant language system. These two concepts are important in the phonological analysis as they determine the communicative effect of each phoneme. Moreover, the severity of the speech disability in this framework depends on the number and the types of the errors; the more errors the speech reveals, the more severe the disorder is.

Another flaw in this classification system is that it does not consider the cases where the sound is mispronounced in a transitional phase, moving from one place of articulation to another. Furthermore, there is another critique relevant to the definition of the addition error, accordingly the addition of a non-standard sound would not be justifiable in this classification. Moreover, the definition of distortions is so simple and it does not even require the phonetic characteristics of the error segment. It is possible that two phonemes might be mispronounced in the same way, sharing the same distorted articulatory gestures, and then the effective communication will be hindered. Therefore, following the traditional framework of error analysis to analyze this speech error, where each mispronunciation is analyzed individually, it will be impossible to show this contrast between the two distortion patterns (cf. Grunwell 1986: 62-70).

To summarize, this simple assessment does not provide a precise analysis of the phonetic nature of the child's mispronunciations, thus it does not accurately evaluate the severity and the exact nature of the speech disorder.

1. This error analysis framework is a descriptive assessment that analyzes the differences between correct and deficient speech sounds.
2. Error analysis does not determine any systematic error patterns or any regularities in the atypical speech, and instead of that,
3. Error analysis describes the atypical speech in terms of the articulation errors. Consequently, the possibility of providing principled treatment programs and

applying effective remediation strategies, based on speech error patterns will be impossible. Therefore, inaccurate remediation methods might be suggested by teaching the speaker to correct his/her articulation of each atypical sound individually.

It could be generalized that the framework of error analysis provides a quick screening assessment and evaluation of the child's speech. On the other hand, this assessment is an inadequate assessment as it is a phoneme-based, phonetic rather than phonemic in its approach of assessing the errors separately. Grunwell (1986: 69) further explains that the practical application of the phonemic assessment in this framework is difficult and complex when considering the complicated requirements needed to establish an extremely lengthy list of all the possible minimal pairs in the language system. This means that the whole idea of using such an articulation test will not assure providing natural spontaneous representative data together with the inadequacy of the assessment framework in error analysis. Therefore, it would be more effective to consider other frameworks with more precise phonological methods in analyzing the child's individual phonological system and characterizing the articulation patterns to plan the suitable remediation strategies.

## 2.3 Contrastive analysis: comparing phonological systems

Phonology is concerned with describing and analyzing the organization of sound and speech patterns in relation to their function in the spoken language. Additionally, the most obvious characteristic of the speech of the atypical children is their clear defective communicative competence in using the spoken language resulting from their atypical articulation of the speech sounds. Moreover, the analysis of the traditional ''phonetic'' framework of error analysis has been shown to be inadequate in assessing these speech disorders. Therefore, a phonological framework should be more adequate in describing and assessing speech disorders than the previous phonetic framework.

This framework of contrastive analysis depends on analyzing the patterns of the speaker's phonological system in comparison with patterns in the typical phonological system as a basis for the assessment of the speech disorders. This comparison identifies the articulation deficits and the atypical patterns, and therefore establishes the suitable remediation goals. This framework considers the description of the typical phonological system as providing the regularities in the typical speech patterns described in terms of rules governing the speech behaviour. The basis for this contrastive analysis is summarized in the definition of the phonological system as follows:

> "A description of the sound patterns in spoken language in terms of a finite inventory of sound elements, which are dependent upon each other in functioning contrastively and which combine with each other in forming larger linguistic units."(cf. Grunwell 1981: 12).

This definition clearly implies that the basic phonological unit is the phoneme. Additionally, it further states that the phonological description includes both the paradigmatic and the syntagmatic dimensions in describing the system and the structure of spoken language. This phonological description is based on the dual idea of: (a) the hierarchy of organization and (b) the systematic contrastive function among speech patterns. Accordingly, when a child's speech presents free variation between two phonetically-contrastive units, this indicates that the potential contrastive relation between the two contrastive sounds has not yet been established in his phonological system: i.e. the child's system is unstable, therefore it is a system in change and therefore it can not function effectively. Thus, the phonological analysis of the child's speech development has been described as a gradual process of expansion and progress in mastering and developing the contrastive speech patterns and combinations. This process is viewed as a positive development towards acquiring the adult-like speech patterns (cf. Grunwell 1986: 75-78).

One inadequacy in the contrastive analysis framework is that it can not be applied easily in cases with ''acquired phonological disorders'' such as adults with dysphasic or dyspraxic speech impairment. The speech patterns in these cases are highly inconsistent and unpredictable, thus it is very difficult and inappropriate to suggest treatment strategies and guidelines based on this assessment (cf. Grunwell 1986: 79).

### 2.3.1 Analysis of the child's individual phonological system

The analysis of the child's phonological system in his/her speech patterns includes the following procedures as described by Grunwell (1986: 81):

1. a statement of the phonotactic possibilities;
2. a statement of the sets of contrastive phones at each place in the structure, together with details of the non-contrastive variants of each contrastive phone;
3. a statement of the feature compositions of the contrastive phones.

Grunwell (1986: 81-82) further explains that the statement of the phonotactic possibilities in the syllable structure in words is explained in terms of the consonant C and vowel V combinations. The potential syllable structures in a child's speech are classified into monosyllabic, disyllabic or multisyllabic forms. Then each structure is analyzed separately, and the percentage of occurrence of each structural type will be calculated to find out its frequency and dominance in the child's speech. This phonotactic description gives an image of the child's habitual speech patterns.

Grunwell (1986) explains through providing an example, analyzing Martin's speech, how this framework functions. Therefore, to describe the contrastive phones along with their relevant feature compositions in the child's speech, it is necessary first to describe the child's phonetic inventory. This description includes the voicing value, place and manner of articulation along with the distribution of these phones in word structure. In this description, any phone the child produces only once or twice in his sample, or when the phone's occurrence is restricted to repeated words, then this phone would be marginal in the analysis as it does not represent the child's natural spontaneous speech patterns. Moreover, Grunwell (1986: 84) states that in the analysis of the contrastive phones and in the identification of the variants of the contrastive phones, this framework uses a phonemic analysis, specifically the criteria of complementary distribution and free variation to describe the contrastive phonetic differences in the child's system.

This analysis considers each phone to be potentially contrastive unless there is supporting evidence showing that it is a variant of a contrastive phone. A child might apply phonetic overlapping in his speech patterns, this happens when s/he pronounces two contrastive phones variably in some words as if they were allophones of the same phone, but these two phones have been shown to be contrastive in the adult system through the existence of several minimal pairs (cf. Grunwell 1986: 86). Overlapping as illustrated in (Grunwell 1986) means that phonetically-different segments might not be functionally contrastive in the child's phonological system at certain stages in his typical or atypical phonological development. This case of overlapping suggests an important intervention strategy as the child might be able to articulate the phone correctly, but s/he is unable to correctly use it to form a phonological contrast in conveying the communicative function connected with signalling different meanings resulting from using contrastive phones.

### 2.3.2 Assessment of the child's individual phonological system

In the theory of contrastive analysis, two approaches can be applied to assess the child's phonological system: (a) either assessing the normality and the adequacy of his/her system as a phonological system by itself, or (b) comparing it with other systems highlighting the differences and the deficits that may exist between them. When the child maintains and keeps the phonetic contrasts without an overlap between them, then his/her speech patterns are described as systematic and typical, even if in certain cases variability would be apparent to some extent in the child's attempts to master adult pronunciation patterns. However, there are two cases of variability that are considered to be indications of the atypical system in the child's speech as Grunwell (1986: 88) explains.

The first case is the previously mentioned phonetic overlap of contrastive phones as if they are allophones of one phoneme. Therefore, the relevant intervention will focus on suppressing the deviant realisation and stabilising the correct contrastive articulation.

In the second type of variability, the child will apply phonetically distinct phones in a free variation manner, which means that these contrastive phonemes in the adult system are not contrastive in the child's system. Therefore, the child is producing these contrastive phones in such a way that they are different realisations of the one and the same phone. The treatment in this case should modify the child's phonological system by teaching him/her the contrastive nature between the phonemes being incorrectly articulated in free variation.

The contrastive assessment of the developmental atypical phonological system analyzes the organisational characteristics of the child's speech patterns, characterizing this system as being deviant in comparison with the typical phonological systems as defined by Grunwell (1986: 91):

1. limited phonotactic resources: very few, if any, consonant clusters occur; words are constituted of strings of simple syllabic structures; open syllables predominate;
2. limited phonetic resources: place and/or manner of articulation feature contrasts are restricted; the fortis/lenis distinction between obstruents is often lacking;
3. different sets of contrastive phones operate at different places in structure.

Therefore, assessment in the contrastive framework is based on comparing the organisational patterns in the atypical and the typical adult phonological systems according to three dimensions: the phonotactic possibilities, the set of contrastive phones and their distributions in syllable and word structure. This assessment maps the child's phonological system to the adult's system in a simple graphic form based on the child's contrastive phones signalling meaning differences in the language, but not on his phonetic realisations of the adult phonemes (cf. Ferguson 1968, Grunwell 1986: 94).

The treatment strategies depending on analyzing the contrastive assessment aim at modifying and improving the inadequacies in the child's phonological system through expanding and enlarging the distribution of the existing contrastive phones to all other places in the system structure as well as introducing new contrasts into his/her developing system.

Finally, this framework has been criticized for not being able to specify information about the structural dimension within the phonological development in the child's system. This assessment approach describes the atypical patterns, but it does not specify the distribution of the developing contrastive units at certain positions in the structure of the sound system of the child in other phonotactic positions.

## 2.4 Distinctive feature analysis of atypical speech

As previously stated, the development of distinctive feature theory began with the work of Jakobson and Trubetzkoy from the end of the 1920s and 1930s during the Prague School era and thereafter. This framework came as a result of Jakobson and Trubetzkoy's seminal work on distinguishing phonology from phonetics and studying speech sounds on the levels of *langue* and *parole* respectively.

Trubetzkoy (1931) and Jakobson (1941/1968, Jakobson, Fant, and Halle 1952; Jakobson and Halle 1956) have developed the distinctiveness between phonemes into a binary system of a finite set of distinctive features. This theory uses the phonetic feature descriptions, representing the articulatory and the acoustic characteristics of the phones; namely, voice, place, and manner features. By taking the contrastive the phonological functions of phonemes into account. This framework provides a phonemic analysis, describing each phoneme as ''a case of the simultaneously-occurring distinctive features'', which form the basic analytical, distinctive sound unit in this phonological analysis (cf. Grunwell 1986: 104-105).

Jakobson, Fant, and Halle (1952) and Jakobson and Halle (1956) further developed the theory of the distinctive features by including the acoustic features of the sounds. Therefore they developed a twelve-feature binary system to analyze the speech sounds or phonemes in all languages. Tobin (1997: 14-15) refers to these features as universal articulatory and acoustic distinctive feature oppositions (cf. Jakobson and Halle 1956):

1. vocalic versus nonvocalic,
2. consonantal versus nonconsonantal,
3. compact versus diffuse,
4. tense versus lax,
5. voiced versus voiceless,
6. nasal versus oral,
7. discontinuous (or interrupted) versus continuant,

8. strident versus mellow,
9. checked versus unchecked,
10. grave versus acute,
11. flat versus plain, and
12. sharp versus plain.

One of the main concepts associated with this phonological theory based on the articulatory and acoustic distinctive features is “markedness”. This concept can be summarized in the fact that certain combinations of these features are considered more natural (unmarked) than others (marked). This markedness principle and the binary system of distinctive feature analysis have often been used in phonological analyses in general and developmental and clinical phonological analyses across languages in particular. However, the framework of distinctive feature analysis and markedness has been evaluated as being an abstract misleading approach in phonological analysis it gives based on its unclear specifications, classifications and its own definitions (cf. Grunwell 1986: 104-130).

## 2.5 Generative phonology

Generative phonology (GP henceforth) is a theory based on Generative Grammar which was originated by Chomsky and Halle (1968) in their work *The Sound Pattern of English*. GP describes the sound patterns and structures in terms of context-sensitive phonological rules, where the distinctive features of segments are used to group these segments into natural classes revealing regularities in the sound patterns. The description of the speech patterns in this framework includes two levels of phonological representations; an underlying representation and a surface representation. The underlying representation refers to the basic form of the word before any phonological rules have been applied to it, presumably showing what a native speaker knows about the abstract underlying phonology of his language. On the contrary to that, the surface representation is assumed to represent the actual sound production. Phonological rules map the underlying representations into the surface phonological representations, showing the structural change through explaining the phonological processes of deletion, insertion, substituting segments, or changing the features of segments (cf. Grunwell 1986: 134-137).

### 2.5.1 GP and the language acquisition device

Several theories have attempted to explain the process of language acquisition and how children comprehend and learn to speak a particular language. Noam Chomsky (1957) first published a criticism of the behaviourist theory of language acquisition. Specifically, Chomsky (1957) referred to the defects of the behavioural model based on the creativeness of humans in producing an infinite number of sentences and the fact that children often produce sentences they have never heard before. Moreover, Chomsky criticized the concept of the impoverished language input that children receive according to behaviourism by taking into account the fact that adults and caregivers do not typically speak to children in grammatically complete sentences. Therefore, what the child hears and the input s/he receives would represent only a limited sample of the ambient language.

Therefore, Chomsky (1965) developed the nativism approach and concluded in the innateness theory that children must be born with a faculty for language acquisition, meaning that language acquisition is biologically determined. This faculty is referred to as the Language Acquisition Device (LAD). The main claim of this theory is that human beings are born with neural circuits in the brain containing linguistic information. Therefore, receiving the language input through hearing speech would trigger the child's natural predisposition and aptitude to learn the language. Chomsky (1965) further explains that the underlying principles and structures in the natural faculty of the child's brain will enable the child to interpret what s/he hears. Therefore, Chomsky (1965) concludes that these principles are common to all human languages, e.g., all languages share common grammatical rules and principles which he calls the universal principles of human languages. According to the innateness theory, the child is born knowing nothing specific to his/her mother tongue. It is through receiving adequate linguistic input that the child deduces how the specific language s/he hears expresses these underlying principles.

Chomsky's innateness theory has been modified both by Chomsky himself and by others as well. The original concept of innateness theory that the LAD represents the specific knowledge and content of human languages has been modified by Dan Isaac Slobin (1973). Slobin modifies the concept of LAD, meaning that the child must be born with the procedures of the language acquisition mechanism that will enable him to make inferences from the linguistic input he receives. Therefore, processing the input based on the linguistic universals through the child's innate cognitive competence, would result in acquiring the ambient language (cf. Slobin 1973).

The idea of the innate language faculty has received support and evidence from research in other areas of language study. Slobin (1973) referred to the already established facts that anatomy of the human vocal tract is particularly adapted to the mechanisms of articulation involved in speech sound production. Moreover, specific areas of the brain have long been identified as having distinct linguistic functions; namely, Broca's area and Wernicke's area. Previous research has shown that stroke victims in the areas of the brain may suffer various language problems and dysfunctions, ranging from problems with retrieving words to an inability to comprehend and interpret the syntax of the language depending on the specific area of the brain that has been damaged.

### 2.5.2 GP and child speech

The GP framework describes chid speech by matching the child's articulation patterns through the phonological rules of adult articulation/speech. Thus, adult articulation/speech being represented by the phonemic forms of the words forms the input to the phonological rules, while the output is the child's articulation. This description is believed to be justified based on the idea that the child's underlying representations are identical to his ambient language (Lorentz 1976). Consequently, this approach specifies the features of the child's speech as being derived from the adults' articulation features, showing as well the changes resulting from the applied phonological process (cf. Grunwell 1986: 137-139).

Grunwell (1986:142) summarizes the principles of the GP analysis of child speech in the sense that the phonological rules can:

- change feature specifications that is change segments; cf. substitutions and distortions;

- delete segments; cf. omissions;
- insert segments; cf. additions;
- interchange (reorder or permute) segments, that is metathesis; cf. transpositions;
- coalesce segments.

A representative example of the GP analysis of change feature specifications in child speech is found in the following example cited in (Grunwell 1986:143):[2]

ANN 5; 11 (1979)

car [ta]

girl [ɖɜɪ]

singing [ʂɪɴɪɴ]

In Ann's speech all velar consonants have been produced as alveolar consonants. Thus, the features of the segments have been changed, more specifically, these are the features regarding the place of articulation that have been changed. This change would be represented using the GP framework as follows:

$$\left\{\begin{array}{lcl} +\text{cons} & & \\ -\text{cor} & & +\text{cor} \\ -\text{ant} & \rightarrow & +\text{ant} \\ +\text{high} & & -\text{high} \\ +\text{back} & & -\text{back} \end{array}\right\}$$

This framework is effective in describing the error patterns in children's speech represented in the phonological rules, thus the relevant remediation will be directed to correcting this pronunciation which will be generalized to other segments showing the same pattern represented in the phonological rule (cf. Compton 1975: 74ff).

Nonetheless, Chomsky's work on language acquisition has many limitations and has been criticized for being an abstract theoretical model of language acquisition. Chomsky's work mainly consists of detailed complex explanations of grammatical rules. The theory basically explains language acquisition through children being

2 The author in the original text uses more examples, but only some of these cases have been quoted here to explain the anaylsis procedure.

exposed to the language input. This model does not base its explanation on studying real cases of language acquisition by children. This theory does not consider the influence of the interaction between the child and the parents and caregivers, thus no account of the functions of language can be found in this theory.

This framework has been found to be very abstract, theoretically complex and detailed in describing the child speech patterns. Therefore, subsequent theories focused on the real ways in which children normally acquire and develop language through their interaction with parents and caregivers. Consequently, other phonological theories are presented and described in the following sections that achieve the same analytical aim of explaining the phonological patterns in language acquisition and child speech.

## 2.6 Natural Phonology and child speech

The theory of Natural Phonology[3] (NP) explains child speech by analyzing the sound changes based on the concept of the natural phonological process, which is defined, according to Stampe (1973a:1) as:

> "A mental operation that applies in speech to substitute, for a class of sounds or sound sequences presenting a specific common difficulty to the speech capacity of the individual, an alternative class identical in all other aspects but lacking the difficulty property."

According to this definition, natural processes could be thought of as the natural and automatic responses of children to the articulatory and perceptual difficulties which speech sounds or sound sequences present. They are universal processes, since all humans show the same potential in responding to the difficulties of speech by applying these processes. A child will gradually learn to suppress some of these natural responses in order to acquire language-specific phonology.

It can be explained, based on this definition, that these natural processes are mental operations; which means that these substitution changes occur in the central nervous system of the speaker. These processes are not simply physical or motor slips

3 A more detailed account of this theory, which forms the analytical framework of this study, will be presented in CHAPTER 3 .

resulting from faulty timing or missed targets; they represent the substitution of new phonetic targets. Stampe's definition shows that the kind of adjustment processes could not be produced by the organs of articulation themselves, or by the peripheral innervations of these organs. Anticipatory substitutions, in particular, suggest that these substitution processes take place in the central nervous system of the speaker, before the required subsequent articulatory commands are sent out (cf. Donegan and Stampe 1978a, sec.2.1). Moreover, processes are shown to be psychologically real because they can be suspended even when there are conditions for their application. (Stampe 1973 [1979]: 9) makes the following remark with reference to the mental nature of processes: "[a]lthough substitutions are mental in occurrence, they are physical in teleology: their purpose is to maximize the perceptual characteristics of speech and to minimize its articulatory difficulties".

Another piece of evidence supporting the mental nature of these natural processes is the fact that children actually learn to suppress certain processes when their native language requires them to do so in the same way as adults suppress certain *optional* processes in some styles but allow them to apply in others. Finally, the mental nature of processes is clear and straightforward in the fact that they apply also in silent, mental speech, where there is no reason or explanation for physical misses or mistiming. Moreover, the psychological reality of process outputs, as attested by spontaneous spellings, gives further proof for the mental nature of these processes (cf. Stampe 1973a: 6).

Classical Natural Phonology is mainly concerned with the phonetic bases of phonology and this justifies the common misreading of NP as minimizing and reducing phonology to phonetics. However, if cognitive, psychological, and socio-pragmatic factors play a role in NP, Natural Syntax, and Natural Text Linguistics, this means that they are also important and integral in NP. Moreover, there are also some important non-phonetic factors such as rhythmic organization, various semiotic functions and typological principles, as well as the notion of prototype which play a role in strengthening and motivating phonological naturalness.

## 2.7 Optimality theory

The linguistic framework of optimality theory (OT henceforth) was first developed in the early 1990s (McCarthy & Prince, 1994, 1995; Prince & Smolensky, 1993). The framework has been first used for describing grammatical systems of languages, therefore, it proved to be very useful and influential in the field of phonology in particular. In later stages, the framework of OT has been applied to analyze and account for the process of language acquisition as can be seen in the literature (cf. Barlow 2001b; Barlow & Dinnsen 1998; Dinnsen, McGarrity, O'Connor, & Swanson 2000; Ohala 1996; Smolensky 1996a, 1996b).

OT is different from the other generative linguistic frameworks in the way it explains grammar. In OT there are no rules or processes; instead, this framework uses the concept of universal violable constraints. The constraints in OT are universal cross-linguistic patterns, as they can be found among all speakers of all human languages. The principle of constraints in OT helps in characterizing the cross-linguistic similarities as well as the variation among languages depending on the degree of the violation of these constraints, which results in each language having a unique grammar system.

According to Tobin (2009a: 171) the framework of OT is one of the most interesting frameworks within the development of Generative Grammar which:

- recognizes "deep" versus "surface" forms
- focuses on formal description
- searches for universal principles based on typology and language acquisition
- aims to achieve economy in its analyses, among other paradigm specific principles.

OT describes grammar on two levels; the universal level and the language-specific level. The set of constraints (CON) on the phonological representations forms the universal part in this framework. OT accounts for the means of generating the relationships between an actual lexical input and all its potential outputs which is called generator (GEN) through a certain evaluation mechanism. The optimal output for a certain input will be evaluated against the set of the ranked constraints in that specific language, evaluator (EVAL). At the language-particular level, OT accounts for the constraints hierarchy, where each language specifies its set of inputs and its unique and specific ranking of the universal constraints. Thus, the ranking of the constraints restricts and specifies the structure of the optimal output forms in each language. More specifically, OT resembles other generative linguistic frameworks in the relationship between input and output representations, which is an analogy of the relationship between the mental (the underlying) and the surface representations in rule-or process-based frameworks (cf. Barlow 2001: 242-243).

Barlow (2001: 243) explains the input-output relation as follows: for any input such as /kæt/ a (possibly infinite)[4] set of different possible phonetic outputs as candidate forms will be provided by GEN. GEN provides each input form with a (possibly innite) set of output candidates. EVAL of that specific language system will evaluate these forms based on the constraints hierarchy of this language and choose only one optimal output form from these competing forms. Some of the competing candidates can be identical to the input (e.g., [kæt]), while others can be very different (e.g., [bab] or [mu]).

### 2.7.1 The nature of OT constraints

As has been previously mentioned, the main hypothesis in OT is the presence of universal constraints which are violable. According to OT, the specific ranking of these universal constraints forms the only way that differentiates the grammatical systems of all human languages. This variation in the relative ranking means that constraints have different hierarchies and degrees of importance in different grammar systems. More specifically, higher ranked constraints are always more important in the relevant grammar. Therefore, Barlow (2001: 243) states that the optimal output would be chosen by EVAL as the one that violates the fewest highest ranked constraints. There are two categories of constraints in OT: the faithfulness constraints and the markedness constraints:

4 This idea of generating an infinite set of output candidates in OT has been discussed and modified as (a possibly infinite set) as this idea is actually problematic. For more discussion of the advantages of using the finite-state tools over the manual tableau methods in generating the optimal outputs, see (Karttunen 1998).

- Faithfulness constraints imply that both input and output forms need to be identical to one another. This means that a certain violation to faithfulness constraints is encountered when changes in the features' makeup of the segments occur as for example, when segments are deleted, inserted. (Barlow 2001: 243) explains the faithfulness constraints with the following example:

“if a child produces the word sleep as [sip], a faithfulness constraint called MAX (“no deletion”; McCarthy & Prince, 1995) is violated because the /l/ is omitted. Similarly, if sleep is pronounced as [swip], a faithfulness constraint called IDENT-FEATURE (“don’t change manner features”; McCarthy & Prince, 1995) is violated because the /l/ changed to a [w].”

- Markedness constraints on the other hand, imply that the optimal outputs should be unmarked, thus they should have a simplified structure. The markedness of the language sound system can be identified by its phonetic and perceptual properties. Barlow (2001: 244) further adds that the frequency and distribution of the sound properties within and across languages can be considered as another indicator of the markedness of the optimal outputs. Therefore, the marked structures are the structures that are difficult to articulate and perceive or the ones that have limited occurrences within or cross-linguistically. More specifically, fricatives, affricates, liquids, and consonant clusters fall in the category of the marked properties of the universal language sound system, while vowels, glides, nasals, and stops are examples of the unmarked properties. This concept of the markedness of the universal sound systems can be shown by the fact that many languages lack marked sounds and structures. Moreover, marked structures tend to be acquired relatively late by children and these are the structures that form the most difficulty for second-language learners as shown in many studies: (cf. Blevins 1995; Maddieson 1984; Smit, Hand, Freilinger, Bernthal, & Bird 1990). Barlow (2001:244) states that:

“The occurrence of marked structures in output forms results in a violation of markedness constraints. Thus, the word sweep pronounced as [swip] violates a markedness constraint called *COMPLEX (“no clusters”;

McCarthy & Prince, 1995) due to the marked cluster [sw-]."

The two categories of universal constraints are in an antagonistic relationship as a result of their conflicting nature which results in the constraint violability as explained before. More specifically, each optimal output form will violate some particular constraints while satisfying others. This means that certain faithfulness constraints must be violated while satisfying certain markedness constraints, and at the same time satisfying certain faithfulness constraints will imply violating other markedness constraints in the mechanism of determining and choosing the most optimal output in a specific language. Barlow (2001: 244) further explains this conflict between the constraints using the same example, thus she states:

> "If a grammar allows sweep to surface as relatively unmarked [sip], violation of *COMPLEX is avoided; however, this entails a violation of the faithfulness constraint MAX, because /w/ is deleted. On the other hand, if a different grammar forces sweep to surface as [swip], violation of the faithfulness constraint MAX is avoided (because no segments are deleted); however, the markedness constraint *COMPLEX is violated because of the marked [sw-] cluster. The difference between the two grammars lies in the ranking of constraints. In the former grammar, satisfaction of *COMPLEX is more important than satisfaction of MAX, meaning that *COMPLEX outranks MAX. In the latter grammar, MAX is more important than *COMPLEX; thus, MAX outranks *COMPLEX."

The hierarchy of the constraints implies that the higher ranked constraints have to be satisfied by the optimal output form, while the lower ranked constraints do not affect choosing the optimal output form. OT has been applied to phonological analysis, where the main aim of analyzing the speech sample is to specify the relevant ranking of the constraints in a given sound system. More specifically, OT has been applied to specify the differences in the ranking of the constraints between child versus adult speech and between typical versus atypical speech productions.[5]

5 The theory of OT is concerned with adult lexical input, and in language acquisition, the idea of input is also applied to adult speech, while the output refers to child speech. This is therefore, the same foundation, but not the same theory.

Moreover, Barlow (2001: 244) refers to the possibility in certain language systems to allow for more than one candidate to be chosen as an optimal output. This variability in the constraints ranking is called *stratified domination hierarchies;* meaning that the constraints are ranked equally instead of being hierarchically ranked (cf. Tesar & Smolensky 2000). Additionally, Barlow (2001: 244) provides an example of this case, where a grammar might allow *sweep* to surface as both [swip] and [sip]. Therefore, in this particular case, the two constraints: *COMPLEX and MAX are ranked equally in this grammar system.

Consonant clusters are described as marked structures as has been shown by their limited occurrence in the world languages (Blevins 1995), and as shown in the difficulty of producing them by children and second language learners (cf. Eckman 1984; Ingram 1989a; Locke 1983). Therefore, when cluster reduction occurs, it is explained as a way of avoiding the violation of the markedness constraint *COMPLEX.

*CODA (McCarthy & Prince 1995) represents another markedness constraint against syllable-final consonants (codas): i.e. codas are not allowed to appear in the optimal outputs. Blevins (1995) states that coda consonants are also considered as marked structures as many languages do not allow final consonants. Additionally, children often delete final consonants during the acquisition process of languages that allow codas (cf. Ingram 1989a; Locke 1983). According to this markedness constraint, outputs with final consonants violate the *CODA constraint. On the contrary, producing outputs with deleting the codas like (h*at* → [hæ]) satisfies the *CODA constraint. Barlow (2001: 244) concludes that children who tend to delete final consonants in their speech must have *CODA ranked high in their relevant grammar systems.

*FRICATIVES ("no fricatives"; Barlow 1997; Barlow & Gierut 1999) is another markedness constraint which prohibits fricatives in optimal outputs. In the same way, the constraint *LIQUIDS ("no liquids"; Barlow 1997; Barlow & Gierut 1999) does not allow optimal outputs to have liquids. These constraints reflect the markedness feature of both fricatives and liquids, as shown by their relatively limited occurrence cross-linguistically and by the difficulty of producing them by children (cf. Hawkins 1987; Maddieson 1984; Smit et al. 1990). Accordingly, when children produce fricatives as stops, *FRICATIVES is satisfied, and in the same way, children would avoid violating *LIQUIDS when they produce liquids as glides (*lake* → [wek]). Thus, stopping or gliding in the child speech specifies the ranking of the constraints in their grammars by having the markedness constrains *FRICATIVES or *LIQUIDS (respectively) ranked high (cf. Barlow 2001: 244-245).

### 2.7.2 OT and child speech

The theoretical framework of OT has been applied to analyze and explain the error patterns in typical and atypical language acquisition systems. In OT, the ranking of the universal constraints is considered as the main principle of differentiating two languages. Additionally, child speech is described in OT as showing a different ranking of the constraints than in the relevant adult speech in that particular language system. Furthermore, OT supposes that variations in the acquisitional norms between individual children are caused by different constraint rankings among them (cf. Barlow 2001: 245).

OT has been applied to specify the ranking of the constraints in the speech of children with a phonological disorder. In her study, Barlow (2001a) analyzed the speech of "John" (aged 3:9 [years:months]). The data in this study have been collected from John's responses to a single-word test based on the Bankson-Bernthal Test of Phonology (Bankson & Bernthal 1990). Similarly to other accounts of child speech within other frameworks, Barlow (2001a: 245-246) states that John's articulations were characterized by their simplified unmarked features when compared to the adult forms especially in the early stages of development (cf. Ingram 1989a, 1989b; Stoel-Gammon & Dunn 1985). OT accounts for this feature in the child's speech system by stating that child speech reveals a different ranking of the constraints (and opposite to the adult system) with the markedness constraints outranking the faithfulness constraints (cf. Smolensky 1996a, 1996b).

To explain the methodology of analyzing phonological speech disorders within the OT framework, an example of final consonant deletion in *John's* productions as has been reported in Barlow (2001a) which will be presented here. Barlow (2001a: 246) explains that the speech pattern in *hat* being produced as [hæ] results from the fact that the markedness constraint *CODA ("no final consonants") outranks the faithfulness constraint MAX ("no deletion"), thus forbidding final consonants to occur in this child grammar system.

Table 2 shows how OT explains final consonant deletion with reference to the conflict between the two constrains *CODA and MAX. Barlow (2001a: 246) illustrates that adult speakers of English have an opposite ranking where MAX outranks *CODA allowing final consonants to occur in their speech productions. In OT and as shown in Table 2 the constraints are ranked across the top, starting on the left side with the most important constraint, but the least important are ranked to the right side. In the final consonant pattern presented earlier, the markedness constraint *CODA is the most important and therefore outranks the faithfulness constraint MAX. The ranking of constraints is shown in (1), where the two constraints are separated by double right-angled brackets (">>").

(1) Final consonant deletion

*CODA >> MAX

*Table 2: Final consonant deletion: hat /hæt/ → [hæ].*[6]

| */hæt/ hat* | **CODA* | *MAX* |
|---|---|---|
| a. [hæt] | *! | |
| b. ☞ [hæ] | | * |

Table 2 shows the input form /hæt/ and the output candidates (a) and (b) on the left side-column; with the faithful marked (identical) candidate (a) [hæt] and the unfaithful unmarked candidate (b) [hæ] where the final consonant [t] is being deleted. Candidate (a) satisfies the faithfulness constraint MAX which is shown by the blank cell under the MAX column for candidate (a). On one hand, candidate (a) has a violation status as indicated by an asterisk ("*"), this candidate violates the markedness constraint *CODA, which is the most important constraint in this system. On the other hand, candidate (b) satisfies *CODA because it deletes the final consonant /t/, again this is indicated in the table by the blank cell under the *CODA column for candidate (b). Simultaneously, candidate (b) violates the faithfulness constraint MAX

6 ☞= optimal output; * = constraint violation; *! = fatal violation; = equal ranking; >> = crucial ranking.

as a result of deleting /t/. Therefore, both candidates violate one of the two constraints; however, one violation is more serious than the other. In OT, violating higher ranked constraints is worse than violating lower ranked constraints; violating higher ranked constraints is considered to be fatal. Table 2 indicates that candidate (a) has a fatal violation and it is indicated with the exclamation mark ("!"). This status prevents such a candidate from being an optimal output in this particular grammar system, therefore, candidate (b) will be the only optimal candidate. This status is indicated usually by the manual indicator sign (the pointing hand) to the left of candidate (☞).

Constraints re-ranking in OT also accounts for the grammatical change in children developing the adult patterns in their speech production as a response to their exposure to adult speech in that relevant language. This requires and implies that the child grammar system has to demote the markedness constraints below the faithfulness constraints to match the adult grammar system patterns. This process of constraints re-ranking is still under discussion and debate as is clear in the OT literature (cf. Hayes 1999; Tesar & Smolensky 2000). OT indicates the importance of the clinician -while treating children with phonological disorders- to choose therapy targets that will enhance re-ranking the constraints. More specifically, this reranking indicates demoting the highly ranked markedness constraints such as *FRICATIVES, *LIQUID-[r], *LIQUID-[l], and *CODA below the faithfulness constraints in the child grammar system (cf. Barlow 2001: 252).

## 2.8 NP, PHB and OT: similarities and differences

The theories of NP, Phonology as Human Behaviour[7] (PHB) and OT will be compared and contrasted in this section. These three theories show similarities and differences with regard to their theoretical and methodological backgrounds. Gibbon (2009: 76) states that these "theories are regarded as overlapping in some respects, complementary in others, and not as competitors." The theories of NP and PHB have a "naturalistic" and "ecological" approach as defined for NP by Gibbon (2009: 83–84), and for PHB by Diver (1979, 1980, 1981) as referred to by Tobin (2009a: 170). Therefore,

7 Theory of PHB will be used in analyzing the speech patterns in this study. The theoretical orientation and the clinical application of PHB will be explained in the next chapter of this thesis.

the naturalist paradigm of both NP and PHB will be compared with the formalist generative paradigm including OT in this section.

On one hand, these three theories will be compared according to the interaction between the opposing forces of the human factor and the communication factor in the naturalistic paradigm and between the markedness and the faithfulness constraints in the generative paradigm of OT on the other hand. The concepts of the phonological processes and language universals are treated differently in these three theories. Gibbon (2009: 76) states that "both NP and OT use collections of operations on representations as "rules", "processes" and "constraints", but do not demonstrate explicitly how these operations or constraints are connected in a coherent system." Therefore, the relevant similarities and differences of these three theories will be presented in Table 3.

*Table 3: NP, PHB, and OT: where do the theories overlap?*

| | *Natural Phonology* | *Phonology as Human Behaviour* | *Optimality Theory* |
|---|---|---|---|
| Paradigm | naturalist | naturalist | formalist generative |
| Methodological approach | ecological; applied in developmental and clinical sittings | ecological; applied in developmental and clinical sittings | ecological; applied in developmental and clinical sittings |
| Language universals | innate phonological processes | cross-linguistic phonotactic favourings | universal markedness & faithfulness constraints |
| Language specific rules | inhibitions of universal phonological processes | analysis of actual language use & phonotactic favourings | unique hierarchy of constraints in each language |
| Synergetic forces | human vs. communication factor | human vs. communication factor | markedness vs. faithfulness constraints |
| Preferences | favours structures that are natural, less complex, easy to be produced with more lexical contrastiveness | mini-max struggle: desire & preference to create maximum communication with minimal effort | faithfulness constraints outrank markedness constraints |
| Analysis method | deep& surface structures | does not deal with underlying representations | inputs & potential outputs |
| Implicational hierarchies | rules before processes. Fortitions before lenitions | explains natural phonological processes through PHB principles (mini-max struggle) | constraints ranking |
| Explanation | based on internal& external evidence | based on internal& external evidence | based on formalism |

More specifically, the naturalistic paradigms represented here by NP and PHB also differ in their similarity levels to the formalism of the generative paradigm. The following argument which is based on the discussions that are made by Donegan and Stampe (2009(, Dziubalska-Kołaczyk (2002), Gibbon (2009), Tobin (2009a) will explain these differences as follows:

1. Both NP and OT deal with the underlying representations, though, the underlying representations of OT are more abstract than those of NP. On the other hand, PHB does not generally refer to the underlying representations or language universals, instead it refers to the actual language use and language

specific analysis, where certain phonotactic favourings are used as principles to explain typical and atypical sound production mechanisms.

2. The distinctions and implicational hierarchies on process application in NP; namely, rules versus processes, and fortitions (strengthening processes) versus lenitions (weakening processes) constitute formal requirements in this naturalist theory. OT and NP differ in the order of application of their constraints and processes. PHB does not consider this formal order from underlying to surface representation. All OT constraints apply simultaneously as it is clear from its tableau representation. Additionally, stratal OT permits multiple steps in constraint application. In NP, fortitions apply before lenitions and more specifically fortitive processes would apply simultaneously before the lenitive processes that would also apply simultaneously.
3. NP and OT search for language universals in different ways. Donegan and Stampe (2009) state that NP views language universals as being represented in the phonetically motivated phonological processes that occur in speech production and perception. OT explains the phonological alternations through the interaction of a set of universal phonetically-based constraints (cf. Donegan and Stampe 2009: 22). NP views language-specific rules as being represented in the inhibitions of the phonological processes in the relevant language. OT treats language universals in a different way. Kager (1999: 4)[8] defines the grammar system for OT as "a system of conflicting forces that are embodied by constraints which are universal, but are ranked in a hierarchy which is not universal" , this hierarchy reflects the language-specific rules. These are the constraints of markedness and faithfulness in OT which, as Donegan and Stampe (2009: 22) state, the speaker brings to the language, rather than inducing a system of rules through observing the surface forms in that language. Gibbon (2009: 79-80) also adds that:

   > "The negative (markedness) and positive (faithfulness) constraints can in principle be compared with rules and processes, and perhaps also fortition and lenition preferences respectively, including the ordering principles of NP (rules before processes) and

8 As cited in Tobin (2009: 172).

OT (markedness before faithfulness)."

Moreover, Tobin (2009: 172) further extends this comparison when he interprets these forces in OT based on the naturalistic and the ecological basis of PHB as follows:

1. markedness represents the force of grammatical factors that exert pressure towards the prevalence of unmarked forms (more natural, less complex, easier to produce?) types of structure;
2. faithfulness, on the other hand, represents the force of combined grammatical factors that preserve lexical contrastiveness (clearer communicative distinctions and oppositions?)

4. NP and OT base their explanations of speech production and perception on the conflicting universal forces (processes and constraints) which are attributed to human phonetic abilities. Dziubalska-Kołaczyk (2002: 79) states that OT is a preference theory and its constraints indicate preferences, but they differ from the nature of preferences in NP:

   > "The difference lies in the fact that the constraints are inductive generalizations about grammars of the studied languages while the preferences are deductive inferences about grammars based on universal higher-order principles applicable to language as well as to other natural phenomena."

   Dziubalska-Kołaczyk (2002: 79) further explains how the constraints and the preferences in OT and Natural linguistics can be compared and how their conflict can be resolved (Table 4). Moreover, Donegan and Stampe (2009: 22) have also confirmed this resemblance between OT constraints and natural phonological processes as they both refer to similar phonetic difficulties and they are both "violable; constraints may be outranked, as processes may be suppressed or limited." Therefore, they also add that the ranking of constraints in OT is similar to the inhibitions or the limitations of NP processes in their function of specifying the language-specific phonology. In this particular issue of specifying the language-specific phonology, PHB, on the other hand, and opposite to NP, first explains language-specific generalisations and then statistically presents their phonotactic favourings. Then, based on these statistically supported favourings of these generalisations, PHB observes the phonotactic preferences that appear across languages, and only then it concludes that these cross-linguistic patterns may be the language universals that also reflect similar favourings and preferences in other areas of human behaviour.

*Table 4: Constraints and preferences in OT and NL*[9]

| | *OT* | *NL* |
|---|---|---|
| Constraints | Wellformedness conditions, describe acceptable structures, violable, universal, statements of "general tendencies, not absolute laws" (Archangeli 1997: 7) | Extra-linguistic principles, language-external conditions on linguistic competence (see Ritt 2001), universal |
| Preferences | Since constraints are violable and express tendencies, they are ontologically preferences; still, the theory is interested in " ideal competence", and the concept of " preference" suggests "performance"; therefore, not used in the theory | Correspond to " constraints" of OT (exactly the same description): metagrammatical statements of tendencies (Singh in press); intermediate-level elucidatory principles (Dressler 1999a, Vennemann 1983), " below higher principles and above the specific linguistic consequences of preferences" Dressler (1999: 390) |
| Resolution of conflicts among c/p | Via language-specific ranking, descriptive | Universal hierarchy of functionally and semiotically based parameters, additionally shaped in a given language by language-specific ecological constraints (basis of selection from among the possible, cf. Maddieson 1999), "principled constraint ranking ", weak explanation in Vennemann's (1983) terminology |

5. The three theories can also be compared according to the concept of ''preferences''. Gibbon (2009: 79) in comparing NP to OT (Table 5) states that in NP "a certain rule of fortition or lenition may be preferred, i.e. may apply, otherwise this may not be the case. In a similar vein, other things being equal, in OT, a more general constraint may be violated if necessary." Additionally,

9 Originally, Dziubalska-Kołaczyk (2002) used full terms in her text: Constraints and preferences in Optimality Theory and Natural Linguistics. Abbreviations have been used here for formatting purposes.

the concepts of preferences in NP and the ranked constraints in OT can be matched to the idea of the statistically supported empirical favourings that PHB adopts, thus the concept of preferences is present in the three theories and is used to explain the articulation patterns in both typical and atypical speech and the distribution of phonemes in languages.

*Table 5: Some tertia comparationis for NP and OT.*[10]

| *Tertia comparationis* | *Natural Phonology* | *Optimality Theory* |
|---|---|---|
| Logic | default (intuitive, e.g. rules are ordered and preferential and precede processes) | default constraint logic (e.g. markedness constraints outrank faithfulness constraints) |
| Inference | unconstrained ordered derivational rules (rewriting or substitution rules), also analogical argumentation (cf. 'figure-ground' metaphor) | modus ponens (all inputs of type *A* are blocked by constraint *p*; input *x* is an *A*; therefore *x* is blocked by constraint *p*), implemented as a tableau-based constraint resolution procedure from formal logic |
| Generalisations | rules before processes | faithfulness before markedness constraints |
| Representations | plain text + symbolisation with unconstrained derivational rule notation | formalisation as ordered constraints defaults |
| Explanation | descriptive + final (teleological) | hypothetico-deductive |
| Empirical evidence | internal (distributional) + external (diachronic, pathological, ...) | internal (with recent applications to external domains) |

6. The concept of economy in NP is achieved by fewer inhibitions of the phonological processes, but economy in OT is achieved by fewer faithfulness constraints. Considering the fact that the generative paradigm assumes that all phonological alternations are learned, OT shows dissimilarity to this paradigm in assuming that the phonological constraints in this theory are innate. This fact draws OT closer in spirit to NP. Moreover, the concept of economy as it is related to the number of processes or constraints involved in going from

10 Originally, Gibbon (2009) used full terms in his text: Some tertia comparationis for Natural Phonology and Optimality Theory. Abbreviations have been used here for formatting purposes.

underlying-input or ''deep'' structures to output-''surface'' structures does not form a major theoretical and methodological issue in the framework of PHB as referred to in (Tobin 2009a: 172). Furthermore, Donegan and Stampe (2009: 23) add another similarity between the theories of OT and NP. They illustrate that the initial ranking of markedness above faithfulness constraints "markedness constraint dominance" in child speech corresponds to the initial over-application of phonological processes in children. Therefore, the process of ''re-ranking'' including the demotion of the markedness below the faithfulness constraints would function in a similar way as process suppression or limitation in NP.

7. External evidence, i.e., language use in context, biological, physiological, cognitive, psychological and the sociological factors is the key concept in the explanatory framework of the naturalistic (descriptive) approaches; NP and PHB. Therefore, NP and PHB compare the process of language acquisition as well as the non-random distribution of sounds in human languages with other aspects of human behaviour that are related to the muscular control necessary for the execution of fine motor movements. On the contrary, the explanation in generative phonology and OT, depends on formalisms in the evaluation of the outputs, and on the internal evidence by mainly judging the structure of language and explaining the distribution of the smaller linguistic forms in the context of the larger language forms (cf. Gibbon 2009: 77).
8. The three theories, both the natural and the formal paradigms, can be described as being ecological as they have been applied and used in the developmental and clinical sittings, and language teaching. (e.g. for NP: Dziubalska-Kołaczyk and Przedlacka 2005; Grunwell 1987; Ingram 1990. PHB has also been applied to the areas of developmental and clinical phonology and prosody for a wide variety of languages (e.g. English (Tobin 1997a, b, 1999, 2002); Spanish (Enbe, Gurlekian & Tobin 2006); Hindi-Urdu (Fatihi 2007); Japanese (Miyakoda 2003, 2004a, b, Tobin & Miyakoda 2004a, b, 2006); Finnish (Moore 1991a, b, 1993, Moore & Korpijaakko-Huuhka 1996, Moore & Rosenberg-Wolf 1998), Israeli Hebrew (Green & Tobin 2008a-b, Halpern & Tobin 2008, Tobin 1995, 1997a); and Israeli Sign Language (ISL) (Fuks & Tobin

2008; Tobin 2007a-b, 2008). Moreover, PHB has been combined with other phonological theories such as Natural Phonology (NP) and Optimality Theory (OT) in additional developmental and clinical analyses of Hebrew (e.g. Adi-Ben-Said 2006; Adi-Ben-Said & Tubul-Lavi 2009; Ben-David 2001); Polish (e.g. Połczyńska-Fyszer 2007; and Jordanian Arabic (Bader & Gibbon 2008). Moreover, the recent application of PHB to a computer program mainly based on lip-reading in studying the hearing-atypical children (cf. Schocken 2008) has contributed to the "technological" aspects in this paradigm. Therefore, this addition in the theory has helped in replying to the issue raised by Gibbon (2009: 83–84) in referring to the importance of "technology" in "Natural Linguistics" and the "ecology" of the linguistic theories which is discussed below regarding NP and OT.

9. Donegan and Stampe (2009: 24) point to another difference between OT and NP. They state that OT handles the articulatory and perceptual difficulties instead of focusing on the processes that humans apply to get rid of these difficulties as explained in the theory of NP. Donegan and Stampe (2009: 24) further comment on the difference between OT and NP regarding limiting the linguistic inputs. OT refers to the "the richness of the base", thus there are no limitations on the inputs as embedded in its principle: "the set of *inputs* to the grammars of all languages is the same" (Smolensky1996 b, 3). In contrast, such limitations are noticed in NP, as they are imposed on the lexical forms through the language-specific rules that limit the way speakers would perceive these forms in their language. This last comment leads to another difference between these two approaches with regard to the process of perception. Donegan and Stampe (2009: 24) further explain that both theories; OT and NP, base their explanations on their constraints and processes, respectively. More specifically, OT assumes that perception is completely faithful to the phonetic output (Smolensky 1996a), while this is not the case in NP, where perception is not seen as being faithful to the surface forms in the language. NP explains perception as being phonemic and language-specific, and it is influenced by the phonological processes and their interaction. Donegan and Stampe (2009: 24) further state that:

> "fortitive processes constrain the hearer's inventory of pronounceable and thus perceivable sounds, and lenitive processes allow the hearer to perform a causal analysis of sounds that do not belong to the inventory and to perceive them as variants of those that do belong."

10. Gibbon (2009) in his paper *Formal is natural* refers to a further difference between the two theories of NP and OT that deals with the potential of these theories in predicting the number of syllables in a particular language. NP obviously does not correspond to this demand, but it is possible to attain such a prediction in OT. Gibbon (2009: 80) explains this difference as follows: "OT is in principle capable of predicting the size of this set: it is equal to the size of the output of the generator component, minus the size of the subsets filtered out by each constraint." Gibbon (2009) further explains some fundamental epistemological differences between the frameworks of NP and OT. Gibbon (2009: 78) illustrates that the theory of NP does not provide a clear formalization of the preference selection and the ordering of rules and processes. He further states that although the theory of OT is more precise in its evaluation method of the optimal output based on the ranking of constraints, it does not empirically and clearly explain its faithfulness and markedness constraints, their basis and their ordering. Therefore, Gibbon (2009) refers to the lack of using an appropriate technology; e.g., the PRAAT phonetics workbench and speech synthesis systems in the explanatory models of the frameworks of NP and OT to test their phonological and phonetic descriptions. He argues for the importance of technology in the theoretical and empirical science in providing "a "payback" to the context of language use and users from which the original external evidence came." Gibbon (2009: 100) concludes with evaluating the interaction between the appropriate technological application and these two theories as follows:

> "The comparison of Natural Phonology with Optimality Theory indicates that both of these approaches can benefit from increasing the explicitness of notions such as "input" when it comes to incorporating "external evidence" from language acquisition into the purview of the theory, and

> that both these approaches can benefit from each other. The same applies to the benefits to be derived from a fully explicit formalisation of both these theories, and the deployment of these formalisations via operational models in practical applications which benefit language users and their communities."

It can be concluded that these three theories show a similar aim in their search for universal phonological rules to explain the non-random distribution of phonemes in human languages through explaining the conflicting forces of the human factor (markedness constraints) and the communication factor (faithfulness constraints). Moreover, and as it has been explained earlier, these theories differ in their methodological approaches. Both PHB and NP depend on external evidence e.g., principles that are directly associated with fine motor control in other human tasks in PHB and other aspects of human behaviour in NP, as an explanation for the non-random distribution of phonemes in human languages. On the contrary, OT derives the surface structures (optimal outputs) from the deep structures based on a set of formal constraints (universal principles) which have a unique hierarchy in each particular language.

Nonetheless, the three frameworks can be linked together through the overlap in their functional orientations. For example, the phonological processes in NP can be explained according to the main principles of PHB and simultaneously with reference to the conflicting forces of the markedness (human factor) and faithfulness constraints (communication factor) of OT. This overlap between these three theories can be illustrated through some examples, which are quoted from the examples and the principles of PHB as they have been applied for over two decades to analyses of developmental and clinical phonology that appear in (Tobin 2009a: 181-183)[11]. The following are some examples of these principles:

1. Additional articulators are disfavored, e.g. devoicing, nasalization, glottal replacement (human factor/markedness?).
1. Apical articulations are favored in general and in final position (lower communication force) in particular, e.g. fronting, apicalization

11 The examples presented here are part of the nineteen principles that the author explained in his text. (cf. Tobin 2009a)

(human factor/markedness?).

2. Among constrictions, maximal constriction is favored, e.g. stopping (human factor/markedness?).
3. Among apertures, maximal aperture is favored, e.g. vocalization, gliding (human factor/markedness?).
4. The preservation of the stressed syllable bearing the most communication information, if the original structure of the word is reduced by the deletion of syllables (human factor/markedness? + communication factor/faithfulness?).

## 2.9 Summary

Seven different theories and framework approaches in the analysis of the phonological systems have been presented in this chapter. More specifically, this chapter compares and contrasts accounts of seven distinct theories; namely, error analysis, contrastive analysis, distinctive features, GP, NP, PHB and finally OT. As has been shown, these theories provide diverse methodologies to study SLI.

It is the basic explanatory principle in the theory of NP in dealing with sound changes and alternations which motives this choice in the current study. Since phonological processes are natural, they have been found to be capable of explaining and accounting for a wide variety of linguistic aspects such as "linguistic performance, first and second language acquisition, speech pathologies, casual speech, language games and errors, sound change, silent speech and implicational universals" (cf. Dziubalska-Kołaczyk 2004: 9-13). Therefore, the processes in the speech samples of this study, both typical and atypical, will be analyzed according to the explanatory principle of NP, more specifically, according to the tension between the clarity of perception and the ease of articulation (Donegan and Stampe 1979: 130). Moreover, this tension will be explained through analyzing the processes which usually reflect contradictory teleologies; listener-friendly vs. speaker-friendly processes in encoding and decoding the intention of the speech or what is called in the theory of NP as ''the underlying representation of speech''. Donegan and Stampe (1979:163) refer to this principle of naturalness in the phonological representation: "if a given utterance is naturally pronounceable as the result of a certain intention, then that intention is a natural perception of the utterance."

Moreover, PHB has been applied to several other areas of research including: the interfaces between the diachronic combinatory phonology and inflectional & derivational morphology across languages: e.g. Old, Middle and Modern English (Tobin 2006); Old Church Slavonic, Old and Modern Russian (Buk 2003); Biblical and Modern Hebrew (Perelstein 2008); Classical, Modern and Urban Palestinian Arabic (Saif 2004); Hungarian (Salmon 2003); Latin (Cohen 2001); Latin, Spanish and Portuguese (Oron 2003); Ladino (Tubul 2002). PHB has also studied the interfaces between phonology and the lexicon in the Hebrew triconsonantal (CCC) root system (Tobin 2004; Nissan 2007); in a literary text (Podzhrebin 2005; Roe-Portianski 2007), and in the definite article in Yemenite Arabic (Ali & Hameed 2007). Furthermore, the theory of PHB has also been applied to a wide range of other historical, psycholinguistic and sociolinguistic aspects in many languages (e.g. Contini-Morava, Kirsner, & Bachiller-Rodriguez 2004; Davis, Gorup & Stern 2006; Enbe & Tobin 2007; Joue & Collier 2006; Reid, Otheguy & Stern, 2000; Tobin 1993, 2001, 2004). Furthermore, recent studies have also implemented PHB to a computer program based on lip-reading for the hearing impaired (Schocken 2008; Schocken, Geri, Neumann & Tobin, 2008). Finally, the theory of PHB has been compared to and contrasted with other functional, formal and quantitative-oriented phonological theories such as Phonometrics (e.g. Zwirner & Zwirner 1966, 1970 in Tobin 1988c); Prague School phonology (e.g. Tobin 1988a, 1997a-c, 2007d); NP e.g. Donegan and Stampe 1979; Dressler 1996; Dressler et al. 1987; Dziubalska-Kołaczyk 2001, 2002; Dziubalska-Kołaczyk & Weckwerth 2003; Stampe 1972/1979 in Tobin 2007c, 2009; and OT (e.g. Archangeli & Langendoen 1997; Kager 1999; McCarthy 2002, 2003, 2008) in Tobin 2000b, 2009.

For these reasons, NP and PHB have been chosen as the analytical framework of this work. Moreover, a functional explanation of the phonological processes of the SLI speech with reference to the theories of NP and PHB and their principles will be presented in this study. These two theories will be applied to explain the nature of the sound changes in both typical and atypical development of the JA-speaking children and to identify the deviations in the SLI speech from the typical expected patterns in JA.

# CHAPTER 3 Natural phonology, phonology as human behaviour and SLI

## 3.1 Introduction

NP is a new explanatory theory of phonology. The main thesis of this theory is concerned with the phonetic forces of the production and the perception of speech sounds. These implicit forces govern the development of each person's speech articulatory patterns as well as their development and evolution over time. (Stampe 1969, 1973a) refers to these forces as being manifested through mental processes or substitutions that occur systematically, but also subconsciously to adapt the speaker's phonological intentions to his own phonetic capacities, which would enable the listener to perceive the intentions behind those apparent phonetic adaptations.

NP views the phonological system of each language as the residue of a system of universal processes reflecting infant phonetic limitations and explaining the relationship between the phonetic capacities and the limitation of the speaker. “The phonological system of a language is largely the residue of an innate system of phonological processes, revised in certain ways by linguistic experience” (Stampe 1969: vii). During childhood, these processes will develop certain pronunciation patterns that would be considered as interim before the mature adult-like articulation in that particular language would be mastered through the gradual process of constraining the ''non-adult-like'' patterns. Consequently, those residual patterns would be the implicit forces of speech production and perception. This conflict will be solved by means of the natural/functional phonological processes, both of lenitions and fortitions, which will suppress and order these processes.

Donegan and Stampe (1979) argue that the theory of NP differ from the other theories previously discussed in this dissertation NP, PHB and OT: similarities and differences. These models provide methods useful for linguistic empirical analysis, as well as for explaining the learned aspects of the language. Nonetheless, it is not evident that the phonetically motivated sound changes and substitution processes in child's speech are learned. Conversely, it has been observed that these changes are natural responses to the implicit forces of speech production and perception. Donegan and Stampe (1979: 132) state that the innate restrictions of the child's phonetic abilities cause these sound variations to occur, and that it can not be supported empirically that the phonetically motivated alternations and sound changes are governed by rules which are acquired. Moreover, Donegan and Stampe (1979: 131) have the following opinion with reference to these sound changes:

> “The phonetic changes must arise from the failure of children to constrain certain natural substitutions, and that variation in adults, another likely source of change, must result from natural substitutions which the individual has suppressed in certain speech styles but which apply inadvertently in other styles.”

Donegan and Stampe (1979: 127) provide another definition of the phonological processes highlighting the natural explanations of this theory as follows: “a natural reflection of the needs, capacities, and world of its users, rather than a merely conventional institution”. Processes are described as a natural reflection because it is the speakers and their vocal tracts that determine the application of these processes. The concept of "needs" found in this definition refers to the psycholinguistic aspect of speech production; namely, the communicative and expressive needs. Moreover, Donegan and Stampe (1979) indicate that two references can be referred to by the concept of capacities in this definition. Capacities can refer to the speaking capacity; which means that the source of this capacity is the speaker himself as the design of his vocal tract enables him to speak and produce speech sounds. Moreover, this concept can also refer to the capacity for speech, where the source for this capacity depends on providing a context for the speaker, and on his identity and speech style. This means that this capacity will differ depending on whether the speaker is a native speaker, a second language learner, and on whether s/he is developing the language normally or is having certain speech problems. This capacity would also vary according to the speech audience; a speech addressed to a child would be different from that addressed to an adult in the same way that a speech addressed to a foreigner would have a different style than that addressed to another native speaker.

On the other hand, Donegan and Stampe (1979) explain that the sociolinguistic aspect in the phonological processes in the speech production by referring to the concept of *the world of its users;* the speaker in the speech context. This definition means that the speaker is subject to his vocal tract capacities, but the application of the phonological processes does not depend only on phonetics. This definition means that there are both internal and external constraints influencing the application of the phonological processes. Part of these constraints are imposed by the language internal system represented by the sounds inventories and its relevant phonotactics. The other constraints are imposed by the language external factors such as the speaker's age, sex, language style and his group membership (cf. Donegan and Stampe 1979).

## 3.2 Processes versus rules

Stampe (1969, 1973a) draws a strict and a clear distinction between phonology and morphonology. He explained that the natural phonological processes of NP can not be equated with the phonological rules of GP. Generally speaking, generative phonologists usually refer to natural rules, but most of the substitutions they describe are fundamentally different in character and nature from the processes that are described by NP.

Stampe (1973a) and Dziubalska-Kołaczyk (2002:25-27) explain that processes are dynamic, inborn, natural and productive in their nature; they apply to borrowings, puns, slips of the tongue etc. (e.g. *scotch tape* → [$t^h$atS $sk^j$eip]. Moreover, Donegan and Stampe (1979: 144) further explain these differences by stating that processes have synchronic phonetic motivation which limits the speaker's productions. Rules, on the other hand, show the status of conventions, which means that they do not have this phonetic motivation and they lost their phonological productivity and thus became frozen in the grammar. This means that rules must be learned from input and internalized in the language system. They require cognitive efforts to be learned and formulated in the course of observation (e.g. *electric/electricity)*, unlike processes which are innate in nature and apply subconsciously; in fact, the speaker notices them only if they are not present. Processes lack any semantic or grammatical functions which rules have, in certain cases, processes may remove the semantic distinction between words that are phonologically relevant as in (latter/ladder) (cf. Donegan and Stampe 1979: 144, 2009: 9).

The sound change in (*electric/electricity)* further explains another difference in the status of processes and rules: rules are described as prelexical; they apply within words, contributing to the word formation (in *electricity* there is a rule /k/→/s/), but processes are postlexical applying only to an already created words. Processes may apply across word boundaries as well. In other words, rules generally operate in the domain of the morpheme, applying before all processes, thus rules feed processes (cf. Donegan and Stampe 2009: 5-7).

There are other aspects that differentiate morphonological rules from phonological processes. Donegan and Stampe (1979: 144) state that rules usually imply and represent real constraints on correctness rather than on articulation, thus they are often morpheme specific. Rules, besides governing sound alternations, would also tolerate exceptions. Processes, on the other hand, are exeptionless; they operate on the features of the phonemes themselves. Processes govern sound alternations and changes and do represent articulation constraints which would require a special effort on the speaker's part to violate, when it is possible. Donegan and Stampe (2009: 9) explain this difference by referring to the allophonic substitution which causes no morphological differences as follows:

> Because processes may make allophonic substitutions, speakers may be quite unaware of their effects. Rules may be habitual and quite unconscious, but they never govern allophonic substitutions; they are acquired through the observation of linguistic differences, and speakers are usually unconscious of allophonic differences .

Table 6 presents a brief summary of the nature and the motivation for the phonological processes as well as their different ontological status from that of rules.

*Table 6: Processes vs. rules (after Katarzyna Dziubalska-Kołaczyk, p.c.)*

| *Processes* | *Rules* |
|---|---|
| Synchronic phonetic motivation | Semantic, grammatical function |
| Innate | Learned |
| Apply unconsciously | Formed through observation |
| exceptionless | Tolerate exceptions |
| Apply to slips, Pig Latin, foreign words | Do not apply to slips, Pig Latin, foreign words |
| Obligatory or optional | Obligatory (conventional, style-independent) |

The processes as shown in Table 6 and as been explained in (Stampe 1973a: 1) are said to be natural responses to specific innate limitations of the speaker's phonetic capacity, the same limitations which the child faces in his early efforts to use his language. These processes are universal as they are phonetically-motivated and because the speech production and perception apparatus are universal. Since they are mental spontaneous responses to innate difficulties and articulation limitations, processes are described as natural; as they are not acquired cognitively as rules in the GP (cf. Chomsky and Halle 1968) which are acquired by a cognitive manipulation of the observed speech.

Rules are always obligatory and must be observed independently of style, e.g. regardless of the casual/emphatic style of speech the rules of the language must be applied regardless of any phonetic demands. Processes can be obligatory or optional since they are style and context-sensitive. Donegan and Stamp (2009: 10) further state that processes are variable in their application depending on the "speech rate and other real-world circumstances; like fatigue, drunkenness, objects in the mouth, injuries, etc."

Donegan and Stamp (1979: 144) state that processes apply spontaneously, involuntarily and unconsciously when articulation limitations are encountered, and they are brought to consciousness only negatively. A process becomes noticeable to a speaker, thus he is aware of its use only when he meets pronunciations to which it does not apply; in the difficulty encountered in an attempt to repeat and imitate a foreign sound or sound sequence. Rules, on the other hand, are quite habitual, and thus in their application they might become unconscious and involuntary. Rules are described as learned; as they are usually formulated based on the observed alternations or the noticed differences of which the speaker is necessarily conscious. When a speaker finds an exception to a rule, it is possible that he finds it hard to be remembered and memorized, but never hard to be pronounced and articulated.

Finally, not only are processes and rules different in their nature, but they also differ in the order they follow in speech processing. Processes apply after the applications of the language rules, and apply to unintentional slips of the tongue, to Pig Latins, and to foreign words, but rules do not apply to such cases. (cf. Stampe 1973a: 45, Donegan and Stampe 1978a, sec. 2.5, Donegan and Stamp 1979: 144-145 ).

## 3.3 Phonological processes in Natural Phonology

Phonological processes are defined in (Stampe 1973 [1979]:1) as :

> "A mental operation that applies in speech to substitute, for a class of sounds or sound sequences presenting a specific common difficulty to the speech capacity of the individual, an alternative class, identical but lacking the difficult property."

The concept of substitution in the definition above has metaphorically been used, thus it does not only refer to the phonological change involved in the different processes of substitution. This concept of substitution can refer to two processes: first substituting for something as in the case of substituting a difficult sound or a sequence of sounds by an easier one, but also to refer to the process of the substitution of something for nothing; as in the phonological process of deleting the sound which involves an articulatory difficulty. In other words; the concept of substitution as a phonological process refers to two processes; substitution itself in the usual sense as well as to the process of deletion.

The phonological process of substitution, in both of these changes; the substitution and the deletion serves one purpose, i.e. helping to avoid some articulatory difficulty. This underlying purpose of applying a certain substitution can be understood in the process of devoicing which involves substituting voiced stops for example with the voiceless stops. The aerodynamics of articulation of the voiceless stops are considered to be easier than the ones of the voiced stops, which explains the operation of this process in solving this articulation difficulty. Therefore, substitution as referred to in (Stampe 1973, 1979) operates in a way to avoid only the feature that forms a particular articulatory difficulty, while keeping the other features intact. This fact sets NP apart from the generative frameworks which will explain such a change as resulting from and involving two or three processes operating simultaneously. On the contrary to this, in NP a single and only one particular process can cause a phonological change, subsequently for two or three changes in the articulation to happen, two or three phonological processes are needed to explain this relevant change (cf. Donegan and Stampe 1979: 137). It should be pointed out that a single word can have more than one natural phonological process-children's data- both typical and atypical often have two or more processes per word.

Stampe (1973 [1979]: 9) refers to the mental nature of the phonological processes in his following remark: "[a]lthough substitutions are mental in occurrence, they are physical in teleology: their purpose is to maximize the perceptual characteristics of speech and to minimize its articulatory difficulties". In this definition, phonological processes can be described and referred to as the natural reaction to the articulatory difficulties presented by speech perception and production. Additionally, natural processes have also been defined in (Trask 1996: 236) as:

> "Any phonological process which is readily understandable in terms of such factors as the anatomy and physiology of the organs of speech and the acoustic characteristics of speech sounds and which is therefore to be expected in languages. While clearly important, the notion has proved difficult to characterize explicitly."

It is this feature of the phonological processes in being natural reactions to articulatory difficulty which enables them to explain a wide variety of phenomena and variations involved in: "linguistic performance, first and second language acquisition, speech pathologies, casual speech, language games and errors, sound change, silent speech and implicational universals" (Dziubalska-Kołaczyk 2004: 9-13). PHB argues that this is not absolutely true as the rules for all allmorphs in English also reflect ''natural reactions to articulatory difficulty'': e.g. with the plural/genetive/and past tense suffixes and third person singular verb suffixes in English: final voiceless consonant ''governs'' /s/ and /t/ final voiced consonant ''governs'' voiced /z/and /d/: e.g. bookS vs. dogZ, walkT vs. buzzD, sitS vs. callZ.

Donegan – Stampe (1979: 130) state that the tension between clarity and ease of articulation is the motivation of the application of these phonological processes. In other words, it is the tension resulting from the contradictory aims between both the ENCODER and the DECODER which motivates these processes. Therefore, for the speaker to overcome the articulatory difficulty of a sound or a cluster of sounds, he would normally use a particular phonological process which "merges a potential phonological opposition into that member of the opposition which least tries the restrictions of the human speech capacity" (Stampe 1969: vii).

### 3.3.1 Ontology and teleology

The fact that phonological processes apply in relaxed styles of speech and slips of the tongue should not lead to the conclusion that they simply result from articulatory mis-timing or what could be described as the ''mis-shooting'' of the articulators. The sound change involved in the process of anticipatory substitution implies that such a change is a mental one and it takes place in the central nervous system of the speaker. On the one hand, Stampe (1973a) also noted that since these processes apply in silent speech, this excludes the fact that these processes could be only the result of articulation such as mis-timing or inaccuracies.

On the other hand, Donegan and Stampe (1979: 136) noted that despite the mental nature of the substitution processes, these are also processes that respond to physical phonetic limitations and articulatory difficulties. It is in the cases where the basic form would be more difficult to be produced than the derivative form'' the form with the substitution process'' as in the following examples that the authors have originally used: *re*[d,b]*man*, *rai*[n,m]*bow*, *se*[t,p]*back*, etc.

### 3.3.2 Natural application of processes

In NP, and according to its *principle of naturalness,* the phoneme is described as an underlying *intention* which is shared by the encoder and the decoder. Therefore, both the processes and the phonemes are psychologically real, in the sense of sharing both the mental and the physical reality of speech that is shared by all language users. This means that in the application of a particular process, a particular surface variant of a sound from a specific phoneme will be derived, thus and according to NP this phoneme must be the underlying intention of this sound. Thus, the phonological representations are described as being explicable in terms of the phonetically motivated processes, as stated in the *principle of naturalness*:

> "The principle of naturalness allows one to establish a possible phonological representation: if a given utterance is naturally pronounceable as the result of a certain intention, then that intention is a natural perception of the utterance (i.e. a possible phonological representation)" (Donegan and Stampe 1979:163).

The concept of n*aturally pronounceable* forms in NP refers to the forms that are *derivable by means of phonological processes* as Donegan and Stampe (1979:163) explain. As has been mentioned and explained previously, processes apply in all types of the phonological behaviour of language users: in typical language performance, child language, L2 acquisition, all types of language and speech disorders, casual and emphatic speech, slips and errors, language games, as well as in whispered and even silent speech. Therefore, phonological processes explain and account for all these types of language behaviours. By substituting the implying sound by the implied one, processes can be described as accounting for the implicational universals. From this illustration, it is obvious that the task of NP is to search for phonological processes in the world languages[12].

The nature and the teleologies of the phonological processes impact their application in many ways. Donegan and Stampe (1979) state that phonological processes operate on ''natural classes'' of segments. Natural classes must have a natural connection, which would be the phonetic teleology of the phonological

12 In the same way, it can also be argued that RULES can be found in all uses of language: in typical language performance, child language, L2 acquisition, all types of language and speech disorders, casual and emphatic speech, slips and errors, language games, as well as in whispered and even silent speech. And if one can find RULES in all these contexts, then one can also claim, therefore, that phonological RULES also explain and account for all these types of language behaviours. So all of these claims made the difference between NP and GP not to be absolute.

process. They further explain this teleology with reference to the nature of these processes as mental responses to phonetic difficulties and articulatory limitations. Thus, when a particular phonetic context provides a difficult presentation that would undergo a certain substitution, then all other similar contexts and representations with that similar difficulty will undergo the same phonological change. Donegan and Stampe (1979: 137) state:

> "Each natural process, then, applies to a natural class of representations (namely, all representations which share a common articulatory, perceptual, or prosodic difficulty to a common degree), and each process makes substitutions by altering a single phonetic property to remedy the difficulty. Since the substituted sound should, in each case, be as perceptually similar to the original target as possible, it follows that the changes processes make will be minimal: a process normally changes only one feature. This means that apparent two-feature changes take place in two steps; for example, a change in which [ʊ] → [ʌ] is in fact [ʊ] → [ɨ] → [ʌ] or [ʊ] → [ɔ] → [ʌ]."

As opposed to the learned rules, Donegan and Stampe (1979) state that natural processes do not telescope in their application, because they are phonetically motivated, thus it is necessary to have this particular phonetic causality or motivation for a certain natural process to apply. Rules, as lacking this phonetic motivation do telescope and can change one phoneme for another no matter how many features would be included in this change. Unless the RULES themselves also happen to reflect ''ease of articulation'' as in the examples of English allomorphs. Correct phonological rules in Hebrew reflect this in a most obvious way as well.

The phonetic motivation condition of natural processes entails that different motivations will independently cause different natural processes to variably and independently apply, as each process will be an independent response to a different articulation limitation. Adversely, different phonetic contexts with the same motivations will lead to the same single process even when they vary in the level of the difficulty they entail; the same substitution will apply in response to the most difficult context, if it applies to the one providing the least difficulty. Donegan and

Stampe (1979) explain this principle by considering the *implicational hierarchies of applicability,* they note that these implicational conditions are unilateral as the scale of the difficulty itself is unidirectional.

The natural application of the phonological processes does not solely depend on the physical properties of the segments, but rather on the mental categories of these phonological features. Otherwise, these processes would apply despite whatever kind of perceptual or articulatory influence they might entail.

The last condition governing the application of the processes has to deal with the extralinguistic setting and the relevant speech style. According to (Dressler 1972) processes can be optional in their application depending on the extralinguistic setting and the speech style and with variation in their input classes; expansion or contraction according to their implicational conditions and constraints patterns.

### 3.3.3 Constraints on process application

Although natural processes are universal, they do vary in their application between different languages, among individuals or children, over time and in different speech styles and situations. This comparative variation reflects the implicational hierarchies that limit the application of these natural processes.

According to NP, Donegan and Stampe (1979) explained the way that children acquire their native languages, the question which caused mystery for a long time. They stated that the child normally does not have to learn the natural processes by themselves, but he has to learn only the limitations and the application constraints that his own language shows and imposes on these processes. Children have to learn certain constraints on the inputs of the phonological processes as implied by the lexicon of their own languages.

Donegan and Stampe (1979: 140) pointed out that "most phonological alternations and restrictions are motivated by the nature of the learner rather than the language and do not involve the cognitive burden implied by the distributional analyses and evaluation criteria of modern phonological theory." They also provided an example of the natural process of word-final obstruent's devoicing, pointing out that German and Vietnamese children do not have to learn this natural constraint. It is the English speaking child who has to learn how to produce words with voiced final obstruents, which is not very easy, as this articulation needs to obstruct the airflow to obtain the required vibration of the vocal folds. Donegan and Stampe (1979) further explain these various degrees or hierarchies of the applicability of this devoicing and voicing processes depending on several factors, just to mention some variables; the ''palatality'' of the relevant obstruent will provide more difficulty as a result of the required greater duration. It is also not easy for children to voice posterior obstruents as a result of the small ''air-chamber'' between the articulators and the glottis. These examples explain the phonetic basis of the constraints and the hierarchies governing the applicability of the natural processes as illustrated in (Donegan and Stampe 1979).

Donegan and Stampe (2009: 8) further explain the implicational conditions on the application of the phonological processes. They state that these universal processes may be suppressed and limited in their application due to the conditions that might favour or disfavour them in certain contexts. For example, devoicing is more applicable to back obstruents than to front ones. This tendency is phonetically motivated as explained in the articulation difficulties of "maintaining the air flow across the glottis (which is required for glottal vibration) when the oral closure is closer to the glottis". Donegan and Stampe (2009: 8) add that the applicability of the processes also vary according to the level of the speech formality, its rate and the attention that the speaker pays to it. Therefore, lenitions (processes enhancing the ease and simplification of articulation) occur more often in faster speech.

### 3.3.4 Types of the phonological processes

As this work is mainly concerned with the phonological patterns of language acquisition; typical and atypical development, the discussion in this section will only focus and explain the segmental phonological processes.

#### 3.3.4.1 Fortitions vs. lenitions

It has been recognized that language as a system for encoding and decoding information is shaped by two opposing forces. The first force has the teleology of maximizing the intelligibility and the perceptual features of speech and the other force is implied in the tendency towards minimizing the articulatory efforts.

Generally speaking, the need for assuring more intelligibility can be seen and achieved through applying the phonological substitutions by which individual segments are made phonetically optimal. The tendency towards ease and simplification, on the other hand, is achieved through applying the kind of the phonological substitutions by which the articulation of sequences of segments phonetically is to be made optimal (cf. Donegan and Stampe 1979, 2009).

Following the distinction in these two opposing forces, it could be stated that segmental phonological processes can be classified according to their functions, thus and again following the principal division, this classification reflects the old ‘clarity-versus-ease’ dichotomy which is similar to the PHB min-max axiom: maximum communication through minimum effort.

A further distinction among the phonological processes is to be made; thus fortitive processes are to be compared and contrasted with lenitive processes. Donegan and Stampe (2009: 2) state that:

> “Fortitions apply to enhance the divisions of the prosodic score and the clarity of intended sounds, and then lenitions apply to enhance the fluency of the sequence of sounds. Fortitions make sounds more like themselves and less like adjacent sounds; lenitions make sounds more like their adjacent sounds, sometimes to the point of identity.”

Additionally, this distinction between fortitions and lenitions can be compared with the distinctions in Lindblom's (1990) H&H (hypo- and hyper-articulation) theory. This theory explains the adaptive processes in the speech communication. More specifically, Lindblom (1990) illustrates that the speaker would usually adjust his speech production either to the processes of hyper-articulation or hypo-articulation within and between his utterances. In the hyper articulation, the speaker normally provides the listener with maximally distinctive linguistic units, the process which can be compared to fortitions. The speaker would minimize his articulatory efforts in the hypo articulation as in the lenitive processes.

Donegan and Stampe (2009: 3) further add that: “Clarity-motivated processes do not apply to the result of fluency motivated processes “Fortitions first, lenitions last”, in the slogan of Donegan and Stampe 1979.” They further explain that fortitive processes increase the phonetic properties of individual segments with the aim of making them more perceivable through emphasizing specific phonetic features. They are called fortitions or strengthening processes because they increase the degree of stricture of the segment, some of its phonetic property, as well as increasing the contrast between the segment and its environment. Generally speaking, fortitions occur in strong positions, affecting vowels in the syllable peak position and consonants in word-initial "syllable-onset" positions. However, if a decrease in sonorancy is included, then the very common process of a word-final devoicing would logically be described as a fortition as well. This is similar to the results found in the analyses of typical and atypical language acquisition in Israeli-Hebrew speakers in Tobin (e.g. 1997, 2002, 2009) where greater effort was expended to enhance the communication contrast in speech.

Lenitive processes, on the other hand, are more common, they are conditioned processes affecting sounds. Lenitions typically occur in syllable or word-final positions as well as in intervocalic positions. Lenitions usually have the impact of increasing the pronounceability of segment sequences by assimilating the properties of one segment to those of a neighbouring segment, deleting segments, and by substituting segments that are weaker in some respect for those that are stronger. Such processes are weakening in the sense that they decrease the phonetic properties of segments, eliminating the contrast between the segment and its environment. Consequently, the affected sound shows a lessening in the degree of the stricture and an increase in its sonority might be included (cf. Donegan and Stampe 1979, 2009). This, in turn, is similar to the non-random distribution of the phonological processes and errors found in the PHB analyses of typical and atypical language acquisition: phonological errors and processes enhancing communication that require more effort via increased articulatory gestures such as phonemic substitutions, reduplications, etc. appeared in the more communicatively salient contexts such as initial position or stressed syllables while those errors that require fewer articulatory gestures and less effort such as omissions/deletions appeared more in less salient communicative contexts such as unstressed syllables and final position. These similar findings were found in PHB analyses across languages for both genders (with slight differences between males and females) in all age groups.

Within the framework of NP, phonological processes have been studied in connection to their reference to consonants (Goman 1979):

> "Fortitions create phonology. They not only refer to our perception of the speech act, they also account for it. Fortitions regulate what sort of thing can count as a mental representation, or mental intention, concerning speech. Lenitions, on the other hand, lead to phonetics. They regulate our notion about what is a suitable or affordable utterance (Goman 1979: 43)."

The same tendency has been found in PHB studies. The vast majority of phonological processes occur in consonants rather than vowels. PHB holds that consonants are not only more difficult to produce because they involve greater control over the musculature of a larger set and number of articulators than vowels. The also therefore create more distinct and clear-out communicative oppositions.

It has been found and referred to in the literature of NP that phonological processes are classified into lenitions and fortitions based on the functions they serve as well as on the context where they appear. lenitions and fortitions operate on a segmental level, but not on the suprasegmental level as the prosodic processes (Luschützky 2001). Moreover, different labels referring to fortitions and lenitions refer to different aspects of language, thus reflecting different process typology. In referring to the phonetic space, these processes are referred to using the centrifugal/ centripetal terms, but the reference would be to the phonetic gestures when strengthening or weakening terms are used. Additionally, foregrounding or backgrounding terms would address the communicative teleology, and prelexical/postlexical terms address the grammatical functions. Finally these processes will have paradigmatic/syntagmatic functions when referring to their structure and they can also be classified as adaptive/evolutive in the functional typology (cf. Luschützky 2001).

Where NP and PHB may differ is in how they relate these phonological processes to prosody. PHB analyses and applications of prosodic patterns in typical and atypical speech in Buenos Aires Spanish and Israel Hebrew ( Enbe, Claudia and Tobin 2009, Green, Hila and Tobin 2009) show very strong associations and affiliations between the two to the point that one may even define and distinguish certain prosodic patterns in a way similar to phonological processes and errors that differentiate between typical and atypical speakers across languages, gender (with slight differences between males and females) and age groups.

Fortitive processes, which are also referred to as strengthening or centrifugal processes, have and show a listener–friendly function. Fortitions operate in affecting individual sound segments in strong positions, therefore they have a paradigmatic nature (cf. Donegan and Stampe 1979). Fortitive processes like dissimilation, diphthongization, syllabification, and epenthesis affect the individual segment to make it more pronounceable and perceptible. It is for the function of strengthening the clarity of the level of the listener's perception, that fortitive processes will enhance and increase the implied contrast between the adjacent segments for achieving a better and rather a sharper perception. Therefore, fortitions have a perceptual teleology, operating independently of the context, and totally depending on the system inventory. Additionally, fortitions are style-sensitive processes; usually appear in contexts where perceptibility of segments is very important as in the formal/lento/attentive/emphatic speech.

Lenitions (weakening or centripetal processes) have a speaker–friendly function. The teleology of lenitive processes is explained in the articulation change that is involved in these processes to achieve the ease of articulation for the speaker and to decrease the pronounceability burden. Lenitive processes like assimilation, monophthongization, desyllabification, and deletion decrease the articulatory distance between the features of the segment and its adjacent segments. Lenitions are context-sensitive, thus having a syntagmatic nature in operating on sound sequences in a particular context. Lenitions usually apply in weak positions; to consonants in syllable-final positions and to unstressed vowels. Lenitions usually appear in speech styles where clarity of speech is not highly valued as in informal/allegro/intimate/inattentive/rapid speech styles. These situations provide certain demands on the speech itself which explains the need and motivation for the ease of articulation (cf. Donegan and Stampe 1979).

The different speaker (encoder) versus hearer (decoder) ''friendliness'' orientations for these different phonological processes has been found and confirmed in the PHB analyses of typical and atypical speakers as well across languages for both genders (with slight differences between males and females) and all age groups.

In terms of semiotics, Dressler (1985a) also highlights the clarification of the functions of the lenitive/fortitive processes. Accordingly, fortitions are referred to as the *foregrounding processes* as a result of their dissimilatory nature. Lenitions, on the other hand, and a result of their assimilatory nature are termed as the *backgrounding processes* serving the obscuration function. The terms *foregrounding* and *backgrounding* that Dressler (1985a) uses reflect the semiotic figure-and-ground principle which "sharpens the contours of what is to be perceived" (Dressler 1985a: 3).

(Dressler 1985a) describes these processes as prelexical and postlexical, based on their functions with reference to the lexicon. The prelexical processes are fortitive having the function of defining the phoneme inventory and the phonotactics of these phonemes, thus they govern both the segment and sequential structure. The postlexical processes, on the other hand, are lenitive which "derive phonetic output from phonemes" (Dressler 1985a: 30). In addition to this classification, Dressler (1985a) states that "the same process may function both pre- and postlexically" (Dressler 1985: 30). Thus, predicting and suggesting the possibility that lenition/fortition and the post/prelexical characters "will coincide largely within the phonology of any language" (Dressler 1985: 33).

## 3.4 Natural Phonology and functionalism

Balas (2009) explains the functional nature of the theory of NP in two senses; namely, its explanation and application. Firstly, Balas (2009) considers the explanation that this theory provides, such a functional explanation helps in increasing our understanding of the way that language system works. Secondly, Balas (2009) also refers to the practical applications of this theory, especially in the domain of second language acquisition and speech therapy. NP assumes the similarity between the human ability in using a language and the other human cognitive abilities. More specifically, NP explains that the tasks involved in using, speaking and comprehending a language need and imply the same cognitive abilities that humans use in other cognitive activities, like: visual perception, thinking or any other motor control ability. This way of relating language to other domains of human life in this theory emphasizes its functional nature.

Dziubalska-Kołaczyk (2002) in her book *Beats-and-Binding Phonology* refers to the constituents of the functional explanatory model of the theory of NP. This model refers to the communicative and the cognitive functions as the two main functions of language. Accordingly, as a subsection of the communicative function, phonology has two main functions concerned with the perceptibility and the pronunciability of segments. Moreover, the following principles form the main properties of the explanatory model of NP (cf. Dziubalska-Kołaczyk 2002:28-30) and can be characterized as follows:

1. Goal conflict as it is represented in the contradiction between the lenitive processes to minimize the speaker's articulatory efforts and the fortitive processes to facilitate and maximize the listener's perception.
2. Multi/plurifunctionality: meaning that one or several phonological processes might serve one function, and one process might serve many functions at the same time. For example, consonants clusters might be simplified by the application of processes like vowel epenthesis or by consonant deletion. Consonant deletion can facilitate the pronounceability, but vowel epenthesis can serve both functions of having an easier pronounceability and perceptibility simultaneously.
3. A hierarchy of functions, where the communicative and the cognitive functions are the two main functions of language. Then on this hierarchy, there are other subordinate functions; like distinctiveness followed by the language system specific functions.
4. Form follows function as the phonological processes apply to serve and achieve certain functions. The most efficient forms and means will be preferred to by the speaker following the minimax principle to achieve the most affectivity.
5. Dysfunction and functional deficiencies: linking linguistic forms or operations to the functions they serve is all what functional analysis is about. Moreover, inconsistency and incongruity between forms and functions might sometimes

happen.

6. Alternative explanations can be seen as a direct consequence of two factors: the multicausality of actions and the properties of the functional explanation of this theory.
7. The functional explanation of the theory of Natural Phonology and as a consequence of all the previous features can be described as a preference explanation rather than absolute statements. This feature will be further explained in this study.

(Dziubalska-Kołaczyk 2002: 30) summarizes the above features in the following remark:

> "To explain functionality in Natural Phonology thus means that any time one identifies a function of a given form, one must take into consideration the above seven aspects of functional explanation. In other words, one must remember that a function proposed to justify a form may: 1. conflict with another function; 2. be accompanied by another function; 3. be subordinate to another function; 4. not fully determine the form, or, in other words, there may be forms which would serve this function more efficiently; 5. not be compatible with the form at all, i.e., the form could be dysfunctional. Therefore, the proposed explanation 6. may not constitute the only explanation of the form and 7. must have preferential nature, i.e., must allow for a margin of other factors which may influence the form."

Much of the same common functional purpose that lead to the same theoretical and methodological implications hold for PHB as well (cf. Tobin 2002, 2009) in general and regard to the singular and multiple applications of phonological processes. Tobin further explains aspects of this diverse and complex distribution by appealing to situational and linguistic context related to the mini-max principle of achieving maximum communication (through fortitions) with minimal effort (through lenitions).

Additionally, Dziubalska-Kołaczyk (2004) refers to the basic characteristics of the theory of NP as a framework that can be summarized in three points. First, the functional and semiotic nature of the predictions and explanations reflects the multifunctionality of forms across languages. Thus it is possible, to some extent, to predict the form on the basis of its function; simultaneously, certain forms may have more than one function, in the same way, as a particular function may be served by multiple different forms.

Second, Natural Linguistics is a preference theory where the generalizing statements have the status of universal or language-specific preferences, thus, they are not absolute rules. Such preferences are described as scaled as less to more preferred forms replacing other concepts like; admissible and non-admissible forms. The concept of preference *implies a human agent* (Dziubalska-Kołaczyk 2004: 5) which reflects that the speakers have some control over their language use, through their preferred behavioural strategies, which form the functional explanation of this framework. Natural linguistics views the tension between contradictory preferences criteria to achieve the ease of production vs. the clarity of perception as a principle to structure linguistic grammars (as is also found in PHB) as opposed to the principle of distinctiveness in structuralism and the simplicity in GP.

Dziubalska-Kołaczyk (2004) further indicates that the third main characteristic is that Natural Linguistics depends on the external linguistic evidence as a substantive one. Therefore, the speaker's linguistic competence can be analyzed not only by depending on the internal linguistic evidence (grammaticality judgements), but also on the external evidence factors, "such as cognitive abilities and physiological predispositions, in phonological processes." *(*Balas 2009: 44). Furthermore, to provide an explanation in NP, it is not satisfactory to refer to the "internal explanation only, i.e. characterized the formal relationships between phonological entities within a self-contained grammar system. NP stresses that the function of conveying meaning as well as cognitive and physiological factors influence language to such an extent that it is not feasible to describe and explain language without referring to the broadly understood functions it has." *(*Balas 2009: 46). Therefore, the external evidence can be found apparent and present in the performance data, such as e.g., formal and casual speech, speech of young children or speech of L2 learners, slips and speech errors (cf. Dziubalska-Kołaczyk 2004). The theory of PHB shares this reliance on external evidence as well- as implied by the name of the theory which relates (linguistic) phonology to (extra-linguistic) human behaviour.

## 3.5 Natural Linguistics as a preference theory

NP offers predictions providing a set of dynamic, preference-based processes which have been applied to describe many phonological phenomena including first and second language acquisition, aphasia and other speech and sound disorders. The preference-based theories developed by Stampe (1973), Dressler (1997), Vennemann (1983, 1988) and Dziubalska-Kołaczyk (2001, 2002) will be presented in this section. This presentation will examine the use of the concept of *a preference* as has been applied and used in theory of NP. PHB (since Diver 1979) can also be classified as a "preference theory" based on or grounded in a similar theoretical and methodological functional motivation.

### 3.5.1 Stampe (1973)

Preferences in all naturalist theories are described as being based upon language acquisition and language use. In NP, Stampe (1973), before Dressler, first introduced this notion and the principle of preferences as having the form of consequences for a language.

The functional explanatory principle of naturalness predicts that preferences would occur as a result of the contradictory needs between the speaker and the listener in their language usage. Accordingly, the preferences would fulfil either the ease of articulation, or maximize the perception (Stampe 1973). Thus, the speaker would naturally prefer, just to mention some examples, the processes which result in cluster simplicity and similarity of place/manner of articulation. On the contrary to this, the listener would naturally prefer the processes maximizing and facilitating his perception (cf. Stampe 1973).

Thus, this principle can be explained through the application of the articulatory preferences. These processes, as they are governed by the function of achieving the articulatory simplicity, and therefore, tend to realize this goal by means of applying lenitions or speaker-friendly processes, such as assimilations and reductions. Consequently, a cluster of segments will be simplified in order to facilitate its articulation and to minimize the required articulatory efforts. This process of consonant cluster reduction will be particularly noticeable in languages which have consonant clusters.

### 3.5.2 Dressler (1997, 1999a)

The semiotic principle of naturalness uses the concept of "*preference*" to replace the notion of constraints as explicitly presented in (Dressler 1999a). (The theory of PHB from Diver 1969 onwards also uses the terms ''favourings'' as well as ''prefernces''). Dressler (1999a)explains preferences in NP as being deduced from nonlinguistic levels resulting in "a hierarchic, deductive system within which linguistic preferences occupy a general second rank, below higher principles and above the specific linguistic consequences of preferences" (Dressler 1999a:390) as shown in Table 7 (as cited in Dziubalska-Kołaczyk 2002: 76) and with reference to the universals-to-performance quintuple Figure 1 which will be explained in the next section. Therefore, NP depends on "deductive inferences about grammars based on universal higher-order principles applicable to language as well as to other natural phenomena" (Dziubalska-Kołaczyk 2001: 77).

Table 7: The explanatory system of natural linguistics.

| | |
|---|---|
| **Higher principles**<br>(e.g., the principle of the least effort of cognitive economy) | *Non-linguistic*<br>*(cognitive, phonetic, psychological, sociological, etc.)* |
| **Preferences**<br>(e.g., a preference for a simple phonotactics, for a CV structure) | *Linguistic* |
| **Preference parameters**<br>(pronounceability, perceptibility) | *Functional and semiotic* |
| **Consequences of preferences**<br>(absence of clusters in a language) | *Linguistic* |

Dziubalska-Kołaczyk (2002) explains the language universals by placing them in a deductive hierarchy and by referring to the properties implied by the phonological processes which can vary in their naturalness level and their implicational applicability; some apply in all languages, others are to be suppressed. The language type consists of a selection from these language universals, both of which would be filtered to suit the language specific system. The final performance will be specified according to the sociolinguistic and the psycholinguistic norms of usage.

According to (Dressler 1999b) the concept of preferences can be compared to the concept of markedness; the more preferred the form is, means that the less marked it is. Preferences also imply both the criteria and the choice of principles to order these criteria. Preferences are governed by parameters; they could be "transitive, asymmetric and irreflexive." If a conflict between preferences occurs, then "agents strive towards maximal benefits or expected utility" (Dressler 1999a: 391-392). This means that the preference would be towards what is more natural, "cognitively simple, easily accessible (especially to children), elementary and therefore universally preferred, i.e., derivable from human nature, or unmarked/less marked" (Dressler 1999b: 135).

This conflict between preferences is conditioned by the preference parameters; as the preference might be an explicit direct reflection of the universal principles or a language-specific feature or a language type adequate. According to NP, preferences are basically governed by the extralinguistic factors; "preferences in the use and acquisition of language become frozen in preferences of language structure" (Dressler 1999a: 394). Therefore, Dressler emphasizes that it is the external evidence that is basically more significant to validate the universal preferences.

### 3.5.3 Vennemann (1983, 1988)

Vennemann's linguistic theory of preferences criticizes general descriptive linguistic theories and supports external evidence as found in NP theoretical principles. Vennemann states that the linguistic preferences in NP are explanatory because they are based on other non-linguistic, external evidence. These views are stated explicitly in the following, Vennemann (1983: 9-10):

> "A general linguistic theory [of the sort making universal qualifications] is by its very nature incapable of telling us what is usual and what is rare in the languages of the world; it can only tell us what is possible and what is impossible. (...) We can arrive at explanations for the regularities within a certain domain by turning to theories that are not theories for that

particular domain (e.g., for grammatical theories, these include: theories of phonetic production, perception, learning, memory, communication, action, semiotic theories etc.)"

As it is clear from this quotation, Vennemann (1983) states that strong explanations of preferences can only be derived from non-linguistic theories, while linguistic theories usually provide weak explanations in scaling the preferences according to a particular parameter. Vennemann (1983) also elaborates on the concept of the graded preference, meaning that when structures are described as less preferred in a language system, this means that they have a more tendency to change to improve and become more preferred.

### 3.5.4 Dziubalska-Kołaczyk (2002)

In *Beats-and-Binding Phonology,* Dziubalska-Kołaczyk (2002) develops another explanatory model to preference-based theories. Dziubalska-Kołaczyk (2002, 2004: 5) states that a preference " implies a human agent", thus it reflects the speaker's strategies. In this theory, Dziubalska-Kołaczyk (2002) has developed a model for phonotactics, where the constraints on the phonotactics in consonant clusters are a case and a reflection of the universal preferences. As Maddieson (1984) states that 70 per cent of the world's languages do not have consonant clusters, thus having the CV syllable structure as the universally most preferred syllable shape. Those languages with a CV syllable structure are organized in phonotactic terms, following and representing phonotactic preferences constraints on clusters. These language systems specify the hierarchy of clusters, in which there are three levels of preferences. One level represents which clusters are the preferred and the possible ones. The other level illustrates which clusters are dysfunctional in a position although they are preferred and possible clusters. And finally defining the impossible clusters. The theory of PHB was first introduced in Diver (1969) based on an explanation of the favourings and disfavouring of certain classes of initial consonant clusters in English which was later expanded to over 45 languages for different language families by Tobin (2002, 2007).

According to the Beats-and-Binding Phonology, Dziubalska-Kołaczyk (2002) explains two functions of the phonotactic preferences in counteracting the CV preference and the dysfunctional consonantal clusters. She considers the Optimal Sonority Distance Principle (henceforth OSDP) as a determining basis of the phonotactic preferences. The most preferred clusters according to OSDP would be those having the greatest difference in the values of the sonority distance "*sondis*". In Beats-and-Binding Phonology, and according to OSDP, the clusters that are preferred in a particular given position in a word will not have the same status "preferred" in other positions.

In Beats-and-Binding Phonology, Dziubalska-Kołaczyk (2002) develops a new matrix; the universal cluster space, against which language-specific phonotactics can be compared. Dziubalska-Kołaczyk (2002) also illustrates and adds that other preferences like the ones chosen to form and maintain articulatory easy phonological sequences might override the universal phonotactic preferences to a certain extent.

## 3.6 The universals-to-performance quintuple

The universals-to-performance quintuple diagram (Figure 1) as (cited in Dziubalska-Kołaczyk 2002:31) refers to five sub-theories of naturalness as (Dziubalska-Kołaczyk 2002:31-32) explained below:

> "(I) the theory of universals (which can also be understood as the theory of markedness), (II) the theory of type adequacy and (III) the theory of language-specific system adequacy, which decide the outcome in performance. Still, more factors contribute to the final shape of performance; these are (IV) normative, i.e., sociolinguistic factors and (V) psycholinguistic factors, i.e., the ones directly connected with language use."

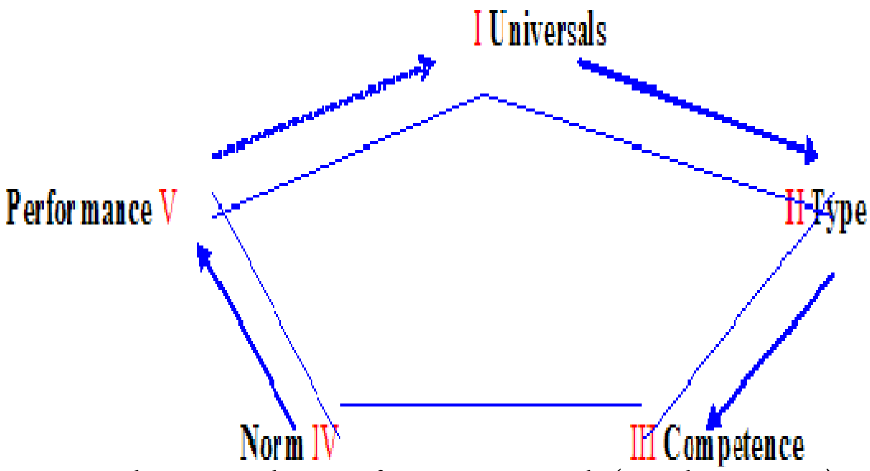


*Figure 1: The universals-to-performance quintuple (Dressler 1985: 292).*

(Dziubalska-Kołaczyk 2002) further explains the indirect way in which the universal properties are realized and modified in performance in this quintuple diagram (originally established by Hjelmslev and Coseriu, and adapted by Dressler, cf. Dressler 1985: 292). This representative quintuple consists of five main elements that must be considered to explain the performance: (1) universals, (2) type, (3) language-specific competence, (4) sociolinguistic norms and (5) the linguistic performance. (Dziubalska-Kołaczyk 2002) states that each of these elements functions and provides the basis for the next element and will be filtered by the next element at the same time.

In this study, the phonological speech impairment in JA will be characterized with reference to this preference theoretical view of NP. Therefore, examples will be provided to explain the phonological processes in the recorded data within this quintuple. The interaction between the universal properties and the Arabic-Language specific rules and its realization in performance of SLI children in JA will be described and explained in the following chapters.

### 3.6.1 The universality of natural processes

The universal features and the nature of the phonological processes in form and motivation do not mean that they apply universally. (Donegan 2002: 64) states that:

> The universality of processes does not mean that they apply in all languages–only that they are motivated in all speakers.

The universality of the phonological processes manifests itself in each language differently, as each language selects certain particular processes which constitute its language-specific NP. Therefore, it may be noted that some processes apply in certain language systems, while some difficulties could remain. Moreover, other language specific types and features have to be learned and mastered by native speakers (cf. Donegan 2002).

Phonological processes specify what the language users; the speaker can do, but not what must be done. To explain the universality of processes, (Donegan 2002) illustrates the applicability of the process of obstruent devoicing cross-linguistically. Although it is a universal process, it does not apply in all languages. But this fact does not mean that it loses its universal motivation. The devoicing of a word final obstruent applies, for example in Polish and German, but not always in English. Thus an English-speaking person needs to learn how to maintain the voicing during the closure or obstruction phase in the articulation of the voiced sound in order to produce a word final voiced obstruent.

## 3.7 NP: Application of theory

The functional nature of this theory and has been explained in the earlier sections is evident in the explanations it offers and its application to study and analyze areas where human factors are involved. This application justifies and proves the external evidence that could be found in other domains of human cognitive activities; language perception and production, as well as human abilities of memorizing and learning.

The application of NP to areas like first and second language acquisition and speech therapy implies explaining the processes of conveying meaning, as well as explaining the cognitive and physiological factors which are very important factors in this application (cf. Balas 2009). NP has been put into practice and applied in many studies, but in this work only relevant cases to the current analysis will be referred to. Thus, examples of the successful application of the principles of NP in the domain of developmental and clinical phonology will be presented in this section. The following two studies explain how naturalness has been integrated into phonology to analyze pathological aspects of second language acquisition and speech therapy.

Połczyńska-Fiszer (2007) examined in her study both first and second language dysarthria in a group of patients having traumatic brain injury (henceforth TBI) after prolonged coma. As a basis for this examination Połczyńska-Fiszer used the articulatory processes as they normally occur in child speech during his first language acquisition. These processes have been proposed by NP and further applied and explained by the theory of PHB(cf. Tobin 1997). Furthermore, this study provides a taxonomy of the characterizing processes to diagnose TBI patients with dysarthria.

Połczyńska-Fiszer (2007) found in this study that the speech patterns of the TBI patients involved more regular phonological processes and more phonetic motivation in comparison to the frequent typical patterns in first language acquisition. The analysis also showed that the speech of TBI patients showed several lenitive processes, this characteristic is very important as this performance was not previously described in the relevant literature on dysarthria patients. Incomplete consonant closure and consonant approximation were among these particular characterizing lenitions. Therefore, this analysis may be used in the diagnosis of dysarthria, and by specifying the specific weakened articulators, the injured brain nerves can be identified for further therapy. Połczyńska-Fiszer (2007) study was among the first to relay both on the phonological processes introduced by NP and then further elaborated upon and explained via the theory of PHB by Tobin (1997).

## 3.8 Combining NP and PHB in natural phonological processes

Tobin (1997, 2009a) explained many of the natural functional processes that have been applied to the domain of developmental and clinical phonology (cf. Stampe

1972/1979; Grunwell 1972; Ingram 1989; and Tobin 1997). Tobin (2009a) illustrated and provided an explanation for these processes according to the principles of Phonology as Human Behavior and also offered Israeli Hebrew examples from a corpus of a large number of speakers that have been recorded at the speech and hearing clinic. In this account, Tobin provided the chronology; referring to the age range when these phonological processes will normally occur in child speech.

The following is a summary of the taxonomy of the phonological processes as illustrated by Tobin (2009: 177-181):

• Functional processes influencing syllable structure:

1. Final consonant deletion: CVC ➔ CV (chronology: 2:0 ➔ 3:2)
2. Deletion of unstressed syllables (chronology: 2:0 ➔ 4:0)
3. Consonant cluster reduction: CC ➔ C (chronology: 2:0 ➔ 3:6-8)
4. Reduplication (chronology: 2:0 ➔ 2.5)
5. Epenthesis: addition of segments (usually an unstressed vowel)

• Assimilation processes (consonant/consonant–vowel harmony)

1. Velar or nasal or labial, etc. assimilation (chronology: 2:0 ➔ 2:8)
2. Prevocalic voicing of consonants (chronology: 2:0 ➔ 3:5)
3. Devoicing of final consonants (chronology: 2:0 ➔ 3:1)

• Substitution processes:

1.Processes reflecting the substitution of active articulators:

1. Fronting (chronology: 2:0 ➔ 3:5)
2. Backing

1.Processes reflecting the substitution of turbulence and/or airflow:

1. Stopping: variable chronology depending on sounds and language (chronology 2:0 ➔ 5:0+)
2. Gliding of liquids: (variable chronology 2:0 ➔ 5:0+)
3. Glottal replacement

These processes and their explanation in PHB will be used and referred to in later sections of this work for the purpose of explaining the phonological patterns in the SLI speech in JA within the universals-to-performance quintuple in Figure 1 (cf. Dressler 1985: 292) cited in (Dziubalska-Kołaczyk 2002:31).

## 3.9 Phonology as Human Behaviour: applying theory to clinic

### 3.9.1 Introduction: Diver (1979, 1995) and PHB

The theory of Phonology as Human Behavior PHB is viewed as part of the historical development of the twentieth-century structural, functional and cognitive linguistics. The theoretical background in PHB was developed by William Diver (1979) in his analysis of the non-random distributional patterns of initial consonant clusters in English. Then, the same analysis was extended to explain the non-random combinational patterns of vowels and consonants in English (Diver 1993) and in language in general (Diver 1995). Therefore, William Diver (1975: 13) states that:

> Phonology, then, is for us an attempt to understand the non-random distribution within the signal, and grammar is the attempt to understand the non-random distribution of the signals themselves.

Following Diver's work, PHB has been applied and used as an analytical framework to explain the combinational patterns of consonants and vowels in many other languages such as Italian (Davis 1984/1987), Hebrew (Tobin 1990b, c), and Spanish (Flores 1997). More specifically, the theory of PHB has also been used to study and explain the non-random distribution of initial consonantal clusters in almost forty-five different languages from different language families as well as artificial languages like Esperanto and Klingon. In addition, Tobin (2000a) applied PHB to study various areas of developmental and clinical phonology and prosody (cf. Moore 1991a, b, 1993; Moore & Korpijaakko-Huuhka 1996; Moore and Rosenberg-Wolf 1998; Tobin 1995, 1997a, b, 1999, 2000b). Moreover, Tobin has compared and contrasted PHB to other functional and what is described as quantitative-oriented phonological theories (cf. Tobin 1988c, 2000b).

Diver (1979) argued that a more complete theory of phonology must consider both the communication and the human factor. Following the principle of minimal effort that was suggested by André Martinet (1955), Diver (1979) also explained that there is always a constant struggle between both the human and the communication factors. This implies that humans need the maximum communication and perception to be simultaneously achieved through the least amount of efforts for that production. Diver (1995: 61) further explains this phonological hypothesis of considering the roles of both the human and the communication factor as follows:

> "The observations, the sound waves, are produced by people. The problem is to discover what motivates people to produce particular sound waves on a particular occasion. The purpose of the hypotheses is to reveal motivation by demonstrating the relation of the observations to the orientations, for the orientations represent the controlling circumstances of the entire procedure. The way this works out, in analytic practice, is that the essential motivation is communication, and that the details of how communication is effected (sic) are controlled by considerations of the available human physiology, by principles of acoustics, and by normal characteristics of human behaviour; that is, by the other orientations."

Diver extends his views with regard to the phonological hypothesis in considering the interactional nature and the contradiction between the communication and the human factor. Therefore, Diver (1995) suggests a possible order of first language phonological development as follows:

1. The first stage is represented by the single-cavity /a/ being produced to furnish an undifferentiated resonance for the excitation of the vocal folds.
2. With the involvement of other articulators; namely, the dorsum and the lips, the two-cavity system will develop. Therefore, the articulation system will include three maximally differentiated vowels; /i/ and /u/ being added to /a/.
3. Starting to use the apex of the tongue in a fairly undemanding way provides another articulatory shape to the oral cavity. Therefore, and without using the dorsum and lips, the phoneme /l/ is introduced. This articulation requires the vocal folds to be excited.

4. The last developmental stage is mainly characterized by developing a fine motor control over the apex of the tongue. This control helps to excite and shape the cavity, in the maximally differentiated positions of /t/ and /s/. (cf. Tobin 2002).

Diver (1995) also explains the phonotactic restrictions governing the distributional patterns of the consonants and the vowels in a syllable, morpheme or word with reference to his views on the interaction between the human and the communication factors. Diver (1995: 69) illustrates that in terms of the precision of control and its influence on the phonotactic preferences of sounds in these larger units of communication:

> "In terms of precision of control, it is evident that the more phonological units are combined in the formation of a single morpheme, the more control is required, in terms of the number of individual members to be produced and in terms of the coordination of the sequencing."

Diver (1995) illustrates that preferring a particular morpheme in the text, specifies the characteristics and the features of the sound waves. Thus, this process reflects how the human factor (motivation) affects the combinations of sound waves. This also shows the interplay between the precision of control and sound preferences, therefore, proving the interaction between the human and the communication factors.

In his analysis of the non-random distributional patterns of consonants and vowels, Diver (1979, 1993, 1995) focuses on the phonotactics in explaining the interaction between the human and the communication factor in different morpheme/word positions. He showed that cross-linguistically, there are more consonants than vowels, although they are found to be more difficult to be produced than vowels. He explained this fact by referring to the communication factor; stating that consonants in general provide clearer communicative distinctions than vowels, thus they are more important for the perception purposes.

Furthermore, Diver (1979, 1993, 1995) illustrates the phonotactics stating that a morpheme/word-initial position is the position which carries the highest communicative force. It is in this position where there is a random distribution of consonant phonemes with varied degrees of articulatory difficulty. In this particular position, phonemes with visual places of articulation will be favoured (labial, labio-dental, or apical-dental) as they will be easily perceived both visually and aurally.

Regarding the phonotactics in a syllable- and word-final position, Diver (1979, 1993, 1995) also states that the communicative force in this position is the lowest. This fact explains the clear preference and the tendency to have phonemes that require the least amount of the articulatory efforts at this position. This means that the interaction between both the communication and human factors will be solved in favour of the phonemes that are easy to be produced like the apical phonemes and the voiceless phonemes produced through the activation of only one set of oral articulators.

### 3.9.2 Theoretical and methodological conclusions within PHB

#### 3.9.2.1 Parameters and principles: Tobin (2002)

Tobin (2002: 213-214) concluded the following phonological and the phonotactic parameters from the theory of PHB opposing the traditional categories (adapted from Diver 1979, Davis 1984/1987, Tobin 1990b, c, 1995, 1997a, and b):

1. Identifying the active articulators and the relative difficulty of controlling them. Tobin (2002) uses this concept to replace the traditional term referring to the place of articulation which always implies the passive articulators.
2. The relative degrees of stricture, aperture and the turbulent vs. non-turbulent airflow have been identified. Therefore, they replace the traditional category of manner of articulation. These articulations require different articulatory control; mobile and stable as Tobin (2002: 213) names them. Finally leading to different acoustic patterns in the production of individual sounds as well as different phonation processes like: labialization, apicalization, velarization, nasalization, and glottalization.
3. Tobin (2002: 213) describes the number of sets of articulators that need to be controlled in order to produce different acoustic patterns. This identification replaces the traditional concepts referring to voicing, fortis-lenis distinction and nasality.

4. In this theory, consonants and vowels have been referred to as phonemes of constriction and aperture respectively (cf. Tobin 2002: 213). This theory also explains the articulatory control to produce these different acoustic patterns.

These parameters of the theory of PHB are particularly important and relevant to the analysis of the results in this dissertation. They will be referred to to explain the phonological processes in the SLI speech and their relevance to language universals and Arabic-specific rules.

### 3.9.3 Quantitative results derived PHB: Tobin (2002)

Tobin (2002: 213-214) refers to the following quantitative principles as have been derived from the developmental/clinical application of the theory of PHB and as adapted from (Diver 1979, Davis 1984/1987, Tobin 1990b, c, 1995, 1997a, b). These results explain the interaction between the human and the communication factors in the theory of PHB. These result are considered in this theory to explain the functional processes in the clinical domain:

1. Disfavouring the additional articulators.
2. Disfavouring the coarticulation by near articulators. Tobin (2002: 213) states that the coarticulation using the same articulators or the same phoneme is even more disfavoured, especially as has been shown in the roots of the Semitic languages (cf. Tobin 1990b, c).
3. Different word positions hold different communicative force which will influence the favouring or disfavouring of different articulatory and acoustic features. Therefore, the production of certain phonemes would be preferred in certain position:
4. Apical articulations are generally preferred and in particular in syllable/word-final position.
5. It has been found through observations that visual articulations are particularly preferred in word/root initial position.
6. Explosive (mobile/stop) phonemes are normally preferred in initial position. While, turbulent (stable/fricative) phonemes will be preferred in final position.

7. Disfavouring the transitions within a single phoneme from one distinct constriction to another.
8. Different articulatory and acoustic features (e.g., mobility/stability) lead to restrict the consonant clusters.
9. Among constrictions, principles of PHB favour the maximal constriction, while the maximum aperture is preferred among apertures.
10. Disfavouring sequences of phonemes requiring the same articulators during their production unless their juxtaposition proves to be mutually beneficial due to other factors (cf. Tobin 2002: 214).
11. Substitution processes involve the preservation of many distinctive features (usually 2 out of 3) as well as the preservation of as many communicative distinctions as possible in the original word (e.g., keeping the same number of phonemes per word). Therefore, these processes require more articulatory efforts than deletion processes.
12. Substitution processes require more effort than deletion processes even when the speaker substitutes a readily available phoneme already found in his repertoire that suits the immediate phonetic environment where it applies.
13. The original phonetic structure of the word in applying deletion processes can be reserved if deletion does not involve syllable reduction and through reduplication as well.
14. In reducing the original structure of the word through deletion of syllables, the stressed syllable is usually maintained as it holds the most communicative force.
15. Enlarging the original structure of the word by epenthesis will simplify the transition between more difficult sounds.

From the above explanation, it becomes obvious that PHB sees no pure synchronic phonology, rather it supports the dynamic interaction between the communication and the human factors and its consequences on motivating a constant control over language change. Therefore, Tobin (2002: 215) concludes with the following major remark in connection to the synchronic and diachronic phonological analyses:

> Conclusion #1: Language in general -- and phonology in particular -- can be seen as a synergetic mini-max struggle: the desire to create maximum communication with minimal effort (cf. Tobin 1990a: ch. 3).

Applying the theory of PHB to analyzing the articulatory errors and the phonological processes found in the developmental and the pathological clinical phonology leads to modify the conclusion #1 (cf. Tobin 2002: 215). This modification results from the fact that the human factor in the atypical phonologies often override the communication factor, and the clinical intervention therapy tries to balance the two factors again:

> "Conclusion #2: Developmental and clinical speech processes and errors may be viewed as an extreme version of this synergetic mini-max struggle: there is less than maximum communication because of either extreme minimal effort or a lack of control over the articulatory tract or mechanisms. Greater effort will be exerted in order to achieve more efficient or better communication through clinical intervention" (cf. Tobin 1995, 1997a, b, 1999, 2002: 215).

These quantitative results that are derived from PHB theory will be applied directly to explain the phonological processes that characterize the SLI in JA. PHB's principles concerning the dynamic interaction between the communication and the human factors and its consequences on the linguistic performances of this SLI speech sample will be used to describe the distinguishing differences between AMN and SLI children in this study.

## 3.10 Summary

The theory of PHB which to a certain extent further extends and explains the phonological processes of NP will be used as a framework for analyzing the phonological processes found in the typical developmental and the atypical phonology of the Arabic-speaking children in this study. Reference will be made to the principles and conclusions of PHB. Therefore, the principle of the mini-max struggle in achieving maximum communication through minimum articulatory effort will be referred to in analyzing the phonotactic distribution of phonemes in both the typical and atypical phonological development in JA.

Therefore, the articulation errors and the phonological processes in both the developmental and the clinical settings in the data in this dissertation will be explained according to the interaction principles between the human and the communication factors. This analysis will indicate if the interaction between the maximum communication with the lack of the articulatory control in this speech SLI would represent the modified version of the mini-max struggle (cf. Tobin 2002).

# CHAPTER 4 Modern Standard Arabic and JA

## 4.1 Arabic phonology: Introduction

Arabic is a Semitic language spoken by more than 250 million native speakers, according to Ethnologue, 350 million including second language speakers (2005 est). Modern Standard Arabic (MSA henceforth) is the largest living Semitic language with 27 sub-languages. Today, MSA is commonly used in all Arab speaking countries in science, learning, literature, press and in the mass media. MSA is not the language of everyday speech where people in different Arab countries speak different dialects of Arabic. There are differences in the phonology, morphology and syntax between these dialects, thus the verbal communication between these dialects can be difficult. Consequently, an adequate competence in MSA is necessary to ensure the understanding between speakers of different Arabic dialects.

## 4.2 The phonetic inventory

The phonetic inventory of MSA and the dialect being spoken in Jordan, which has been referred to in this dissertation as JA (JA), is represented in Table 8 as cited in Amayreh & Dyson (1998: 653). MSA includes 29 consonants including nine stops, twelve fricatives, two affricates, two nasals, two liquids and two glides (cf. Al-Ani 1970: 23-25).

*Table 8: Standard Arabic consonants, and common dialectical variants.*[13]

| *Manner of Articulation* | *Place of Articulation* | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Bilabial* | | *Labiodental* | | *Dental* | | *alveolar-dental* | | *Palatal* | | *Velar* | | *Uvular* | | *Pharyngeal* | | *Glottal* | |
| | *V* | *VL* | *V* | *VL* | *V* | *VL* | *V* | *VL* | *V* | *VL* | *V* | *VL* | *V* | *VL* | *V* | *VL* | *V* | *VL* |
| *Stop* | b | | | | | | d | t | | | (g) | k | | q | | | | ʔ |
| | | | | | | | dˤ | tˤ | | | | | | | | | | |
| *Fricative* | | | | f | ð | θ | z | s | (ʒ) | ʃ | | | ʁ | χ | ʕ | ħ | | h |
| | | | | | ðˤ | | | sˤ | | | | | | | | | | |
| *Affricate* | | | | | | | | | dʒ | (ʧ) | | | | | | | | |
| *Nasal* | m | | | | | | n | | | | | | | | | | | |
| *Liquid* | | | | | | | | | | | | | | | | | | |
| Lateral | | | | | | | l | | | | | | | | | | | |
| Tap/Trill | | | | | | | r | | | | | | | | | | | |
| *Glide* | w | | | | | | | | j | | | | | | | | | |

The dialect of the MSA as used in Jordan will be included as this dialect is the major concern of this study. This dialect has additional consonants, these are the consonants between parenthesis () in Table 8. This is the kind of Arabic that children in our case will acquire as a mother tongue. Moreover, Amayreh and Dyson (1998) have also included the dialectal variants in their study of the phonetic inventories of young Arabic-speaking children. JA in Table 8 has one more stop consonant, two more fricatives, and one more affricate in comparison with the phonetic inventory of MSA. In MSA, there are four emphatic, or pharyngealized consonants; sounds produced with a secondary articulation with the root of the tongue is retracted toward the back wall of the pharynx. These emphatics include: [dˤ], [tˤ], [sˤ], [ðˤ], (cf. Shahin 1996 cited in Amayreh and Dyson 1998; Al-Ani 1970).

13 Consonants between parenthesis () are common dialectical variants used in Jordan.

*Table 9: Arabic long and short vowels.*

| | *Short* | *Long* |
|---|---|---|
| *Hight front unrounded* | i | i: |
| *High back rounded* | u | u: |
| *Low central unrounded* | a | a: |

The phonetic inventory of both MSA and JA has three long vowels (/a:/, /i:/, /u:/) and their short cognates (/a/, /i/, /u/) (Table 9) as explained in (Al-Ani 1970).

## 4.3 Syllable and stress patterns

Both MSA and JA have five possible syllable shapes: CV, CVC, CVV, CVVC, and CVCC. The first four shapes can occur in all syllable positions, while on the contrary, the fifth shape occurs only word-finally or in isolation. Epenthesis is applied sometimes in casual speech to simplify the CVCC syllable shape to be pronounced as CVCVC (e.g., /χubz/ bread→/χubiz/). In other cases, deletion of the short vowel will create a CCV(C) shape instead of CVCVC (e.g., /dʒiba:l/ mountains→/dʒba:l/). Consonant clusters of two elements usually occur only medially and finally, but never word-initially (cf. AL-Ani 1970). Every word in Arabic has an *inherently-stressable syllable*, which receives the primary stress. The location of this stressed syllable varies according to the number and the types of syllables in the word. AL-Ani (1970: 88) explains in his book ''Arabic Phonology'' the rules governing the lexical item stress as follows:

1. When a word is made up of a string of the CV type syllables, the first syllable receives the primary stress and the remaining syllables receive weak stresses:

| | | |
|---|---|---|
| kátaba | ˈCV-CV-CV | 'he wrote' |
| dárasa | ˈCV-CV-CV | 'he studied' |

2. When a word contains only one long syllable, the long syllable receives the primary stress and the rest of the syllables go unmarked receiving weak stresses:

| | | |
|---|---|---|
| káatib | ˈCVV-CVC | 'writer' |
| muʕállimahu | CV-ˈCVC-CV-CV- | 'his |

| | | |
|---|---|---|
| | CV | teacher' |

3. When a word contains two long syllables or more, the long syllable nearest to the end of the word (the very last syllable does not count) receives the primary stress and, in most cases, the one closest to the beginning receives the secondary stress:

| | | |
|---|---|---|
| raʔiìsuhnna | CV-CVV-CV-CVC-CV | 'their chief'(fem. pl.) |
| mustáwdaʕáatuhum | CVC-ˌCVC-CV-ˈCVV-CV-CVC | 'their deposits'(masc. pl.) |

## 4.4 The acquisition of Arabic consonants

According to Amayreh & Dyson (1998) in their study "The acquisition of Arabic consonants" as spoken in Jordan, some interesting findings have been found. These findings in (Amayreh & Dyson 1998) highlight the differences in the acquisition of the standard consonant sounds and their acceptable forms as acquired (75% correct in all positions tested) in each period: early, intermediate, and late. These differences are shown in Table 10 as cited in (Amayreh & Dyson 1998: 647).

*Table 10: Comparison between the standard and acceptable sounds.*

| *Sounds* | *Early (2:0-3:10)* | *Intermediate (4:0-6:4)* | *Late (After 6:4)* |
|---|---|---|---|
| Stops | | | |
| Standard | /b/, /t/, /d/, /k/ | | |
| Acceptable | /b/, /t/, /d/, /k/, /q/,/ʔ/ | | |
| | | Fricatives &Affricates | |
| Standard | /f/, /ħ/ | /s/, /ʃ/, /χ/, /γ/, /h/ | /θ/, /ð/, /ð/, /z/, /s/, /dʒ/, /ʕ/ |
| Acceptable | /f/, /h/ | /θ/, /s/, /s/, /ʃ/, /χ/, /γ/, /h/, /χ/, /ð/, /dʒ/ | /ð/, /z/, /ʕ/ |
| | | Sonorants | |
| Standard | /m/, /n/, /l/, /w/ | /r/ | |
| Acceptable | /m/, /n/, /l/, /w/, /j/ | /r/, /j/ | |

Amayreh & Dyson (1998) noticed that the acquisition of consonants in MSA will develop gradually, as shown in Table 10; thus they refer to three main acquisition developmental periods: early, intermediate and late. The following consonants /b/, /t/, /d/, /k/, /f/, /ħ/, /m/, /n/, /l/, and /w/ have been observed to be acquired in the early developmental stage. Therefore, four non-emphatic stops, two non-emphatic fricatives, both nasals, the lateral liquid and the lateral glide are to be acquired normally in the age group (< 2:0 to 3:10). Amayreh & Dyson (1998) pointed out that the following consonants; five non-emphatic fricatives, the /r/ tapped and trilled and the palatal glide were found to be intermediately acquired (around 4:0 to 6:4): /s/, /ʃ/, /χ/, /γ/, /h/, /r/, and /j/. Amayreh & Dyson (1998) also found that the following consonants; all the emphatic consonants, the interdental fricatives, two voiced fricatives /z/ and /ʕ/ and the palatal affricate /dʒ/ are usually acquired lately in the age group (> 6:4): /t/, /d/, /q/, /ʔ/, /θ/, /ð/, /ð/, /z/, /s/, /ʕ/, and /dʒ/.

The above findings clearly indicate that Arab children acquire the emphatic consonants later than their non-emphatic cognates. Amayreh & Dyson (1998) found that the acceptable variants of the Arabic consonants were generally acquired in the typical development, before their equivalent standard consonants. Moreover, in their study on the acquisition of Arabic consonants, Amayreh & Dyson (1998) observed that Arab children will produce the medial consonants more accurately than both initial and medial consonants, with no differences in the accuracy of acquisition between initial and final consonants. Amayreh & Dyson (1998) found no significant differences in the accuracy of the acquisition with regard to gender differences at any age level; thus both male and female children display the same accuracy in the acquisition of the Arabic sounds during the different developmental stages.

Amayreh & Dyson (1998: 648) compared the acquisition ages (acquisition equals 75% correct in all positions tested) in Arabic and English as referred to in three studies (Table 11). The authors found out that the acquisition ages of the Arabic consonants were most similar to the results reported by Smit et al. (1990).

*Table 11: Acquisition ages of consonants in Arabic and English.*

| Sound | Arabic | | English | | |
|---|---|---|---|---|---|
| | Standard | Acceptable | Smit et al., 1990[14] | Prather et al., 1975[15] | Templin 1957 |
| /b/ | 3:0-3:4 | 3:0-3:4 | ≤3:0, ≤3:0 | 2:8 | 4:0 |
| /t/ | 2:6-2:10 | 2:6-2:10 | ≤3:0, ≤3:0 | 2:8 | 6:0 |
| /d/ | 3:0-3:4 | 3:0-3:4 | ≤3:0, ≤3:0 | 2:4 | 4:0 |
| /k/ | 2:6-2:10 | 2:6-2:10 | ≤3:0, ≤3:0 | 2:4 | 4:0 |
| /f/ | 2:6-2:10 | 2:6-2:10 | ≤3:0, 3:6 | 2:4 | 4:0 |
| /θ/ | >6:0-6:4 | 5:0-5:4 | 5:6, 6:0 | >4:0 | 6:0 |
| /ð/ | >6:0-6:4 | >6:0-6:4 | 4:0, 5:6 | 4:0 | 6:0 |
| /s/ | 5:0-5:4 | 5:0-5:4 | 3:0, 5:0 | 3:0 | 4:6 |
| /z/ | >6:0-6:4 | >6:0-6:4 | 5:0, 6:0 | >4:0 | 7:0 |
| /ʃ/ | 5:0-5:4 | 5:0-5:4 | 4:0, 5:0 | 3:8 | 4:6 |
| /dʒ/ | >6:0-6:4 | 4:0-4:4 | 4:6, 4:0 | >4:0 | 7:0 |
| /h/ | 5:0-5:4 | 5:0-5:4 | ≤3:0, ≤3:0 | 2:0 | ≤3:0 |
| /m/ | ≤2:0-2:4 | ≤2:0-2:4 | ≤3:0, ≤3:0 | 2:0 | ≤3:0 |
| /n/ | 2:6-2:10 | 2:6-2:10 | ≤3:0, ≤3:0 | 2:0 | ≤3:0 |
| /l/ | 3:6-3:10 | 3:6-3:10 | 4:6, 6:0 | 3:4 | 6:0 |
| /r/ | 5:6-5:10 | 5:6-5:10 | 6:0, 5:6 | 3:4 | 4:0 |
| /w/ | 2:6-2:10 | 2:6-2:10 | ≤3:0, ≤3:0 | 2:8 | ≤3:0 |
| /j/ | 6:0-6:4 | 2:6-2:10 | 3:6, 3:6 | 2:4 | 3:6 |

The similarities and the differences in the ages of acquisition between Arabic and English are very important for the cross-linguistic purposes of this study. Amayreh & Dyson (1998) noticed in their study that the acquisition ages as reported by Prather et al. (1975) were generally earlier than in Arabic and the two other studies of English. Amayreh & Dyson (1998) explained this difference by the methods that have been used in these studies to determine the acquisition age. More specifically, the average

14 Ages of girls, then boys

15 Sounds tested in only two positions with percentages for two positions averaged

percentage of correct productions in two positions was used in Parther's study to determine the acquisition age of each particular phoneme, while Smit et al. (1990) depended on computing the percentage of all correct productions of each phoneme by an age group regardless of position. However, Amayreh & Dyson (1998) and Templin (1957) considered the articulation with 75% accuracy in all positions tested as the main indicator to determine the relevant acquisition age.

## 4.5 Features of JA

JA shows features of both standard and vernacular Arabic forms. JA combines aspects of MSA which is the language of media and education, and aspects of the vernacular forms that represent the common language of communication in the daily life in Jordanian society. JA is mainly characterized and differentiated form MSA by the following features, cf. Benmamoun (2000) and (Albustanji 2009: 28):

- The absence of the case markers.
- Distinctive syntactic case of negation.
- Free word order.
- The absence of mood distinctions.
- The absence of dual or gender distinctions in the plural form.
- A reduced type of used complementizers and affixal number agreement between the verb and the subject regardless of the word order.

The structural properties of JA versus MSA will in presented in the following sections of this chapter.

### 4.5.1 Verb morphology in MSA and JA

#### 4.5.1.1 Verb morphology in MSA

The morphological differences showing the agreement features explain the main differences between the perfective and the imperfective forms in MSA. Both prefixes and suffixes usually show the agreement features in the imperfective form in MSA, while on the contrary, the same effect is realized by suffixes in the perfective form. Table 1 and Table 2 as cited from (Albustanji 2009: 31) show the differences between the perfective and imperfective forms in SA.

*Table 12: Standard Arabic Imperfective*

| *Person* | *Number* | *Gender* | *Affix* | *Affix+Verb* |
|---|---|---|---|---|
| 1 | Singular | F/ M | ʔa- | ʔa-ktub |
| 2 | Singular | M | ta- | ta-ktub |
| 2 | Singular | F | ta-ii | ta-ktub-ii |
| 3 | Singular | M | ya- | ya-ktub |
| 3 | Singular | F | ta- | ta-ktub |
| 2 | Dual | F/ M | ta-aa | ta-ktub-aa |
| 3 | Dual | F/ M | ya-aa | ya-ktub-aa |
| 1 | Plural | F/ M | na- | na-ktub |
| 2 | Plural | M | ta-uu | ta-ktub-uu |
| 2 | Plural | F | ta-na | ta-ktub-na |
| 3 | Plural | M | ya-uu | ya-ktub-uu |
| 3 | Plural | F | ta-na | ta-ktub-na |

*Table 13: Standard Arabic perfective*

| *Person* | *Number* | *Gender* | *Affix* | *Affix+Verb* |
|---|---|---|---|---|
| 1 | Singular | F/ M | -tu | Katab-tu |
| 2 | Singular | M | -ta | Katab-ta |
| 2 | Singular | F | -ti | Katab-ti |
| 3 | Singular | M | -a | Katab-a |
| 3 | Singular | F | -at | Katab-at |
| 2 | Dual | F/ M | - tumaa | Katab- tumaa |
| 3 | Dual | M | -aa | Katab-aa |
| 3 | Dual | F | -ataa | Katab-ataa |
| 1 | Plural | F/ M | -naa | Katab-naa |
| 2 | Plural | M | -tum | Katab-tum |
| 2 | Plural | F | -tunna | Katab-tunna |
| 3 | Plural | M | -uu | Katab-uu |
| 3 | Plural | F | -na | Katab-na |

#### 4.5.1.2 Verb morphology in JA

The distribution of agreement features in the perfective and the imperfective forms in JA shows similarities to the relevant distribution in MSA. However, there are some differences. More specifically, and with regard to the relevant morphology, JA shows no mood distinctions. Moreover, the plural forms in JA show no dual or gender distinctions as illustrated in Table 12 and Table 13 as cited from (Albustanji 2009: 32):

*Table 14: JA Perfective*

| *Person* | *Number* | *Gender* | *Affix* | *Affix+Verb* |
|---|---|---|---|---|
| 1 | Singular | F/ M | -t | katabt |
| 2 | Singular | M | -t | katabt |
| 2 | Singular | F | -ti | katabti |
| 3 | Singular | M | -Ø | katab |
| 3 | Singular | F | -it | katabit |
| 1 | Plural | F/ M | -na | katabna |
| 2 | Plural | F/ M | -tu | katabtu |
| 3 | Plural | F/ M | -u | katabu |

*Table 15: JA Imperfective*

| *Person* | *Number* | *Gender* | *Affix* | *Affix+Verb* |
|---|---|---|---|---|
| 1 | Singular | F/ M | ʔa- | ʔaktub |
| 2 | Singular | M | tu- | tuktub |
| 2 | Singular | F | tu-i | tukutbi |
| 3 | Singular | M | yi- | yiktub |
| 3 | Singular | F | ti- | tiktub |
| 1 | Plural | F/ M | ni-u | niktub |
| 2 | Plural | F/ M | ti-u | tiktubu |
| 3 | Plural | F/ M | yi-u | yiktibu |

#### 4.5.1.3 Agreement paradigms in MSA

The main factor that determines the person and gender agreement between verb and subject in MSA is the word order (Benmoumoun 2000). More specifically, in the case where the verb precedes the subject, VSO order, then there is a "partial agreement" as Benmamoun (2000) referred to it. In this agreement, the verb shows person and gender agreement with its subject. However, if the verb follows the subject, SVO order, then the verb shows "full agreement" in the number, person and gender features. Benmamoun (2000) uses the following examples, which are cited in (Albustanji 2009: 33) to illustrate these two case of agreement:

ʔakal- at ţ- ţaalibaat- u

eat. Past- 3fs def- students. fp- nom

"The students ate."

ţ- ţaalibaat- u ʔakal- na

def- students. fp-nom eat. Past- 3fp

"The students ate."

Benmamoun (2000) further explains that in MSA and only in the context of SVO order, the number agreement is usually realized by an affix added to the verb. Benmamoun (2000) adds that in the cases where the lexical subject occurs between the auxiliary verb and the main verb, the subject normally shows partial agreement with the auxiliary verb and a full agreement with the main verb as in the following examples cited in (Albustanji 2009: 34):

Ka:nat ţ- ţa:liba:t- u ya- ʔakal- na

be. past. 3f**s** the– students. fp- nom 3- eat- fp

"The students were eating."

ţ- ţa:liba:t- u kun-na ya- ʔkul- na

the- students. fp- nom be. past.3fp 3- eat- fp

"The students were eating."

#### 4.5.1.4 Agreement paradigms in JA

Conversely, in JA, number agreement between the verb and the subject is always realized by an affix in both SVO and VSO orders. This pattern means that the word order does not affect this agreement in JA as shown in the examples (cf. Albustanji 2009: 34):

ʔakal-w lawla:d

eat. Past- 3mp def-boys

"The children ate."

lawla:d ʔakal-w

def- boys eat. Past- 3mp

"The children ate."

In addition to the complete agreement in JA in the preceding examples, and contrary to MSA, the verb always shows full agreement with its subject. This agreement is independent from the position of the subject to the auxiliary verb and the main verb as Albustanji (2009: 35) illustrates in the following examples:

Ka:nat ţ- ţa:libaat takul

be. past. 3fs the –students. fp 3fs- eat

ţ- ţa:liba:t Ka:nat takul

the –students. fp be. Past. 3fs 3fs- eat

"The students were eating."

### 4.5.2 Negation in MSA and JA

#### 4.5.2.1 Negation in MSA

Benmamoun (2000) refers to two main negation particles in MSA: /laa/ and /maa/. These two particles differ in their syntactic status; /laa/ is mainly used with the present tense, while, /maa/ does not show any inflection for tense.

Benmamoun (2000) adds that MSA has three variants of the negation particle /laa/, they include /lam/ and /lan/ the forms that show tense information, while /laysa/ is a variant that shows agreement information. /laysa/ functions as a free morpheme, which can be prefixed with feminine or masculine agreement inflections as illustrated in the examples (cf. Albustanji 2009: 36):

Laysa ʔal- ţa:lib laysat ʔal- ţa:libatu

Neg. m. def– student (masculine) neg. f. def- student (faminine)

“It is not the student (male)” “It is not the student (female)”

#### 4.5.2.2 Negation in JA

Benmamoun (2000) further illustrates the difference in negation between JA and MSA. Negation in JA is realized by two morphemes, the proclitic /ma/ and the enclitic /ʃ/ or /š/ as has been used in (Benmamoun 2000). /ma/ usually precedes the word to which it is phonologically joined, but /š/ is phonologically attached to the end of the preceding word, thus forming a single unit. Albustanji (2009: 36) illustrates this difference in these examples:

ma- bad- i

Neg- want- I

"I don't want."

badd- i- š

Want- I- neg

"I don't want."

## 4.6 Summary

The structural features differentiating JA from MSA have been illustrated in this chapter as JA is the main focus in the analysis of this study. Moreover, and as it has been explained earlier, this is the type of Arabic that children in our case normally acquire as a mother tongue. This study is mainly concerned with analyzing the typical and the atypical phonological development in JA-speaking children. Therefore, the very basic differences in the phonetic inventory, verb morphology, agreement paradigms, and negation particles between MSA and JA have been briefly explained. Furthermore, this brief illustration aims at providing the reader with the basic background regarding the existing differences between the two variants of Arabic in this particular context. This brief discussion should not be taken as a thorough illustration about these two variants of Arabic as it is not the main aim of this work.

# CHAPTER 5 Phonological processes in child speech

## 5.1 Introduction

As previously mentioned, studying and analyzing the natural phonological processes that occur in children's speech have received considerable attention in the domain of NP. NP takes into consideration the limited articulatory abilities of children as the straightforward natural justification for their typical tendency to employ and use many substitutions in their speech production development process. It has also been noted that children typically do not make these substitutions randomly or irregularly. It is generally agreed (cf. Stampe 1969; Edwards 1979) that children can perceive phonemic distinctions long before they can produce them. Therefore, it is assumed that children know what the typical sounds are or what they should be like, thus their words internal representations correspond to adult forms. This assumption is verified by the observation (cf. Stampe 1969: 446) that when a child acquires some sounds which he had previously been unable to produce, thus substituting them, he does not have to rehear all the words that he had been mispronouncing in order to correct them. Instead he would normally be able to change the pronunciation of the relevant sounds in all the words where he had been applying a substitution in a way of avoiding that relevant articulatory difficulty.

The cases in which children change their word internal representations by applying these consistent substitutions according to their articulatory abilities are instances of natural phonological processes. The natural processes in the speech of children have the same functions and the same conditions on their application as those processes in adult speech or in the process of language change (cf. Stampe 1973).

As a child acquires new articulations and learns to produce the more difficult segments or sequences of his native language, he stops applying the substitutions that he used to apply as a result of the limited articulation abilities at first. Now the child will suppress the processes he had been applying, or he can limit their application, so that he stops substituting the segments or the sequences that his language requires him to produce them accurately. This means that it is a natural progression of development that the child will normally pass through while learning to correctly produce the sounds and sound-sequences of his language, thus the child will have to suppress and limit some processes all together. It has been found that the child, in certain limited ways and contexts, can also allow some other processes to continue to apply; as the language, in such cases, may require that a process be limited to a subset of its original inputs (cf. Stampe 1973).

Another way in which children sometimes limit the surface effects of a process is by constraining its natural iterative application (cf. Stampe 1973: 59-68). According to (Stampe 1973), the function of using each process, as a natural spontaneous response to the child's limited articulation abilities, is to substitute a less difficult class of sounds or sound-sequences for a more difficult class. If it happens, in learning a language, that a child continues to make a substitution which does not apply in the language as spoken by adults, he has actually added a process to the phonological system of his language by failing to learn to accurately pronounce its input. That is, his phonological system differs from the standard adult system of his language in the sense that he applies a process which other adult speakers do not normally apply. This case would be described as a change in the phonological system of acquiring the relevant language.

## 5.2 Literature review and previous work

### 5.2.1 Language acquisition in normally developing systems

A long-standing concern and research interest of speech-language clinicians have been focused on discovering whether or not functional (non-organic) speech disorders are simply the result of delays in the typical acquisition process (cf. Ingram 1976; Leonard 1973). This is an important question as depending on this distinction and the exact definition of the disorder, an accurate diagnosis would be possible. Consequently, deciding on the proper planning and the execution of a prospective intervention program would be possible. The ability to answer this question depends on the availability of descriptions of both the available atypical systems as well as the descriptions of typically acquired systems at various stages of development in the process of typical language acquisition. There are many cross-sectional, and longitudinal studies on typical language acquisition that provide rich sources of descriptive information on early developing systems. Locke (1983) and Stoel-Gammon & Dunn (1985) provide detailed descriptions on typical as well as atypical systems. Additionally, specific properties of these linguistic systems could be used and considered as a basis for the required comparison showing the similarities and differences within and across children in the process of language acquisition.

With regard to the fundamental characteristics in the commonalities and the individual differences in early, typically developing systems in language acquisition processes, two main contradictory findings have emerged in the relevant studies. Firstly, there are commonalities in the general structural properties of the systems as well as in the acquisition order of these properties. Secondly, the presence of individual differences in the details of specific acquisitional orders has also been proved as shown in the research (cf. Dyson 1988; Edward 1979; Farewell 1977; Jakobson 1968; Menyuk 1968; Olmsted 1966; Stoel-Gammon 1985, 1987). Defining the fundamental basic characteristics of typically acquired systems made many authors to analyze these findings in details, attributing them to any one or some combination of the following possible explanations: universal linguistic principles (cf. Jakobson 1968), limitation and suppression of processes (cf. Donegan & Stampe 1979; Stampe 1972), factors relevant to the cognitive creativity (Macken& Freguson 1983), environmental influences (Ingram 1988), as well as other biological factors as in Locke (1983, 1988).

A detailed account has been provided in the previous chapter about the relevance of different phonological theories providing different linguistic frameworks in analyzing the child's phonological disability. Many aspects of these systems have included describing and assessing the relevant phonetic and phonemic inventories, phonotactics, rules or processes, and the lexicon of these atypical phonological systems. Much descriptive information in the relevant literature is available on the principles that would limit the variation in two basic properties of phonological systems; the sounds that occur in a language (phonetic inventory) and the distribution of these sounds (phonotactics).

On one hand, the principles that are formulated based on the distinctive features rather than on the sounds per syllable allow commonalities across individuals to be noticed as well as to observe the typical individual differences in the acquisition of specific sounds as defined by that particular feature (Jakobson 1968). For example, sounds from the general class of nasals, glides, and obstruent stops are among the first acquired, while liquids are generally acquired quite late (cf, Stoel-Gammon 1985). Thus, the sounds of early inventories would be distinguished by major class feature such as being [sonorant], [consonantal], and [syllabic]. The addition of a liquid consonant in more complex inventories would require distinguishing between nasal and non-nasal sonorant consonants. It has also been found in the research that stops are generally acquired before fricatives (cf. Jakobson 1968), which appeals to the distinctive gesture [consonantal]. The [voice] distinction has also been reported to be acquired early in the range of obstruent distinctions (cf. Machen & Barto 1980). Another major finding about the phonetic inventories among typically developing children is that consonants with a relatively forward point of articulation are acquired before consonants with a more posterior place of articulation (cf. Locke 1983; Tobin 1997, 2002); thus, an [anterior] distinction is acquired relatively early.

On the other hand, considering phonotactics, it has been found in the cross-linguistic studies that stops are generally first acquired in word-initial position, while fricatives are first acquired post-vocalically (Ervin-Tripp 1966). Despite the fact that these principles interact to define the general outline of language acquisition, individual differences in the order of acquiring specific sounds within a given class have been noticed. This will be tested and observed in the data analysis in this study of both the typical and the atypical acquisition in JA.

### 5.2.2 The nature of atypical language systems cross-linguistically

The idea that both commonalities and individual differences as the basic characteristics defining children with typical language acquisition suggests that these basic characteristics of typically acquired systems may provide a basic characterization of the atypical speech (Dinnsen et al. 1990). However, there are comparatively few descriptive studies available on the nature of the atypical language systems that would provide the possibility for comparing the systems within the atypical children as well as between typical and atypical children. For example, there are only some detailed studies with descriptive information on the phonological systems of children with functional speech disorders (cf. Grunwell 1981; Ingram 1976, 1981, Stoel-Gammon & Dunn 1985; So & Dodd 1994). These studies show that there is a great similarity in the phonological errors among languages; also they refer to another type of errors that are language specific. “A normal developmental rule in one language can be unusual rule in another” (So & Dodd 1994: 249).

Other studies have focused on limited aspects of error patterns in an individual child’s system (Leonard 1985) or on the common processes and the phonological patterns that are found across atypical systems. So & Dodd (1994) in studying phonologically atypical Cantonese-speaking children, reported that most of the processes and the sound changes noticed among their cases were also reported in other languages like in English (e.g. fronting, stopping and cluster reduction). Leonard (1985) analyzed in his paper the unusual phonological behaviours in the speech of children with functional articulation disorders and he classified their linguistic behaviours and language performance into three types;

1. Perceptually salient but unusual sound changes whose systematicity is readily detectable,
2. perceptually salient but unusual sound changes whose systematicity

is more difficult to discern, and

3. systematic phonological behaviours whose very identity is apparent only after careful analysis (Leonard 1985: 4).

Moreover, Bortolini and Leonard (1991) compared, in their study, nine phonologically atypical children matched for the size of their consonant inventories with other nine typically developing Italian-speaking children in the age (4. 9) to (7. 1) years old. And, as previous studies, they noticed that children in both groups used processes that are typically reported for English-speaking children; assimilation, cluster reduction and liquid deviation. Despite their first remarks, Bortolini and Leonard (1991) noticed that the phonologically atypical children applied some phonological processes in quite another way than their typically developing children; such as in their deletion of the stop rather than the sibilant in the relevant consonant clusters. Bortolini and Leonard (1991) further explained the difference in the substitution of /l/ for /r/ by Italian-speaking children as opposed to the case in English, where children will substitute /w/ for /r/. Through this difference, Bortolini and Leonard (1991) noticed and confirmed that those phonologically atypical Italian children are aware of Italian phonology in their underlying representation, namely in this specific context that /r/ is an alveolar trill. This idea indicates that even atypical children are aware of the phonetic characteristics of the phonemes in their languages.

### 5.2.3 Cross linguistic patterns in delayed and deviant phonology

Research in SLI has also explored children with both receptive and expressive language disorders in relation to normal cognitive skills. For example, Scarborough and Dobrich (1990) state that although these children who have been having a language delay may appear later to recover normal language skills (usually by the age of five). This recovery can be termed and described as being *illusory*. This idea is explained according to the supposed presence of the "plateau stage" in the process of language acquisition for typical children at about the age of four or five. These findings on the illusory nature of language recovery supported by other findings showing that certain syntactic and phonological difficulties were very common and caused-to some extent-persistent problems in children who otherwise appeared to outgrow their language impairment (cf. Aram & Nation 1975; Bishop & Edmundson, 1987). Rescorla, Roberts & Dahlsgaard (1997) also supported in their study the same finding stating that there are some aspects of difficulty that will be apparent during the recovery process of the children with delayed development; therefore, it is termed and described as an *illusory recovery*.

It is well known as has also been supported in the relevant literature that older preschoolers with language delays are at a very considerable risk for what could be described as long-term language, academic, and social problems. It has been shown in the findings of these studies that in later childhood and beyond, from 28% to 75% of children who were diagnosed as having SLI in preschool years, showed residual speech-language difficulties, and from 52% to 95% exhibited and experienced some obvious difficulties and inadequacies in their reading abilities (cf. Aram & Nation 1980; Hall & Tomblin 1978; Paul& Cohen 1984; Strominger & Bashir 1977).

Comparatively, little is known and documented about the prognosis for toddlers with slow acquisition of expressive language. Normative data regarding the expressive language growth, as it has been represented in the child's vocabulary size and measured by his communicative competence in relevance to his age, have been well established in the literature. Many sources have stated that the average vocabulary size of sustainability is to be more than 50 words as well as the use of some word-combinations at the age of 18-24 months old (cf. Bzoch & League 1972; MaCarthy 1954; Nelson 1973; Thal & Dale 1989). However, Fenson, Dale, Reznick, Hartung, and Burgess (1990) found in their study that the average expressive vocabulary size is to be of 110 words at the age of 18 months and around 312 words at the age of 24 months among normal toddlers. Additionally, Rescorla (1989) showed in her study that 10-14% of the middle class children who have been sampled with the Language Development Survey failed to produce 50 different words or were not able to produce two-word utterances by their second birthday. What is still unknown is the percentage of these "late talkers" who will probably demonstrate chronic deficits later during their language development. Additionally, the percentage of those children who will grow out as typical "late bloomers" as Rescorla (1989) described them is still unspecified.

Phonological difficulties are not generally included as a criterion to be considered in the diagnostic categories of SLI and SLI expressive. Nevertheless, studies reporting the nature of the phonetic and the phonological difficulties encountered by these children have provided evidence of their persistent phonological impairment. For example, Leonard et al. (1987) found that children with SLI showed unusual productions of nonsense words regardless of whether the words consisted of sounds included, not included, or attempted in their phonetic inventories. Typically developing children had these unusual productions significantly more often when the words contained consonants that are not included in their phonetic inventories than when they attempted words contained consonants that are part of their phonetic inventories. In combination with findings that SLI children demonstrated similar phoneme production to that of younger, language-matched control children as in (Paul & Jennings 1992), these findings suggest that the phonological systems of these linguistically-atypical children were delayed as well as less systematic than those of typically developing children in their relevant language system.

Two empirical relevant phenomena have been referred to and discussed in the longitudinal studies with regard to the development of children with early language delay (ELD). Short-term follow-up assessments and evaluations over the preschool period have shown that many of the ELD children will demonstrate and very often normal levels of language proficiency by the age of five to six years (cf. Bishop & Edmundson 1987; MacKeith & Rutter 1972; Morley 1972). This evidence for recovery from ELD is unclear and not easily explained especially in considering the strong evidence that longer-term outcomes may often be less favourable as referred to and discussed in the literature (cf. Bashir, Wiig, & Abrams 1987; Wallach & Bulter 1984). Several more questions remain here; how to reconcile these contradictory findings- that both short-term recovery and long-term persistence are possible consequences in the case of ELD? And what is the real case and what would be the most probable results of the therapy after this diagnosis? The only possible straightforward and practical interpretation is that the ELD cases do vary in reality and would show different levels of severity or the subtypes of their ELD. Accordingly, having different diagnoses would be the criterion to determine whether recovery or persistence will be the most predictable outcome for particular individuals. This finding is further evidenced by the observation that children with milder delays, speech and language problems or with a narrower range of speech problems (e.g., isolated phonological deficits) usually have the tendency to show later a less probability to exhibit persistent language difficulties or reading problems (cf. Bishop & Edmundson 1987; Hall& Tomblin 1978; King, Jones, & Lasky 1982; Levi et al. 1982).

Alternatively, some studies show that the two previously mentioned findings; the total recovery and the persistence of certain language impairments may occur in the same case of ELD, but at different stages in the child's language development (cf. Bishop & Edmundson 1987; Scarborough & Dobrich 1985b; Stark et al. 1984). This observation means that even those children who achieve normal levels of language skills showing an appropriate competence to their age (usually by the age of five years), they may still have the possibility for other subsequent language difficulties or reading disabilities at later stages in their development. This situation would probably occur when normal language proficiency development would progress in a stepwise linear manner, characterized with periods of rapid growth, which would be separated by plateau periods, or other stages of a relatively slow or a little noticeable change in the child's linguistic performance (cf. Scarborough & Dobrich 1985a).

One can assume from the previous discussion that if ELD children have been diagnosed as having a rather delayed, but typical language acquisition, then it would be possible that they could catch up with their typical age mates, while the AMN children would remain on an extended level in their language acquisition development. According to this "illusory recovery" model, differences in the language acquisition would be expected and possible to re-appear once the children passed the next developmental period or the sudden fast developmental growth.

Furthermore, and continuing reviewing the literature on SLI cross-linguistically, Stoel-Gammon (1989) analyzed the speech of two toddlers who were diagnosed as having speech-language impairment-expressive (SLI-E) at the age of two. At this particular age, both children showed very limited phonetic inventories as well as a tendency to produce syllable shapes of a comparatively reduced complexity. In addition, one child demonstrated some unusual sound preferences during his babbling period. In a similar study of 34-month-old children with SLI-Expressive or general SLI and age-matched typically developing children, Paul and Jennings (1992) examined these issues using a larger sample (18 SLI-E and 25 typically developing). In their study, they analyzed the speech demonstrated in 10-minute play interactions and found, like Stoel-Gammon (1989), that the children demonstrated smaller phonetic inventories and less complex syllable shapes than their age-matched typically developing children. But in contrast to Leonard et al. (1987) Paul and Jennings (1992) did not state that the phonological systems of these children were qualitatively different from their age-matched typically developing children. More precisely, Paul and Jennings (1992) found that those children with SLI and SLI-E produced phones that appear early in typically developing children. Moreover, other researchers; Whitheurst, Smith, Fischel, Arnold, and Lonigan (1991) noted “depressed phonological development” in children with SLI-E they examined in their study. Moreover, Whitheurst et al. (1991) suggested that the basis for the deficits in children's expressive language competence lies in their restricted, depressed phonological representations.

Rescorla and Ratner (1996) tested the relation and the relevant connection between phonetic difficulties and SLI-E. They recorded, coded and examined the children’s vocalizations, phonetic inventories, and their syllable shape patterns and found that the SLI-E children show some common features characterizing their language disorder. More specifically, Rescorla and Ratner (1996) noticed that these SLI-E children produced fewer vocalizations, had limited inventories with regard to consonant production, and more V (vowel) and CV (consonant-vowel) syllable units than the relevant typically developing control group. The study attempted to provide evidence supporting the view that these phonological acquisition patterns in these children are a clear representation of delayed as opposed to deviant systems.

Moreover, and in their study, Rescorla and Ratner (1996) attempted to determine and find answers to other issues. They wanted to discover whether SLI-E could be attributable to the phonological deficits, whether both SLI-E and phonological difficulties appear independently, or whether having symptoms of an expressive language delay would definitely decrease and inhibit the child's opportunities for further phonological practices. Their findings in this study of SLI-E were consistent with other studies of typical language acquisition in the sense of approving the link between volubility; fluency and talkativeness, and language acquisition (cf. Sullivan & Rathner 1991). The lack of talkativeness and having decreased or limited phonetic inventories in children with SLI-E could be relevant to delayed expressive language development as well as to the maternal interactive style providing fewer and limited opportunities for linguistic practice. These findings would also support Stoel-Gammon's suggestion (as cited in Paul & Jennings 1992) that speech and language development are intimately and directly connected during the early stages of language acquisition. The direction of causality between the two factors and the way they can affect each other are still unclear.

The findings and the research issues raised in the previous literature could lead to the supposition that it might be possible that later talkers basically have poor or limited phonological skills; therefore they would show slow oral motor of phonological abilities and a delayed linguistic competence. It could also be possible that the phonological skills of the late talkers are depressed and limited as late talkers usually do talk less. Therefore, they get less practice with their phonological production because of their speech, which would consequently limit and hinder their phonological development.

#### 5.2.4 Phonological processes in typical and atypical systems

Studies that explicitly compare specific aspects of typical and atypical systems are very few. In one study, Hodson and Paden (1981) studied the phonological processes among typical and atypical children and found them to be similar. In two other studies (Ingram 1980; Schwartz, Leonard, Folger, & Wilcox 1980), the phonetic inventories and the syllable shapes of typical and atypical language systems were explicitly compared. The researchers found that both groups basically used the same number of sounds, moreover they noted that the most frequently occurring sounds and syllable shapes were the same for both groups. More specifically, the phonetic inventories of most subjects in both groups included nasals, glides, voiced and voiceless stops, and at least one fricative. The results in these two studies focused on group characteristics only, despite the fact that individual differences were noted. That is to say, that there have been no attempts in their research to observe the individual differences in the phonetic inventories and the phonotactics of the individual atypical systems. Therefore, it can be concluded from these studies that the limits of variation in the basic properties of the atypical phonological system were unspecified and exclude comparisons with the basic and well-established properties of typical systems. Furthermore, Dinnsen et al. (1990) suggested that when individual differences exist, it is unknown and uncertain whether they are to be considered as a principled variation or to be treated as a kind of cross-sectional or longitudinal differences found in typical first language acquisition . The analysis in this thesis takes this fact into consideration, thus provides a comparative analytical examination of the typical and atypical phonological developing systems in characterizing SLIin JA.

Stoel-Gammon (1987) has shown a strong correlation between the number of the consonants in the phonetic inventories and the vocabulary size in typical 2-year-old children. This finding affirms the idea that toddlers with abnormally small vocabularies, when compared with age-matched normally developing children, may show phonological differences from their typically speaking peers. Furthermore, Stoel-Gammon (1987) notes that isolated or single word-naming articulation tests are not the most appropriate tools for evaluating and assessing the phonological performances in children less than 3 years old. Stoel-Gammon (1987) recommends that more comfortable spontaneous or natural conversational interactions would be more appropriate, as that would provide a more valid context to assess the speech-sound production at this particular age group. Nonetheless, it should be further noted that the conversational interaction method could hinder and reduce the intelligibility of the child’s sample, as the target of his production is not always known, or it can not always be predicted when compared with the intelligibility of the samples elicited through the imitation tasks as used to evoke single-word production. Therefore, the advantages and disadvantages of both methods are to be considered while deciding on the appropriate method for the data collection and speech examining in this study to insure achieving the accurate diagnosis of SLI in JA.

Robb, Bauer, Sullivan, and Mashima (1990) have conversely emphasized the importance of considering and examining both word and non-word vocalizations in assessing the speech development in young children. They justify their method in the sense that in applying the non-word vocalizations, the researcher might find important information about the actual toddlers' phonological capacity. In their study and because the examined toddlers presented slow expressive language development, they produced few interpretable words, thus they were largely unintelligible. Therefore, both interpretable and uninterpretable word-like utterances from their sample were considered, transcribed and analyzed.

On the other hand, Paul & Jennings (1992) in analyzing toddlers' phonological behaviours applied three global measures: the size of the phonetic inventory, the complexity of canonical shapes, and the percentage of correct consonants in comparison to adult targets. These measures have been documented and referred to in the literature as shown when Stoel-Gammon (1987:324) argued that:

> "Norms for children under 3 years should be broad-based, involving measures of several aspects of client's phonological system. Assessing correct production, or mastery of a particular phoneme is not ... as important as obtaining a general picture of the child's phonological abilities."

Several studies did not consider the contextual influences, and thus failed to explain their relevance to the articulatory inconsistency (cf. Spriestersbach and Curtis 1951; Nelson 1945). These studies could be described as being limited in several important ways. Their analyses depended solely on one-word responses as they relied on contrived speaking situations that have been previously planned; accordingly, their sample included only imitative responses. In examining the importance and the influence of the contextual factors, it has been stated theoretically and proved experimentally that the articulatory dynamics of the connected speech differ from the dynamics of naming responses that would be demonstrated in the single-word articulation tests (cf. Ohman 1966). Furthermore and as has previously been discussed in the critique of the error analysis framework, there is the question of to what extent these single-word-responses will realistically represent the child's habitual speech patterns. Grunwell (1982) states that in both typical and atypical speakers an utterance consists of more than one word and is not a mere naming act. Thus, the naming responses might be an artificial representation of the child's speech patterns, as the child might perform well in the naming task, but might experience obvious speech problems and show disability in more spontaneous natural settings. For this particular reason, this study uses both methods of elicitation in the data collection to ensure that the speech samples are a real representation of the child's actual speech in JA.

Various studies have shown that the quality of the phonological representations of words in the child's lexicon constitutes a vital determining factor in his linguistic ability. The same has been noted in several studies devoted to language development in deaf children (cf. Alegria 1998). However, the construction process of these phonological representations are not fully understood, particularly in children with specific language impairment SLI. Theoretically, the phonological representations are not considered to be progressively constructed. Accordingly, very young children are supposed to be able to perceive, produce, and represent speech in terms of phonemic categories, also this suggests that young children's phonological representations are supposed to be specified as early as birth and are assumed to be equivalent to adults' phonemic forms. Such a view generally needs evidence and support in the literature that is concerned with infants and young children's discrimination abilities (cf. Aslin, Husczyk & Pisoni 1998). However, it must be noted that children's discrimination abilities imply and show that their early phonological representations are not as well defined as those of adults. That is because these discrimination processes essentially use immediate memory, thus should not be confused with categorization processes, which imply storage in the child's long term memory. A child might actually be able to differentiate between two adjacent stimuli, but at the same time he might be unable to identify the phoneme constancy (cf. Bird & Bishop 1992).

In more recent studies and contrary to the previous studies, the idea that phonological representations consist of segmental units from the very beginning, and that they are specified as early as birth is quite questionable. The examining of the typical language acquisition in children shows and supports the progressive nature of the construction and the specification processes of the phonological representations. These processes start in early childhood and last until the child has an explicit access to the phonemic awareness which is identified and facilitated by the beginning of his literacy in the relevant language system. These findings have been previously explained as they form the basic explanatory force in the frameworks of NP, PHB and OT. These findings have been referred to through the inhibition and the limitation of the phonological processes in natural linguistics and the re-ranking of the constraints in OT (NP, PHB and OT: similarities and differences).

It has been noted in several studies that in the typical process of children developing adult phonology that they usually exhibit a theoretically interesting and as yet unexplained process referred to as ''articulatory inconsistency''. That is to say that those children will be able to produce a particular speech segment or a phoneme, as produced by typical adults, correctly in some instances while incorrectly in others. This process has been noted long time ago and attracted the research attention to investigate child's speech; both “the typical development” as in (Leopold 1947; Perkins 1952; Smith 1973) and “the delayed development” as early as in the following studies (cf. Spriestersbach and Curtis 1951; Curtis and Hardy 1959; Siegel, Winitz, and Conkey 1963; Winitz 1963). This articulatory inconsistency suggests important implications in the relevant description of child phonological competence, especially in describing the nature of the lexical representations. Accordingly, if these articulatory inconsistencies are related to the phonetic contextual variables only, then they could be justified as in the way that the child theoretically perceives speech in terms of the adult systems. Nevertheless, the child's speech production abilities and competence are actually controlled by some motor difficulties (cf. Kornfeld 1971 and Smith 1973). However, if these articulatory inconsistencies are not related to the contextual variables, then these processes could only be justified by the child perceiving and producing his speech sounds within his own system.

### 5.2.5 Descriptive diagnostic classifications of phonological disorders

Much attention has been given to analyzing cases of atypical children, but little effort has been devoted to examine the classification systems that are generally used to refer to these children. In many studies atypical children have been classified into subgroups according to the assumed aetiological basis and the causes of their language disorder (cf. McGinnis 1963; Wood 1964; Morley 1967). Thus efforts in many studies have been devoted to classifying the types of language disorders aetiologically with little reference to the descriptive specification and elaboration of the accompanying language behaviour itself. As a result of this practice, providing the differential diagnosis of atypical children based on the relevant aetiological syndromes has become the main obvious activity for speech clinicians. Reviewing the relevant literature, several studies have focused on this issue, and thus explained the language characteristics of various aetiological groups, for example, the mentally challenged, and the emotionally disturbed children. An implicit assumption in the findings of such studies seems to be that children in each group would usually demonstrate definite characteristics of language variations by which that group can generally be defined and diagnosed. Such an assumption seems to be questionable, especially when the criteria for the subject selection are often unclear or when multiple aetiological factors might be involved in causing the language disorder.

Alternatively, to circumvent and solve the problems of classifying language disorders aetiologically, some researchers (Eisenson 1968; Berry 1969) have chosen another approach in treating children with language disorders as a single homogeneous group. This method obscures the linguistic differences and variations among the children in such a general grouping method which is based on the definition of atypical language development as the unifying factor among the group population.

Unfortunately, it should be noted that classifying atypical children according to the relevant aetiology or as if they were a homogeneous group does not appear to be the most appropriate and the most convenient method of choice. Alternatively, another approach, which is basically the descriptive and the diagnostic classification of the developmental phonological disorders has been proposed (cf. Shriberg 1982a; Shriberg & Kwiatkowski 1982a, 1982b, and 1982c). This diagnostic classification system has been further elaborated (Shriberg & Kwiatkowski 1983) and it basically uses seven aetiological classification "families" for both developmental and acquired phonological disorders. Language in such cases is the main concern and the major problem to be addressed, consequently, it is logical and more appropriate to base the required classification system according to the language variations presented by the child.

Both typical and deviant language behaviours can be described according to several linguistic bases, such as the most common practice that is followed in describing language behaviours in terms of phonological, syntactic, and semantic characteristics. In practice, it is preferred to provide a description of the child's atypical language behaviour on these different linguistic levels of description. This description can assess the child's linguistic competence and performance through analyzing his ability to comprehend, spontaneously formulate, and repeat specific linguistic features, e.g., phonological, syntactic, and semantic aspects. Depending on this type of language performance-descriptive data, it would be more accurate to group children with similar patterns of language behaviours for further classification purposes.

## 5.3 Phonological representations in AMN children

Considering the relevant literature, it has been shown and proved by several studies that from birth onwards, infants are able to discriminate between almost all the consonantal contrasts of their native languages, as well as those of unfamiliar languages (cf. Eimas, Siqueland, Jusaczyk, & Vigorito 1971). As the infant grows, his sensitivity to the relevant contrasts in his mother language or the ambient language will progressively replace this discrimination ability. Werker & Tees (1984) state that the first reorganization of the babies' phonological system is to be achieved at the age of ten months. Additionally, the stage at which the infant acquires his first words indicates an implied decrease in the attention he would pay to the included relevant phonetic details of these learned words.

Additionally, Stager and Werker (1997) reported in their study that in 14-month-old infants, but not 8-month-old infants, less phonetic details are found to be processed in acquiring words than in simply hearing these words. The same finding has been referred to and confirmed by an earlier study; namely, Halle and de Boysson-Bardies (1996). In this study, the authors have shown that the complete recognition of words by children aged 11 months was not prevented by the phonemic deformations (e.g., biberon-piberon in French; which is equivalent to feeding-bottle-veeding-bottle in English). These findings and observations suggest that children pay less attention to the phonetic details of the words when the access to their meaning is their main concern.

In the developmental scheme, it could be noted with reference to the previous findings that losing the phonetic details would represent the second developmental stage; where a more functional perceptual reorganization will take place. These previously mentioned findings are summarized in (Werker & Tees 1999) stating that the processing of the segmental information in the newly learned words would exceed the attention and "the mnemonic abilities" of children at this particular age. The lexical burst would represent the third developmental phase (i.e., around 18-20 months of age). Indeed, as the child learns more and more words, thus increasing the entries in his own lexicon, the encoding and the processing of the finer representations allowing him to discriminate between similar words is more likely to occur at this stage (cf. Werker & Tees 1999; Swingley & Aslin 2000). It is during this third developmental stage, where vocabulary growth would influence the restructuring of the phonological representations in the child's system (cf. Jusaczyk 1993; Metsala 1999; Metsala & Wally 1998; Werker & Tees 1999). More specifically, the increasing vocabulary in the child's lexicon would confront him with similar sounding words (e.g., right and write) the process which requires that these words must be learnt as distinct forms to be stored in separate entries in the child's long-term memory.

The lexical restructuring model has been proposed by Metsala & Wally (1998) in which they explain that the vocabulary growth specifies the relevant phonological representations in the child's lexicon. In this model, two claims are particularly relevant: (a) recognizing words in young children usually is a more holistic process when compared to older children or adults, resulting form the fact that the size of the receptive lexicon will influence the recognition of words, and (b) two factors, which are represented by the overall vocabulary size and the familiarity or the phonological similarity of words, make the lexical restructuring a rather gradual and a word-specific process in the child system. These claims have been evidenced by the findings reported and presented in several studies. For instance, the existing differences in the process of word recognition between adults and children have been explained by applying a mispronunciation detection task (cf. Walley 1987, 1988) and using ''a gating paradigm'' as reported in another study (cf. Walley, Michela, & Wood 1995).

## 5.4 Phonological representations in SLI children

Several studies have reported on the phonological representations of typically developing children, therefore, it has been explained and understood that these representations are progressively elaborated upon by children with typical language development (NLD). On the other hand, the corresponding comprehension of what such representations include and and how they are elaborated upon in children with SLI is not as fully explained as in the case of NLD. Considerable research has been conducted in the area of the speech production of children with phonological disorders (cf. Leonard 1998). Unfortunately the available data and the observations from these studies can be described as being limited. These observations are not enough to clearly and precisely specify the context in which these disorders are caused by the poor quality of the phonological representations or they are resulting from deficits in the relevant perception and the speech production processes.

The literature shows that different factors have been suggested and proposed to explain these language disorders; for example, Edward and Lahey (1998) suggested that the SLI disorders could be particularly attributable to the quality of the phonological representations by these children. In their study, children with SLI aged 4 to 10 years were examined using a repetition task and appeared to have poorer phonological representations than their age-matched typically developing children. In this study, Edward and Lahey examined the following three factors as possible explanations for this difference between the two groups: differences in their auditory discrimination, forming and holding phonological representations in their working memory, and testing the processes that are involved in the motor planning and execution.

Based on the observations obtained from this study, Edward and Lahey (1998) stated that the auditory discrimination did not provide strong support to justify the difference. The two groups of children did not differ significantly with regard to the percentage of their errors for the phonemes that were supposed to be difficult to discriminate, also they did not differ in terms of motor planning and execution, rather than that the researchers reported that the latency of the responses was comparable in both groups of children, regardless the presence of speech and language disorders among children. Edward and Lahey (1998) also noticed no significant difficulties among these children concerning the sound classes that are typically acquired in late stages.

The observations reported by Edwards and Lahey (1998) provided evidence that the difficulties that have been experienced by the SLI children while forming or holding the phonological representations in the working memory have been causing the difference between SLI and NLD children. This explanation is obvious in the observations that SLI children showed more errors in the syllable structure and more phoneme deletion processes than their typically developing peers in the control group. With these observations, Edwards and Lahey (1998) noted that the phonological representations of SLI children proved themselves to be ''underspecified'' and more holistic, thus could be described as resembling the phonological representations of younger children with NLD. Considering Edwards and Lahey's findings with reference to the theories of the ''limited-capacity'' processing (cf. Kail 1994), this explanation would be elaborated as follows; children with SLI could be able to form appropriate phonetic representations, but their real difficulty is that they would revert to their earlier and more holistic representations when facing the overload condition. This explanation means that forming accurate phonological representations in SLI children would be possible, but the processes would not be as easy and fast as in NLD children, which will finally result in overloading the SLI systems.

Moreover, Edwards and Lahey (1996) have studied children's perception and recognition performances by comparing the performance of 4 to 9 years old SLI children to that of the control group, the age-matched typically developing children. In this examination, the authors used a lexical decision task to test the recognition performances of the two groups in response to the auditorily presented materials. Edwards and Lahey (1996) pointed out in their investigation to the slow answers of SLI children when compared to their typically developing peers, but they did not clearly explain the reason of this response latency in SLI children. However and generally speaking, after observing several cases, the examiners added that these differences could be justified by the fact that SLI children possess a less fine-tuned phonetic representation that will definitely affect the speed of their word recognition abilities and performances in a negative way. Moreover, these differences might also be attributed to a generalized slowness noticed in SLI children, particularly when it is accompanied by stress due to being confronted by a task involving and requiring certain phonological and metalinguistic processes.

The former explanation has also been referred to and supported by Dollaghan (1998) through using ''an auditory gating paradigm'' in this study. Dollaghan showed that for 6 to 10 years old SLI children, in order to recognize unfamiliar words they would need a larger portion of the acoustic signal than their typically developing age-matched peers would typically need. It is important to note that the difference in the recognition performance of both groups on familiar words was not a significant one in this study.

Furthermore, Dollaghan (1998) stated, and as has generally been found and supported, that SLI children were less accurate in the processing of word-initial information. These findings suggest that word recognition processes tend to be clearly vulnerable, especially when processing demands are increased, as in the case of examining the recent representations in the lexical memory for the purpose of distinguishing them from previously established ones. Dollaghan (1998) found that SLI children were also less successful, thus making more errors than their NLD peers, particularly in the tasks requiring identifying initial consonants. This finding of this study leads to the generalization that SLI children besides having these apparent representational deficits, they demonstrate obvious deficits and lower-level in their speech perception abilities. This means that the ''underspecification'' of the phonological representations in SLI children causes the difference in their recognition performance when compared with NLD children.

Reviewing the relevant literature on the difference between SLI and NLD children, it is obvious that most of the studies have been reporting such an assumption (except for Edwards & Lahey 1996) by depended on the comparison with control children who are matched on the chronological age basis. Therefore, to generalize this conclusion, it was necessary to compare these observations and to study these results in other cases where children will be matched on the receptive lexical level. This receptive lexical comparison is particularly needed in examining the relation between the phonological restructuring and the lexical development, and more specifically, the influence of the vocabulary growth (cf. Metsala & Walley 1998). Consequently, the differences between SLI and NLD children matched basically on the receptive lexical level should not be significant and actually should not be found. Examining and considering different aspects of the developing phonological system would help in analyzing the phonological characteristics of children's word productions.

The findings of much research are based on relational analyses by comparing the child's pronunciation of a word with its adult standard form in the relevant language system. This comparison may examine the relevant correct sound productions and then would describe the emergence and the mastery of the phonemes in the relevant adult language. This approach has been used for a long time as Templin (1957) and Poole (1934) followed and applied this relational analysis to establish norms of articulatory development. Relational analysis can also provide a description of the incorrect productions by comparing the differences between the adult and child articulations in terms of segments, features, or phonological processes.

Children's articulation patterns could also be analyzed by applying another approach through focusing on the child's own productions. This method is described as the independent analysis as referred to in (Stoel-Gammon & Dunn 1985). This method describes the sounds, syllable structures and shapes as produced by the child, thus it provides a comprehensive view of the child's phonological system without comparing his own language production to that of the standard ''adult speaker'' system. This method can also be useful in describing the characteristics of children's vocalizations in the language development stage that precedes the onset of the production of their meaningful speech.

Studies applying the independent analysis method of children’s word productions have shown that the phonetic inventories of the child's early meaningful speech are predominated and mostly characterized by the use of particular sound classes. Winitz and Irwin (1958) have analyzed in their study, the meaningful speech of 93 children in the age range between 13 to 18 months, of both adult-based words and ''self-language'' words (as they call them) or what can be described as "nonsensical phoneme combinations". The examiners found that phones from the classes of stops and nasals constitute approximately 80% of the consonantal sounds produced in children's speech. Glides ([w, h]) have formed the next frequent sound class at a percentage of 14% of the consonantal phones produced in the speech of these 13 to 14 months old children and at only 6% among the subjects who are 17-18months old in a follow-up study.

In addition to the previous studies, and after studying 15 children, Ingram (1981) formed a description of the phonetic inventory for each child based on the frequency of the occurrence of the phones they produced. Although the children were older than those in Winitz and Irwin’s study, namely between 17 to 26 months, by comparing their phonetic inventories, Ingram (1981) found that the consonantal phones occurring in their speech were basically the same. In a more detailed analysis of the phonetic inventories of these children, Ingram (1981) noted that in word-initial position, more than half of the children had six stops; namely, [b, d, g, p, t, k] two nasals [m, n]. In addition, five of the fifteen subjects produced two fricatives [f] and [s] word-initially. On the other hand, the phonetic inventories word-finally were rather smaller; consisting of the same limited set of sound classes. The phones [p, t, k, n] occurred in more than half of the samples, but [m] occurred in the inventories of six of the fifteen subjects. The predominance of the sound groups of stops, nasals, and glides in children's early meaningful speech has been also apparent and supported by the findings of other longitudinal studies analyzing the speech of a single child as well as the speech of a small group of children (cf. Menn 1971; Stoel-Gammon & Cooper 1984). These studies indicate that some sounds are more difficult than others for children to perceive and produce. Thus, the child will be able to produce some sounds earlier than others, and s/he will also employ some phonological processes that are natural and normal among all languages according to her/his articulation limitations (cf. Donegan and Stampe 2009; Owens 1992; Tobin 2002).

## 5.5 Developmental phonological disorders

Phonological development is the gradual process of acquiring adult speech patterns. The most fundamental work in the field of developmental phonology or child phonology is Jakobson's (1941/1968) *Child language, aphasia, and phonological universals*. This work has inspired much subsequent research. Jakobson's analysis of child phonology has been accepted by PHB in the sense that it views the child acquisition of the distinctive features and phonemes as hypothetical units in the phonological analysis of child language acquisition. Nonetheless, the basic ideas of combinatory phonology with regard to the importance of the human factor in explaining phonology and phonotactics (which are central concepts in PHB) have not been sufficiently considered in Jakobson's theory- Moreover, Jakobson's theory does not consider the level of phonotactics in its explanation (cf. Tobin 1997: 174-178). But despite this, Tobin (1997: 178) describes the theory as one of "the most highly valued approaches to developmental phonology."

Tobin (1997: 174) refers to the Jakobson's claims about the phonological development as summarized by de Villiers and de Villiers (1978: 38-39) as follows:

1. Babbling is essentially unrestricted and bears no relation to the child's later acquisition of adult phonology.
2. Phonological development is best described in terms of the mastery of distinctive features.
3. The child does not approximate the adult's phonemes one by one, but he develops his own system of phonemic contrasts, not always using the same features as adults to distinguish between words.
4. Finally, the pattern of phonological development in all children is systematic and universal.

Developmental phonological disorders have also been referred to in the literature as phonological impairment or phonological disorders interchangeably. These disorders are a group of language disorders affecting children's ability to develop easily understood speech, normally by the time they are four years old. Additionally, phonological disorders could involve a difficulty in some or all aspects of learning and organizing the sounds needed for producing clear speech, reading and spelling. Developmental phonological disorders may sometimes occur in conjunction with other communication disorders as in certain cases of stuttering, specific language impairment, or childhood apraxia of speech.

In observing the speech of children who are less than 5 years old, it would be easily noticed that their speech sounds would not be articulated correctly all the time. In certain cases, it is possible that young children’s speech can be quite difficult to understand because their sound system is not sufficiently organized yet and has not been fully developed as in adult speech. Therefore, children's phonetic, phonemic and phonological development have been analyzed by many researchers, who studied in detail children’s acquisition of individual speech sounds, and the way they typically organize sounds into speech patterns. Table 16 shows the speech intelligibility levels from 18 to 36 months; as cited in Lynch, J. I., Brookshire, B. L., and Fox; D.R. (1980), published in a Parent-Child Cleft Palate Curriculum: Developing Speech and Language. CC Publications, Oregon, page 102. A comprehensive understanding of children's typical development of language is critical, significant and necessary for the speech-language pathologists to distinguish delayed from atypical language development symptoms.

*Table 16: Speech intelligibility from 18 to 36 months.*

| |
|---|
| By 18 months a child’s speech is normally 25% intelligible |
| By 24 months a child’s speech is normally 50-75% intelligible |
| By 36 months a child’s speech is normally 75-100% intelligible |

As implied in children's gradual progress in their speech intelligibility levels, they would be expected to make predictable articulation errors very often (Table 17) (cf. Bowen, C. 1998) before they finally reach the level of acquiring adult speech patterns. These errors and deviations in children's speech while learning the adult sound system are generally referred to as the phonological processes.

The relationship between children's phonological and phonetic development is a rather complex one. For children to develop typical speech patterns, they need to learn both: i.e. the relevant phonetic and the phonological features of their sound system. The professional literature shows that research into children's speech development has mainly explained the phonological patterns; thus explaining the processes of elaborating the speech output into a system of contrastive sound units. However, considerable attention has been devoted to explore how children acquire their motor speech control, thus the relation between children's phonological and phonetic development has been studied. The child's phonological system includes a set of rules operating on a set of phonemes through certain abstract representations that the child builds with reference to the language he is exposed to, including its phonemic inventory, phonotactics, syllable structure, and its phonological processes. This system usually progresses gradually along with other cognitive abilities in the child's typical development through his preschool years (cf. Atkinson-King 1973, Moskowitz 1975).

*Table 17: Phonological processes in normal speech development.*

| *Phonological Process* | *Example* | *Description* |
|---|---|---|
| Context Sensitive Voicing | "Pig" is pronounced as "big" "car" is pronounced as "gar" | A voiceless sound is replaced by a voiced sound. In the examples given, /p/ is replaced by /b/, and /k/ is replaced by /g/. Other examples might include /t/ being replaced by /d/, or /f/ being replaced by /v/. |
| Word-Final Devoicing | "Red" is pronounced as "ret" "Bag" is pronounced as "bak" | A final voiced consonant in a word is replaced by a voiceless consonant. Here, /d/ has been replaced by /t/ and /g/ has been replaced by /k/. |
| Final Consonant Deletion | "Home" is pronounced as "hoe" and "Calf" is pronounced as "cah" | The final consonant in the word is omitted. In these examples, /m/ is omitted or deleted from "home" and /f/ is omitted from "calf". |
| Velar Fronting | "Kiss" is pronounced as "tiss" "Give" is pronounced as "div" "Wing" is pronounced as "win" | A velar consonant, that is a sound that is normally made with the middle of the tongue in contact with the palate towards the back of the mouth, is replaced by a consonant produced at the front of the mouth. Hence, /k/ is replaced by /t/, /g/ is replaced by /d/ and 'ng' is replaced by /n/. |
| Palatal Fronting | "Ship" is pronounced as "sip" "Measure" is pronounced as "mezza" | The fricative consonants 'sh'and 'zh' are replaced by fricatives that are made further on the palate, towards the front teeth. 'sh' is replaced by /s/, and 'zh' is replaced by /z/. |

| *Phonological Process* | *Example* | *Description* |
|---|---|---|
| Consonant Harmony | "Cupboard" is pronounced as "pubbed" "dog" is pronounced as "gog" | The pronunciation of the whole word is influenced by the presence of a particular sound in the world. In these examples: (1) the /b/ in "cupboard" causes the /k/ to be replaced by /p/, which is the voiceless cognate of /b/, and (2) the /g/ in "dog" causes /d/ to be replaced by /g/. |
| Weak Syllable Deletion | "Telephone" is pronounced as "teffon" "Tidying" is pronounced as "tying" | Syllables are either stressed or unstressed. In "telephone" and "tidying" the second syllable is "weak" or unstressed. In this phonological process, weak syllables are omitted when the child says the word. |
| Cluster Reduction | "Spider" is pronounced as "pider" "Ant" is pronounced as "at" | Consonant clusters occur when two or three consonants occur in a sequence in a word. In a cluster reduction, part of the cluster is omitted. In these examples /s/ has been deleted from "spider" and /n/ from "ant". |
| Gliding of Liquids | "Real" is pronounced as "weal" "Leg" is pronounced as "yeg" | The liquid consonants /l/ and /r/ are replaced by /w/ or 'y'. In these examples, /r/ in "real" is replaced by /w/, and /l/ in "leg" is replaced by "y". |
| Stopping | "Funny" is pronounced as "punny" "Jump" is pronounced as "dump" | A fricative consonant (/f/, /v/, /s/, /z/, /ʃ/, /ʒ/, '/ð/ or /h/), or an affricate consonant (/tʃ/or /dʒ/) is replaced by a stop consonant (/p/, /b/, /t/, /d/, /k/ or /g/). In these examples, /f/ in "funny" is replaced by /p/, and /dʒ/ in "jump" is replaced by /d/. |

The current study will compare this general account of the phonological processes in normal speech development (Bowen 1998) with the specific SLI and AMN cases in JA. Therefore, similarities and differences, if there will be any, will be described based on the data in this study.

The child's phonological development depends on his/her gradual acquisition of the phonemic inventory, and the phonotactics of his/her native language. Thus, the child will normally apply the typical phonological processes in his/her mastery of the adult system, thus s/he would eliminate these errors that characterize her/his deviant production form the typical system. The elimination of these phonological processes would usually be noticed by the time the child is five years old (Table 18) (cf. Bowen 1998), although individual variations among children would also be included in this gradual elimination process.

*Table 18: Ages by which phonological processes are eliminated.*

| *Phonological Process* | *Example* | *Gone by approximately Years; months* |
|---|---|---|
| Context Sensitive Voicing | Pig = big | 3; 0 |
| Word-Final Devoicing | Pig = pick | 3; 0 |
| Final Consonant Deletion | Comb = coe | 3; 3 |
| Velar Fronting | Car = tar | 3; 6 |
| Palatal Fronting | Ship = sip | 3; 6 |
| Consonant Harmony | Mine = mime<br>Kittycat = tittytat | 3; 9 |
| Weak Syllable Deletion | Elephant = efant<br>Potato = tato | 4; 0 |
| Cluster Reduction | Spoon = poon<br>Train = chain<br>Clean = keen | 4; 0 |
| Gliding of Liquids | Run = one<br>Leg = weg | 5; 0 |
| Stopping of /f/ | Fish = tish | 3; 0 |
| Stopping of /s/ | Soap = dope | 3; 0 |
| Stopping of /v/ | Very = berry | 3; 6 |
| Stopping of /z/ | Zoo = doo | 3; 6 |
| Stopping of /ʃ/ | Shop = dop | 4; 6 |
| Stopping of /dʒ/ | Jump = dump | 4; 6 |
| Stopping of /tʃ/ | Chair = tare | 4; 6 |
| Stopping of voiceless 'th' /θ/ | Thing = ting | 5; 0 |
| Stopping of voiced 'th' /ð/ | Them = dem | 5; 0 |

The Ages by which phonological processes are typically eliminated by the AMN in JA in the current study can also be compared to the ages in Table 18 as described by Bowen, C. (1998).

The following phonetic developmental norms in Table 19 were established for a population of Australian children by Kilminster, M.G.E., & Laird, E.M. (1978) as quoted in (Bowen 1998).

*Table 19: Normal phonetic development.*

| *Ages by which 75% of children tested in a study accurately used the speech sounds listed in Column 2 in single words.* | *Speech sounds* | *The manner in which the speech sounds are produced* |
|---|---|---|
| 3 years | h as in he | Voiceless fricative |
| | zh as in measure | Voiced fricative |
| | y as in yes | Voiced glide |
| | w as in we | Voiced glide |
| | ng as in sing | Voiced nasal |
| | m as in me | Voiced nasal |
| | n as in no | Voiced nasal |
| | p as in up | Voiceless stop |
| | k as in car | Voiceless stop |
| | t as in to | Voiceless stop |
| | b as in be | Voiced stop |
| | g as in go | Voiced stop |
| | d as in do | Voiced stop |
| 3 years 6 months | f as in if | Voiceless fricative |
| 4 years | l as in lay | voiced liquid |
| | sh as in she | voiceless fricative |
| | ch as in chew | voiceless affricate |
| 4 years 6 months | j as in jaw | voiced affricate |
| | s as in so | voiceless fricative |
| | z as in is | voiced fricative |
| 5 years | r as in red | voiced liquid |
| 6 years | v as in Vegemite | voiced fricative |
| 8 years | th as in this | voiced fricative |
| 8 years and 6 months | th as in thing | voiceless fricative |

The similarities and the differences concerning age of acquisition of speech sounds between Arabic and English as they have been represented in three studies (as cited in Amayreh & Dyson 1998) is of particular relevance to this study and will be also discussed. Amayreh & Dyson (1998) noticed that the age of acquisition of consonants as reported by Prather et al. (1975) were generally earlier than in the case of Arabic and the two other studies of English. Amayreh & Dyson (1998) explained this difference according to the methods used in these studies. The average percentage of the correct productions in two positions was used in Parther's study to determine the acquisition age of each particular phonems. Smit et al. (1990) depended on computing the percentage of all the correct productions of each phoneme by an age group regardless of the position of production. However, Amayreh & Dyson (1998) as well as Templin (1957) considered the factor of achieving the percentage of 75% correct in all positions tested to determine the relevant acquisition age. Amayreh & Dyson (1998) compared the acquisition ages among these four studies (Table 11) and they concluded that the age of acquisition of the Arabic consonants was most similar to the results reported by Smit et al. (1990).

Apart from the previously mentioned typical functional processes in the gradual speech development among children, many speech-language clinicians consider the idiosyncratic processes in Table 20 to be the indicators of the possible occurrence of atypical phonological development (cf. Small 2005).

*Table 20: Phonological processes in abnormal speech development.*

| *Phonological Process* | *Example* | *Description* |
|---|---|---|
| Glottal Replacement | Replacing the “k” sound in the word “pick” with a glottal stop. | The substitution of a glottal stop for another consonant. |
| Backing | “time” pronounced as “kime” “zoom” pronounced as “goom” back in the mouth. | The substitution of velar stops for consonants that are usually produced further back in the mouth. |
| Initial Consonant Deletion | “cut” pronounced as “ut” “game” pronounced as “aim” | When a single consonant at the beginning of a word is omitted, it is called initial consonant deletion. |
| Stops Replacing Glides | “yes” pronounced as “des” “wait” pronounced as “bait” | The substitution of a stop for a glide. |
| Fricatives Replacing Stops | “sit” pronounced as “sis” “doll” pronounced as “zoll” | The substitution of a fricative for a stop. |

According to these indicators, the findings of this study concerning the characterizations of the atypical phonology in JA will be compared with the observations in Table 20.

The process of the typical phonological development of children to develop an appropriate organized speech sound system involves the consideration of three factors: (i) the way the speech sound is stored in the child's mind, (ii) the way the child articulates this sound and (iii) the rules and processes matching these two factors together. Accordingly, the phonological therapy would take these three factors into consideration, along with the fact that children gradually develop their language phonology in order to be able to decide whether children have phonological disorders or not. There is a range of evidence-based approaches to phonological therapy. Not all children with phonological disorders need therapy; in certain cases, some children might have a delayed phonological development, showing certain phonological patterns which are similar to those of younger children having typical age appropriate phonological systems. In this case, these children would simply need more time and practice to catch up with their peers. In other severe cases, especially of having atypical phonological development, children show unique phonological patterns which are different from those of younger or age-matched typically developing children. Children with atypical phonologies need more time and an intensive speech language clinical intervention (speech therapy) to acquire the adult forms of the typical phonological development in their language, though this typical acquisition can not be assured in these cases (cf. Ingram 1978).

In certain cases, it might happen that children with developmental phonological disorders may have other speech and language difficulties such as immature grammar, syntax, stuttering or other difficulties in word-retrieval processes, as a result of their immature systems (cf. Paul and Shriberg 1982; Shriberg et al. 1986). Furthermore, the assessment files show that speech and language disorders may vary in the degree and the symptoms of the disorder. Therefore, in some cases, children may have a developmental phonological disorder, with a clear impairment in their speech clarity in the preschool years, but without any subsequent reading or spelling problems. It is also possible, as Leonard (1985) states that in some cases the phonological impairment would probably delay, or hinder the development in other aspects of the language performance and thus it might cause serious consequences in the child's future achievements.

Some follow-up studies of children with phonological impairment show significant improvement with age. Nonetheless, it is also evident that during adulthood individuals with phonological impairment usually have residual and subsequent problems and might perform below the level of their matched peers with regard to varied speech, reading, spelling and phoneme awareness skills. Furthermore, other assessment and follow-up studies have referred to certain cases where children-after overcoming their developmental phonological disorder-continued to show other difficulties. These studies show that although the speech of these children might sound quite normal and more intelligible at a certain point, they might sometimes appear to have subsequent reading and spelling problems. These children might have a noticeable general slowness in acquiring the pre-literacy skills that are required to enable them to read fluently, to understand, to spell, and to produce written work. Considerable research has been done to examine these subsequent consequences and it has been found that SLI children generally show poor phonological awareness accompanied with poor metalinguistic ability. This general feature can be further explained, it means that based on their phonological awareness, they would definitely have poorer ability to recognize and manipulate the sounds and syllables to form words as in the adult system. This will lead to a poorer metalinguistic capacity to think, talk and use the language when those SLI children will be compared with typically developing children (cf. Lewis and Freebrain 1992).

Moreover and as has been previously discussed, phonological speech disorders have been referred to in the literature as functional articulation disorders, and thus the relationship between these disorders and the child's learning of the fundamental school skills was not well recognized and considered. Children with functional articulation disorders were treated in a way that mainly concentrated on their difficulties in the articulation of speech sounds, thus the traditional articulation therapy was only directed to remedy the child's articulatory problem. Oller (1973) states that children demonstrating simple speech-sound difficulties such as lisping (saying ‘th’ instead of ‘s’ and ‘z’), or those having problems in glide articulating ‘r’, ‘l’ or in ‘th’ without any noticeable organic reasons are usually described as having functional speech disorders.

Developmental phonological disorder, on the other hand, is not merely a new term referring to well-known old articulatory problems, but it is another approach reflecting the influence of the psycholinguistic perspective especially on the way that speech-language clinicians now understand and treat these phonological disorders. Pollock and Rees (1972:453) point out that:

> The speech of the child who makes phonemic errors, predominantly, reflects his inadequate or deviant phonological system rather than his ability to plan or execute selected articulatory movements.

Therefore, Pollock and Rees (1972) conclude that children with functional articulation disorders show phonemic rather than phonetic errors. Moreover, when children have phonological disability, they would be able-in most cases-to produce all the sounds needed for clear speech, thus they would not be diagnosed as having articulation problems or motor speech disorders. However, in certain cases children might have together with their obvious developmental phonological disorders other difficulties in their motor control and/or motor planning for speech.

In traditional articulation therapy, behavioural methods will be followed and applied in teaching children how to correctly articulate the sounds that have earlier been either omitted or not produced correctly in their speech. This articulatory therapy will first focus on articulating each sound separately, then gradually introduce the new correctly produced sounds into longer and longer utterances, until the child would be able to correctly produce this sound in his normal spontaneous conversational speech.

Despite the fact that traditional articulation therapy is appropriate for treating cases with speech articulation difficulties such as in lisping, it is found to be unsuitable in treating children with developmental phonological disorders. Instead, speech and language clinicians usually apply phonological principles in their treatment and intervention to remedy and help children with phonological disabilities. The definition states clearly that phonological therapy is based on the systematic nature of phonology. Phonological therapy employs and applies conceptual activities, rather than the *motoric* activities, which are followed in the functional articulatory therapy techniques, to facilitate the development of age-appropriate phonological patterns. This therapy maintains generalizations as its basic and fundamental goal in helping and encouraging the overall development of the appropriate cognitive structure and organization of the child's underlying phonological system.

## 5.6 Summary

The diagnosis of phonological disorders depends on many factors, but the age of the child seems to be a highly important factor. Children might have speech production difficulties that are considered part of their typical language development for their age. In some cases, children might be eight years old, and they are still making the same errors as in a typically developing four year old child. In this latter case, these children would be diagnosed as possibly having phonological disorders. Research has shown that children with phonological disorders may produce the same speech sound errors as the younger typically developing children; however, sometimes they might demonstrate more instances of omissions, substitutions, and distortions in their speech patterns.

Moreover and it has been reported previously, cross-linguistic studies indicate that children with phonological disabilities nearly follow the same pattern and the same order of speech sound acquisition as in typically developing children. However, they develop their speech sound skills more slowly. This comparison clearly explains how age plays an important role in determining the accurate diagnosis of phonological disorders. It is generally recommended in the diagnosis of phonological disorders that the physician would examine if there are some other possible causes and explanations for the signs and the symptoms displayed in the child's speech. Furthermore, the child's hearing should be tested, because if the child is having hearing difficulties, then speech sounds that are not heard well can not be correctly imitated and acquired. It is also recommended to examine the children's reading comprehension especially in relation to their school-age to have an accurate diagnosis of any other accompanying language disorders that might occur in addition to the phonological disorder.

Statistically speaking, phonological disorders of unknown causes or origin are considered more common than the phonological disorder that is caused by neurological or other structural abnormalities. It has been estimated that around 7-8% of children at the age of five years old might have a phonological disorder without any obvious cause, and about 7.5% of the children in the age range of three to eleven are likely to show symptoms of developmental phonological disorder. It has been also noticed that phonological disorders are more common among boys than girls; two to four times as many boys as girls is the approximate rate of probability of having phonological disorders between both sexes.

The analysis that will be presented in CHAPTER 7 and CHAPTER 8 will be an application of and even addition to these theoretical views and the experimental descriptions concerning the typical and the atypical speech cross-linguistically. Therefore, this study aims at providing a further account of typical/atypical phonological development in general and in particular to add JA to the descriptions that have been presented on the phonology of child speech in other languages.

# CHAPTER 6 The study: design and methods

## 6.1 Introduction

This study is concerned with the empirical issues in the analysis of SLI in the speech of a sample of JA-speaking children. This study further aims at developing diagnostic tools for assessing the developmental status of the phonological processes in the child's atypical speech based on the chronology of the development of these processes in typically developing children. This research also aims at providing a sound linguistic basis for this atypical phonological development. The theoretical linguistic basis for the study is taken from NP and PHB. Additionally, one of the theoretical goals is to provide a description of applying the principles of NP and PHB into the domain of distinguishing the delayed from the atypical development in JA.

Therefore, this study provides a source of descriptive information on early developing phonological systems by presenting such a description for typical and atypical systems in JA. Specific properties of these linguistic-phonological systems could be used for a comparison, showing the similarities and differences within and across these SLI and typically developing children. Therefore, efforts are made in this study to contribute to providing further descriptions of both typically acquired and atypical systems in JA. This study specifically describes the natural phonological processes in the speech of seven children who have been previously diagnosed on the basis of standard medical evaluation and hearing tests as having SLI. These natural phonological processes are analyzed, and compared with the processes in the speech of age-matched typically developing (AMN) children to characterize their phonological disability.

Arabic-speaking misarticulating children in the age range 4-10 years will form the subjects of this study. These SLI children have been selected from speech and hearing centres in Amman, the capital city of Jordan and Irbid city[16].

## 6.2 Previous work

Very few studies have been conducted in the filed of the phonological disorders in JA. A comparison between the work in this study and the previous studies will be presented in the following section. The comparison will include summaries of the previous studies with regard to: (a) the problem addressed, (b) the theory and (c) the methods that have been used as well as (d) the results that have been found in these studies.

### 6.2.1 Sound changes in Arabic-speaking typically developing children

Amayreh and Dyson (2000a) analyzed the articulation/phonological errors and sound changes in fifty Arabic-speaking typically developing children aged between 2;0 and 4;4. To elicit the samples, a picture naming articulation test representing all the initial, medial and final consonants of MSA has been used(cf. Amayreh, 1994). The recordings were transcribed following the consensus procedure of Shriberg, Kwiatkowski and Hoffman (1984). For this analysis, Amayreh and Dyson (1994) adopted the Logical International Phonetics Programs, LIPP (cf. Oller and Deglado 1990) for the phoneme inventory count, substitution analysis and the identification programs of the patterns of the phonological processes in both English and Arabic. Furthermore, Amayreh and Dyson (2000a: 82) distinguished between the acceptable forms, errors and changes in JA as follows:

1. Acceptable refers to productions of some consonants that do not match Educated Spoken Arabic (ESA) forms, but that are acceptable as dialectical variants in Jordan.
2. Errors are productions that are neither ESA nor acceptable; i.e. that would not be used by normal-speaking adults even in casual speech.
3. Changes from ESA refer to all productions that do not match ESA forms and combine productions that are acceptable as well as others

16 Irbid is one of the main cities in the north of Jordan

that are true errors.

Amayreh and Dyson (2000a) calculated in their study the percentages of the consonants that are articulated in an unacceptable manner and the percentages of the consonants that have been changed from ESA. This analysis aimed at describing the effect of these sound changes and errors on classes of consonants and at discovering the phonological processes that characterize these two types of sound changes. Amayreh and Dyson (2000a) summarized the accuracy in the production of the consonants as being *the most difficult* when the production of the sounds involved changes or errors more than 75% of the time, and as being *unstable* for those production errors that occurred in 51%-75% of the production. The term *emerging* described the changes and errors that occurred between 26% and 50% of the time, while the term *the least difficult* referred to the changes and errors that occurred in (less than 25%) of the consonants' productions.

According to these classifications, Amayreh and Dyson (2000a) found the following:

1. that the most difficult consonants for the youngest children were the three emphatic stops (/q/, /dˤ/, and /tˤ/), the two emphatic fricatives (/ðˤ/, and /sˤ/), the two dental non-emphatic fricatives (/θ/, and /ð/), and /r/;
2. the least difficult consonants were the three stops (/b/, /t/, and /ʔ/), the two nasals (/m/ and /n/), two of the back fricatives (/ħ/ and /χ/) and /l/.
3. The voiceless uvular stop /q/ has been found to be a difficult consonant for the oldest children in the age group (4;0- 4;4);
4. for all ages, the most frequent changes were those of voicing difficulties.
5. The most accurate productions were nasals and non-emphatic stops.
6. Emphatic consonants were the least accurate followed by the fricatives and the glides in the scale of difficulty.

Amayreh and Dyson (2000a) further shows that de-emphasis occurred in 50% of the productions, while stridency deletion and lateralization of /r/ occurred at 25-50%. The authors noticed that syllable reduction, final consonant deletion, consonant sequence reduction, fronting, final devoicing, initial voicing and stopping have been less frequently applied among their sample, as they occurred between 1-24% of the time.

Moreover, Amayreh and Dyson (2000a) found that articulatory difficulty is the explanation for the articulation/phonological errors and sound changes in the production of the emphatic consonants, consonant sequences and lateralization of /r/. They also explained that the “unexpected” early accuracy of back fricatives and /l/ as being a result of the high frequency and the high functional load of these sounds in Arabic, this tendency has been observed by the ease of articulation of these sounds among young children. Contrary to that accuracy, the authors also noticed that de-emphasis - which is a simplification pattern applied by children while producing such difficult sounds through deleting the secondary articulation - occurs due to the low frequency and the low functional load of emphatic consonants in Arabic.

### 6.2.2 Phonological impairment in Arabic-speaking children

Mitleb (1987a) provided a thorough phonetic analysis of a sample of twenty Arabic-speaking misarticulating children examining the phonological process of substitution as applied by those children. In this analysis he provided seven rules of the process of substitution, thus supporting the approach of GP and agreeing at the same time with Jackobson's theory of the natural order in which the child acquires his phonetic inventory.

Mitleb (1992) examined in his study, within the framework of GP, the variability of the misarticulations of two JA-speaking children. This study uses the same analytical approach used by Gierut in analyzing the misarticulations of children learning English (cf. Gierut 1984, 1985). Speech samples were collected using a picture naming elicitation task as well as naming friends and family members. Additionally, Mitleb (1992) included spontaneous speech samples in his study through asking questions and following the conversational style with the two females who formed the study-sample. Mitleb (1992) assumed in this study that SLI children do have an identical knowledge to that of the relevant ambient speech, thus those children are considered to be a homogeneous group and any discrepancy in between will be considered as a process (cf. Shriberg & Kwiatkowski 1982). Moreover, violations of the markedness theory have been noted in this study, more specifically, regarding voicing in the speech of the sample. Accordingly, Mitleb (1992) claims that it is the violations of the markedness principles that characterize the functional speech misarticulations. These disorders might result of non-ambient underlying representations and constraints being placed in the child's phonetic inventory, thus restricting his ability of producing certain consonants found in the typical speech (cf. Gierut 1984, 1985). On one hand, Mitleb (1992) agrees to a certain extent with the two possible explanations for such errors as posited in (Gierut1984). The author states that despite having ambient-like underlying representations, the presence of such production errors might be due to either one of the following two possible explanations; namely,

> "First, the child may have ambient underlying representations in some positions, but not in others... A second factor accounting for production errors is the child's use of rules altering ambient-like underlying representations (Gierut 1984: 188-190)."

On the other hand, Mitleb (1992) noticed the difficulties that will be encountered in characterizing the functional misarticulations depending on these two factors as suggested by Gierut (1984). Additionally, he criticized this approach as being too costly regarding the need for many phonological rules and features to describe and explain these misarticulations. Most importantly, Mitleb (1992) claims that it is the deviant phonological system that shows such markedness violations, but other errors are to be classified as delayed systems (cf. Connell 1982). In the same study, it has been stated that these misarticulations also show some violations of the typological universals proposed by Dinnsen and Eckman (1975). These violations are represented in the case when the child applies devoicing word-initially or stops voicing word-medially and finally, but not initially as well as substituting /ħ/ for /ʕ/ only word-medially while keeping the phonetic contrast in other positions.

In applying the generative framework in this study, Mitleb (1992) claims it to be a more neutral framework in characterizing the variations among misarticulators. Moreover, within this framework, the author finds no fundamental role to be assigned to markedness in the order or ease of acquisition in the phonological systems of the SLI children. Finally, on the remedial level, Mitleb (1992) concludes his study by stating that it will be easier for SLI children to learn the sound contrasts they have knowledge of than the sounds they have no knowledge of (cf. Dinnsen and Elbert 1984, Mitleb 1987).

## 6.3 Methods and procedures

The descriptive developmental approach to language disorders has been used in this study. Accordingly, SLI in JA-speaking children has been described rather than classified into categories based on their causes or aetiology. Consistent with the purpose of this study, children's articulatory abilities have been tested to elicit the necessary data by using a picture-naming articulation test as it is represented in Table 21:

*Table 21: Test words (Amayreh and Dyson 1998)*

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| /b/ | /ba.ˈna:t/ girls | /ħi.ˈba:l/ ropes | /dub/ bear |
| /t/ | /ta.la.ˈfawn/ telephone | /mif.ˈta:ħ / key | {/ba.ˈna:t/}*[17] |
| /t/ | /tˤa:.ˈja:.ra/ or /ˈtˤa:.ʔi.ra/ airplane | /ˈma.tˤar/ rain | /batˤ/ ducks |
| /d/ | {/dub/} | /ˈmad.ra.sa/ school | /ˈwa.lad/ boy |
| /dˤ/ | /ˈdˤif.dˤaʕ/ frog | /ˈbaj.dˤa/ egg | /ˈʔab.jadˤ/ white |
| /k/ | /ˈkur.si/ chair | /ˈsa.ma.ka/ fish | /ʃub.ˈba:k/ window |
| /q/ | /ˈqa.lam/ pencil | /ˈba.qa.ra/ cow | /ˈwa.raq/ paper |
| /ʔ/ | /ˈʔa.sad/ lion | /ru.ˈʔu:s/ heads | _____ |
| /m/ | /mawz/ banana | {/ˈsa.ma.ka/} | {/ˈqa.lam/} |
| /n/ | /na:r/ fire | /ˈʕi..nab/ grapes | {/ta.la.ˈfawn/} |
| /f/ | /fi:l/ elephant | /sa.ˈfi:.na/ ship | /χa.ˈru:f / sheep |
| /θ/ | /θal.ˈla:.dʒa/ refrigerator | /mu.ˈθal.laθ/ triangle | {/mu.ˈθal.laθ/} |
| /ð/ | /ˈða.nab/ tail | /dʒu.ˈðu:r/ roots | _____ |

17 Words in which more than one sound are tested are repeated here under both target sounds, with the second occurrence in {}. The child needs to produce them just once.

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| /ðˤ/ | /ðˤahr/ back | /naðˤ. ˈðˤa:.ra/ glasses | /ˈħa:.fiðˤ/ boy's name |
| /s/ | /ˈsa:.ʕa/ watch | {/ˈʔa.sad/} | /ˈdʒa.ras/ bell |
| /sˤ/ | /ˈsˤu:.ra/ picture | /ˈħi.sˤa:n/ or /ʔiħ. ˈsˤa:n/ horse | /ba:sˤ / bus |
| /z/ | /za.ˈra:.fa/ giraffe | /ɣa.ˈza:l/ deer | /ʁa:z/ oven or stove |
| /ʃ/ | {/ʃub.ˈba:k/} | /fa.ˈra:ʃa/ butterfly | /ʕuʃ/ nest |
| /χ/ | {/χa.ˈru:f/ } | /ˈʔaχ.dar/ green | /ˈbatˤ.tˤi:χ/ watermelon |
| /ʁ/ | {/ʁa.ˈza:l/} | /ju.ˈʁas.sil/ or / ˈjaɣ.sil/ wash | _____ |
| /ħ/ | {/ħi.ˈsa:n/} | /tuf.ˈfa:.ħa/ apple | {/mif.ˈta:ħ/} |
| /ʕ/ | {/ˈʕi.nab/} | {/ˈsa:.ʕa/} | /ˈʔisˤ.baʕ/ finger |
| /h/ | /ha.ˈdij.ja/ gift | /zu.ˈhu:r/ flowers | /wu.ˈdʒu:h/ faces |
| /dʒ/ | /ˈdʒa.mal/ camel | /da.ˈdʒa:dʒ/ chicken | {/da.ˈdʒa:dʒ/} |
| /l/ | /laj.ˈmu:n/ lemon | /ˈta:.wi.la/ table | {/fi:l /} |
| /r/ | {/ru.ˈʔu:s/} | {/ˈba.qa.ra/} | {/na:r/} |
| /w/ | {/ˈwa.lad /} | /mar.wa.ˈħa/ fan | _____ |
| /j/ | /jad/ hand | {/ˈʔab.jadˤ/} | _____ |

Using this test enabled the researcher to examine the children's phonological development and their articulation proficiency of the Arabic-consonants as pronounced in ESA in Jordan Table 8.

The data collected from SLI children while articulating separate words in naming the relevant pictures, and by carrying out another narrating task suitable for older subjects, enabled the researcher to observe their general language articulatory and expressive skills. The children in this study were not aware that their responses were audio-taped. The probe samples the twenty eight Arabic consonants in word-initial, medial, and final positions. The language that has been investigated in this test ESA; moreover, JA has been included in this analysis. These words have been sufficiently chosen from the subjects' ambient language. Therefore, the test words would be familiar to the children and easy to read. Each subject has been tested using an appropriate hearing screening test in the clinic to ensure that s/he has no organic causes for the impairment.

The sample in this study has been chosen with reference to the relevant speech and language evaluation report that has been used as a part of the diagnosis and therapy process at the speech clinic. This medical report includes details about the purpose of the evaluation, history and behavioural observation, environmental considerations and dialectal patterns, the child's hearing, speech assessment, articulation and phonological competence, oral peripheral exam as well as the child's language assessment regarding both expressive and receptive skills. The report ends with the diagnostic impressions and the recommendations that are needed to help the child to learn to accurately speak and use the language. The assessment also includes the child's typical developmental milestones. These reports have been referred to in order to choose the SLI children that have been medically diagnosed as not having any organic problem.

The characterization of the SLIin JA will be drawn depending on the results of this work and with reference to the natural sequence of development according to which those children are expected to be acquiring JA speech sounds. Therefore, the reference to the analysis of the phonetic inventories of young Arabic-speaking children between the ages of 14-24 months (cf. Amayreh and Dyson 1998) will be very relevant and necessary in the analysis of AMN children in this study.

## 6.4 The experimental design

### 6.4.1 The descriptive-developmental approach

McCormick and Schiefelbusch's (1984: 36) perspective explains the reason for choosing the descriptive-developmental method as the methodological framework in this study, McCormick and Schiefelbusch (1984: 36) state:

> "There is every reason to think that children with deficient language: (a) need language learning experiences as rich as those provided normal

> language users, (b) will attend to, understand and talk about many of the same objects, events and relations as typical learners, and (c) want and need to experience the same control over their environments as their more competent peers at the same stage of development."

Therefore, in using the Descriptive-Developmental approach, the researcher has been describing and comparing the SLI children's ability to articulate the Arabic speech sounds with that of the AMN children. That is justified as in this approach linguistically-disabled children are thought of as typically developing children in their need to learn the language.

### 6.4.2 Data collection methods

The samples have been collected by two methods, thus they are either in single words form or in the form of connected speech depending on the age of the children. This data have been annotated using the PRAAT phonetic workbench, first at a broad phonetic level, then at the narrow phonetic level for selected extracts. These transcriptions have been then analyzed both ways; quantitatively and qualitatively. The sample has been analyzed within the framework of the theories of NP and PHB. To reiterate: NP was initiated by David Stampe in 1969 and more explicitly in 1979. In this view, phonology is based on a set of universal phonological processes which interact with one another. This framework suits the current analysis of SLI phonological processes in JA as according to Stampe (1973a: 1) a natural phonological process is defined and described as "a mental operation that applies in speech to substitute for a class of sounds or sound sequences presenting a specific common difficulty to the speech capacity of the individual, an alternative class identical in all other aspects but lacking the difficulty property." Accordingly, natural processes are considered to be natural and automatic responses of speakers to the articulatory and the perceptual difficulties which speech sounds or sound sequences present to their users. Accordingly, a detailed analysis of the data has been performed to examine the sound errors and the phonological patterns existing in the speech of the SLI children in JA. Then the frequencies of these phonological processes have been computed to find out the most frequent processes adopted by the SLI children as well as the less frequent processes in this speech. The final results have been discussed in light of the theoretical implications related to language universals, language acquisition and language development within the frameworks of NP and PHB.

In applying the descriptive-developmental approach, an evaluative analysis has been performed to describe the phonetic inventory of each child in the sample, along with the error analysis of the child's phonological patterns. By applying this approach, it has been possible to identify the strength and the weakness and the aspects of difficulty of SLI children in JA.

In conclusion, this analysis might form a basis towards setting the speech therapy goals and the evidence-based intervention phonological development strategies. Moreover, this study will provide a descriptive profile of the SLI systems in JA by stating what the SLI children can and can not do in their use of language in an attempt to describe their language behaviours and to identify those areas that need therapy and to set the relevant aims of remediation through a suitable therapy plan.

## 6.5 The study

### 6.5.1 Goals overview

As far as this study is a descriptive analysis of SLIin JA-speaking children, a field study for this research has been required to evaluate the methodology. In this study, the developmental phonological processes in the SLI speech have been assessed and analyzed.

During the data collection different clinics have been visited, namely: The Centre of Phonetics Research-University of Jordan, the departments of: Audiology and Speech Pathology-Jordan University of Science and Technology; Speech Pathology and Audiology in the American Middle East University-Amman, the Queen Alia Association for Speech and Hearing, and Royal Medical Services-Farah Rehabilitation Centre. More specifically, the sample in this study have been collected at three speech and pathology centres in three weeks-time to evaluate the methodology of applying the single-word picture-naming articulation test (cf. Amayreh and Dyson 1998) and the narrating style as effective methods in providing the accurate descriptive information about the child's phonological development.

### 6.5.2 Objectives of the field study

The field study reported here aims at observing the differences in the phonological processes between the AMN and SLI children in JA. The analysis starts by observing the patterns of the chronology of the phonological processes in the typical development of four (2-5) years old JA-speaking children. These patterns are fundamental in evaluating and assessing the phonological abilities of the seven members of the (4-7) years old SLI population and in identifying their deviations from the typical expected patterns in JA.

The analysis aims to provide a functional explanation of the phonological processes of SLI children with reference to NP and PHB principles. This study will summarize the phonological characteristics of this atypical speech in order to be accounted for and considered as the symptomatology of phonological disorders in JA. More specifically, this analysis aims at specifying the nature of the phonological characteristics of this particular disability. Therefore, this analysis tests the hypothesis of this study; namely, that the phonological processes in the SLI in JA are not different from those processes in AMN children, and that SLI children would apply the same phonological processes as their AMN children counterparts. Therefore, this hypothesis claims that there are no phonological differences between typical acquisition, delayed acquisition and the impaired/atypical acquisition in JA.

Therefore, and in order to test the hypothesis of this study, this analysis aims to specify whether these phonological processes in the SLI participants' productions are lenitions or fortitions in the nature of their application as well as with reference to their functions according to the NP simplification and reduction-definition criteria. This study aims to specify the nature of the phonological system in SLI children and its relation to the phonological system in the AMN children in JA to test this hypothesis.

### 6.5.3 Brief timetable

The field work in Jordan has been organized in a way that is represented in Table 50 in order to collect the necessary representative data to fulfil the aims of this study.[18]

18 See appendix A for further information about the visits to the speech pathology centres in Jordan

### 6.5.4 Activities description

During the first week, contacts with the clinical speech and hearing centres have been set up and appointments in the second week have been fixed. Generally speaking, this data collection work was in three clinical centres in three universities namely: University of Jordan in Amman; the capital city and Jordan University of Science and Technology and Al-Yarmouk University in Irbid city and one state hospital; Al Hussein Medical Care Centre, in Amman.

These centres have been visited to set up appointments, filling in the formal applications to get the formal acceptance and approval to work there and consult the specialists working there. After these meetings and discussions, the formal procedures that need be done in the field work have been arranged. Moreover, a training and diagnosis session at the speech clinical at the University of Jordan has been attended during the treatment of a six-year-old girl with a cleft palate.

#### 6.5.4.1 Kinds of meetings

Al Hussein Medical Centre, in Amman has been visited during this field work for discussion and consulting physicians, PhD holders, specialists and consultants in speech pathology. The field study has been supported, thus through the cooperation and the help with the speech clinicians at this centre, all the needed facilities have been provided to work at the clinic, and to record the SLI cases.

These discussion with the clinicians at this centre showed the lack of the existing data on the morphological and the syntactic analysis of typical and atypical speech in JA. Therefore, these areas would be considered in future research.

Furthermore, Al-Yarmouk University in Irbid has been visited to consult useful references about the phonology and the morphology of the Arabic language, and differences between ESA and JA. These distinctions form this bases for the analysis of the data in this study.

#### 6.5.4.2 Kinds of recordings

Most of the data for this analysis have been collected at the pathology centre at Jordan University of science and technology in Irbid city.

The field work at the speech clinic in King Abdulla Educational Hospital in Jordan University of Science and Technology was very important. The families of the SLI cases have been contacted and special sessions have been arranged for the purpose of recording the data for this study. It is important to mention that the the medical reports have been consulted to choose only the children who are having functional articulatory disorders. Accordingly, the appointments have been set at the clinic. The data have been recorded by testing the SLI cases using varied techniques, depending on the linguistic competence of each SLI child as follows:

1. The easy way to make my first words- learning real fun- Arabic flashcards, 2006 Rabie children Books, Amman, Jordan.
2. Early objects pocket colour cards. Super Duper publications, Greenville, USA.
3. Action pictures highlighting the use of the descriptive adjectives emphasizing appearance differences.
4. Photo Phonology, minimal pair cards with their colourful, realistic photos as an essential tool for phonological therapy, 2003 Super Duper publications.
5. Webber classifying cards, 2000 super Duper publications:
   - Classifying animals.
   - Classifying things to wear.
   - Classifying items round the home.
6. *My Arabic encyclopaedia in photos* for children in the age range from 1-4 years old. The Educational Institution for Enhancing and Developing the Child's Talents, Damascus, Syria, representing:
   - The human body parts.
   - My family.
   - Household objects.
   - Kitchen objects.
   - My colours.
   - My clothes.
   - Fruit and vegetables.
   - Shapes.

- Animals.
- Means of transport.
- Jobs.
- Opposites.

7. Varied colourful toys representing household and kitchen objects to motivate the children who are shy to bring them into the play to let them talk and describe the objects they see and the activities that they are doing.

An account of the typical phonological development in JA was needed after collecting the representative data from the SLI children in JA. Accordingly the final step in the data collection stage was to look for typically developing children, to contact their families and to record them. Therefore, these latter recordings have helped in providing an account of the typical development as a basis for the comparison and the diagnosis in this study. Accordingly, the same articulation test has been used to elicit recordings from the typically developing children as has been used earlier with the SLI children at a selection of different ages, for example: 2 years, 3 years, 4 years and 5 years.

### 6.5.5 Summary of the methodological design

A systematic relatively small scale corpus was created. Advanced statistical results are not possible on this small corpus, but initial theoretically motivated questions have been sharpened by close analysis of the corpus. Corpus designing, collecting, recording and storage have been carried out according to the recommendations of the "Spoken Language Corpus chapter" Gibbon et al. (1997) proposed by the Expert Advisory Group on Language Engineering Standards (EAGLES). Accordingly, these recordings based on different kinds of systematic elicitation were used: about 10 minutes each of speech from four AMN children, two males and two females, in the age range 2 to 5 years old were recorded. Additionally, about 20 minutes each of speech from seven SLI children, 6 males and one female, in the range 4 to 7 years old were recorded. Longer sessions were necessary with the SLI children because of temporal properties of the impairments, the need for somewhat different test types, concentration problems and the need to provide motivating breaks and to maintain a friendly atmosphere as well.

For the AMN children, spontaneous narration plus single word articulation tests were used to collect data on all the Arabic consonants in word initial, medial and final positions (following the study of Arabic consonant acquisition by Amayreh & Dyson 1998) in Table 21. For the SLI children, the same procedures were used, plus flash card sets routinely used in the clinics where children have been treated, selected from five different flash card sets by different authors. In addition, two further types of stimulus were used: first, an Arabic encyclopaedia for children from 1 to 4 years old, focusing on human body parts, family, household objects, kitchen objects, colours, clothes, fruit and vegetables, animals, shapes, means of transport, jobs, and selected opposites. Second, various colourful toys representing household and kitchen objects were used as well. Following the list of the recommendations and standards in Gibbon et al. (1997: 170-172), the recordings were annotated using the PRAAT phonetic workbench, first at a broad phonetic level, then at the narrow phonetic level for selected extracts as “this level, the narrow phonetic transcription, of representation will be far more accurate as a record of what was said.” (Gibbon et al. 1997: 160). The analysis of these recordings is presented in CHAPTER 7 and CHAPTER 8 .

# CHAPTER 7 The study: phonological processes in AMN children

## 7.1 Introduction

As has been explained in CHAPTER 6 the corpus designing, collecting, recording and storage have been carried out according to the recommendations of the "Spoken Language Corpus chapter" Gibbon et al. (1997) proposed by the Expert Advisory Group on Language Engineering Standards (EAGLES). Accordingly, the recordings based on different kinds of systematic elicitation tasks were used: about 10 minutes each of speech from four AMN children (They will be referred to as A1, A2, A3, A4), two males and two females, in the age range 2 to 5 years old were recorded.

For the AMN children, spontaneous narration plus single word articulation test (Table 21) were used to collect data on almost all the Arabic consonants in word initial, medial and final positions (following the study of Arabic consonant acquisition by Amayreh & Dyson 1998).

Following the list of the recommendations and standards in Gibbon et al. (1997: 170-172), the recordings were annotated using the PRAAT phonetic workbench, first at a broad phonetic level, then at the narrow phonetic level for selected extracts.

In this particular chapter, the description of the typical development of the Arabic consonant sound system in four developmental stages from two years old to five years old is presented. The sample has been collected from recording four typically developing children; two boys and two girls as previously mentioned. This description has been established after hearing the recordings several times, examining the development of the phonetic inventory in each stage in word initial, medial and final position, and transcribing all the present allophones, as well as the substitution processes found in the recorded data. Therefore, for each developmental stage two profiles will be presented representing the phonetic inventory and the substitution patterns in this relevant stage. One representative example of each sound articulated in each position will be provided in the narrow phonetic transcription. Moreover, the representative examples of the child's articulations have included the dialectical forms (JA) as this analysis is supposed to examine the acquisition of the child's mother tongue.

The typical acquisition of the Arabic consonant sounds in these recordings will be analyzed in comparison to the findings in (Amayreh & Dyson 1998) in their study on ''The Acquisition of the Arabic Consonants''. Around 87 productions for child in each stage have been included, examined with the PRAAT analysis for the duration of these productions, and thus transcribed to provide an accurate representation of the status of each child's speech development. Additionally, description of the main findings regarding the chronology and the patterns of the phonological processes will be explained in the following section in comparison with previous relevant studies in JA, more specifically with the findings in (Amayreh & Dyson 1998).

## 7.2 The phonetic inventory and substitutions in AMN children

### 7.2.1 A1: Two-year-old child

The examples in Table 22 and Table 23 represent the phonetic inventory along with the sound substitutions in the two-year-old stage:

*Table 22: The phonetic inventory of a two-year-old*[19]

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| [b] | [ˈbi.nit] a girl | [ˈbaa.ba] dad | [ˈtʰab̥] dog |
| [t] | [ˈtʰaa.ʕa] watch | [ˈχat.tʰih] pillow | [ˈwa.lat] boy |
| [tˤ] | | [ˈbatˤ.tˤah] duck | |
| [d] | [ˈdaa.dih] chicken | [ˈwad.dih] rose | |
| [dˤ] | | | |

19 The empty cells mean that no representative examples have been found in the recordings.

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| [k] | [ˈkʰwaj.jis] fine | | |
| [q] | | | |
| [ʔ] | [ˈʔʰaɱf] nose | [ˈʔʰb.ba.ʔah] four | [ˈlaʔ] no |
| [m] | [ˈmaħ.ħa.ba] heloo | [ˈmaa.ma] mom | [ˈnũm] mouth |
| [n] | [ˈnũm] mouth | [ˈʔʰaɱf] nose | [ˈtʰa.ħin] plate |
| [f] | [faj.ˈjaa.ʤih] refrigerator | | [ˈʔʰaɱf] nose |
| [θ] | | | |
| [ð] | | | |
| [ðˤ] | | | |
| [s] | | [ˈʕas.sih] goat | [ˈtʰaas] glass |
| [sˤ] | | | [ˈbaasˤ] bus |
| [z] | | [ˈʔʰuw.zih] bannana | |
| [ʃ] | [ˈʃaʕ.ɬah] one hair | [ˈfal.ʃih] mattress | [ˈʔid.dijʃ] I dont want |
| [χ] | [ˈχjaa.ɬa] cucumber | | |
| [ʁ] | [ˈʁaas] head | | |
| [ħ] | [ˈħa.lijb̥] milk | [ˈtʰa.ħin] plate | [ˈluwħ] go away |
| [ʕ] | [ˈʕas.sih] goat | [dij.ˈʕããn] hungry | [ˈtʰuwʕ̥] Jesus |
| [h] | [ˈhajn] eye | [ˈɬah.ɬa] flower | [ˈbatˤ.tˤah] duck |
| [ʤ] | | [ˈʁiʤ.ʤij] my leg | |
| [l] | [ˈlaat] Malaak, angel, a girl's name | [ˈbaj.ɬah] egg | [ˈtʰaa.mil] a boy's name |
| [ɻ] | [ˈɻa.ba.ga] nick | | [ˈʔʰi.diɻ] leg |
| [w] | [ˈwa.lat] boy | [ʔu.ˈwaa.ħah] apple | [ˈʔum.muw] his mother |
| [j] | | [tʰaj.ˈjaa.ɬah] airplane | [ˈbaaj] goodbye |
| [g] | [ˈga.ɬãm] pencil | [ˈɻa.ba.ga] nick | |

*Table 23: Substitutions in the phonetic inventory of a two-year-old*

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| [b] | [ʔ] [ˈbad.dijʃ] as [ˈʔid.dijʃ] I dont want | [s] [ˈχub.zih] as [ˈχus.sih] bread | |
| | [h] [ˈba.tˤin] as [ˈhʰam.min] belly | | |
| [t] | [ʔ] [tuf.ˈfaa. ħa]as [ʔuw.ˈwaa.ħah] apple | | |
| [tˤ] | [m] [ˈba.tˤin] as [ˈhʰam.min] belly | | |
| [d] | [t] [ma.ˈχad.dih] as [ˈχat.tih] pillow | | [t] [ˈwa.lad̥] as [ˈwa.lat] boy |
| [dˤ] | | [ɬ] [ˈbaj.dˤah] as [ˈbaj.ɬah] egg | |
| [k] | [t] [ˈkʰalb̥] as [ˈtʰab̥] dog | [t] [ˈkʰaj.kah] as [ˈtʰaj.tah] cake | |
| [m] | [Ø] [ma.ˈχad.dih] as [ˈχat.tih] pillow | | |
| | [ʔ] [ˈmuw.zih] as [ˈʔʰuw.zih] bannana | | |
| [n] | [m] [ˈʁa.na.mih] as [ˈkʰa.ma.mih] goat | | |
| [f] | [t] [ˈfaa.dij] as [ˈtʰaa.dij] boy's name | [w][tuf.ˈfaa. ħa] as [ʔuw.ˈwaa.ħah] apple | |
| [θ] | [n] [ˈθũm] as [ˈnũm] mouth | | [t] [θa.ˈlaaθ] as [ˈjaat] three |
| | [f] [θal.ˈlaa.ʤih] as [faj.ˈjaa.ʤih] refrigerator | | |
| [ð] | | [j] [ˈʔʰi.ðin] as [ˈʔʰajn] an ear | |
| [s] | [t] [ˈsaa.ʕah] as [ˈtʰaa.ʕah] watch | [t] [ˈja.suwʕ̥] [ˈtʰuwʕ̥] Jesus | |
| [sˤ] | [t] [ˈsˤuwb.bah] as [ˈtˤuwb.bah] stove | | |
| [z] | [l] [ˈzah.ɻa] as [ˈɬah.ɬa] flower | [s] [ˈʕan.zih] as [ˈʕas.sih] goat | [ʤ] [ˈɻuz] as [ˈʁuʤ] rice |
| | | [n] [χa.ˈzaa.nih] as [ˈnaa.nih] closet | |
| [ʃ] | [t] [ʃa.ˈʤa.ɻah] as [ˈtʰad.wah] tree | | |

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| [χ] | [ʔ] [ˈχam.sih] as [ˈʔʰas.sih] five | | |
| [ʁ] | [k] [ˈʁa.na.mih] as [ˈkʰa.ma.mih] goat | | |
| [ʕ] | [ʔ] [ˈʕam.mih]as[ˈʔʰam.mih] aunt | [ʔ] [ˈmit.ʔib] as [ˈmit.ʔib] boy's name | |
| [ʤ] | [d] [ˈʤaa.ʤih] as[ˈdaa.dih] chicken | [d] [ˈʔʰi.ʤiɻ] as [ˈʔʰi.diɻ] leg | |
| [l] | [Ø] [ˈlħaaf] as [ˈħaaf] quilt | [Ø] [ˈkʰalb̥] as [ˈtʰab̥] dog | |
| [ɻ] | [ʁ] [ˈɻaas] as [ˈʁaas] head | [l] [ˈzah.ɻa] as [ˈɬah.ɬa] flower | |
| | | [d] [ˈwaɻ.dih]as [ˈwad.dih] rose | |
| | | [ʁ] [ˈʔʰiʤ.ɻij]as [ˈʁiʤ.ʤij] my leg | |
| [j] | [Ø] [ˈja.suwʕ̥] as [ˈtʰuwʕ̥] Jesus | [n] [ˈʔʰiʕ.juwn] as [ˈʔʰiʕ.nuwn] eyes | |
| [g] | | [d] [ˈmaʕ.la.gah] as [ˈmaʕ.dah] spoon | |

The examples in the phonetic inventory and the sound substitutions in the two-year-old stage (Table 22) and (Table 23) show that this child in this particular stage has already acquired the voiced bilabial stop /b/ and the voiceless alveolar-dental stop /t/ and was able to produce them in all word positions. This fact supports the findings in the early stage of acquisition according to (Amayreh & Dyson 1998), although some examples show that /b/ was substituted by the voiceless glottal stop /ʔ/ word-initially and by the voiceless alveolar-dental fricative /s/ word medially under assimilation effects. The voiced alveolar-dental stop /d/ was produced both word-initially and medially but not finally, together with some cases where it has been substituted by the voiceless alveolar-dental stop /t/ both word-medially and finally. The voiceless velar stop /k/ was produced only word-initially, and it was substituted by the voiceless alveolar-dental stop /t/ both word-initially and medially in some examples.

The voiceless labiodental fricative /f/ was produced both word-initially and finally, but not medially and it was substituted by the voiceless alveolar-dental stop /t/ word-initially and by the bilabial glide/w/ word-medially (Table 23).

The voiceless pharyngeal fricative /ħ/, the lateral liquid /l/, the bilabial glide /w/ and both nasals /m/ and /n/ were produced in all word positions, again supporting (Amayreh & Dyson 1998) findings. In certain cases the bilabial nasal stop /m/ was substituted by the voiceless glottal stop /ʔ/ word-initially and sometimes it was deleted, but the alveolar-dental nasal stop /n/ was substituted by the bilabial nasal stop /m/ word-medially and under assimilation effects.

The lateral liquid /l/ has been deleted in certain examples both word-initially and medially, although it has been produced in all word positions in many other articulations. The partial acquisition of the voiced alveolar-dental stop /d/, the voiceless velar stop /k/ and the voiceless labiodental fricative /f/ at this age could be viewed as typical to this stage in comparison with the findings in (Amayreh & Dyson 1998) which state that this early period of acquisition lasts from (2:0-3:10). Therefore, this would give the child more time to achieve the complete acquisitions of these consonants.

Considering the acquisition of the consonants that are supposed to be acquired in the intermediate stage (around 4:0 to 6:4): /s/, /ʃ/, /χ /, /ʁ/, /h/, /r/, and /j/ (cf. Amayreh & Dyson 1998), the following somewhat unexpected results have been found after studying the substitution patterns in Table 23. This child has already acquired the voiceless alveolar-dental fricative /s/ and produced it both word-medially and finally although in some productions /s/ was substituted by the voiceless alveolar-dental stop /t/ word initially. Surprisingly, this child has also produced the voiceless palatal fricative /ʃ/ and the voiceless glottal fricative /h/ in all word positions, even though some productions show that /ʃ/ was inconsistently substituted by the voiceless alveolar-dental stop /t/ word-initially. The voiced and the voiceless uvular fricative /ʁ/ and /χ/ respectively were produced only word-initially. In certain cases, word initially /ʁ/ was substituted by the voiceless velar stop /k/ and /χ/ was substituted by the voiceless glottal stop /ʔ/.

The productions at this age also show that the child is already able to produce the voiced alveolar-dental trill /r/ both word-initially and finally, but not medially. In certain cases /r/ was also substituted by the voiced uvular fricative /ʁ/ word-initially and medially, and by the dark liquid lateral /l/ and the voiced alveolar-dental stop /d/ word-medially. The last sound in this group is the voiced palatal glide /j/ that was correctly articulated both word-medially and finally but not initially as it was deleted in several cases and substituted by the alveolar-dental nasal stop /n/ word medially under assimilation effects as it is clear in Table 23. Obviously these findings show partial disagreement with the findings in Amayreh & Dyson (1998) as the child by the age of two years has partially acquired the consonants that are supposed to be acquired later in the intermediate stage (around 4:0 to 6:4). More specifically, the child is able at this age to articulate /ʃ/ and /h/ in all word positions, with the rest of the consonants: /s/, /χ/, /ʁ/, /r/, and /j/ being partially acquired.

Additionally, the following findings have been transcribed while examining the acquisition of the consonants that are supposed to be acquired in the late stage (>6:4): /tˤ/, /dˤ/, /q/, /ʔ/, /θ/, /ð/, /ð ˤ/, /z/, /sˤ/, /ʕ/, and /dʒ/) according to Amayreh & Dyson (1998). The voiceless emphatic alveolar-dental stop /tˤ/ was produced only word-medially, and substituted by the voiced bilabial nasal /m/ word-initially under assimilation effects. The voiceless uvular stop /q/ and the voiced emphatic alveolar-dental stop /dˤ/ have not been acquired, which confirm the findings in (Amayreh & Dyson 1998), while /dˤ/ has been substituted by the dark liquid lateral [ɫ] word-medially. Moreover, the voiceless glottal stop /ʔ/ has been acquired and produced in all word positions which does not confirm the findings in (Amayreh & Dyson 1998) at this stage. Considering the acquisition of the voiceless dental fricative /θ/ as this age, it has been found that this particular phoneme has not been acquired and it has been substituted by the voiced alveolar-dental nasal /n/ and by the voiceless labiodental fricative /f/ word-initially and by the voiceless alveolar-dental stop /t/ word-finally. The data in this stage also show that the voiced dental fricative /ð/ and its emphatic cognate /ðˤ/ have not been acquired, and /ð/ was found in some examples to be substituted word-medially by the voiced palatal glide /j/. The voiced alveolar-dental fricative /z/ on the other hand, has been transcribed in these recordings to be produced only word-medially, but it has been substituted by the dark liquid lateral [ɫ] word-initially, and by the voiceless alveolar-dental fricative /s/ and the voiced alveolar-dental nasal /n/ word-medially and by the voiced palatal affricate /dʒ/ word-finally.

The voiceless alveolar-dental emphatic fricative /sˤ/ was produced only word-finally, and was substituted by the voiceless alveolar-dental stop /t/ word-initially. The voiced palatal affricate /dʒ/ was produced only word-medially and has been substituted by the voiced alveolar-dental stop /d/ both word-initially and medially. The examples in the recordings also reveal that this two year old child was able to produce the voiced pharyngeal fricative /ʕ/ in all word positions, though in certain cases it was inconsistently substituted by the voiceless glottal stop /ʔ/ both word-initially and medially.

The above findings show partial disagreement with (Amayreh & Dyson 1998) as the child at the age of two has partially acquired the consonants that are supposed to be acquired later in the late stage (>6:4): /tˤ/, /dˤ/,/q/, /ʔ/, /θ/, /ð/, /ðˤ/, /z/, /sˤ/, /ʕ/, and /dʒ/. On the one hand, the child at this age has unexpectedly articulated /ʔ/ and /ʕ/ in all word positions, with the rest /tˤ/, /z/, /dʒ/, and /sˤ/ being partially acquired in different word positions, but not in all positions. On the other hand, and in accordance with (Amayreh & Dyson 1998), the following sounds have not been acquired at this age /dˤ/, /q/, /θ/, /ð/, and /ðˤ/as the examples in Table 22 show.

### 7.2.2 A2: Three-year-old child

The examples in the phonetic inventory along with the sound substitutions in the three-year-old stage (Table 24)and (Table 25) show that this child at this particular age has already acquired all the consonants that are supposed to be acquired in the early stage (<2:0 to 3:10) as in (Amayreh & Dyson 1998). Considering the representative examples in Table 24 and Table 25, it is clear that this child has acquired the following consonants /b/, /t/, /d/, /k/, /f/, /ħ/, /m/, /n/, /l/, and /w/ and produced them correctly in all word positions without applying any substitution processes. These findings totally confirm those of Amayreh & Dyson (1998) on the early acquisition stage in JA.

*Table 24: The phonetic inventory of a three-year-old*

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| [b] | [ˈbi.ziɻ] nuts | [ˈluʕ.bah] doll | [ʔʰal.ˈʕaab̥] toys |
| [t] | [ˈtʰalʒ] snow | [ʔʰik.ˈtʰaab̥] book | [ˈbuwt] boots |
| [tˤ] | [tˤaj.ˈjaa.rah] airplane | [qi.ˈtˤʰaaɻ] train | [ˈbatˤtˤ] ducks |
| [d] | [ˈdub̥] bear | [ˈbad.dij] I want | [ˈʔʰil.ʔʰa.sad̥] lion |
| [dˤ] | [ˈdˤuf.daʕ̥] frog | [ˈbaj.dˤah] egg | [ˈʔʰab.jad̥ˤ] white |
| [k] | [ˈkbaaɻ] big | [ˈʤaa.kaj.tih] jacket | [ˈmaa.lik] a boy's name |
| [q] | | | |
| [ʔ] | [ˈʔʰaɱf] nose | [ˈʔʰal.ʔa.sad̥] lion | [ˈlaʔ] no |
| [m] | [ˈmaa.lik] a boy's name | [ʕãm.ˈmuwh] uncle | [bit.ˈnããm] she sleeps |
| [n] | [ˈnatˤ tˤ] he jumped | [ˈbin.nij] brown | [ʔal.ˈwããn] colours |
| [f] | [ˈfa.ɻaħ] joy | [ˈʔʰasˤ.faɻ] yellow | [ˈɻaff] a shelf |
| [θ] | [ˈθum.mu] his mouth | [ʔʰik.ˈθijɻ] a lot | [θa.ˈlaaθ] three |
| [ð] | [ˈðajl] tail | [ˈʔʰið. ði.ʔib̥] wolf | |
| [ðˤ] | [ˈðˤa.hiɻ] back | [naðˤ.ˈðˤaa.ɻah] glasses | [ˈʔʰab.jað̥ˤ] white |
| [s] | [saj.ˈjaa.ɻah] car | [ʔis.ˈnããn] teeth | [ˈnaas] people |
| [sˤ] | [ˈsˤuwt] sound | [ʔisˤ.ˈħaab̥] friends | [ˈsˤuwsˤ] chick |
| [z] | [ˈzah.ɻij] pink | [ˈbi.ziɻ] nuts | [ˈʒiinz̥] jeans |
| [ʃ] | [ʃaʕ.ˈɻaat] hair | [ˈʔʰaʃ.hãm] a boy's name | [ˈkʰaɻʃ] belly |
| [χ] | [ˈχu.biz] bread | [ˈʔʰil.χajɻ] goodness | [batˤ.ˈtˤʰiiχ] watermelon |
| [ʁ] | [ʁa.ˈzaal] dear | [ʔim.ˈʁaa.ɻah] thicket | |
| [ħ] | [ħa.ˈliib̥] milk | [ˈʔʰaħ.maɻ] red | [ʕal.ˈmas.baħ] to the swimming pool |
| [ʕ] | [ˈʕiid̥] feast | [ʔʰal.ˈʕaab̥] toys | [ˈʔʰisˤ.biʕ̥] finger |
| [h] | [ˈhaa.da] this | [ˈʔʰaʃ.hãm] boy's | [ʔiz.ˈʁij.ɻih] small |

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| | | name | [20] |
| [ʤ] | [ˈʤaa.kajt] jacket | [ʔiʤ.ˈɻaas] bells | [ˈθalʤ] snow |
| [l] | [ˈluʕ.bah] doll | [ˈlaj.lah] night | [ʔib.ˈtʰuw.kil] she eats |
| [ɻ] | [ˈɻa.ʔa.bah] nick | [ˈluw.ɻa] girl's name | [ˈʔʰaħ.maɻ] red |
| [w] | [ˈwaɻ.dih] flower | [ˈʔʰas.wad̥] black | [ˈlaw] if |
| [j] | [ˈjawm] day | [ˈʕijd̥] feast | [buɻ.tu.ˈqʰaa.lij] orange (adj) |
| [g] | | | |

*Table 25: Substitutions in the phonetic inventory of a three-year-old*

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| [ʤ] | [ʒ] [ˈʤaa.kajt] as [ˈʒaa.kajt] jacket | [ʒ] [ˈʔiʤ.ɻaas] as [ˈʔiʒ.ɻaas] bells | [ʒ] [ˈθalʤ] as [ˈtʰalʒ] snow |
| [ð] | | [d] [ʔa.ˈðaan] as [ʔa.ˈdaan] ears | [d] [ˈʔʰa.χað̥] as [ˈʔʰa.χad̥] he took |
| [dˤ] | [ðˤ] [ˈdˤaw] as [ˈðˤaw] light | [ðˤ] [ˈbaj.dˤah] as [ˈbaj.ðˤah] egg | [ðˤ] [ˈʔab.jad̥ˤ] as [ˈʔab.jað̥ˤ] white |
| [q] | [ʔ] [ˈqʰa.lãm] as [ˈʔʰa.lãm] pencil | [ʔ] [ˈʔʰal.qu.dis] as [ˈʔʰal.ʔu.dis] Jerusalem | [ʔ] [ˈʔʰaz.raq] as [ˈʔʰaz.raʔ] blue |
| [g] | [ʔ] [ˈga.lãm] as [ˈʔʰa.lãm] pencil | [ʔ] [ˈɻa.ga.ba] as [ˈɻa.ʔa.ba] nick | [ʔ] [ˈʔʰaz.rag] as [ˈʔʰaz.raʔ]blue |

The representative examples of the consonants in the intermediate stage at this age show almost a total disagreement with Amayreh & Dyson (1998), as the child by the age of three years has already acquired the consonants that are supposed to be acquired later during the intermediate stage (around 4:0 to 6:4). More specifically, the child at this age has been able to articulate all of the following consonants in all word positions: /s/, /ʃ/, /χ/, /h/, /r/ with only one exception as the voiced uvular fricative

20 An adjective form for a third person singular feminine noun.

/ʁ/ has been partially acquired, as the relevant data do not show any occurrence of this consonant word-finally.

The following unexpected findings have been noticed while studying the acquisition of the consonants that are supposed to be acquired in the late stage (>6:4) according to (Amayreh & Dyson 1998) namely: /tˤ/, /dˤ/, /q/, /ʔ/, /θ/, /ð/, /ðˤ/, /z/, / sˤ /, /ʕ/, and /dʒ/). Again this three year old child has already acquired these consonants and produced them in all word positions, this result contradicts the findings of Amayreh & Dyson (1998). Additionally, the data show some substitution cases (Table 25); first the voiced emphatic alveolar-dental stop /dˤ/ has been substituted in certain case and in all word positions, by the voiced emphatic dental fricative /ðˤ/. Secondly, the voiced non-emphatic dental fricative /ð/ has been substituted both word-medially and finally by the voiced non-emphatic alveolar-dental stop /d/. The third process of substitution has been found in the case where the child substitutes the voiced palatal fricative stop /ʒ/ for the voiced palatal affricate /dʒ/ in all word positions. The last two substitutions have some additional prestigious and stylistic connotations for female linguistic choices in JA. The data show no occurrences of the voiced and the voiceless uvular stop /g/ and /q/ respectively in the child's phonetic inventory at this age. This child has substituted the voiceless glottal stop /ʔ/ for both the voiced and the voiceless uvular stop /g/ and /q/ respectively in all word positions. This substitution process has sociolinguistic connotations concerning the social dialects in Jordan, this kind of substitution is highly favoured and is considered as being more prestigious than both g/ and /q/, though it could be also seen as a feature of the female linguistic choices in JA, thus the influence on the child's speech can be due to the mother's language.

### 7.2.3 A3: Four-year-old child

The phonetic inventory in the current analysis together with the sound substitutions of the four-year- old child (Table 26) and (Table 27) show more agreement with Amayreh & Dyson (1998)'s findings than those of the previous two stages.

*Table 26: The phonetic inventory of a four-year-old*

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| [b] | [ˈbaab̥] door | [ˈluʕ.bah] doll | [ki.ˈtʰaab̥] book |
| [t] | [ˈtʰiin] figs | [zaj.ˈtʰuwn] olive | [ˈtʰuwt] berry |
| [tˤ] | [tˤaj.ˈjaa.ɹah] airplane | [ma.ˈtˤʰaaɹ] airport | [ˈbatˤtˤ] ducks |
| [d] | [da.ˈʤaaʤ] chicken | [ˈmad.ra.sah] school | [ˈqʰird̥] monkey |
| [dˤ] | [ˈdˤuf.daʕ̥] frog | [ˈbaj.dˤah] an egg | [ˈʔʰab.jad̥ˤ] white |
| [k] | [ki.ˈtʰaab̥] book | [ˈsa.ma.kah] fish | [ˈʃub.baak] window |
| [q] | [ˈqʰa.lãm] pencil | | [ˈʔʰaz.ɹaq] blue |
| [ʔ] | [ˈʔʰaɱf] nose | [ˈʔʰal.ʔa.sad̥] lion | [ˈlaʔ] no |
| [m] | [mik.ˈwaa.jih] iron | [ˈʤa.mal] camel | [sa.ˈliim] a boy's name |
| [n] | [ˈnuwɹ] light | [ˈsniin] years | [ħaj.ˈwããn] animal |
| [f] | [ˈfaa.jiz̥] boy's name | [ˈʔʰasˤ.faɹ] yellow | [χa.ˈɹuwf] sheep |
| [θ] | [ˈθawb̥] dress | [θa.ˈlaa.θah] three | [θa.ˈlaaθ] three |
| [ð] | [ði.ˈɹaaʕ̥] arm | [ʤu.ˈðuwɹ] roots | [ˈmun.qið̥] saver, a boy's name |
| [ðˤ] | [ˈðˤa.hiɹ] back | [ˈʔʰaχ.dˤaɹ] green | [ˈbajð̥ˤ] eggs |
| [s] | [ˈsaa.ʕah] watch | [ˈʔʰa.sad̥] lion | [ˈmiss] a female teacher |
| [sˤ] | [ˈsˤaa.liħ ] a boy's name | [ˈʔʰasˤ.faɹ] yellow | [ˈbaasˤ] bus |
| [z] | [ˈzah.ɹah] flower | [ˈʔʰaz.ɹaq] blue | [ˈlawz̥] almond |
| [ʃ] | [ˈʃa.ʤa.ɹah] tree | [fa.ˈɹaa.ʃah] butterfly | [ˈbaʕ.ɹi.fiʃ] I dont know |
| [χ] | [χa.ˈɹuwf] sheep | [ˈʔʰaχ.dˤaɹ] green | [ˈkˤuwχ] cottage |
| [ʁ] | [ˈʁaad̥] there | [ˈjaʁ.sil] to wash | |
| [ħ] | [ħa.ˈliib̥] milk | [ˈʔʰaħ.maɹ] red | [tim.ˈsʰaaħ] corocodile |
| [ʕ] | [ʕa.ʤa.ˈlaat] wheels | [ˈluʕ.bah] doll | [ði.ˈɹaaʕ̥] arm |
| [h] | [ha.ˈðˤuwɫ] these | [ˈgah.wah] coffee | [ˈʃad.dih] playing cards |
| [ʤ] | [ˈʤa.mal] camel | [da.ˈʤaaʤ] chicken | [ˈθalʤ] snow |

| Arabic consonants | Word Initial | Word Medial | Word Final |
|---|---|---|---|
| | | | |
| [l] | [ˈluʕ.bah] doll | [ˈbluw.zih] blouse | [ta.ˈʕaal] come here |
| [ɻ] | [ɻũm.ˈmããn] pomegranate | [za.ˈɻaa.fa] giraffe | [sa.ˈɻiiɻ] bed |
| [w] | [ˈwaa.ħad̥] one | [ˈtʰuw.fi] toffee | [ʔil.ʕãm.ˈmuw] the uncle |
| [j] | [ˈjad̥] hand | [ˈbajt] house | [ˈwaa.dij] vally |
| [g] | [ˈgah.wah] coffee | [ʔiɳ.ˈlii.zi] english | [ˈfuwg̊] up |

*Table 27: Substitutions in the phonetic inventory of a four-year-old*

| Arabic consonants | Word Initial | Word Medial | Word Final |
|---|---|---|---|
| [ð] | | [ðˤ] [ˈhaa.ða] as [ˈhaa.ðˤa] this | |
| [dˤ] | [ðˤ] [ˈdˤ a.ɻa.ba] as [ˈðˤa.ɻa.ba] he hit | [ðʰ] [ˈbaj.dˤah] as [ˈbaj.ðˤah] an egg | [ðˤ] [ˈʕadˤ.dˤa] as [ˈʕaðˤ.ðˤa] he bit |
| [n] | | [tˤ] under assimilation [ban.tˤa. ˈluwn] as [batˤ.tˤa. ˈluwn] trousers | |

The data indicate that this child has already acquired the consonants that are supposed to be acquired in the early and the intermediate stages according to Amayreh & Dyson (1998) findings. The following consonants which are described as being acquired early (<2:0 to 3:10); /b/, /t/, /d/, /k/, /f/, /ħ/, /m/, /n/, /l/, and /w/) have all been produced correctly in all word positions without any substitutions. Only one remark must be added regarding the child's production of the voiced alveolar-dental nasal /n/ in one production the child has substituted /n/ for /tˤ/ when he articulated [ban.tˤa.ˈluwn] as [batˤ.tˤa.ˈluwn]. This assimilation process increased the ease of articulation in this case as will be explained in the next chapter.

The findings here completely confirm those of Amayreh & Dyson (1998), as the data indicate that all the consonant of the intermediate stage: /s/, /ʃ/, /χ/, /ʁ/, /h/, and /r/ have been acquired without any cases of substitution. This child is four years old and has acquired all of these consonants which completely confirm the findings of of Amayreh & Dyson (1998) who state that these consonants are typically acquired around 4:0 to 6:4. Furthermore, there are no occurrences of the voiced uvular fricative /ʁ/ word-finally in the child's phonetic inventory as it does not occur in his spontaneous speech and it was not possible to represent this consonant in this particular word position in a picture that the child can easily recognize at this age, thus it could not be established if he has already acquired this consonant word-finally or not.

Surprisingly, this four-year-old child has already acquired almost all of the consonants that Amayreh & Dyson (1998) found to be typically acquired in the late stage (>6:4); namely, /tˤ/, /dˤ/, /q/, /ʔ/, /θ/, /ð/, /ðˤ/, /z/, /sˤ /, /ʕ/, and /dʒ/, thus the development milestones in this child do not confirm the findings of Amayreh & Dyson (1998). Moreover, the data also show that this four-year-old child has produced all these consonants in all word position with only one exception; namely, there was no example of the voiceless uvular stop /q/ word-medially. This last finding is quite atypical as Amayreh & Dyson (1998) reported that children will produce consonants more accurately word-medially than both in initial and final positions for all consonant classes. Therefore, if the child produced the consonant both word-initially and finally, this means that the child would be able to produce the sound word-medially as well, however this production was not present in any example.

Dialectical variation may count for the kind of substitutions that have been noticed in this case (Table 27) in which the voiced emphatic dental fricative /ðˤ/ is substituted for the voiced non-emphatic dental fricative /ð/ only word medially, and the case where the voiced emphatic dental fricative /ðˤ/ is substituted for the voiced emphatic alveolar-dental stop /dˤ/ in all word positions. This substitution pattern was not present in all productions containing /ð/ and /dˤ/ and it was only more obvious and noticeable in spontaneous speech as the child tended in such situations to use his dialectical forms, but in the picture naming test he tended to use the standard Arabic.

### 7.2.4 A4: Five-year-old child

The data in Table 28 indicate that this child by the age of five has already acquired all the consonants that are supposed to be acquired in the early, intermediate and the late stages according to Amayreh & Dyson (1998) classifications.

*Table 28: The phonetic inventory of a five-year-old*

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| [b] | [ˈbint] girl | [ʔil.ˈbaab̥] the door | [ˈħaɹb̥] war |
| [t] | [ˈtʰis.sʕah] nine | [ˈtʰwii.ti] tweety | [ˈbint] girl |
| [tˤ] | [ˈtˤaa.ɹa] he flew | [ˈʃuɹ.tˤah] police | [ˈʔʰij.nutˤ] he is jumping |
| [d] | [ˈdaz̥z̥] pushed | [ʔil.waɹ.ˈdʰij.jih] rosary | [ʔasˤ.sˤaj.ˈjaad̥] the hunter |
| [dˤ] | [ˈdˤuf.daʕ̥] frog | [ˈʔʰaχ.dˤaɹ] green | [ˈʔʰab.jad̥ˤ] white |
| [k] | [kas.ˈlããn] lazy | [ˈʔʰiʃ.ʃa.ba.kih] the net | [ˈʔʰil.ma.lik] the king |
| [q] | [ˈqʰa.lãm] pencil | [ˈʔʰal.quds] Jerusalem | [ˈʔʰað.ðawq̥] the taste |
| [ʔ] | [ˈʔʰaɹ.nab̥] rabbit | [ˈʔʰal.ʔa.sad̥] the lion | [ʔaʃ.ˈjaaʔ] things |
| [m] | [ʔim.ˈdaw.waɹ] round | [za.ˈmããn] long time ago | [ˈjawm] day |
| [n] | [ˈnaaɹ] fire | [ʔis.ˈniin] years | [ʔis.ˈniin] years |
| [f] | [ˈfaaɹ] mouse | [ʕasˤ.ˈfuwɹ] bird | [χa.ˈɹuwf] sheep |
| [θ] | [θa.ˈmããn.jih] eight | [ʔiθ.ˈθaa.nij] the second | [ˈʁajθ] a boy's name |
| [ð] | [ˈðaj.lũn] tail | [ˈʔʰað.ðawq̥] the taste | [ˈmun.qið̥] a saver and a boy's name |
| [ðˤ] | [ˈðˤaɫ.ɫuh] he stayed | [min.ˈðˤaɫ.ɫna] we keep on | [ˈnuɹ.kuð̥ˤ] we run |
| [s] | [ˈsuwd̥] black | [ˈʔʰil.ʔa.sad̥] the lion | [ħa.ˈwaas] senses |
| [sˤ] | [ˈsˤa.ħin] plate | [ʕasˤ.ˈfuwɹ] bird | [ˈbaasˤ] bus |
| [z] | [za.ˈmããn] long time ago | [ˈja.zãn] a boy's name | [ʔil.ˈʁaaz̥] stove |
| [ʃ] | [ˈʃuɹ.tˤah] police | [ʕa.ʃa.ˈɹah] ten | [ˈkʰa.ɹiʃ] belly |

| *Arabic consonants* | *Word Initial* | *Word Medial* | *Word Final* |
|---|---|---|---|
| [χ] | [ˈχãm.siin] fifty | [ˈʔʰaχ.dˤaɻ] green | [batˤ.ˈtˤʰiiχ] watermelon |
| [ʁ] | [ˈʁajθ] a boy's name | [ʔil.ˈʁaaz̥] stove | |
| [ħ] | [ˈħaɻb̥] war | [ˈʔʰaħ.maɻ] red | [mif.ˈtʰaaħ] key |
| [ʕ] | [ˈʕaf.wãn] you welcome | [ˈnil.ʕab̥] we play | [ˈʔʰis.sa.maʕ̥] hearing |
| [h] | [ˈhaa.ʃĩm] a boy's name | [ˈgah.wah] coffee | [ˈʔʰij.duh] his hand |
| [ʤ] | [ʤa.ˈmiil] beautiful | [ˈʔʰi.ʤa] he came | [ˈʤaaʤ ] chicken |
| [l] | [ˈlãm.jah] a girl's name | [ˈʔʰil.la.mis] touching | [ˈʔʰil.lajl] night |
| [ɻ] | [ˈɻaas] head | [ˈfaa.ɻis] a night, a boy's name | [ka.ˈθiiɻ] many, a lot |
| [w] | [ˈwaa.ħad̥] one | [ˈbluw.zih] blouse | [ʔil.ˈχaa.luw] the uncle |
| [j] | [ˈja.zãn] a boy's name | [ˈʁajθ] a boy's name | [ˈwaa.dij] vally |
| [g] | [ˈgããm] he stood | [ˈfuw.gi] above me | [ˈfuwg̊] up |

The data in Table 28 indicate that all the following consonants which are described as being acquired early (<2:0 to 3:10); /b/, /t/, /d/, /k/, /f/, /ħ/, /m/, /n/, /l/, and /w/), have been produced correctly in all word positions without any substitutions. The data also indicate that all the consonants of the intermediate stage /s/, /ʃ/, /χ/, /ʁ/, /h/, and /r/ have been acquired without any substitutions as well. Only one finding has been noticed regarding the child's production of the voiced uvular fricative /ʁ/. It is obvious from the data that the child produced this phoneme both word-initially and medially, but not finally as it was not possible to represent this consonant in a word position in a picture that the child will easily recognize at this age. Moreover, this consonants was not represented word-finally in the child's spontaneous speech, thus it could not be determined whether he has already acquired this consonant word-finally or not. These results totally confirm the findings in Amayreh & Dyson (1998) regarding the acquisition of the consonants in the early and the intermediate stages as the child is five years old now.

The five-year-old child as the data further indicate (Table 28) has also acquired all of those consonants that Amayreh & Dyson (1998) found to be typically acquired in the late stage (>6:4) namely: /tˤ/, /dˤ/, /q/, /ʔ/, /θ/, /ð/, /ðˤ/, /z/, /sˤ /, /ʕ/, and /dʒ/). This child has correctly produced all these consonants in all word positions without any substitution patterns, thus these findings do not confirm the findings in Amayreh & Dyson (1998) at this particular stage in typical development.

## 7.3 Chronology of phonology in typical development in JA

As previously mentioned, the first stage of the current analysis has been concerned with analyzing the phonological processes in the typical development of JA. Therefore, the phonetic inventory and the substitution patterns in each particular developmental level in AMN have been studied. More specifically speech samples collected from the four AMN children participating in this study; two boys and two girls, aged two to five years old have been studied. Based on the results derived from this analysis and compared with the results reported in Amayreh & Dyson's (1998) study, some generalizations on the chronology of the phonological processes in the typical development in JA have been found and presented in Table 29.

This chronology classifies the occurrence of these phonological processes into three categories; the first category specifies the processes that the child often uses at this age and it is represented by a black circle (●). The second category refers to the processes that the child applies only when using the dialectical forms and is represented by a triangle (▲). The third and last category refers to the inconsistently used processes, represented in Table 29 by three dots (...). The last category refers to the processes that the child inconsistently applies while articulating certain sounds, although he is able to articulate the same sounds correctly in other positions. Moreover, the list in Table 29 includes the major and the minor natural processes that occur in acquiring a language system (cf. Tobin 1997) as adapted from (Grunwell 1987; Ingram 1990).

*Table 29: The chronology of typical phonological development in JA.*

| *Phonological Processes* | *Age (in years)* | | | |
|---|---|---|---|---|
| | *2* | *3* | *4* | *5* |
| *Substitution processes* | | | | |
| *Processes reflecting the substitution of active articulators* | | | | |
| *fronting* | ● | ● | ● | ▲ |
| *backing* | ● | ▲… | ▲… | ▲… |
| *Processes reflecting changes in the degree of turbulence /airflow* | | | | |
| *Stopping* | ● | ▲ | … | |
| *Spirantization* | ● | ● | ● | |
| *Glottal replacement* | ● | ▲… | ▲… | ▲ |
| *Gliding* | ● | | | |
| *Lateralization* | … | | | |
| *Vowel neutralization* | … | | | |
| *Processes influencing syllable structure* | | | | |
| *Weak syllable deletion* | ● | | | |
| *Initial consonant deletion* | ● | | | |
| *Final consonant deletion* | ● | … | | |
| *Metathesis* | ● | … | | |
| *Epenthesis* | … | | | |
| *Assimilation processes* | | | | |
| *Consonant harmony* | | | | |
| *labialization* | ● | | | |
| *Velarization* | ▲… | ▲… | ▲… | ▲… |
| *Nasalization* | ● | … | … | |
| *Prevocalic voicing* | ▲… | ▲… | ▲… | ▲… |
| *Final consonant devoicing* | ● | … | … | |

Table 22 to Table 28 represent the phonetic inventory and the substitution patterns in each particular developmental level in the AMN children in JA. The patterns of the phonological processes at these levels have been summarized in Table 29. In addition to this chronology, the following phonological patterns in the typical development in JA can be transcribed and explained:

•Substitution processes have been applied very often during the typical development of the phonology of JA. They occur more often than the other phonological processes as seen in Table 29. More specifically, children tend to apply processes reflecting the substitution of the active articulators more often than the processes that reflect changes in the degree of turbulence/airflow.

◦The process of fronting is present until late stages in the typical development. It is very often applied until the age of four and happens to be applied during the age of five and even later when the child uses the dialectical forms.

◦The process of backing is present during the early stages in the typical development; during the age of two. This process might also be applied either inconsistently before the child masters the adult proper pronunciation or when he uses the dialectical forms until the age of five.

•AMN children in JA share certain tendencies regarding the substitution processes reflecting changes in the degree of turbulence /airflow:

◦The frequent application of stopping, spirantization, glottal replacement, and gliding during the first developmental stage; namely, before the age of three.

◦Spirantization has been frequently applied during the late developmental stages; namely, before the age of five.

◦Glottal replacement has been present even during the age of five and even later through the use of the dialectical forms.

◦Lateralization and vowel neutralization have been applied very rarely and inconsistently only during the first developmental stage.

•Processes influencing the syllable structure show further similarities:

◦ Weak syllable deletion, initial and final consonant deletion, and metathesis have a frequent application during the first developmental stage, more specifically, before the age of three.

◦ Epenthesis has been inconsistently used only during the first developmental stage, at the age of two. This pattern is probably explained by the fact that JA does not have consonant clusters, thus reducing the need for such a process.

• Assimilation processes have indicated a different tendency during the typical development in JA:

◦ Velarization and Prevocalic voicing have been present until the age of five either inconsistently before the child masters the adult proper pronunciation or when he uses the dialectical forms.

◦ Labialization, nasalization and final consonant devoicing have been applied frequently by AMN during the first developmental stage in JA. Additionally, nasalization and final consonant devoicing continued to be inconsistently applied during later stages; namely, at the age of four.

## 7.4 Summary

The first stage of the analysis in this study has been concerned with analyzing the phonological processes in the typical development of JA. Therefore, the phonetic inventory and the substitution patterns in each particular developmental level in AMN have been studied. More specifically, speech samples collected from four AMN children; two boys and two girls, aged two to five years old have been analyzed and these findings are represented in Table 22 to Table 28. Moreover, based on the patterns derived from this analysis and compared with the results reported in Amayreh & Dyson (1998), significant generalizations on the chronology of the phonological processes in the typical development of JA have been found and represented in Table 29.

This current analysis of the phonological processes in the typical development of JA will form the baseline in the analysis of the SLI speech in JA in CHAPTER 8 .

# CHAPTER 8 The study: phonological processes in SLI children

## 8.1 Introduction

This chapter discusses and explains all the phonological processes that have been analyzed in the recorded speech samples from the SLI children participating in our study of JA. Therefore, these processes are supposed to characterize SLI in JA when compared chronologically with the findings of the AMN children in Table 29. Many of these processes have been occurred to a certain extent during the typical developmental stages, though not all of them, as will be illustrated in this chapter. The processes will be presented with phonetically transcribed Arabic representative examples as well as explained within the framework of NP and PHB, a theory which investigates both developmental and clinical segmental and prosodic phonology and phonotactics.

The analysis of the recorded speech samples of the SLI children indicates that fronting, stopping, glottal replacement, and labialization were frequently applied in this sample population. The analysis also shows that SLI children made a frequent use, though to a lesser extent to the other phonological processes: de-emphasis, devoicing, spirantization, backing, and voicing. Weak syllable deletion, initial and final consonant deletion, vowel neutralization, assimilation, metathesis and epenthesis were also applied, but not very often. These initial findings in the SLI speech are are worthy of note when a comparison with the chronology of the phonological processes in the typical development of JA is made.

## 8.2 The characteristics of the phonology of SLI children in JA

The atypical phonoloical development of JA will be examined and characterized in this chapter based on the analysis of the speech recordings of the seven SLI Arabic-speaking children.

## 8.3 Phonological processes in SLI children according to the theories of NP and PHB

The following are the most frequent phonological processes that have been transcribed in the recorded speech samples, which characterize the atypical phonological development when compared compared and contrasted chronologically with the findings of the typical development of the AMN participants in Table 29. As previously mentioned, many of these processes have been found in the speech of the AMN children during their language development stages. The most frequent processes are presented in this section with phonetically transcribed Arabic representative examples from the observed recordings. These examples will be explained and their lenitive vs. fortitive function will be clarified within the framework of NP (cf. Stampe 1969, 1980; Donegan 1978; Donegan and Stampe 1979; Dressler 1985; Dziubalska-Kołaczyk 2002b, c; Ingram 1990, 1986) and PHB, a theory which investigates both segmental and prosodic phonology and phonotactics. PHB has adopted the phonological processes proposed by NP, applied and explained them in the developmental and clinical domains for a variety of languages (e.g. English (Tobin 1997a, b, 1999, 2002); Spanish (Enbe, Gurlekian & Tobin 2006); Hindi-Urdu (Fatihi 2007); Japanese (Miyakoda 2003, 2004a, b, Tobin & Miyakoda 2004a, b, 2006); Finnish (Moore 1991a, b, 1993, Moore & Korpijaakko-Huuhka 1996, Moore & Rosenberg-Wolf 1998), Israeli Hebrew (Green & Tobin 2008a-b, Halpern & Tobin 2008, Tobin 1995, 1997a); and Israeli Sign Language (ISL) (Fuks & Tobin 2008; Tobin 2007a-b, 2008). Moreover, PHB has been combined with phonological theories such as Natural Phonology (NP) and Optimality Theory (OT) in additional developmental and clinical analyses of Hebrew (e.g. Adi-Ben-Said 2006; Adi-Ben-Said & Tubul-Lavi 2009; Ben-David 2001); Polish (e.g. Połczyńska-Fyszer 2007; and Jordanian Arabic (Bader & Gibbon 2008).

### 8.3.1 Substitution processes

#### 8.3.1.1 Processes reflecting the substitution of active articulators

*8.3.1.1.1 Fronting*

It has been noticed during this analysis that among the two possible substitution processes the child shows more frequent application of fronting; "Back (non-apical) consonants are substituted by apical consonants usually preserving the same manner and voicing values." Tobin (1997: 188). In this process both the manner of the articulation and the voicing are usually kept and preserved. Therefore, this process involves changing the active articulators to a more anterior place in the oral cavity. The following are representative examples from the SLI speech:

[ˈsa.ma.kah] as [ˈsa.ma.tah] a fish

[tˤaa.ˈgij.jih] as [tˤaa.ˈdij.jih] a hat

[ˈʃam.ʕaat] as [ˈsam.ʕaat] candles

[ˈʃam.ʕah] as [ˈθam.ʕah] a candle

The above examples represent different cases of fronting in the SLI speech. In studying these examples, it is clear that fronting occur in those cases where the active articulators are changed to a more anterior place in the oral cavity. Therefore, the VL velar stop /k/ is substituted by the VL alveolar-dental stop /t/, or the V velar stop /g/ is substituted by the V alveolar-dental stop /d/. In other cases, the VL palatal fricative /ʃ/ is substituted by the VL alveolar-dental fricative /s/, or in other cases the VL palatal fricative /ʃ/ is substituted by the VL dental fricative /θ/.

Fronting is the earliest substitution process of the active articulators. The tendency that phonologically atypical children and typically developing children frequently apply fronting confirms language universal rules, as according to both NP and PHB, apical consonants are preferred and favoured. This process is explained as it is found that the apex of the tongue is the most flexible, sensitive and the easiest articulator to control among all active articulators (cf. Tobin 1997: 189). Therefore, fronting is a lenition according to its proposed definition in Kul (2007: 155) "lenition is reduction of the three criteria: energy, complexity or aerodynamic unnaturalness."

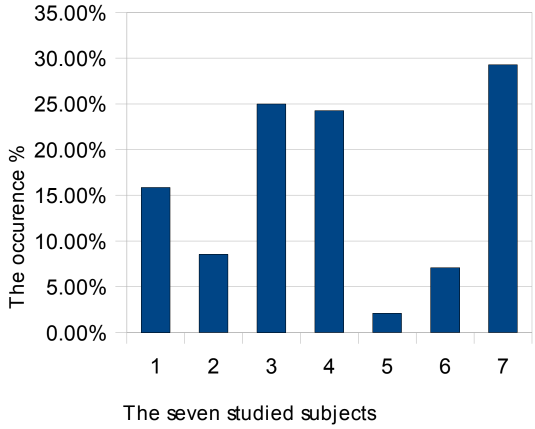

*Figure 2: Fronting in SLI children.*

Figure 2 shows that fronting has been used by all the SLI children in varied degrees. The results in Figure 2 show that fronting has been applied very frequently and comparatively to a high percentage in four SLI cases in this studied sample. The other three SLI subjects show low frequency which is statistically insignificant. But this pattern specifies fronting as one of the characterizing features of SLI in JA.

It is clear from the chronology in Table 29 that this process tends to be present in the speech production of AMN children aged two to four years. Moreover, it is present in the speech of the five-year-old child when the dialectical forms are used, which is the form of Arabic that the child usually acquires before starting learning MSA at schools. This tendency helped in making fronting a very frequent process in the typical development as it has been represented in these examples:

['qããm] as ['gããm] he stood

['fuw.qij] as ['fuw.gij] above me

['fuwq] as ['fuwg] up

In all these three examples, the child has been applying fronting in substituting the voiced velar stop /g/ for the voiceless uvular stop /q/ in using the dialectical forms of the JA.

#### *8.3.1.1.2 Backing*

The second substitution process in which the active articulators are substituted is backing. In the processes front phonemes, apicals; alveolars or dentals are articulated as back phonemes; dorsals or velars. The following examples from the SLI speech show this process:

['ʕam.mih] as ['ʔʰam.mih] an aunt
['mit.ʕib] as ['mit.ʔib] a boy's name

This process is not considered as a typical process, it is described as an idiosyncratic pattern (cf. Grunwell 1987), and it happens as a result of several possible reasons; it could be, for example, that the child can not control the muscles of the top of the tongue, or it could result by trying to reduce the number of the front sounds with the purpose of increasing the communicative distinctions in the context of a previous fronting pronunciation.

Examining the chronology of the typical development shows that this process was in use only during the first developmental stage (at two years of age). Backing has been applied with an infrequent and sometimes with an inconsistent pattern in the case of using the dialectical forms from three to five years of age in the AMN children:

['qa.lãm] as ['ʔʰa.lãm] a pencil

['ɻa.qa.ba] as ['ɻa.ʔa.ba] a nick

['ʔʰaz.raq] as ['ʔʰaz.raʔ] blue

[ʔa.'ðaan] as [ʔa.'daan] ears

['ʔʰa.χað̥] as ['ʔʰa.χad̥] he took

The above examples reflect the influence of the stylistic dialectical variants in JA on the child's speech patterns. This dialectal aspect and its influence on the typical development in JA will be further discussed later in this section.

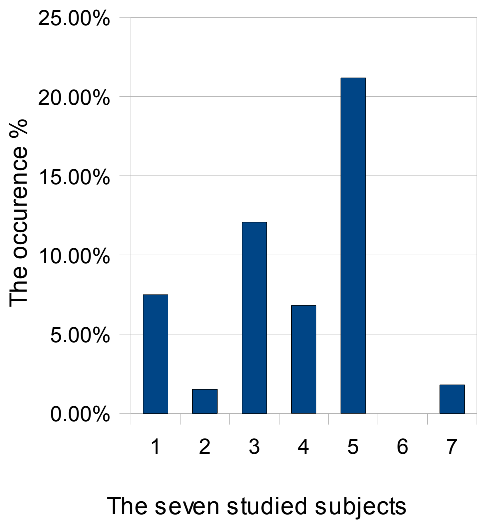

*Figure 3: Backing in SLI children.*

On the other hand, Figure 3 shows the percentages of occurrence of the process of backing among the seven SLI cases in this study. Figure 3 also indicates that backing has been present in SLI speech, although the percentages show that only one case has applied backing quite often. Therefore, this process could also be identified as another characterizing feature of SLI. The following are examples from the SLI speech in JA:

['ba.qa.ra] as ['ba.ʔa.ra] a cow
[ʁs.'saa.lih] as [ʔas.'saa.lih] a washing machine

['χu.biz] as ['ʔu.biz] bread

['bil.ʕab] as ['hil.ʕab] he is playing

['fatˤ.buwl] as ['tad.buwl] or ['θad.buwl] a football

[ʔuʁ.'nij.jih] as [ʕun.'nij.jih] a song

It has been noticed that backing was mostly achieved through the process of glottal replacement along with other cases where the manner of articulation is kept the same. The pattern of backing in [ʔuʁ.'nij.jih] as [ʕun.'nij.jih] has been found to deviate from Arabic specific rules in language acquisition. This case in this context of application shows this deviation, as according to the results in Amayreh & Dyson (1998), it has been noticed that /ʁ/ will typically be intermediately acquired (around 4:0 to 6:4), while /ʕ/will be lately acquired in the age group (after 6:4).

#### 8.3.1.2 Processes changing the degree of turbulence/airflow

The second type of the substitution processes reflects changes in the degree of the turbulence of the airflow during the articulation. This substitution includes six different processes; stopping, spirantization, glottal replacement, gliding, lateralization and vowel neutralization. All of these processes occur to certain extent during typical development, they particularly occur during the stage before three years old, with an inconsistent application of vowel neutralization in the same stage. Moreover, it has been noticed in this analysis that spirantization persists until older ages; up to four years old as it has been clearly represented in Table 29.

*8.3.1.2.1 Stopping*

In the process of stopping, which is a frequent substitution process in child's speech, stop consonants will be used as substitutes for other consonants like fricatives or affricates, thus it is a fortitive process. NP and PHB explain this process of stopping within language universals, as through the process of stopping, the maximum constriction is preferred and thus it is easier to control stops than stable fricatives (cf. Tobin 1997: 189).

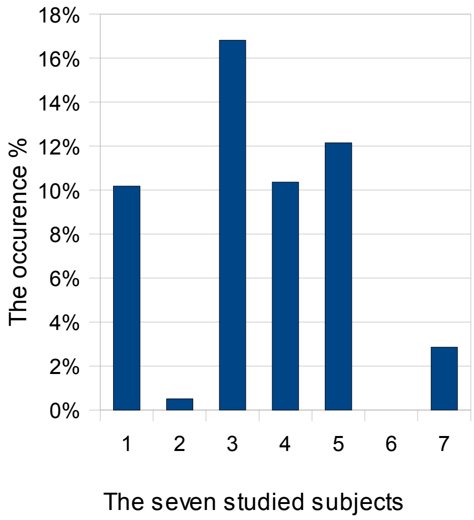


*Figure 4: Stopping in SLI children.*

Figure 4 shows the occurrences of stopping in the SLI recordings. The percentages show that this process has been applied quite often among the studied cases, namely in six cases[21]. Only one participant has not applied any cases of stopping.

As less effort is required in producing stops, therefore it is a lenitive process through the reduction of the unnaturalness of the aerodynamics involved in that relevant articulation (cf. Kul 2007). The production of fricative sounds requires more muscle control for an incomplete constriction to be maintained with a minimal aperture at the same time to produce a rather strong turbulent airflow (cf. Tobin 1997: 189). the following are some representative examples from the SLI speech:

21 It is important to remind the reader that these results are important in this sample as the data is relatively small, although the percentages are statistically unimportant.

[ʁs.ˈsaa.lih] as [ʔas.ˈsaa.lih] a washing machine

[ˈχu.biz] as [ˈʔu.biz] bread

[ˈfun.dʒaan] as [ˈfun.daan] a cup

[naðˤ.ˈðˤaa.ɻaat] as [naʔ.ˈʔaa.laat] glasses

*8.3.1.2.2 De-emphasis*

The following are examples of another lenitive process in which the child is removing the second articulatory part in articulating the emphatic sounds. This process shows the influence from Arabic specific rules as shown through the use of the sound non-emphatic cognate in this sound change.

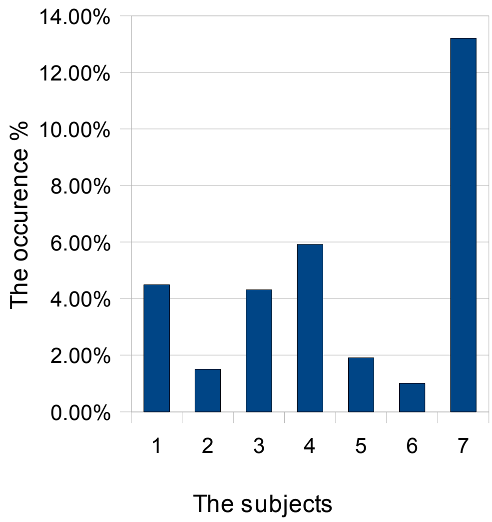


*Figure 5: De-emphasis in SLI children.*

Figure 5 shows that all SLI subjects used this phonological processes to avoid this additional articulation. This process has been present in quite small percentages, therefore generalization can not be made. But it is important to notice that all SLI subjects de-emphasized these sounds, to simplify their speech production.

Additionally, this pattern of de-emphasis confirms the PHB principle that additional articulators are disfavoured (cf. Tobin 1997: 213, 2002). The following cases include occurrence of this de-emphasis in the SLI speech:

[ˈmas.tˤa.ɻah] as [ˈmas.ta.lah] a ruler

[ma.ˈsˤaa.ɻij] as [ma.ˈlaa.sij] money

[ˈbaj.dˤah] as [ˈbaj.dah] an egg

['miʃtˤ] as ['mi.ʃit] a comb

[naðˤ.'ðˤaa.ɻaat] as [dan.'daa.laat] glasses

In substituting [dan.'daa.laat] for [naðˤ.'ðˤaa.ɻaat], the child applies stopping of the emphatic fricative sound without producing the non-emphatic cognate /ð/.

*8.3.1.2.3 Spirantization*

In the following examples the child has substituted stops or other phonemes like approximants by fricatives, thus he is applying the phonological process of spirantization. Spirantization is classified as a fortitive process due to the " suppression of a natural outcome of aerodynamics and motorics. Fricatives are more precise than stops due to the air passage requirements... Therefore, the process can be typologized as fortition since effort is expended" (Kul 2007: 168).

Furthermore, Stampe (1969) describes this process of substituting fricative for approximants as a fortition as the audibility of the sound increases, but he considers substituting fricatives for stops as lenition which might happen because of a weakness in the tongue, hence the inability to produce a stop.

Spirantization is a rather idiosyncratic process that would not be frequently found in children's typical development, but a common process in the pathological speech of individuals having traumatic brain injury (TBI) after a prolonged coma as cited in (Połczyńska-Fiszer, M. 2007: 306) "Other frequently used articulatory processes by the TBI patients were: incomplete consonant closure (ICC), spirantization and vowel centralisation. The three processes are rare in typical children's productions." (cf. Połczyńska-Fiszer and Pufal in press; Połczyńska-Fiszer in press (b)).

The following are examples from typically developing children in JA. These examples indicate that this process has been applied by the AMN children as can be seen in Table 29. This pattern differs from the findings in (Połczyńska-Fiszer, M. 2007) :

['ɻaas] as ['ʁaas] a head

['ʔʰidʒ.ɻij] as ['ʁidʒ.dʒij] my leg

['ʔab.jad̥ˤ] as ['ʔab.jað̥ˤ] white

['ʕadˤ.dˤa] as ['ʕaðˤ.ðˤa] bit

The analysis of the recordings of the AMN in JA does not confirm the previous finding, and has been reported in Table 29. Furthermore, it has been noticed in this analysis that spirantization is frequently found even through older ages among AMN Arabic-speaking children; up to four years old. This might be attributed to the large number of complex obstruents in the phonological repetoire of Arabic and should be a topic of further research.

Additionally, the following examples are representations of spirantization in the SLI speech in JA. The patterns of the application of this process present another Arabic-specific feature:

['ʔab.jad̥ˤ] as ['hab.jað̥ˤ] white

['ʔaɻ̥.nab̥] as ['hal.nab̥] a rabbit

['kun.da..ɻa] as ['hun.da.la] a shoes

['ʤaa.kajt] as ['ʒaa.tajt] or ['ʃaa.tajt] a jacket

['wi.siχ] as ['hi.siχ] dirty

As it is clear from the examples, most glottal stops were articulated as VL glottal fricative, as /h/ would be typically acquired before /ʔ/ in JA (Table 10). Therefore, the exploitation of increased effort in the occurrence of this fortitive process can be explained with regard to the Arabic-specific acquisition norm in this particular context. Also fricatives have been used as substitutes for stops, affricates and glides in some cases as shown in these examples.

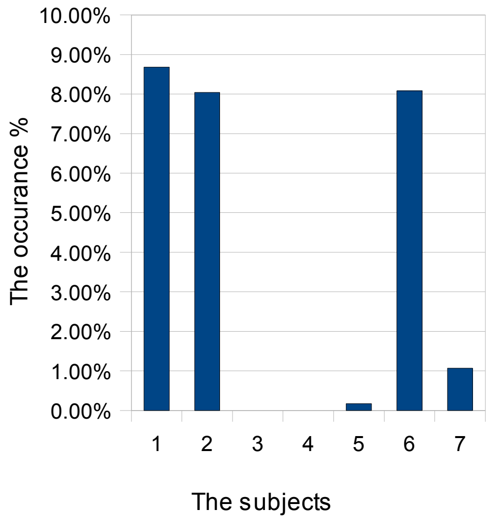

*Figure 6: Spirantization in SLI children.*

Figure 6 shows the frequency of the occurrence of spirantization among the SLI subjects . Relatively speaking, spirantization has not been very often by the SLI cases. Only three cases have applied this process, though not very often used and one case has very rarely applied it. Therefore, and according to these observations spiratization can not be generalized to be a defining feature of SLI in JA. Moreover, the importance of this patterns lies in the fact that it reflects Arabic-specific rules, as the substitution in [ˈʤaa.kajt] as [ˈʒaa.tajt] reflects the stylistic features in JA.

*8.3.1.2.4 Affrication and deaffrication*

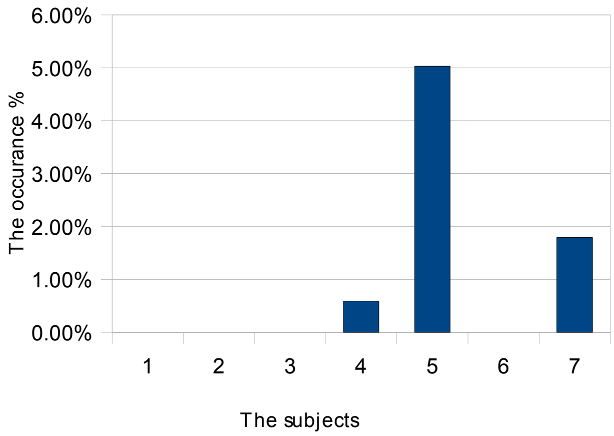


*Figure 7: Affrication in SLI children.*

In affrication, stops and fricatives will be produced as affricates, a process that is mostly applied by children in a way of simplifying the articulation of certain difficult consonant clusters by reducing the muscle control needed for this articulation, thus it is a lenitive process (cf. Tobin 1997: 189). This process, which occurs in child's speech, is described in NP as "homorganic articulatory coalescence" as the fricative sound follows automatically the stop articulation.

As Figure 7 indicates affrication is a less common and a less frequent form of substitution in child's speech. This shows an opposite pattern to the process of stopping in SLI children.

Additionally, in this analysis, very few examples have been found in the typical development in the first developmental stage before three-year-old stage. The same pattern has been noticed in the SLI speech. Affrication is explained in the substituting [ʤ] for [z]as follows:

[ɻuz] as [ʁudʒ] rice.

In deaffrication, an opposite process happens in substituting the affricate with the homorganic stop or fricative through either deleting the fricative or the stop element respectively (cf. Tobin 1997: 190). NP and PHB explain this process in disfavouring the transition between two distinct constrictions in a one single phoneme (cf. Tobin 1997, 2002). This process is defined as a lenitive one in avoiding the difficult articulation of the disfavoured transition from a full stop to a small constriction through a substitution with a simple single sound, mostly through stopping which is easier than producing a fricative. This process confirms the principle of favouring maximum constriction (cf. Maddieson 1999)

Moreover, deaffrication has been explained with PHB, and Tobin (1997: 190) states that:

> "...transitions from one distinct constriction to another within a single phoneme are disfavoured; a more complex sound requiring greater effort or control is reduced to a less complex sound after the speaker has acquired the ability to produce the more difficult stable sounds."

the following are examples of deaffrication from the SLI speech:

[ˈdʒa.bal] as [ˈda.bal] a mountain

[ʔin.ˈdʒaa.sˤah] as [ʔin.ˈdaa.sˤah] a pearl

It is important to mention that the case of substituting the affricate by the homorganic fricative, especially substituting [ʒ] for [dʒ] is considered to be a more prestigious dialectical form especially in the spoken Arabic used by females in Jordan, thus this process reflects Arabic-specific rules. This preference influences the child's typical development and the explanation of its unusual presence in the typical development until later stages; in four and five-year-old speech and even beyond (Table 29). On the contrary, the case of substituting the affricate by the homorganic stop is an atypical process and examples were found only during the first stage in the typical development, especially in the case of substituting [dʒ] by [d].

#### *8.3.1.2.5 Gliding*

Examining the recordings of the AMN children in JA shows that gliding of liquids has been present only in the first developmental stage that is before three years old as these representative examples show:

[θal.ˈlaa.ʤih] as [faj.ˈjaa.ʤih] a refrigerator

[θa.ˈlaaθ] as [ˈjaat] three

[ʃa.ˈʤa.ɻah] as [ˈtʰad.wah] a tree

On one hand, the substitution of glides for liquids is another natural phonological process explained in the sense that a lower degree of muscle articulatory control is achieved through substituting a higher degree of aperture for a smaller degree of closure needed in the articulation of the liquids (cf. Tobin 1997: 189).

On the other hand, the substitution of glides for fricatives is more extreme than the gliding of liquids. The following are representative examples that were transcribed in the typical development before three years old, and in the atypical speech as well:

[tuf.ˈfaa.ħa] as [ʔuw.ˈwaa.ħah] an apple

[ˈʔʰi.ðin] as [ˈʔʰajn] an ear

Both forms confirm and show that maximum aperture is favoured as it requires less articulatory muscle control (cf. Maddieson 1999; Tobin 1997).

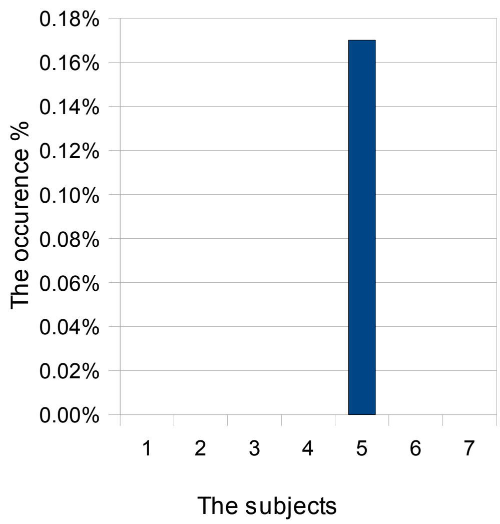


*Figure 8: Gliding in SLI children.*

Figure 8 shows that gliding was noticed in only one SLI case. This indicates that gliding is not a frequent process in SLI speech, thus can not be considered as a characterizing feature of SLI in JA.

#### *8.3.1.2.6 Lateralization*

Lateralization is another phonological process of substituting one liquid for another.

As is clear from the substitution patterns found in the typical development this substitution is present in the first developmental stage and with a very inconsistent application (Table 29) as the following examples show both /l/ and /ʁ/ have been used as substitutes for /r/ among the AMN in JA, this latter case represents frication (spirantization) of a liquid in JA:

['zah.ɻa] as ['ɬah.ɬa] a flower

['ɻaas] as ['ʁaas] a head

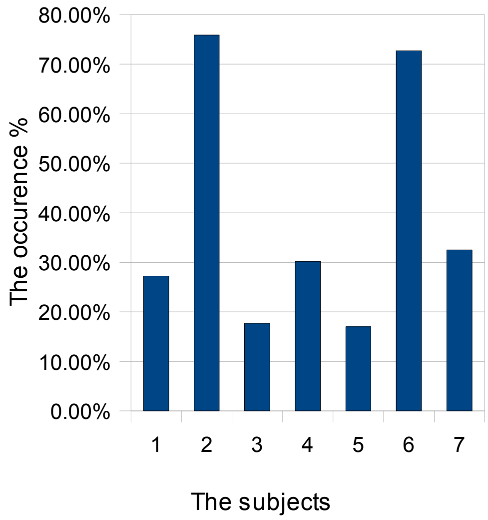


*Figure 9: Lateralization in SLI children.*

As Figure 9 shows, lateralization has been applied very frequently by all the seven SLI cases in this study. In examining the following examples from the SLI speech, a different pattern of lateralization can be noticed:

['ɻaas] as ['lass] a head
['ʔʰaɻ.nab] as ['ʔʰal.nab] a rabbit

[ˈbaʃ.kiiɻ] as [ˈbaʃ.kiil] a towel

[ʃa.ˈʤa.ɻah] as [sa.ˈda.lah] a tree

It is obvious that all occurrence of the non-lateral /r/ have been substituted by the lateral /l/ in word initial, medial and final positions, it is also important to mention that no spirantization of /r/ has been noticed as the case in the typical development.

*8.3.1.2.7 Glottal replacement*

Glottal replacement has been applied frequently in both typical and atypical speech in the relevant data and as can be clearly observed in Figure 10. It is interesting to note that language universally, glottal replacement has been found to be a rather infrequent process. This might be attributable to the presence of a glottal stop and further laryngeal and pharyngeal consonant phonemes in Arabic and other Semitic languages and might serve as a subject of further study.

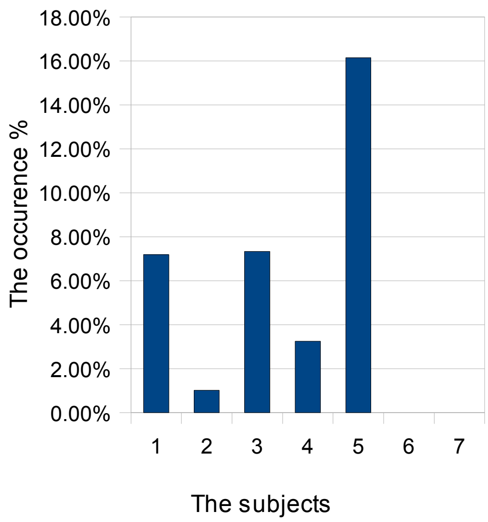


*Figure 10: Glottal replacement in SLI children.*

Figure 10 shows that five out of the seven SLI cases have used the process of glottal replacement in their speech. Glottal replacement reflects aspects of Arabic language-specific rules and the norms of acquiring the language in the particular contexts where it applies; as /χ/ would typically be acquired before /ʔ/ and both /ʔ/ and /ʕ/ would normally be acquired during the same stage Table 10. In this process the voiceless glottal stop /ʔ/ will substitute an intervocalic consonant or a syllable final-position consonant. The explanation is straightforward as it is a favoured tendency to use one set of articulators instead of two in the suitable phonetic environment (cf. Połczyńska-Fiszer 2006, Tobin 1997:190).

['ʔʰɻ̥.ba.ʕah] as ['ʔʰb.ba.ʔah] four

['bad.dijʃ] as ['ʔid.dijʃ] I dont want

[tuf.'faa.ħa] as [ʔuw.'waa.ħah] an apple

['muw.zih] as ['ʔʰuw.zih] a banana

['χam.sih] as ['ʔʰas.sih] five

['ʕam.mih] as ['ʔʰam.mih] an aunt

['ga.lãm] or ['qʰa.lãm] as ['ʔʰa.lãm] a pencil

['ʔʰal.qu.dis] as ['ʔʰal.ʔu.dis] Jerusalem

['ʔʰaz.rag] or ['ʔʰaz.raq] as ['ʔʰaz.raʔ] blue

['ɻ̥a.ga.ba] or ['ɻa.qa.ba] as ['ɻ̥a.ʔa.ba] nick

These representative examples occurred frequently in the typical development before three years old, and rather inconsistently through the child's dialectical forms in the ages after three as in the cases of the glottal replacement of [g] or [q].

The following additional cases have been transcribed for the SLI speech and they show different patterns. Several stops; [dˤ, b, ðˤ, t ] and fricatives; [ʁ, ʕ, h, χ] have been substituted by the glottal stop:

[ʁs.'saa.lih] as [ʔas.'saa.lih] a washing machine

[ʕa.'saa.jih] as [ʔa.'saa.jih] a stick

[ha.'dij.jih] as [ʔa.'dij.jih] a present

['dˤuf.daʕ] as ['ʔif.daʕ] a frog

['χu.biz] as ['ʔu.biz] bread

[bi.'ʤaa.ma] as [ʔi.'daa.ma] pyjama

[naðˤ.'ðˤaa.ɻ̥aat] as [naʔ.'ʔaa.laat] glasses

['tzaq.qif] as ['ʔad.dif] she claps

['ʕas.fuuɻ] as ['ʔas.fuul] or ['ʔaf.fuul]a bird

Additionally, cases of the substitution process includes devoicing, stopping and backing in certain cases; as well as the glottal replacement of [ʁ, ʕ] in the SLI speech.

*8.3.1.2.8 Vowel neutralization*

In the vowel neutralization, and as the following examples will show, non-central vowels are centralized to /a/ and /ʌ/ as central vowels are easier to produce than front and back vowels. The vowel /a/ has the maximum aperture and thus needs less muscle control, therefore, it is the easiest vowel to be produced.

['kfuuf] as ['ku.faf] gloves

[na.'ðˤiij.fiin] as [naðˤ.'ðˤaa.fiin] they are clean

[til.'fiz.jawn] as ['fan.nawn] a television

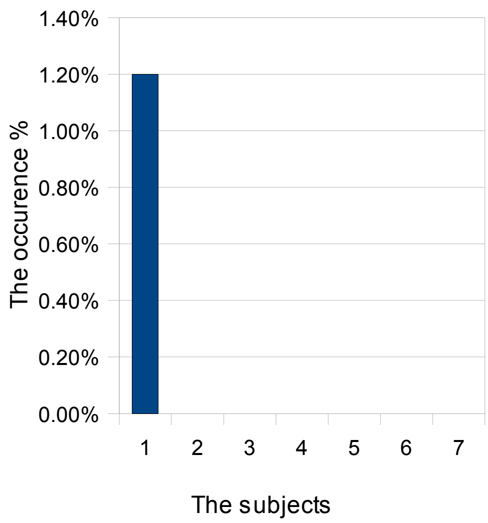

*Figure 11: Vowel neutralization in SLI children.*

Vowel neutralization is considered in NP and PHB to be among the earliest processes in typical phonological development. Surprisingly, no representative examples were found in the typical development of Arabic phonology, while the above examples have been noticed only in the SLI speech. Moreover, this process has been noticed in a very small percentage in only one SLI subjectas it is represented in Figure 11. Statistically, this percentage is very insignificant, therefore, it can not be considered as a feature of SLI in JA.

### 8.3.2 Phonological processes influencing syllable structure

#### 8.3.2.1 Consonant cluster reduction

Figure 12 shows that very few cases of consonant cluster reduction were transcribed in only four SLI cases. This fact means that consonant cluster reduction is not a common process in the atypical speech analyzed in the current study as consonant clusters are not common in Arabic phonology.

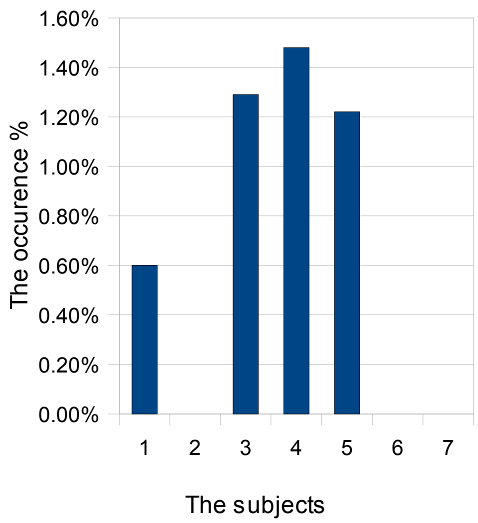


*Figure 12: Consonant cluster reduction in SLI children.*

The following was the only example found in the dialectical forms in the SLI speech:

['btiħ.kij] as ['ħat.tij] she talks

Therefore this is an Arabic language-specific tendency. Although this process reflects the universal CV preference for an ideal syllable structure supported by the fact that almost seventy percent of the world languages do not have consonant clusters. NP and PHB explain this process as 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. Tobin (1997: 187) states:

> "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, coarticulation by near articulators is disfavoured; phonemes of constriction give clearer communicative distinctions than phonemes of aperture (that is why there are more consonants than vowels in languages), but they require more articulatory control (hence the ideal CVC syllable)."

#### 8.3.2.2 Syllable-final consonant deletion

Deleting the syllable final consonant is explained in NP and PHB as a logical and an acceptable process 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 resulting in a CV sequence, which is the canonical preferred syllable structure for a closed and open jaw to produce the best contrast (cf. Tobin 1997: 187).

Surprisingly, very few examples of final consonant deletion were found in the SLI data that have been studied in this work, although they do occur in very small percentages as Figure 13 shows. Additionally, examining the AMN speech shows that this process has been applied only during the first developmental stage and with a very inconsistent pattern during the second stage (Table 29). Therefore, these findings in JA do not agree with the universal nature of this deletion in syllable final position.

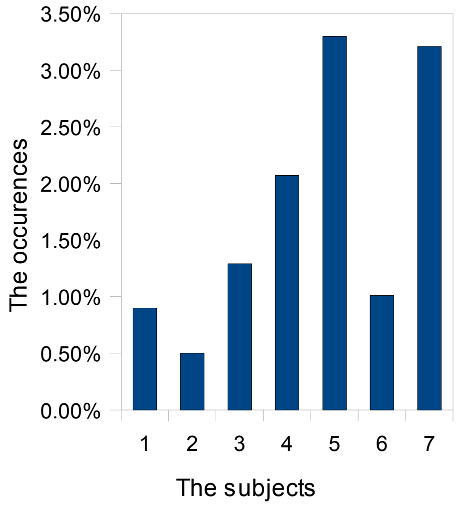


*Figure 13: Final consonant deletion in SLI children.*

The data show that the SLI cases applied another lenitive process instead of the syllable-final-consonant deletion, which helped in reducing the articulatory effort:

['ban.tˤa.luwn] as ['batˤ.tˤa.luwn] trousers

['ʔʰaɻ̥.ba.ʕah] as ['ʔʰab.ba.ʕah] four

These examples were taken from the SLI speech. The subjects applied assimilation through consonant harmony to reduce the required articulatory effort by reducing the involved gestural complexity.

#### 8.3.2.3 Unstressed syllable deletion

This process has been noticed in both typical and atypical speech in JA. This deletion reflects language universal patterns, as it will be explained later.

the following are examples from a typically developing two-year-old child's speech as this process usually occurs during the first developmental stage in JA (Table 29):

['ban.tˤa.luwn] as ['tˤuwn] trousers

[ma.'χad.dih] as ['χat.tih] a pillow

['ja.suwʕ̥] as ['tʰuwʕ̥] Jesus

[θa.'laaθ] as ['jaat] three
['maʕ.la.qah] or ['maʕ.la.gah] as ['maʕ.dah] a spoon

[χa.ˈzaa.nih] as [ˈnaa.nih] a closet

As has been previously mentioned, the process of unstressed syllable deletion has been also noticed in the SLI speech. Figure 14 shows that this process has been applied -although in small percentages- by five out of the seven studied cases. This phonological pattern in the SLI speech can be explained by the following examples:

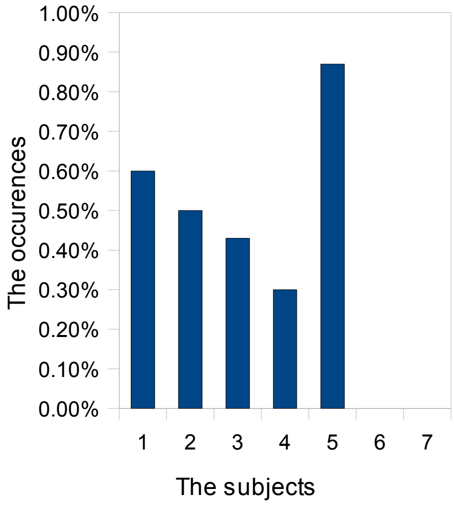


*Figure 14: Weak syllable deletion in SLI children.*

[tit.ˈħam.mam] as [ˈħam.mam] she is having a shower

[bi.ˈħutˤ.tˤil.ha] as [ˈʔud.dil.ha] he gives her

"a dialectical form"

[ʔa.ˈmaʃ.ʃitˤ] as [ˈmaʃ.ʃitˤ] I comb
[til.ˈfiz.jawn] as [ˈfin.nawn] a television

[bi.ˈʕaj.jitˤ] as [ˈʔaj.jitˤ] he is crying

[ˈbuɻ.tu.qaal] as [ˈbul.daan] orange

[ʔal.ˈmad.ɻa.sih] as [ʔal.ˈmas.sih] the school

[til.ˈfiz.jawn] as [ˈfin.nawn] a television

NP and PHB also provide another explanation for the unstressed syllable deletion. This deletion usually applies in a word initial-position being followed by a stressed syllable, thus keeping the stressed syllable which is more communicative and more salient for perception. The initial unstressed syllable, on the other hand, would be the candidate for this simplifying deletion in order to reduce the articulatory efforts as the fewer the number of syllables in a word, the less the articulatory efforts that will be needed (cf. Tobin 1997: 187).

#### 8.3.2.4 Coalescence

Coalescence happens when two consecutive sounds combine and fuse into one sound as a way to reduce the articulatory gestures, thus having less distinctive features. Tobin (1997; 187-188) explains that this process will reduce the articulatory effort required in that articulation at the expense of the maximum communicative effect as in the following case:

['ban.tˤa.luwn] as ['batˤ.tˤa.luwn] trousers

This example was found in the AMN recordings, but no representative examples of this process were found in the SLI recordings in JA.

#### 8.3.2.5 Metathesis and epenthesis

Metathesis and epenthesis are among the phonological processes affecting the syllable structure in both typical and atypical speech through changing the order of the two adjacent phonemes in a word and the addition of one or more phonemes in a word respectively.

['ɻa.qa.ba] or ['ɻa.ga.ba] as ['ɻa.ba.ga] a nick

['ʕatˤ.ʃaan] as ['naʕ.naan] thirsty

['btib.kij] as ['btik.bij] she cries

Studying the recording of the AMN cases, it has been found that metathesis is present in the first sage of typical development and with an inconsistent use until three years of old. Epenthesis has inconsistently been used only during the first developmental stage, but has no other occurrences afterwards (Table 29). The above cases are some representative examples from the speech of the AMN children.

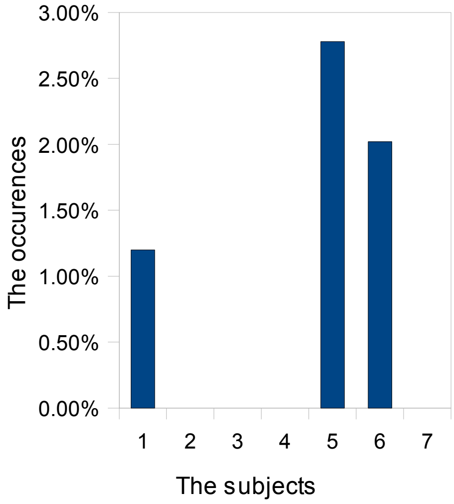


*Figure 15: Metathesis in SLI children.*

Figure 15 shows that metathesis has not been applied very often by SLI subjects in JA. Thus this process can not be considered as a significant characterizing feature of SLI in JA. Figure 15 Further shows that this process has been used by only three SLI subjects and as the percentages indicate, metathesis has been applied in rather small insignificant percentages.

Additionally, the following are examples of metathesis from the SLI speech:

[ˈmaɻ̣.wa.ħah] as [ˈmaħ.la.wah] a fan

[ma.ˈsˤaa.ɻij] as [ma.ˈlaa.sij] money

[ˈdaf.taɻ] as [ˈfad.dal] a notebook

[ˈman.da.lii.na] as [ˈmal.da.dii.na] Clementine

Additionally, and as stated earlier, epenthesis has been inconsistently applied in the typical development during the first stage before the age of three:

[ˈqa.sˤiiɻ] as [ˈʔʰit.siil] short

[ˈmsak.kaɻ] as [ʔʰim.ˈsat.tal] closed

[ˈka.biiɻ] as [ˈʔʰit.biil] big

[mu.ˈɻat.ta.biin] as [ʔʰim.ˈlat.ta.biin] they are tidy

[ˈħi.sˤaan] as [ˈʔʰiħ.sˤaan] a horse

Epenthesis in AMN children has been applied through the insertion of the glottal stop as an extra initial syllable consonant, thus changing the syllable structure and in certain cases the stress pattern as in the preceding examples.

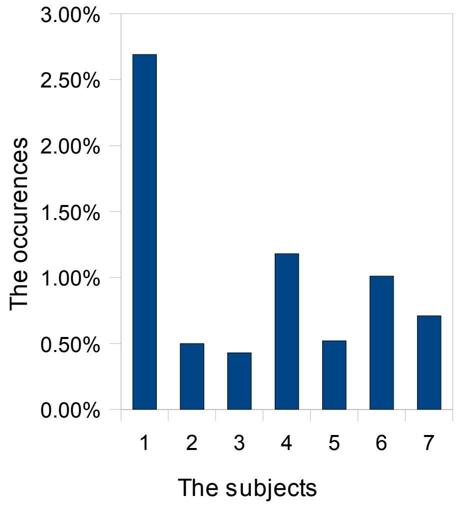


*Figure 16: Epenthesis in SLI children.*

Moreover, Figure 16 Shows that epenthesis has been applied by all the SLI subjects of this sample. This phonological pattern has been applied in few examples in this SLI speech, and in a different way than in AMN children. In addition to this epenthetic pattern of inserting the glottal stop in word-initial position, the following atypical pattern has been found in SLI examples:

['li.saan] as ['til.saan] a tongue

In this example, The SLI child inserted [t] in the syllable initial position, thus changing the syllable shape from CV to CVC. This is an atypical epenthetic pattern in this SLI speech, but it can not be considered as a feature of SLI speech as it has been found only in one child.

### 8.3.3 Assimilation processes

The following assimilation processes have been applied in the atypical data in varied degrees. More specifically, in this analysis, three different assimilation processes have been noticed. These processes are subtypes of the processes of consonant harmony; labialization, velarization, and nasalization in a C1VC2 syllable structure. These processes have been applied to reduce the necessary articulatory effort while simultaneously retaining the same number of sounds in the word.

In this process a consonant in a syllable, usually the problematic sound, assimilates to the place of articulation of another consonant, thus repeating the same active articulators as in the processes of labialization and velarization, while keeping the nasality in nasalization. In these processes fewer articulatory movements, or the same articulatory movements, the number of the active articulators in the production of the syllable/word will be preserved. Therefore, less articulatory effort is needed and at the same time the number of the sounds is retained, thus a word might still be considered to be more easily perceived than in the case of deleting the problematic sound (cf. Tobin 1997: 188).

#### 8.3.3.1 Consonant harmony

##### *8.3.3.1.1 Labialization*

This assimilation processes has been applied in both AMN and SLI speech has appeared in varied degrees:

[θal.ˈlaa.ʤih] as [faj.ˈjaa.ʤih] a refrigerator

[tuf.ˈfaa.ħah] as [ʔuw.ˈwaa.ħah] an apple

[ʃa.ˈʤa.ɻah] as [ˈtʰad.wah] a tree

The above examples of labialization are taken from the typically developing children. The current study shows that this process occurred only before three-year-old stage (Table 29).

Examining the SLI data reveals (cf. Figure 17) that labialization has not been applied quite often in our JA corpus. More specifically, Figure 17 shows that there ere only two labialization processes in typical speech production.

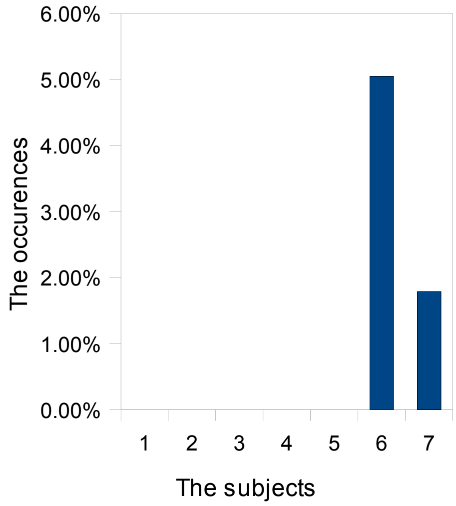


*Figure 17: Labialization in SLI children.*

['ʔʰaɻ.ba.ʕah] as ['ʔʰab.ba.ʕah] four

['laf.ħah] as ['faf.ħah] a scarf

[θal.'laa.ʤih] as [fal.'laa.ʤih] a refrigerator

As these three example and the percentages in Figure 17 show labialization was rarely noticed in the SLI speech. Therefore, labialization can not be considered as a feature of atypical speech in JA.

*8.3.3.1.2 Velarization*

Representative examples of velarization have been found in the speech of the typically developing children as follows:

['ʁa.na.mih] as ['kʰa.ma.mih] a goat

['qʰa.ɫãm] as ['ga.ɫãm] a pencil

['ɻa.qa.ba] as ['ɻa.ga.ba] a nick

['qʰããm] as ['gããm] he stood

['fuw.qij] as ['fuw.gij] above me

['qʰah.wah] as ['gah.wah] coffee

It was noticed that most of the cases of velarization occurred inconsistently while using the dialectical forms, which are acceptable and thus reflect Arabic-specific features. Therefore, velarization has been applied by all AMN children in this study during all their developmental stages due to their use of the Jordanian dialect. On the other hand, this study shows no cases of velarization in the SLI speech, therefore, veralization is not a typical feature of SLI in JA.

*8.3.3.1.3 Nasalization*

As is obvious from the chronology in Table 29, nasalization is a typical phonological process that has been applied frequently in the first developmental stage before the age of three which might inconsistently appear in the child speech in the later stages:

[χa.ˈzaa.nih] as [ˈnaa.nih] a closet

[ˈqʰa.ɫãm] or [ˈga.ɫãm] as [ˈga.mãm] a pencil

[ˈθũm] as [ˈnũm] a mouth

[ˈba.tˤin] as [ˈhʰam.min] a belly

[ˈʔʰiʕ.juwn] as [ˈʔʰiʕ.nuwn] eyes

[ˈʁa.na.mih] as [ˈkʰa.ma.mih] a goat

[sik.ˈkii.nih] as [ˈnii.nih] a knife

This assimilation process has been applied to typical development as a result of the motivation attributed to consonant harmony to reduce the number of the active articulators by PHB.

In considering the occurrence of nasalization in SLI in JA and as Figure 18 reveals, only four participants applied this process. Thus nasalization occurred in only very few cases in SLI recordings as the percentages in Figure 18 indicate. Therefore, this process can not be described as a characterizing feature of SLI in JA.

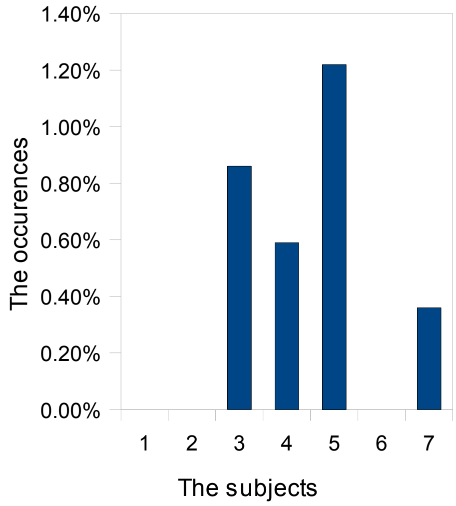


*Figure 18: Nasalization in SLI children.*

Surprisingly, few examples of nasalization were found in the atypical speech:

['fusˤ.tˤããn] as ['fũn.nããn] a dress

[tʰil.'fiz.jawn] as ['fãn.nwn] a television

['nim.mlih] as ['nim.nih] an ant

['sˤa.ħin] as ['ʔʰa.nin] a plate

['ʔʰiʕ.jũũn] as ['ʔʰiʕ.nũũn] eyes

These few examples from the SLI recording show that nasalization was not a frequent assimilation process in SLI speech. This characteristic can be explained by the fact that glides /w, j/, nasals /m, n/ along with the lateral /l/ are the only phoneme classes that the SLI children in this study have mastered in all syllable positions. Therefore, very few processes have affected these sound classes in SLI cases in JA.

#### 8.3.3.2 Prevocalic voicing

The second assimilation process is pre-vocalic voicing. Tobin (1997: 188) explains this process as: "an unvoiced consonant becomes voiced generally before a vowel: the speaker anticipates the control of two sets of articulators in what is usually a longer acoustic phonological segment". Moreover, pre-vocalic voicing is a lenitive process as it reduces the required energy in changing a fortis into a lenis sound "due to the more vigorous resistance offered by the narrowed configuration of the vocal folds to the current of air" Kul (2007: 166).

Pre-vocalic voicing has been applied inconsistently in the typical development during all the four developmental stages that have been examined in this study in JA:

['ʔʰidʒ.ɹij] as ['ʁidʒ.dʒij] my leg

['maʕ.la.qah] as ['maʕ.la.gah] a spoon

['qʰa.ɫãm] as ['ga.ɫãm] a pencil

Most of the cases of this inconsistent use of this voicing among the AMN participants have been a result of using the dialectical forms throughout all the developmental stages even after the age of five. This is an optional choice as the child can use either the ESA or the dialectical forms with no differences in meaning.

Moreover, Figure 19 shows that voicing has been used by all SLI subjects in this study. The percentages in Figure 19 show that SLI subjects varied in the degree of voicing in their speech.

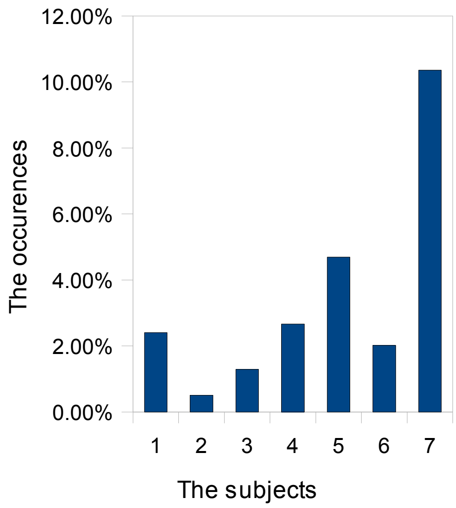


*Figure 19: Prevocalic voicing in SLI children.*

The following are examples from pre-vocalic voicing cases in the SLI speech (excluding voicing in the dialect forms in JA as these are acceptable forms):

[tˤaa.'qij.jih] as [tˤaa.'dij.jih] a hat

['buɻ.tu.qaal] as ['bul.daan] orange

['ʔʰaʃ.qaɻ] as ['has.dal] blond

['fatˤ.buwl] as ['fad.buwl] a football

[bi.'ħutˤ.tˤil.ha] as ['ʔʰud.dil.ha] he gives her

"a dialectical form"

The last two examples present a different pattern of voicing in SLI speech. The child applies syllable-final consonant voicing, a completely atypical phonological process. This process, in this context, increases the number of the active articulators because of the activation of the vocal folds. Therefore, more articulatory effort is needed through this voicing the reason for its absence in the typical development, and therefore classifies it as an atypical phonological process. Therefore, it can be said that despite this small percentage in the corpus, syllable-final consonant voicing can be considered as a feature of the SLI in JA.

#### 8.3.3.3 Final consonant devoicing

Final consonant devoicing (FCD) reduces the number of the active articulators through the deactivation of the vocal folds in the articulation of the final consonant. Tobin (1997: 188) explains that in this process: "additional articulators are disfavoured; voiced consonants become unvoiced in word-final position; where the communicative force is least important or crucial, the speaker opts to activate one set of articulators rather than two." Moreover, and according to the principles of NP and PHB, devoicing can be explained as a lenitive process in the sense that it reduces the gestural complexity. On the other hand, this process could be described as a fortition because it leads to the strengthening of the syllable coda (cf. Dziubalsaka Kołaczyk 2002c).

Devoicing usually occurs in word-final position as this position provides the smallest contribution to the word's communicative force as is clear in the following examples:

['wa.lad̥] as ['wa.lat] a boy

['ʔʰaz.ɻag̊] as ['ʔʰaz.ɻaʔ] blue

['wa.ɻag̊] as ['wa.ɻaʔ] papers

Final consonant devoicing has been applied in the first stage of typical development and with an inconsistent presence up to the age of four as can be obseved in the chronology of the phonological processes in the typical development Table 29.

Final consonant devoicing as presented in Figure 20 has been found in almost all the SLI participants in this study.

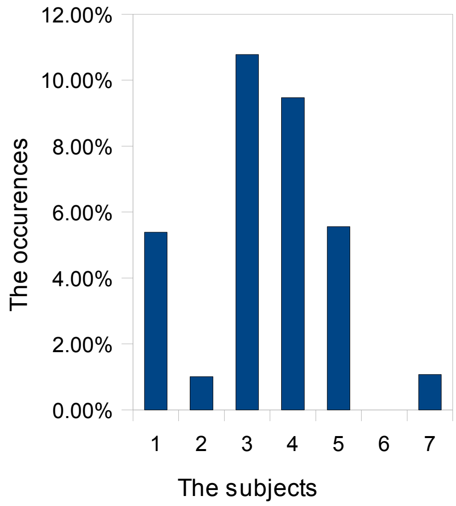


*Figure 20: Final consonant devoicing in SLI children.*

Examining the devoicing examples in the SLI participants reveals that this process has been applied in a different pattern than in the AMN children. More specifically, certain cases have been found in the SLI recordings in this study where both backing and devoicing of the initial syllable consonant occur as in the following examples:

[ˈʁa.zaal] as [ħas.saal] a dear

[ˈʕas.fuuɻ] as [ˈʔʰaf.fuul] a bird

[ʔʰa.ˈʁas.sil] as [ʔa.ˈʔʰas.sil] I am washing

The following examples present a form of initial consonant devoicing in the SLI speech where the same active articulator has been retained:

[ˈðajl] as [ˈθajl] a tail

[ˈzah.ɻij] as [ˈsah.ɻij] pink

Another form of devoicing of both the initial and final consonants in SLI speech occurred as in this example:

[naðˤ.ˈðˤaa.ɻaat] as [naʔ.ˈʔaa.laat] glasses

Despite the small percentages in Figure 19 and Figure 20 it can be concluded from the these patterns of voicing and devoicing appearing in the relevant examples in SLI speech that these processes are to be considered as features of atypical language acquisition in JA.

## 8.4 The phonetic inventory of children with atypical phonological development

With comparison and reference to the Standard Arabic consonants, and common Jordanian dialectical variants as explained in (Amayreh & Dyson 1998:653) as presented in Table 8; this section provides a description of the phonetic inventory profile of each child in the SLI sample in this study.

*Table 30: The missing phonemes in the phonetic inventory of SLI subjects*

| *Phonemes* | *SLI Subjects* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *B1* | *B2* | *B3* | *B4* | *B5* | *B6* | *B7* |
| Stop | q, g, k, dˤ, tˤ | q, g, dˤ | q, g, k, dˤ, tˤ | q, g, k, dˤ, tˤ | q, g, k, dˤ, tˤ | dˤ | q, g, k, dˤ, tˤ |
| Fricative | ðˤ, sˤ, ʃ, ʁ, x, ʕ | sˤ | θ, ðˤ, sˤ, ʁ, ʕ | ð, θ, ðˤ, sˤ, ʁ, ʕ | ð, θ, ðˤ, s, z, sˤ, ʃ, ʁ, χ ,ʕ, ħ | | ðˤ, sˤ, ʁ, ʕ |
| Affricate | dʒ | | dʒ | dʒ | | | dʒ |
| Trill | r | | r | r | r | r | r |

After analyzing the recordings and examining the annotations of the SLI children's articulations, the following phenomena have been found to characterize their phonetic inventory. The following features of these phonetic inventories can be considered as the characteristics of this atypical phonological development in JA as observed in the speech of the seven SLI children participating in the current study:

- Generally, oral stops and fricatives-both emphatic and non emphatic-in all syllable position, are the two most difficult manners of articulation for all the SLI participants in this study.
- Back places of articulation/articulators (non-apical); alveolar-dental, palatal, velar, uvular, and pharyngeal consonants are more challenging than the front places of articulation/articulators.
- Secondary articulation; emphatic consonants are very often missing in all SLI participants as a result of more gestural articulatory complexity.
- It is obvious from the findings presented in Table 30 that the SLI subjects have been limiting their oral stops to the voiced bilabial /b/ and the voiced and the voiceless alveolar-dental /d, t/ in addition to the glottal stop /ʔ/.
- Voiced and voiceless velar, uvular as well as the emphatic alveolar-dental oral stop /g, k, q, dˤ, tˤ/ form a considerable articulatory difficulty for most of the SLI subjects. Therefore, these phonemes are mostly absent in their phonetic inventories.
- Both of the emphatic fricatives; the voiced dental and the voiceless alveolar-dental /ðˤ, sˤ/ are missing in the phonetic inventory of most of the SLI subjects. Therefore, these phonemes represent a gestural complexity for most of the SLI subjects; more specifically, in five out of the seven subjects in this study.
- The voiceless dental fricative /θ/ is missing in the phonetic inventory of nearly half of the subjects.
- Both voiceless fricatives; the palatal and the uvular /ʃ, χ / are totally missing in the phonetic inventory of two subjects in all syllable positions.
- Both voiced fricatives; the uvular and the pharyngeal /ʁ, ʕ/ are missing in most of the SLI subjects; more specifically, five subjects out of seven.
- Obviously, the least problematic fricative sounds for all of the SLI subjects are the voiceless labiodental /f/ and the voiceless glottal /h/, which have been present in all the studied inventories in all syllable positions.

- One SLI subject and specifically, participant E has limited the fricatives to only two phonemes /f, h/ (Table 30). This forms a very rich context for many phonological processes accompanied by considerable unintelligibility.
- The voiced palatal affricate /dʒ/ forms a clear articulatory difficulty for most of the SLI subjects, which explains its absence in all syllable positions. As a result of this articulatory difficulty, /dʒ/ has very often been substituted by the voiced alveolar-dental stop /d/.
- The trilled /r/ presents another articulatory difficulty for almost all of the SLI subjects, consequently, forming a context for gliding. Thus it has very often been substituted with the bilabial glide /w/, and with the palatal glide /j/ in some cases.
- Glides /w, j/, nasals /m, n/ along with the lateral /l/ are the only phoneme classes that the SLI children in this study have mastered in all syllable positions.

## 8.5 Patterns of the phonological processes in SLI speech

The patterns of the phonological processes in the SLI participants have been compared to discover similarities in these patterns in order to characterize atypical phonological development in JA. Therefore, the occurrences of the phonological processes in the SLI subjects have been summarized in Table 31:

*Table 31: The occurrences of the phonological processes in SLI subjects*[22]

| cases | *Substitution Processes* | | | | | | | | | | *Processes changing syllable structure* | | | | | | *Assimilation processes* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *of active articulators* | | *in the turbulence /airflow* | | | | | | | | | | | | | | *Consonant Harmony* | | | *V* | *DV* |
| | *Fro* | *Bac* | *Stop* | *Spi* | *GR* | *Gl* | *Lat* | *VN* | *Aff* | *DE* | *WSD* | *ICD* | *FCD* | *CCR* | *Met* | *Epe* | *Lab* | *Vel* | *Nas* | | |
| B1 | 53 | 25 | 34 | 29 | 24 | _ | 91 | 4 | _ | 15 | 2 | 10 | 3 | 2 | 4 | 9 | _ | _ | 3 | 8 | 18 |
| B2 | 17 | 3 | 1 | 16 | 2 | _ | 151 | _ | _ | 3 | 1 | _ | 1 | _ | _ | 1 | _ | _ | _ | 1 | 2 |
| B3 | 58 | 28 | 39 | _ | 17 | _ | 41 | _ | _ | 10 | 1 | 1 | 3 | 3 | _ | 1 | _ | _ | 2 | 3 | 25 |
| B4 | 82 | 23 | 35 | _ | 11 | _ | 102 | _ | 2 | 20 | 1 | 3 | 7 | 5 | _ | 4 | _ | _ | 2 | 9 | 32 |
| B5 | 12 | 122 | 70 | 1 | 93 | 1 | 98 | _ | 29 | 11 | 5 | 23 | 19 | 7 | 16 | 3 | _ | _ | 7 | 27 | 32 |
| B6 | 7 | _ | _ | 8 | _ | _ | 72 | _ | _ | 1 | _ | _ | 1 | _ | 2 | 1 | 5 | _ | _ | 2 | _ |
| B7 | 82 | 5 | 8 | 3 | _ | _ | 91 | _ | 5 | 37 | _ | _ | 9 | _ | _ | 2 | 5 | _ | 1 | 29 | |

To facilitate comparing these patterns, the occurrences of each process in the recording of each SLI subject have been counted and the percentages of these

22 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis; WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis; Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

- This means that no occurrences were found.

occurrences among all SLI subjects in this study have been calculated and represented in Figure 21[23]:

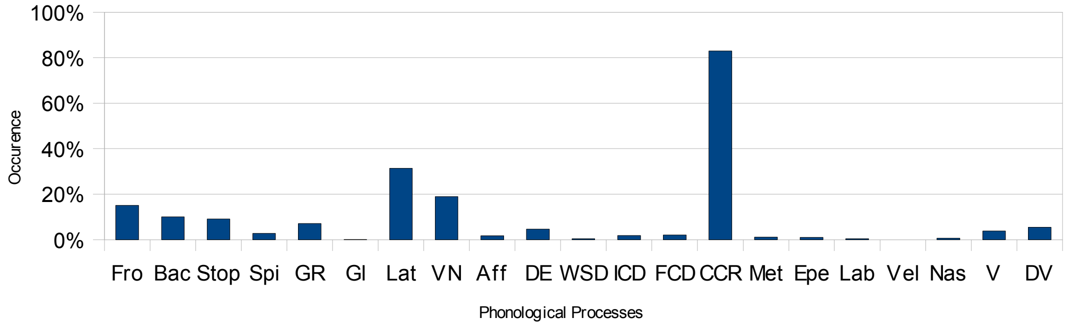


*Figure 21: The distribution of the phonological processes in SLI speech.*

From the initial results, the following specific observations regarding the distribution of the three main types of phonological processes and the frequencies of their specific representative occurrences have been obtained (Table 31). Moreover, it has been found that:

- Substitution Processes; both of the active articulators and in the degree of the turbulence/airflow are the most frequently used processes among all SLI subjects in JA in this study.
- More specifically, lateralization, stopping, fronting, glottal replacement, backing, and de-emphasis have frequently been applied by the SLI cases.
    - More precisely, and after lateralization, fronting has been found to be the most frequently applied substitution process in the SLI speech.
    - Among the processes substituting the degree of the turbulence/airflow, it has been noticed that affrication, gliding and vowel neutralization have rarely been applied among all SLI subjects.
- Processes changing syllable structure have been applied less frequently than other processes among all SLI subjects.
    - More specifically, initial and final consonant deletion have been applied

23 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis; WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis; Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

more frequently than other syllable-structure changing processes.

- Among assimilation processes, voicing and devoicing have been applied more frequently than the assimilatory consonantal harmony processes in SLI speech.
- The least used processes are vowel neutralization and gliding among all SLI subjects in this study.

It can be summarized from this analysis of the SLI data that some of the observations suggest that SLI in JA can actually be classified as delayed acquisition. Moreover, there are other factors which need further and more specific investigation. SLI children may have a different language system, which may involve deviances from the Arabic-specific phonological rules acquired in typical acquisition. The current analysis suggests that this disorder involves different selections from universal phonological processes:

- The frequent application of fronting and stopping confirms the maximum constriction preference (cf. Tobin 1997, 2002; Tobin et al. 2006).
- Articulatory difficulty may be the explanation for the phonological processes in the production of the emphatic consonants; namely, through de-emphasis and for the lateralization of /r/.
- The substitution of glides for fricatives and the gliding of liquids, both confirm the preference for maximum aperture by reducing articulatory muscle control (cf. Tobin 1997, 2002; Tobin et al. 2006).
- The consistent use of unstressed syllable deletion, final consonant deletion, metathesis, epenthesis, pre-vocalic voicing and final consonant devoicing as well as the infrequent application of vowel neutralization, labialization, velarization, and nasalization confirm language universals.

Moreover, this analysis shows the occurrence of other phonological processes that differ from typical universal phonological processes in some atypically determined ways:

- Backing which has frequently been used in SLI speech was mostly achieved through glottal replacement.
- The inconsistent pre-vocalic voicing and devoicing.

    - Final consonant voicing, a completely atypical process.
    - SLI recordings show devoicing of the initial syllable consonant as opposed to the pattern in the AMN children, who typically apply final consonant devoicing because this position provides the smallest contribution to the word's communicative force.
- Glottal replacement has been applied frequently in the SLI speech in our data, although language universally it has been found that this process is rather infrequent. Therefore glottal replacement differs from both language universals and Arabic-language specific phenomena as well as the norms of typical language acquisition in the context where it has been applied; by substituting for certain sounds that have been typically acquired earlier.

The SLI speech analyzed in this study reveals the occurrence of some phonological processes which reflect Arabic language-specific rules in the following ways:

- The use of the dialectical forms, the form of Arabic that the child will acquire before starting learning ESA at school, helped in making fronting a very frequent process.
- De-emphasis and the use of a sound non-emphatic cognate. Moreover, this process confirms one of the fundamental PHB principles, namely the disfavouring of additional articulators, as explained in Tobin (2000, 2007a).
- Spirantization, particularly substituting /h/ for /ʔ/ which differs from the typical acquisition norms in JA.
- Deaffrication, especially substituting [ʒ] for [ʤ] and its stylistic implications in JA.
- The infrequent use of Consonant cluster reduction in SLI speech is another process presenting Arabic-specific features.

### 8.5.1 Phonological processes and phonetic inventories in SLI participants

All the phonological processes in the SLI participants (B1-B7) (Table 31) will be discussed and explained in this section. Additionally, the percentages of the occurrences of the three major classes of the phonological processes in the recordings of each SLI subjectwill be presented separately. Therefore the substitution processes, the processes changing syllable structure, and the assimilation processes in the speech of each SLI subjectwill be presented.

#### 8.5.1.1 B1

The occurrences of all the phonological processes in the SLI-B1 have been summarized in Table 32

*Table 32: The phonological processes in B1*[24]

| | *Substitution Processes* | | | | | | | | | | *Processes changing syllable structure* | | | | | | *Assimilation processes* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *of active articulators* | | *in the turbulence /airflow* | | | | | | | | | | | | | | *Consonant Harmony* | | | *V* | *DV* |
| | *Fro* | *Bac* | *Stop* | *Spi* | *GR* | *Gl* | *Lat* | *VN* | *Aff* | *DE* | *WSD* | *ICD* | *FCD* | *CCR* | *Met* | *Epe* | *Lab* | *Vel* | *Nas* | | |
| *A* | 53 | 25 | 34 | 29 | 24 | _ | 91 | 4 | _ | 15 | 2 | 10 | 3 | 2 | 4 | 9 | _ | _ | 3 | 8 | 18 |
| *334* | 15.87% | 7.49% | 10.18% | 8.68% | 7.19% | 0.00% | 27.25% | 1.20% | 0.00% | 4.49% | 0.60% | 2.99% | 0.90% | 0.60% | 1.20% | 2.69% | 0.00% | 0.00% | 0.90% | 2.40% | 5.39% |

For the purpose of explaining the phonological patterns in B1's speech in details, the percentages of these processes are presented in the following three figures. These figures represent the occurrences of the three major classes of the phonological

24 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis; WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis; Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

_ No occurrences were found.

processes; namely, the substitution processes, the processes changing syllable structure, and the assimilation processes in the speech of this SLI case.

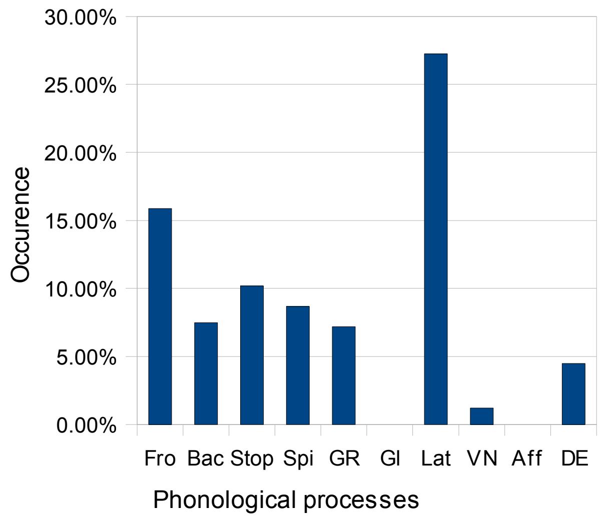


*Figure 22: Substitution processes-B1*

The results in Figure 22[25] show that lateralization and fronting were the most frequent substitution processes and statistically they were the most significant processes in B1's speech. After stopping, spirantization has been a rather frequent process in this case. Figure 22 also shows that backing and glottal replacement have been applied to almost the same degree. De-emphasis and vowel neutralization were present in a few cases of production.

25 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis.

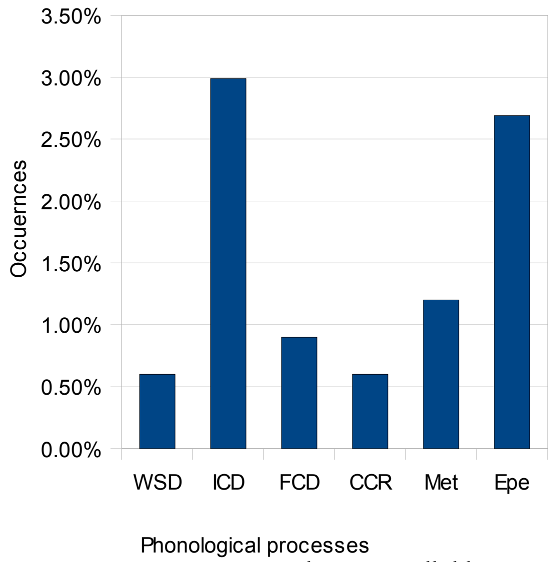

*Figure 23: Processes changing syllable structure-B1*

Figure 23[26] generally shows that B1 has not applied the processes changing syllable structure often in his speech, therefore, all the representing patterns are not significant in this case. More specifically, initial consonant deletion and epenthesis have been the most frequent processes among the processes affecting the syllable structure in B1's speech. Metathesis and final consonant deletion were used more often than the two other processes; namely, unstressed syllable deletion and consonant cluster reduction.

26 Abbreviations: WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; V: voicing; DV: devoicing; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis.

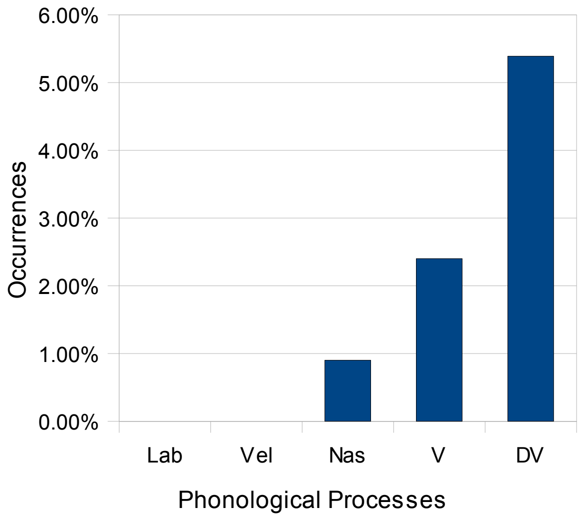

*Figure 24: Assimilation processes-B1*

The results in Figure 24[27] show that assimilation processes have not been very frequent in B1's speech. However, devoicing was the most frequent phonological process among the assimilation processes that B1 has applied in his speech. Voicing was present in very few cases and nasalization was also applied in the same pattern.

27 Abbreviations: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

Table 33 shows the missing phonemes in the phonetic inventory of B1.

*Table 33: The missing phonemes in the phonetic inventory-B1*

| *phonemes* | *subjectB1* |
|---|---|
| Stop | q, g, k, dˤ, tˤ |
| Fricative | ðˤ, sˤ, ʃ, ʁ, x, ʕ |
| Affricate | dʒ |
| Trill | r |

Examining the content of Table 33 shows the phonemes that presented the most articulatory difficulty for SLI-B1. It is quite obvious that almost all emphatic consonants were very difficult to produce by B1.

### 8.5.1.2 B2

*Table 34: The phonological processes in B2*[28]

| | *Substitution Processes* | | | | | | | | | | *Processes changing syllable structure* | | | | | | *Assimilation processes* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *of active articulators* | | *in the turbulence /airflow* | | | | | | | | | | | | | | *Consonant Harmony* | | | *V* | *DV* |
| | *Fro* | *Bac* | *Stop* | *Spi* | *GR* | *Gl.* | *Lat* | *VN* | *Aff* | *DE* | *WSD* | *ICD* | *FCD* | *CCR* | *Met* | *Epe* | *Lab* | *Vel* | *Nas* | | |
| B | 17 | 3 | 1 | 16 | 2 | _ | 151 | _ | _ | 3 | 1 | _ | 1 | _ | _ | 1 | _ | _ | _ | 1 | 2 |
| 199 | 8.54 % | 1.51 % | 0.50 % | 8.04 % | 1.01 % | 0.00 % | 75.88% | 0.00 % | 0.00 % | 1.51 % | 0.50 % | 0.00 % | 0.50 % | 0.00 % | 0.00 % | 0.50% | 0.00 % | 0.00 % | 0.00 % | 0.50 % | 1.01 % |

As has been previously stated and for the purpose of explaining the phonological patterns in B2's speech in detail, the percentages of these results will be presented in

28 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis; WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis; Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

_ No occurrences were found.

the following three figures. These figures represent the occurrences of the three major classes of phonological processes; namely, the substitution processes, the processes changing syllable structure, and the assimilation processes.

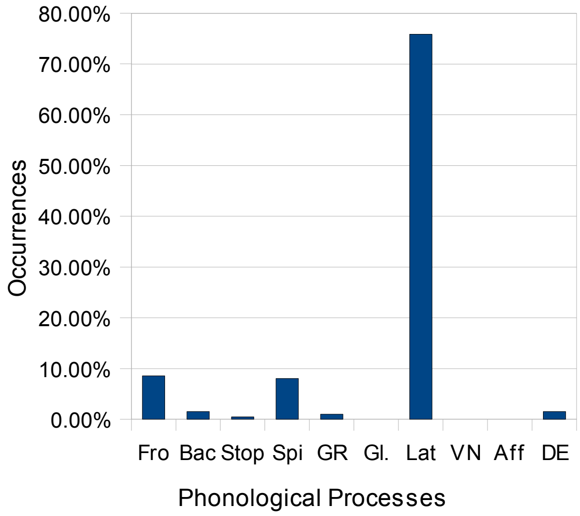


*Figure 25: Substitution processes-B2*

These results in Figure 25[29] show that lateralization was the most frequent substitution process in the speech of B2. Spirantization and fronting were applied in less than 10% among the other very rarely used processes in the speech of this case. Figure 25 also shows that backing and glottal replacement were applied at almost the same frequency, though rarely. De-emphasis and vowel neutralization were present in very few cases in the speech production of this SLI subjectin JA.

29 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis.

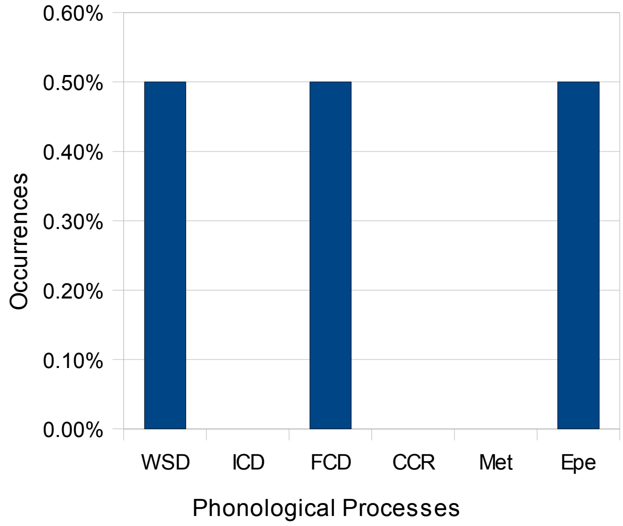


*Figure 26: Processes changing syllable structure-B2*

Figure 26[30] describes the processes affecting the syllable structure in the speech of B2. It shows that unstressed syllable deletion, final consonant deletion and epenthesis have been applied more often than the other processes in the speech of B2. It is clear that this child applied these three processes in exactly the same frequency. Moreover, it is obvious from Figure 26 that initial consonant deletion, consonant cluster reduction and metathesis have not been used by SLI-B2.

30 Abbreviations: WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis.

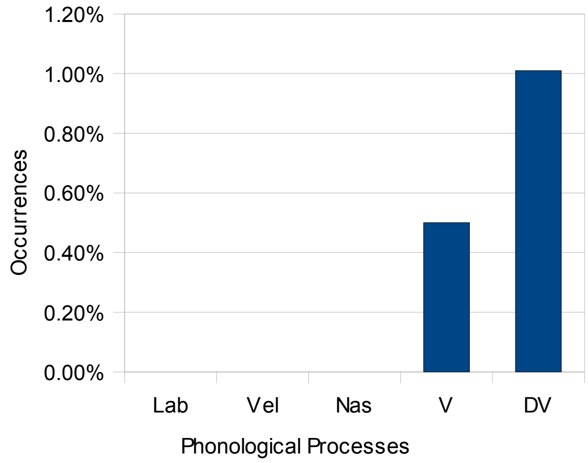

*Figure 27: Assimilation processes-B2*

The results in Figure 27[31] indicate that B2 did not show many applications of the assimilation processes. Though two conclusions can be discussed about this pattern in SLI-B2's speech. First, after devoicing, voicing was present in a few cases. Second, it is this inconsistency in applying voicing and devoicing that has been found to characterize the SLI speech in JA.

*Table 35: The missing phonemes in the phonetic inventory-B2*

| *Phonemes* | *subjectB2* |
|---|---|
| Stop | q, g, $d^ʕ$ |
| Fricative | $s^ʕ$ |
| Affricate | |
| Trill | |

Examining the content of Table 35 shows the phonemes that presented the most articulatory difficulty for B2. Stops and fricatives were of a particular articulatory difficulty for this SLI-B2. It is clear in Table 35 that only two emphatic consonants; /$d^ʕ$/ and /$s^ʕ$/ were very difficult for B2 to produce. It could be possible that it is the active articulator or place of articulation rather than the manner of the articulation that caused this pattern of difficulty in B2's speech.

31 Abbreviations: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

### 8.5.1.3 B3

*Table 36: The phonological processes in B3*[32]

| | *Substitution Processes* | | | | | | | | | | *Processes changing syllable structure* | | | | | | *Assimilation processes* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *of active articulators* | | *in the turbulence /airflow* | | | | | | | | | | | | | | *Consonant Harmony* | | | *V* | *DV* |
| | *Fro* | *Bac* | *Stop* | *Spi* | *GR* | *Gl* | *Lat* | *VN* | *Aff* | *DE* | *WSD* | *ICD* | *FCD* | *CCR* | *Met* | *Epe* | *Lab* | *Vel* | *Nas* | | |
| *C* | 58 | 28 | 39 | _ | 17 | _ | 41 | _ | _ | 10 | 1 | 1 | 3 | 3 | _ | 1 | _ | _ | 2 | 3 | 25 |
| *232* | 25.00% | 12.07% | 16.81% | 0.00% | 7.33% | 0.00% | 17.67% | 0.00% | 0.00% | 4.31% | 0.43% | 0.43% | 1.29% | 1.29% | 0.00% | 0.43% | 0.00% | 0.00% | 0.86% | 1.29% | 10.78% |

The phonological patterns in B3's speech and the percentages of these results are presented in the following three figures.

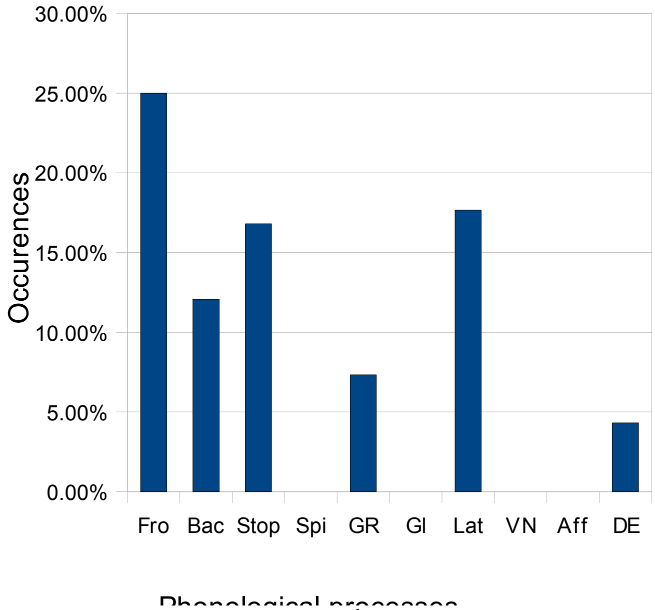


*Figure 28: Substitution processes-B3*

32 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis; WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis; Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

_ No occurrences were found.

These results in Figure 28[33] show that fronting was the most frequent substitution processes in B3's speech. Lateralization and stopping also have frequently been applied by B3. Figure 28 Further shows that backing and glottal replacement were relatively frequent processes for B3 (comparatively speaking based on a small corpus of data). De-emphasis was present in just a few cases of B3's production in this SLI sample.

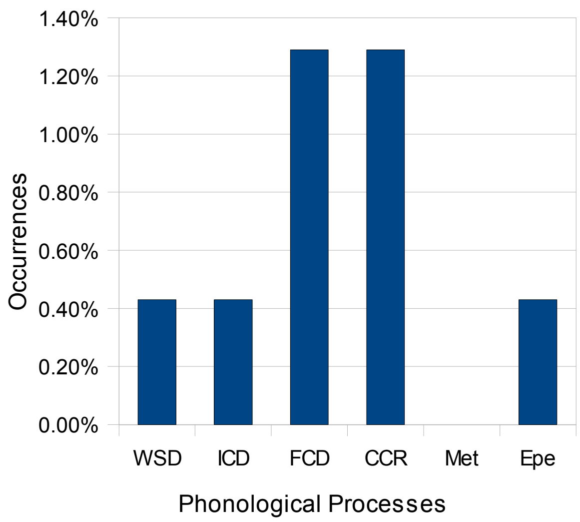


*Figure 29: Processes changing syllable structure-B3*

A quick look at Figure 29[34] shows that B3 used all the substitutional processes affecting the syllable structure in his speech production except for metathesis, which was not transcribed for any single case in SLI-B3's sample. The percentages of these patterns are not significant. More specifically, final consonant deletion and consonant cluster reduction were the most frequent processes. Figure 29 also indicates that unstressed syllable deletion, initial consonant deletion and epenthesis have been applied although to a less degree in SLI-B3's speech.

33 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis.

34 Abbreviations: WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis.

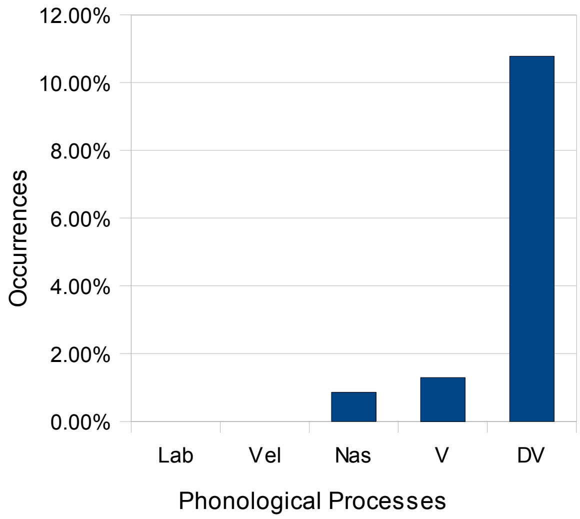

*Figure 30: Assimilation processes-B3*

Among the assimilation processes that SLI-B3 applied in his speech Figure 30[35] shows that devoicing was the most frequent phonological process. Voicing and nasalization were also present but in very few cases.

*Table 37: The missing phonemes in the phonetic inventory- B3*

| *Phonemes* | *subjectB3* |
|---|---|
| Stop | q, g, k, dˤ, tˤ |
| Fricative | θ, ðˤ, sˤ, ʁ, ʕ |
| Affricate | dʒ |
| Trill | r |

Examining the content of Table 37 shows the phonemes that presented the most articulatory difficulty for SLI-B3. It is very obvious that almost all the emphatic consonants were very difficult for SLI-B3 to produce. The affricate /dʒ/ and the trill /r/ were also difficult for SLI-B3 to produce.

35 Abbreviations: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

### 8.5.1.4 B4

*Table 38: The phonological processes in B4*[36]

| | Substitution Processes | | | | | | | | | | Processes changing syllable structure | | | | | | Assimilation processes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | of active articulators | | in the turbulence /airflow | | | | | | | | | | | | | | Consonant Harmony | | | V | DV |
| | Fro | Bac | Stop | Spi | GR | Gl. | Lat | VN | Aff | DE | WSD | ICD | FCD | CCR | Met | Epe | Lab | Vel | Nas | | |
| D | 82 | 23 | 35 | _ | 11 | _ | 102 | _ | 2 | 20 | 1 | 3 | 7 | 5 | _ | 4 | _ | _ | 2 | 9 | 32 |
| 338 | 24.26% | 6.80% | 10.36% | % | 3.25% | % | 30.18% | % | 0.59% | 5.92% | 0.30% | 0.89% | 2.07% | 1.48% | % | 1.18% | % | % | 0.59% | 2.66% | 9.47% |

Table 38 presents all the phonological patterns in B4's speech. Moreover, Figure 31 to Figure 33 present all the percentages of the occurrences of the three major classes of the phonological processes; namely, the substitution processes, the processes changing syllable structure, and the assimilation processes.

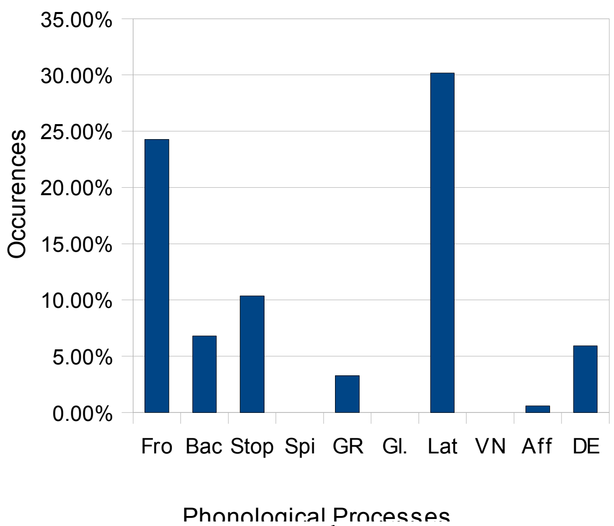


*Figure 31: Substitution processes-B4*

36 Abbreviations: Fro: fronting; Bac: backing; Stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis; WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis; Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

_ No occurrences were found.

The results in Figure 31[37] show that lateralization and fronting were the most frequent substitution processes in B4's speech. Figure 31 also reveals that stopping, backing and de-emphasis were the three other processes that have been applied in SLI-B4's speech, although in small percentages. Glottal replacement and affrication have also been transcribed in a few examples in the SLI-B4's speech .

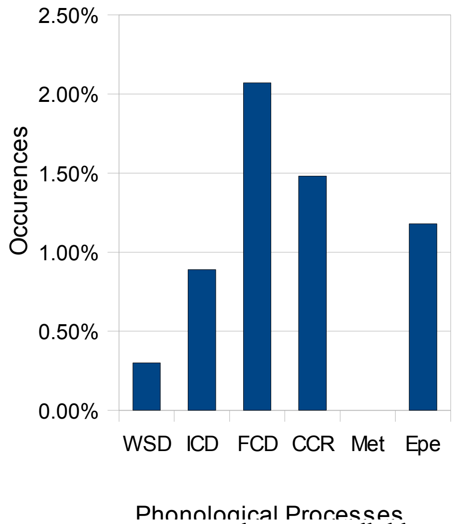


*Figure 32: Processes changing syllable structure-B4*

Figure 32[38] shows that except for metathesis, all the other phonological processes changing syllable structure have been used in SLI-B4's speech. More specifically, final consonant deletion was the most frequently applied process. Consonant cluster reduction and epenthesis have also been applied often. Figure 32 also shows that SLI-B4 used initial consonant deletion and unstressed syllable deletion in a few cases of low percentages.

37 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis.

38 Abbreviations: WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis.

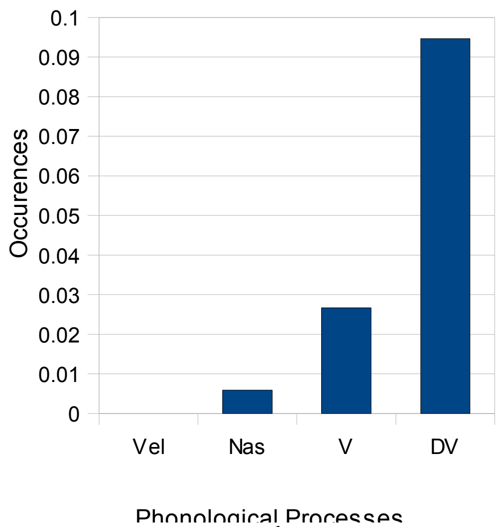

*Figure 33: Assimilation processes-B4*

The summary of the distribution of the assimilation phonological processes in B4's speech Figure 33[39] shows that SLI-B4 did not indicate many assimilation processes in general. There were no examples of lateralization and velarization in this recording. Moreover, devoicing was the most frequent phonological process among the assimilation processes applied in SLI-B4's speech. Voicing was present in very few cases and nasalization was applied even less frequently.

*Table 39: The missing phonemes in the phonetic inventory-B4*

| *Phonemes* | *subjectB4* |
|---|---|
| Stop | q, g, k, dˤ, tˤ |
| Fricative | ð, θ, ðˤ, sˤ, ʁ, ʕ |
| Affricate | dʒ |
| Trill | r |

Examining the content of Table 39 reveals that once again SLI-B4's speech as well as in the other previous analyzed SLI cases, all emphatic consonants presented the most articulatory difficulty. It is also very obvious that the stops and the fricatives were the most difficult manners of articulation for SLI-B4. Additionally, the affricate /

39 Abbreviations: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

dʒ/ and the trill /r/ were also missing in B4's speech, therefore they were both prone to substitution processes as previously discussed.

#### 8.5.1.5 B5

*Table 40: The phonological processes in B5*[40]

| | Substitution Processes | | | | | | | | | | Processes changing syllable structure | | | | | | Assimilation processes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | of active articulators | | in the turbulence /airflow | | | | | | | | | | | | | | Consonant Harmony | | | V | DV |
| | Fro | Bac | Sto p | Spi | GR | Gl | Lat | VN | Aff | DE | WS D | ICD | FCD | CCR | Met | Epe | Lab | Vel | Nas | | |
| E | 12 | 122 | 70 | 1 | 93 | 1 | 98 | _ | 29 | 11 | 5 | 23 | 19 | 7 | 16 | 3 | _ | _ | 7 | 27 | 32 |
| 576 | 2.08 % | 21.1 8% | 12.1 5% | 0.17 % | 16.1 5% | 0.17 % | 17.0 1% | % | 5.03 % | 1.91 % | 0.87 % | 3.99 % | 3.30 % | 1.22 % | 2.78 % | 0.52 % | % | % | 1.22 % | 4.69 % | 5.56 % |

Table 40 Represents all the phonological patterns in SLI-B5's speech. Figure 34 to Figure 36 present the percentages of the occurrences of the three major classes of the phonological processes; namely, the substitution processes, the processes changing syllable structure, and the assimilation processes in SLI-B5's speech.

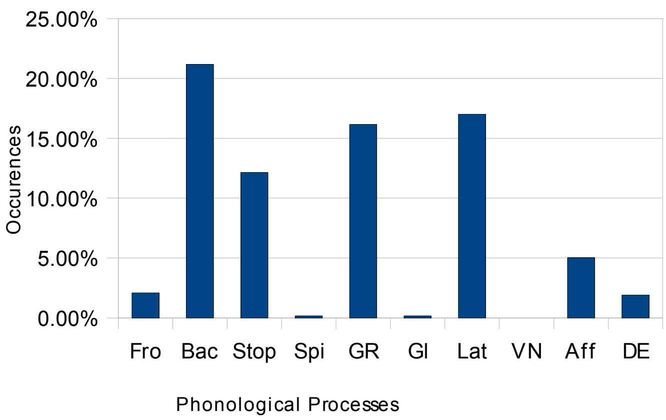


*Figure 34: Substitution processes-B5*

40 Abbreviations: Fro: fronting; Bac: backing; Sto: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis; WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis; Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

_ No occurrences were found.

The results in Figure 34[41] reveal that almost all the substitution processes except for vowel neutralization have appeared in SLI-B5's speech. Examining Figure 34 indicates that backing was the most frequent substitution processes in SLI-B5's speech. Lateralization, glottal replacement and stopping have also been applied quite frequently by SLI-B5. Figure 34 also reveals that affrication, fronting and de-emphasis were applied in relatively small percentages.

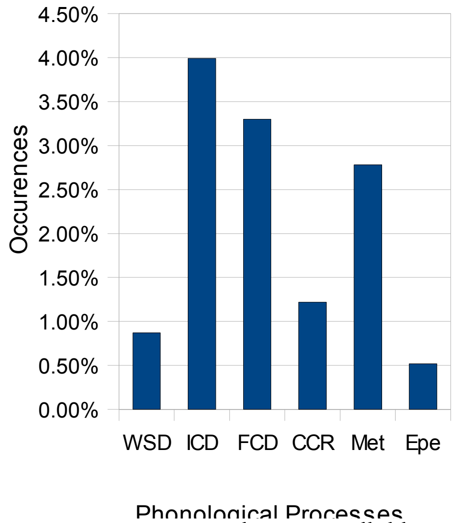

*Figure 35: Processes changing syllable structure-B5*

Figure 35[42] shows the distribution of the six phonological processes changing syllable structure which all have been applied, albeit in small percentages by SLI-B5. Figure 35 shows that initial consonant deletion was the most frequent process, while final consonant deletion and metathesis have been applied as well. The data also reveal that consonant cluster reduction and unstressed syllable deletion have been applied in more cases than epenthesis, though these three processes were transcribed in only a few examples as the percentages in Figure 35 confirm.

41 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis.

42 Abbreviations: WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis.

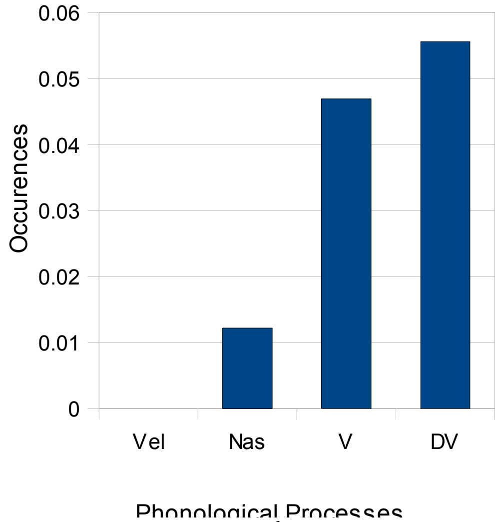

*Figure 36: Assimilation processes-B5*

As has been found in the distribution of the assimilation phonological processes in SLI-B4 Figure 36[43] further indicates that both lateralization and velarization have not been applied in SLI-B5's speech. The results in Figure 36 reveal that devoicing and voicing have been used by SLI-B5, more specifically and as the percentages show, devoicing was more frequently applied than voicing, albeit in small percentages. SLI-B5 has applied nasalization in his speech in very few cases as observed in Figure 36.

*Table 41: The missing phonemes in the phonetic inventory-B5*

| *Phonemes* | *subjectB5* |
|---|---|
| Stop | q, g, k, dˤ, tˤ |
| Fricative | ð, θ, ðˤ, s, z, sˤ, ʃ, ʁ, χ ,ʕ, ħ |
| Affricate | |
| Trill | r |

In addition to the first finding that can be easily observed in Table 41 namely that all emphatic consonants were very difficult for SLI-B5 to produce, Table 41 further shows that almost all the fricatives presented an articulatory difficulty for SLI-B5. Surprisingly , the affricate /dʒ/ was not problematic for SLI-B5 as it was in the previous SLI cases, but the trilled /r/ has been difficult as the examples in the recording show.

43 Abbreviations: Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

### 8.5.1.6 B6

*Table 42: The phonological processes in B6*[44]

| | *Substitution Processes* | | | | | | | | | | *Processes changing syllable structure* | | | | | | *Assimilation processes* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *of active articulators* | | *in the turbulence /airflow* | | | | | | | | | | | | | | *Consonant Harmony* | | | *V* | *DV* |
| | *Fro* | *Bac* | *Stop* | *Spi* | *GR* | *Gl* | *Lat* | *VN* | *Aff* | *DE* | *WSD* | *ICD* | *FCD* | *CCR* | *Met* | *Epe* | *Lab* | *Vel* | *Nas* | | |
| *F* | 7 | _ | _ | 8 | _ | _ | 72 | _ | _ | 1 | _ | _ | 1 | _ | 2 | 1 | 5 | _ | _ | 2 | _ |
| *99* | 7.07 % | % | % | 8.08 % | % | % | 72.73% | % | % | 1.01 % | % | % | 1.01 % | % | 2.02 % | 1.01 % | 5.05 % | % | % | 2.02 % | % |

For the purpose of explaining the phonological patterns in B6's speech in detail, the percentages of these results are presented in the following three figures. These figures represent the occurrence of the three major classes of phonological processes; namely, the substitution processes in Figure 37, the processes changing syllable structure in Figure 38, and the assimilation processes in Figure 39.

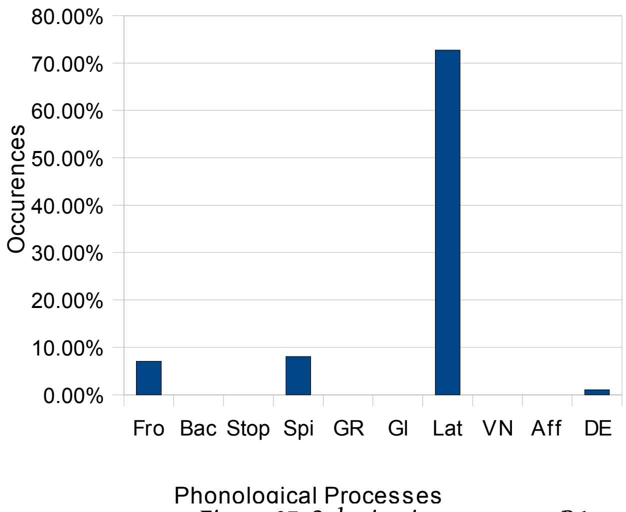


*Figure 37: Substitution processes-B6*

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44 Abbreviations: Fro: fronting; Bac: backing; Stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis; WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis; Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

_ No occurrences were found.

These results of the the distribution of the substitution processes in SLI-B6's speech in Figure 37[45] show that once again lateralization was the most frequently applied substitution processes. Figure 37 indicates the appearance of spirantization, fronting and de-emphasis although in very few examples.

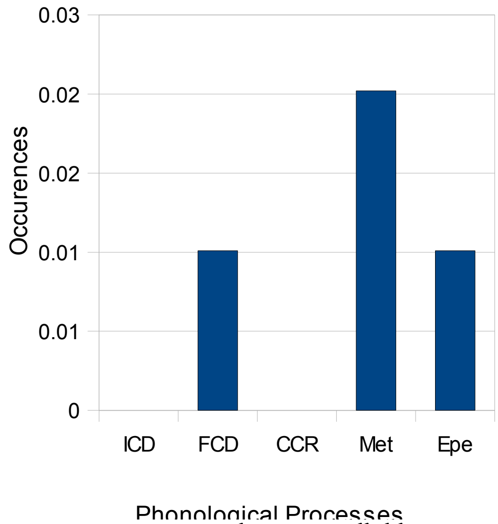


*Figure 38: Processes changing syllable structure-B6*

The summary of the distribution of the processes changing syllable structure in SLI-B6's speech in Figure 38[46] shows that both the processes of initial consonant deletion and consonant cluster reduction have not been used by SLI-B6. Figure 38 shows that metathesis has been the most frequently used process SLI-B6 used to change syllable structure. Final consonant deletion and epenthesis were also applied but less frequently than the process of metathesis.

45 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis.

46 Abbreviations: WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis.

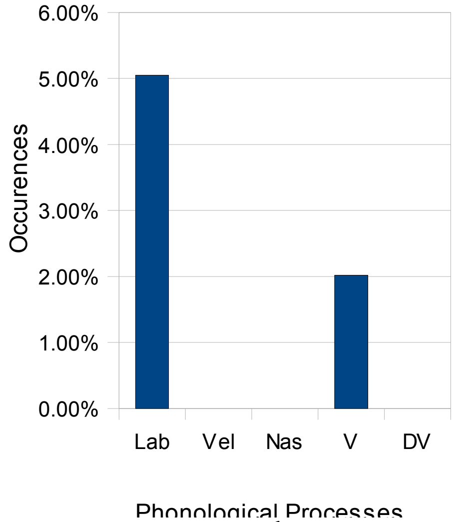

*Figure 39: Assimilation processes-B6*

The results in Figure 39[47] show, comparatively speaking, that labialization was the most frequent phonological process among the assimilation processes that SLI-B6 applied in his speech. Voicing was present in very few cases. SLI-B6 did not show any use of velarization, nasalization or devoicing in his speech.

*Table 43: The missing phonemes in the phonetic inventory-B6*

| *Phonemes* | *subjectB6* |
|---|---|
| Stop | dˤ |
| Fricative | |
| Affricate | |
| Trill | r |

Examining the content of Table 43 shows that only two phonemes were difficult for SLI-B6 to articulate. Table 43 reveals that the emphatic stop /dˤ/ and the trilled /r/ were very difficult for SLI-B6 to produce. This fact explains the frequent use of de-emphasis and lateralization in SLI-B6's speech.

47 Abbreviations: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

### 8.5.1.7 B7

*Table 44: The phonological processes in B7*[48]

| | *Substitution Processes* | | | | | | | | | | *Processes changing syllable structure* | | | | | | *Assimilation processes* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *of active articulators* | | *in the turbulence /airflow* | | | | | | | | | | | | | | *Consonant Harmony* | | | *V* | *DV* |
| | *Fro* | *Bac* | *Stop* | *Spi* | *GR* | *Gl* | *Lat* | *VN* | *Aff* | *DE* | *WSD* | *ICD* | *FCD* | *CCR* | *Met* | *Epe* | *Lab* | *Vel* | *Nas* | | |
| G | 82 | 5 | 8 | 3 | _ | _ | 91 | _ | 5 | 37 | _ | _ | 9 | _ | _ | 2 | 5 | _ | 1 | 29 | 3 |
| 280 | 29.29% | 1.79% | 2.86% | 1.07% | % | % | 32.50% | % | 1.79% | 13.21% | % | 0.00% | 3.21% | % | % | 0.71% | 1.79% | % | 0.36% | 10.36% | 1.07% |

Table 44 explains the phonological patterns in SLI-B7's speech in detail. The percentages of the occurrences of the three major classes of the phonological processes in SLI-B7's speech will be illustrated. Therefore, the substitution processes will be presented in Figure 40, the processes changing syllable structure in Figure 41, and Figure 42 will show the assimilation processes in SLI-B7's speech.

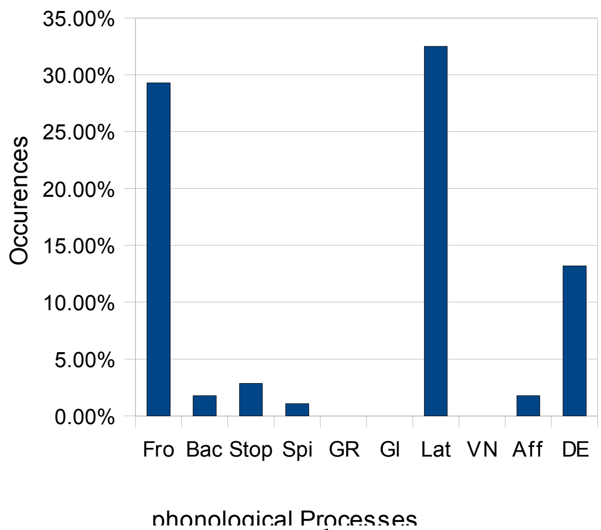


*Figure 40: Substitution processes-B7*

48 Abbreviations: Fro: fronting; Bac: backing; Stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis; WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis; Lab: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

_ No occurrences were found.

The results of the the distribution of the substitution processes in SLI-B7's speech in Figure 40[49] reveal that once again lateralization was the most frequently applied substitution processes. Additionally, Figure 40 shows that fronting and de-emphasis also have been applied frequently. SLI-B7 employed other patterns to substitute the difficult articulatory phonemes through the use of stopping, backing, affrication and spirantization although in varied and small degrees as Figure 40 indicates.

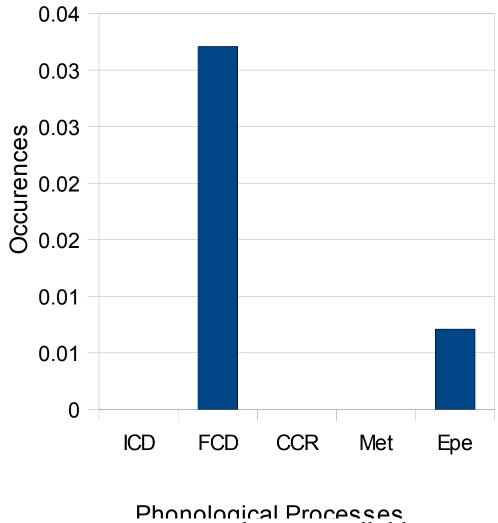


*Figure 41: Processes changing syllable structure-B7*

The distribution of the processes changing syllable structure in SLI-B7's speech in Figure 41[50] reveals that final consonant deletion was the most frequent process followed by the epenthesis that SLI-B7 applied to change syllable structure. Figure 41 also indicates that SLI-B7 used these two processes in extremely small percentages. Moreover, the other processes; namely, initial consonant deletion, consonant cluster reduction and metathesis were not used in SLI-B7's speech.

49 Abbreviations: Fro: fronting; Bac: backing; stop: stopping; Spi: spirantization; GL: gliding; GR: glottal replacement; Lat: lateralization; VN: vowel neutralization; AFF: affrication; DE: de-emphasis.

50 Abbreviations: WSD: weak syllable deletion; ICD: initial consonant deletion; FCD: final consonant deletion; CCR: consonant cluster reduction; Met: metathesis; Epe: epenthesis.

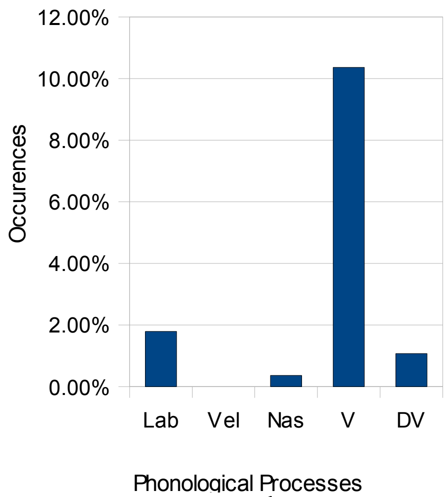

*Figure 42: Assimilation processes-B7*

Figure 42[51] shows the distribution of the assimilation processes in the speech of SLI-B7. The results in Figure 42 show that voicing, despite its small frequency, was the most frequent phonological process among the assimilation processes that SLI-B7 applied in his speech. Labialization and devoicing were also present in a few cases, the process of nasalization was also applied in a very small percentage.

*Table 45: The missing phonemes in the phonetic inventory-B7*

| *Phonemes* | *subjectB7* |
|---|---|
| Stop | q, g, k, dˤ, tˤ |
| Fricative | ðˤ, sˤ, ʁ, ʕ |
| Affricate | dʒ |
| Trill | r |

Examining the content of Table 45 reveals the that almost all the emphatic consonant-both stops and fricatives- presented a similar articulatory difficulty to SLI-B7. This SLI subject had more problems in producing fricative phonemes, as well as the affricate /dʒ/ and the trilled /r/.

51 Abbreviations: labialization; Vel: velarization; Nas: nasalization; V: voicing; DV: devoicing.

## 8.6 Comparison with SLI in previous studies for JA

As previously discussed, this study has been concerned with the empirical issues in the analysis of SLI in the speech of a sample of JA-speaking children. This study has been assessing the developmental status of the phonological processes in the speech of these SLI subjects based on the chronology of their development in typically developing children, who have also been examined in this study.

Therefore, this section will compare this current study with the previous studies in JA. More specifically, Mitleb (1987a) provided a phonetic analysis of a sample of Arabic-speaking misarticulating children. He only examined the phonological process of substitution. In a manner contrary to Mitleb (1978a), the percentages of the occurrences of the three major classes of the phonological processes in the speech recordings for each SLI subject have been presented separately in the current study. Therefore, the substitution processes, the processes changing syllable structure, and the assimilation processes in the speech of each SLI participant have been illustrated.

Mitleb (1987a) analyzed the data in his study based on the approach of Generative Phonology, agreeing at the same time with Jackobson's theory of the natural order in which the child acquires his phonetic inventory. Conversely, the theoretical linguistic basis for the current study has been taken from NP and PHB.

Moreover and in another study, Mitleb (1992) examined within the GP framework, the variability of the misarticulations of two JA-speaking children. Mitleb (1992) assumed that SLI children have an identical knowledge to that of the relevant ambient speech. Accordingly, Mitleb (1992) claims that it is the violations of the markedness principles that characterize the functional misarticulations.

On the other hand, the analysis of the SLI data in this study indicates that some of the observations suggest that SLI in JA can actually be classified as delayed acquisition in certain cases. Moreover, this analysis reveals the occurrence of some phonological processes in SLI speech which reflect Arabic language-specific rules. On the other hand, this analysis indicates that SLI children may have a different language system, which may involve deviances from the Arabic specific phonological rules acquired in typical acquisition. Additionally, the current analysis shows that SLI in JA involves different selections from universal phonological processes. Finally, this study indicates the occurrence of other phonological processes that differ from typical universal phonological processes in some pathologically determined ways as it has been explained earlier (CHAPTER 8 )in this study.

This analysis of the AMN and SLI children in JA can also be compared to Amayreh and Dyson (2000a) who analyzed the articulation/phonological errors and sound changes in Arabic speaking typically developing children aged between 2;0 and 4;4. To elicit the samples, the authors used a picture naming articulation task representing all the initial, medial and final consonants of ESA. This test has been used, among other elicitation tasks to collect the data in this study (6.5.4.2 ). Moreover, corpus designing, collecting, recording and storage have been carried out according to the recommendations of the "Spoken Language Corpus chapter" Gibbon et al. (1997) proposed by the Expert Advisory Group on Language Engineering Standards (EAGLES). Amayreh and Dyson (1994) adopted the Logical International Phonetics Programs, LIPP (cf. Oller and Deglado 1990) for their phoneme inventory count, substitution analysis and the identification programs of the patterns. On the the other hand, SLI in JA has been examined and characterized in this study based on the analysis of the phonological processes in SLI children within the frameworks of NP and PHB.

# CHAPTER 9 Results and Discussion

## 9.1 Introduction

The field study reported here aimed at observing the differences in the phonological processes between age-matched typically developing (AMN) and children with SLI in JA. The analysis started by observing the chronology of the patterns of the phonological processes in the typical development as it has been represented in the speech of four 2-5-year-old JA-speaking children (cf. Table 29). These patterns, although being based on a very limited amount of data, have formed the basis for evaluating and assessing the phonological abilities of the seven cases of the 4-7-year-old SLI population in this study. Moreover this chronology helped in identifying the deviations in the SLI speech from the typical expected patterns in JA. The analysis in this study provides a functional explanation of the phonological processes of SLI speech based on the theories of NP and PHB and their principles.

More specifically, this analysis aimed at specifying the nature of the phonological characteristics of this particular disability in JA. Therefore, this study summarizes the phonological characteristics of this atypical speech as they have been represented in this limited data. Consequently, this work can be referred to as an initial step in considering the symptomatology of SLI in JA which should be followed by a further analysis on a larger scale.

The field work and the analysis tested the hypothesis of this study; namely, that the phonological processes in SLI speech in JA are not different from those processes in AMN children, and that SLI children apply the same phonological processes as AMN children. Therefore, this hypothesis claims that there are no phonological differences between typical acquisition, delayed acquisition and impaired/atypical acquisition in JA.

Therefore, and in order to test the hypothesis of this study, this analysis examined the phonological processes in the speech of eight SLI participants. This analysis classified these processes into lenitions and fortitions in the nature of their application as well as with reference to their functions according to the NP simplification and reduction-definition criteria and the empirically based principled of PHB. This study aimed at specifying the nature of the phonological system in the SLI children and its relation to the phonological system in the AMN children in JA to test this hypothesis.

This study, and as has been explicitly stated earlier, does not claim generalizations regarding typical and atypical development in JA. This study and based on analyzing this current sample has tested the hypothesis about the nature of the phonological system in SLI speech in JA and indicated the aspects of its deviation from the phonological system of AMN children in JA.

For these reasons, a detailed analysis of the collected audio files has been carried out to characterize the differences between AMN and SLI children in JA in the recorded cases. On one hand, the chronology of the distribution of the phonological processes in typical and atypical development in JA has been compared to characterize the deviance of this SLI speech from the Arabic-specific rules. Moreover, this distribution in SLI in this study has been analyzed according to the account of the functional processes as discussed and summarized in Tobin (2009a,b) in testing the applicability of the universal phonological processes to the patterns in SLI speech in JA.

## 9.2 The Length of stressed/unstressed syllables in AMN/SLI speech

### 9.2.1 The design of the experiment

This section present a short experiment comparing the two sets of recordings from JA-speaking children; the first set represents the speech of a child with SLI, and the second represents the speech of an age-matched typically developing child AMN.

### 9.2.2 The hypothesis

Stressed syllables are believed to have longer durations than unstressed syllables in general and no differences are expected to be found in the length of stressed/unstressed syllables between SLI and AMN JA-speaking children.

### 9.2.3 The implementation phase

In applying this experiment, the following steps were carried out:

- Conversational and spontaneous speech samples were elicited and recorded from both 5-year-old SLI and AMN children telling a story.
- One minute and a half-recording have been selected for this analysis from both sample populations.
- The author's own speech interferences (some words and phrases to keep the child's speech fluent) have been extracted and removed using PRAAT.
- After this removal of the adult's speech, both files were ready to be analyzed; having two sets of recordings; SLI and AMN, thus the comparison purpose of this work could be attained.
- After the transcription of the first 33 seconds, the files have been annotated on the syllable level (SAMPA)( Figure 43).

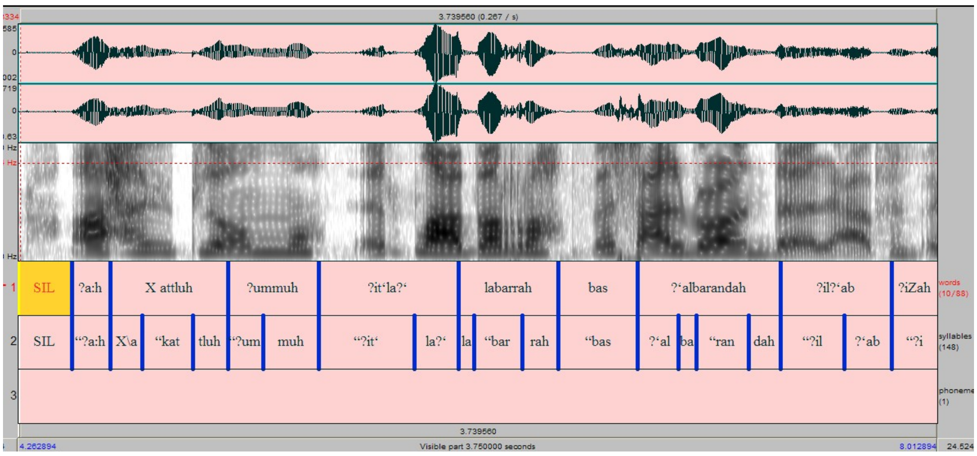

*Figure 43: A representative annotation using PRAAT.*

- Opening each TextGrid file with the TextEditor, to CSV spreadsheet format converter, thus the durations (lengths in milliseconds) of the stressed/unstressed syllables have been calculated (Figure 44).

- The number of the lexical words articulated in both files has been counted to check the difference in the speech rate (Figure 44).

| TierType | TierName | Label | Start | Mid | End | Duration | Category | SIL | stressed | unstressed | lexical | grammatical |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IntervalTier | words | SIL | 0 | 251 | 502 | 502 | SIL | 502 | | | | |
| IntervalTier | words | ka:n | 502 | 647 | 792 | 290 | grammatical | | | | | 290 |
| IntervalTier | words | na:yim | 792 | 942 | 1092 | 300 | lexical | | | | 300 | |
| IntervalTier | words | bilGa:bih | 1092 | 1438 | 1784 | 692 | lexical | | | | 692 | |
| IntervalTier | words | SIL | 1784 | 2112 | 2440 | 656 | SIL | 656 | | | | |
| IntervalTier | words | ?iZah | 2440 | 2576 | 2712 | 272 | lexical | | | | 272 | |
| IntervalTier | words | Su:h | 2712 | 2944 | 3177 | 465 | grammatical | | | | | 465 |
| IntervalTier | words | SIL | 3177 | 3360 | 3543 | 366 | SIL | 366 | | | | |
| IntervalTier | words | ?ilfa:r | 3543 | 3882 | 4222 | 679 | lexical | | | | 679 | |
| IntervalTier | words | SIL | 4222 | 4351 | 4481 | 259 | SIL | 259 | | | | |
| IntervalTier | words | ?a:h | 4481 | 4560 | 4639 | 158 | grammatical | | | | | 158 |
| IntervalTier | words | X\akattluh | 4639 | 4879 | 5119 | 480 | lexical | | | | 480 | |
| IntervalTier | words | ?ummuh | 5119 | 5303 | 5488 | 369 | lexical | | | | 369 | |
| IntervalTier | words | ?it`la?` | 5488 | 5773 | 6059 | 571 | lexical | | | | 571 | |
| IntervalTier | words | labarrah | 6059 | 6262 | 6466 | 407 | lexical | | | | 407 | |
| IntervalTier | words | bas | 6466 | 6627 | 6789 | 323 | grammatical | | | | | 323 |
| IntervalTier | words | ?`albarandah | 6789 | 7080 | 7371 | 582 | lexical | | | | 582 | |
| IntervalTier | words | ?il?`ab | 7371 | 7598 | 7825 | 454 | lexical | | | | 454 | |
| IntervalTier | words | ?iZah | 7825 | 8019 | 8214 | 389 | lexical | | | | 389 | |
| IntervalTier | words | SIL | 8214 | 8321 | 8428 | 214 | SIL | 214 | | | | |
| IntervalTier | words | ma: | 8428 | 8515 | 8602 | 174 | grammatical | | | | | 174 |

*Figure 44: Conversing a TextGrid file into a CSV spreadsheet format*

- The mean and the standard deviation of the stressed/unstressed syllables in both files have been calculated, and then the t-test of these results have been compared using a spreadsheet software (OpenOffice Calc) as shown in Figure 45.

| Number | AMN | SLI | |
|---|---|---|---|
| lexical words | 41 | 24 | |
| grammatical words | 22 | 4 | |
| | | | |
| stressed syllables | | | |
| mean: | 230.5 | 348.5 | |
| standard deviation | 95.63 | 163.85 | |
| T-test; similar sets, number of syllabes | | 0.000645 | |
| T-test; different sets, number of syllabes: as a representation of the different speech rates: | | | 0.000171 |
| | | | |
| unstressed syllables | | | |
| mean: | 158.5 | 313.5 | |
| standard deviation | 52.55 | 170.01 | |
| T-test; similar sets, number of syllabes | | 0.000001 | |
| T-test; different sets, number of syllabes: as a representation of the different speech rates: | | | 0.000001 |

*Figure 45: The mean, standard deviation and t-test results in AMN & SLI*

### 9.2.4 Duration patterns of stressed/unstressed syllables in SLI and AMN

The following findings appearing in Table 46 explain the differences in the speech rate between SLI and AMN children. The results show that SLI children produced almost half the number of the lexical words that AMN children produced during the same time. The ratio could be represented in 2:1 lexical words among AMN and SLI children (per millisecond). This simply and clearly indicates that AMN children have a faster speech rate than SLI children in JA.

SLI children also show a more significant difficulty with the production of grammatical words as presented here. It has been noticed in the recorded sample that SLI children deleted almost all the grammatical words, and just produced the lexical ones (Table 46). This last finding was expected according to language universals: i.e. lexical words are more important for perception than the grammatical items, as they have more communicative force.

*Table 46: Lexical and grammatical words in AMN and SLI recordings*

| *Number* | *AMN* | *SLI* |
|---|---|---|
| lexical words | 41 | 24 |
| grammatical words | 22 | 4 |

The results in Table 47 and Table 48 indicate that the hypothesis that has been suggested in the beginning of this experiment is partially true. The results in Table 47 and Table 48 generally show that stressed syllables have longer durations than unstressed syllables in both SLI and AMN speech recordings confirming the language universal principles of speech perception. Moreover, it has been found in this analysis that the mean length of the stressed syllables for AMN children is 230.5, but the mean length for the unstressed syllables in the same speech is 158.5. The same also has been noticed in SLI speech: 348.5 is the mean length for the stressed syllables vs. 313.5 for the unstressed syllables. This finding serves to falsify the second part of this hypothesis, as there is a very obvious difference in the length of the stressed/unstressed syllables between SLI and AMN Arabic-speaking children. More specifically, both the stressed and the unstressed syllables in the SLI speech tend to have much longer durations than in the AMN speech, 348.5 vs. 230.5 for stressed syllables in SLI vs. AMN respectively and 313.5 vs. 158.5 for unstressed syllables in SLI vs. AMN respectively. This difference in the syllable length between SLI and AMN speech could be due to the difference in the speech rate between both groups. Thus, the slower the speech rate, the longer the syllable duration will be.

*Table 47: Stressed syllables; comparative results for AMN and SLI*

| *Stressed syllables* | *AMN* | *SLI* |
|---|---|---|
| Mean: | 230.5 | 348.5 |
| Standard deviation | 95.63 | 163.85 |
| T-test; similar sets, number of syllables | 0.000645 | |
| T-test; different sets, number of syllables: as a representation of the different speech rates | 0.000171 | |

*Table 48: Unstressed syllables; comparative results for AMN and SLI*

| *Unstressed syllables* | *AMN* | *SLI* |
|---|---|---|
| Mean: | 158.5 | 313.5 |
| Standard deviation | 52.55 | 170.01 |
| T-test; similar sets, number of syllables | 0.000001 | |
| T-test; different sets, number of syllables: as a representation of the different speech rates | 0.000001 | |

The t-test has been conducted twice in this comparative analysis; one time using similar sets (same number of syllables from both files) and the second time using different sets of numbers of syllables. The second test is the real representation of the analyzed files showing different speech rates, thus having different numbers of words and subsequently different numbers of syllables between SLI and AMN speech.

On one hand, the results of the t-test in Table 47 with regard to the differences in the length of the stressed syllables between SLI and AMN speech show the following:

- In the first stage of this test, and by comparing similar sets, the result of the t-test is 0.000645, which means that the two files were 99.9364% different, but the t-test result was 0.000171 when comparing the files containing different number of syllables, indicating that the two files are 99.9829% different.

On the other hand, the results of the t-test in Table 48 with regard to the differences in the length of the unstressed syllables between SLI and AMN speech show the following:

- The t-test result is 0.000001 in both cases, which means that the two files are 99.9999% different. Therefore, it shows no difference whether one compares similar sets or different sets of unstressed syllables between SLI and AMN speech files since the two files are totally different with regard to the length of the unstressed syllables.
- The findings in Table 46 reveal differences in the speech rate between SLI and AMN. SLI children produced almost half the number of the lexical words that AMN children did (22:41) ratio (2:1) lexical words for AMN and SLI (per millisecond). This clearly indicates that AMN children have a faster speech rate than SLI children.
- SLI children deleted almost all the grammatical words, and just produced the lexical ones (24:4) as is also shown in Table 46. This relates to language universals because lexical words are more important for perception.
- The hypothesis in this experiment is partially true as the results generally show that stressed syllables have longer durations than unstressed syllables (for both SLI and AMN).The mean length in AMN speech for stressed syllables is 230.5 and for unstressed syllables is 158.5. On the contrary, the mean length in the SLI speech for stressed syllables is 348.5 and for unstressed syllables is 313.5 as it has been shown in Table 47 and Table 48.
- The second part of this hypothesis is falsified. The analysis shows a very obvious difference in the length of the stressed/unstressed syllables between SLI and AMN speech. Stressed and unstressed syllables in SLI have much

longer durations than in AMN recordings as has been presented in Table 49.

*Table 49: The mean length of stressed/unstressed syllables in SLI and AMN*

| | *SLI* | *AMN* |
|---|---|---|
| Stressed | 348.5 | 230.5 |
| Unstressed | 313.5 | 158.5 |

- It can be generalized from these results that there is a relation between the speech rate and syllable length between SLI and AMN speech; namely, the results show that the slower the speech rate, the longer the syllable duration appears to be.

## 9.3 Characterizing phonological disability in JA

The analytical work that has been done in this study aimed at providing a descriptive characterization of SLI in JA-speaking children based on the speech samples that have been analyzed. As shown in the previous chapters, this analysis focused on describing the occurrences of the phonological processes to illustrate and summarize the phonological patterns in this atypical speech. This initial description can be clinically important in providing a basis for the relevant assessment based on describing the chronology of the phonological processes in the typically developing Arabic-speaking children. It is important to mention again that the features that are described here are based on a small sample, therefore a further study would be needed to test how representative these features can be to characterize the features and the symptoms of SLI in JA.

Additionally, this assessment can be used to basically distinguish delayed from disordered/atypical speech development in JA. It has also been shown that simplification has been the most obvious feature of the atypical speech when it is compared to typical speech. This simplification feature implies that remediation strategies must involve helping the child with SLI to facilitate the pronunciation of the sounds that form an articulatory difficulty.

### 9.3.1 typical and atypical phonology in JA; features and characteristics

The analysis of the speech of the SLI children in this study shows that this speech presents systematic pronunciation patterns. Stoel-Gammon (1991) explained a set of characteristic features of the atypical phonology in English-speaking children. Stoel-Gammon (1991: 28) reported that children with a phonological disability often show evidence of the following properties in their speech:

- A limited set of speech sounds.
- Restricted syllable shapes.
- Persistence of error patterns.
- Chronological mismatch.
- Unusual error type.
- Although having extensive variability, they show lack of progress in their phonological development.

As Stoel-Gammon (1991) explained, a child with phonological disability by the age of three or four would be able to produce only some limited sounds: only one stop, nasal and glide consonants and with limited vowels. Such a speech pattern is what is supposed to be typical in the earliest stages of phonological development as by the age of two years for example, a child will be already able to produce words with some fricative or liquid phones (cf. Stoel-Gammon 1991). In comparing the results of this study with Stoel-Gammon (1991), the following features of the phonetic inventories of the seven SLI children in the current study can be considered among the characteristics of SLIin JA. The SLI subjects in this study have shown the following patterns in their speech:

- Generally, oral stops and fricatives - emphatic and non-emphatic - (in all syllable position) are the two most difficult manners of articulation among all the SLI participants in this study.
- Glides /w, j/, nasals /m, n/ along with the lateral /l/ are the only phoneme

classes that the SLI children in this study have mastered in all syllable positions.

- Back articulators (non-apical); palatal, velar, uvular, and pharyngeal consonants have been more challenging for SLI subjects than the front articulators.
- Secondary articulation; emphatic consonants have been very often lacking in all the SLI participants as a result of the gestural articulatory complexity of emphatic obstruents.
- It is obvious from the findings presented in Table 30 that the SLI subjects have been limiting their oral stops to the voiced bilabial /b/ and the voiced and the voiceless alveolar-dental / d, t/ in addition to the glottal stop /ʔ/.
- Voiced and voiceless velar, uvular as well as the emphatic alveolar-dental oral stops /g, k, q, dˤ, tˤ/ present a considerable articulatory difficulty for most of the SLI subjects, therefore they are mostly absent from their phonetic inventories.

Additionally, the general properties of SLI in JA will be summarized in this concluding chapter by mainly following the classification criteria that are referred to by Grunwell (1982) and Stoel-Gammon's (1991) classification. (Grunwell 1982: 185) refers to three main differences between typical and atypical child speech as involving:

•Persisting normal processes.

•Chronological mismatch.

•Unusual and idiosyncratic processes.

These three major differences will be illustrated in the following sections by providing examples from the analyzed data on SLI in JA-speaking children.

#### 9.3.1.1 Persisting normal processes

As previously mentioned, simplification has been observed to be the most obvious feature of the phonological processes in comparing SLI to AMN speech. This simplification can be seen in the pronunciation patterns in the atypical speech that would be usually observed in the speech of the typically developing children, albeit of the younger age groups.

Grunwell (1982) refers to this similarity as an indication of a developmental disorder as the child continues to use phonological processes that are typical of earlier typical developmental stages. Grunwell (1982: 185) further illustrates this tendency as “a precocious stabilization of the first pronunciation patterns and a virtually complete failure to progress phonologically in language development; that is development is 'arrested'.”

SLI children in this study, who are 4-7 years old have been showing many cases where they frequently applied substitution processes; both of the active articulators and in the degree of the turbulence/airflow, e.g., lateralization, stopping, fronting, glottal replacement, backing, and de-emphasis. This pattern indicates persisting typical processes that would usually be observed in the speech of typically developing children, although of younger age groups and mainly before the age of three in JA (Table 29) where these processes will cease to apply after the first developmental stage in AMN children.

Additionally, SLI children, who are 4-7 years old, have been applying initial and final consonant deletion, where in comparison to AMN children in JA, these processes will not be present after the age of three (Table 29).

#### 9.3.1.2 Chronological mismatches

This analysis further indicates that the speech of the SLI children, in certain cases, has been showing certain pronunciation patterns indicating a chronological mismatch. This phenomenon is characterized by presenting patterns of both the earliest simplifying processes along with other phonological patterns representing later developmental stages. Therefore, a chronological mismatch within a child's phonological system can also refer to the presence of phonological features typical of more advanced developmental levels in an otherwise delayed phonological system. These two properties indicate that this speech development does not follow the usual order of phonological development. This feature also indicates that the child fails to conform to the typical chronological sequence in her/his speech development, thus s/he ends up with a phonological system that is advanced in certain developmental aspects, and at the same time, apparently delayed in other aspects. Stoel-Gammon (1985) provides an example of this mismatch such as the case where the child is able to produce a full range of consonant clusters in a word-initial position, but deletes all final consonants at the same developmental stage.

The SLI subjects have been displaying tendencies where the voiceless pharyngeal fricative /ħ/ has been found to be among the least substituted consonant sounds. This consonant was missing in the phonetic inventory of only one SLI child (cf. Table 30). Moreover, and according to the acquisition norms of standard Arabic (cf. Table 10); this sound should be acquired during the early developmental stage. The speech sample has shown a very interesting speech pattern in this SLI subject. More specifically, the data indicate that in this SLI participant /ħ/ has been very often substituted by /h/ and /ʔ/ the sounds that are typically acquired during the intermediate and the late developmental stages respectively. This particular pattern represents a chronological mismatch in the development of the SLI subjects in JA. The date shows that the phonetic inventories of the SLI children are generally similar to those found in younger children, however in certain cases, the SLI phonological system has simultaneously been showing certain patterns that are typical of more advanced systems as in substituting /h/ and /ʔ/for /ħ/.

The process of backing represents another case of this chronological mismatch in the SLI data. This process has been a frequent process in the atypical speech and mostly appears in the process of glottal replacement. The most frequently missing phonemes in the phonetic inventory of the SLI subjects in this study were among the phonemes that are acquired in the late stage in the typical development of JA. Nonetheless, this study demonstrates that SLI subjects substituted /k/ with /ʔ/ in many cases. This tendency was obvious in the simple fact that five out of the seven SLI subjects did not have /k/ in their phonetic inventories. At the same time, none of these SLI subjects showed any problem with the glottal stop /ʔ/. Therefore, /ʔ/ has frequently been used as a substitute phoneme although /k/ is typically acquired at the early stage, but /ʔ/ tends to be typically acquired during the late developmental stage in JA (cf. Table 10).

Generally speaking, SLI subjects in JA presented the most articulatory problems with the phonemes that belong to the late developmental stage, therefore most of the phonological processes in the SLI speech affected this group of phonemes. SLI subjects in this study, mastered most of the early and the intermediately acquired phonemes. At the same time, SLI cases have been showing some phonological processes that indicate a chronological mismatch in their development as it has been presented in phonological contexts with certain phonemes from both the early and the intermediate developmental stages such as: /k/, /s/, /z/, /ʃ/, /χ/and /ʁ/ have been substituted by phonemes from the late stage.

The phonological patterns of the SLI speech in this study are characterized by omissions and substitution processes. These patterns showed that there is a discrepancy between the chronological age and linguistic age or the phonological competence between SLI and AMN children in JA.

#### 9.3.1.3 Unusual and idiosyncratic processes

Examining the SLI data in this study shows that this phonological system can also be characterized by the occurrence of certain idiosyncratic phonological processes. These atypical patterns can occur rarely or for only very limited periods in typical development. These processes include atypical substitutions or deletion patterns e.g., initial-consonant deletion or glottal substitution, persistent vowel errors, the creation of unusual word and the use of suprasegmental features to mark segmental information. Cross-linguistic studies of typical and atypical phonological development can provide examples where such phonological processes can indicate atypical patterns in one language, but they would be treated as typical processes in another language (cf. Yavas 1991).

This study indicates that the SLI speech in JA can also be characterized by the use of certain idiosyncratic phonological processes simultaneously with a delayed acquisition of some other phonological aspects that usually disappear by the age of three in the typical phonological development. These idiosyncratic processes are similar to the processes presented in Table 20 which have been described as the indicators of the possible occurrence of atypical phonological development (cf. Small 2005). More specifically, this analysis of SLI speech in JA shows the occurrence of those phonological processes that differ from typical universal phonological processes in some pathologically determined ways as follow:

- Backing which has frequently been used in SLI speech mostly through glottal replacement.
- Inconsistent pre-vocalic voicing and devoicing patterns.
    - Final consonant voicing, a completely atypical process.
    - SLI recordings show devoicing of the initial syllable consonant as opposed to the pattern in the AMN children, who normally apply final consonant devoicing because final position provides the smallest contribution to the word's communicative force.
- Glottal replacement has been applied frequently in SLI speech, though language universally it has been found that this process is rather infrequent.

Therefore glottal replacement differs from both language universals and Arabic language-specific phenomena and the norms of typical acquisition in the contexts where it has been applied; substituting for certain sounds that should be acquired earlier according to the norms of typical phonological development.

### 9.3.2 Deviant and delayed phonological development in JA

The present study, based on the cases that have been examined, shows the order in which children learn and acquire speech sounds in JA. As it has been shown in the literature review, most children follow the same patterns of development. This study shows that when the child is acquiring Arabic in this particular order, but is proceeding at a slow pace, then he has a speech/language delay. This analysis also shows some cases where the child is not only slow in developing the language, but he does not follow the same order in acquiring and developing the relevant Arabic speech and language skills as other age-matched children. This is the case where children show gaps in their language development as having some phonological processes that are age-appropriate, but their phonetic inventory is missing some phonemes that should have been acquired by their age according to the chronology of the typical development in JA (cf. Table 10). The other indication of phonological deviance in JA is the case when the child applies some phonological processes that are unusual and have never been used by the age-matched children in the course of the typical development of JA.

The phonological deviance in JA in the analyzed sample can be described by mainly considering the limited set of consonants in the SLI subjects at this particular age and the persistence of certain phonological processes. These speech developmental patterns are not a typical property of AMN children as it has been explained earlier in the data analysis section. SLI can be described by considering the fact that only glides /w, j/, nasals /m, n/ as well as the lateral /l/ have been the only phoneme classes that SLI children in this study have mastered in all syllable positions (cf. Table 30). All the other segments have been produced in an atypical way depending on the phonological context where they appear.

The present study describes the phonological processes that are part of the typical development of JA-speaking children and the ages by which they would typically cease to occur. Furthermore, this analysis has indicated the most frequent phonological processes in the subjects that have been identified with SLI in JA such as: substitution processes; both of the active articulators and in the degree of the turbulence/airflow: lateralization, stopping, fronting, glottal replacement, backing, and de-emphasis. Additionally, the data show that SLI has been characterized by initial and final consonant deletion as well as by the atypical patterns of voicing and devoicing processes.

### 9.3.3 SLI within Arabic-specific rules, NP, PHB constraints

The phonological characteristics of the SLI subjects have been analyzed to test the hypothesis that the phonological processes in SLI speech are not different from those processes in AMN children in JA. Therefore, this study classifies these phonological processes in the speech of the SLI participants into lenitions and fortitions according to the nature of their application as well as with reference to their functions according to NP simplification and reduction-definition criteria. The analysis of the recordings proved this hypothesis to be false by showing and explaining the differences between the AMN and the SLI phonological systems in JA.

Accordingly, the symptomatology of SLI has been investigated. Analyzing the data suggested that SLI in JA can actually be classified as delayed acquisition on one hand, due to the chronological mismatch in the application of the phonological processes between AMN and SLI children. But on the other hand, SLI can also be characterized by the frequent application of the simplification lenitive phonological processes in its three reduction-defining criteria; energy, complexity or aerodynamic unnaturalness. More specifically, in the current analysis, SLI children applied only one fortitive process, namely spirantization, which has been explained as an Arabic-specific feature which clarifies its unexpected presence. Conversely, all the other phonological processes in the SLI data are lenitions in their simplification function. To summarize, eight lenitive processes have been found for SLI and explained by the principles of NP and PHB. These lenitions are the processes of fronting, stopping, de-emphasis, de-affrication, voicing, devoicing, consonantal harmony, and unstressed syllable deletion.

Moreover, this analysis has also investigated the relevance of other factors and principles in accounting for the features of this atypical phonology in SLI in JA. This analysis suggests that SLI children may have a different language system involving certain deviances from specific Arabic phonological rules as acquired in typical development.

The phonological characteristics of SLI have been examined and can be summarized by certain patterns and specifications. More specifically, although this sample of SLI speech in JA can be described as a deviant phonological system when compared with AMN children, it rather confirms language universals through showing different selections from universal phonological processes as follows:

- The frequent application of fronting and stopping confirming the maximum constriction preference of (Tobin 1997, 2002; Tobin et al. 2006, 2009a,b).
- Articulatory difficulty may be the explanation for the phonological errors in the production of the emphatic consonants as shown in the processes of de-emphasis and the lateralization of /r/.
- The substitutions of glides for fricatives and the gliding of liquids confirm the maximum aperture preference of PHB in reducing articulatory muscle control.
- The consistent use of unstressed syllable deletion, final consonant deletion, metathesis, epenthesis, pre-vocalic voicing and final consonant devoicing as well as the application, albeit not very often of vowel neutralization, labialization, velarization, and nasalization confirm language universals.

As has been previously mentioned regarding the idiosyncratic processes in SLI speech, the present analysis further shows other interesting observations about the processes found in the SLI phonological system. This analysis reveals occurrences of other phonological processes that differ from universal phonological processes in some pathologically determined patterns:

- Backing which is frequently used in atypical speech and mostly appears as glottal replacement.
- The inconsistent pre-vocalic voicing and devoicing pattern.

    - Final consonant voicing, a completely atypical process.
    - Initial syllable consonant devoicing as opposed to the pattern in the AMN children, who typically apply final consonant devoicing.
- The frequent use of glottal replacement which deviated from both language universals and Arabic language specific rules in the context where it has been applied.

Additionally, the analyzed SLI speech in this study reveals the occurrence of some phonological processes which reflect Arabic language-specific rules in the following ways:

- The use of the dialectical forms helped in making fronting a very frequent process.
- De-emphasis and the use of the non-emphatic cognate sounds. Moreover, this process confirms the PHB principles and the explanation that PHB provides for the occurrence of these phonological process in SLI speech, namely the disfavouring of additional articulators as explained in Tobin (2000, 2007a, 2009a,b).
- Spirantization particularly substituting /h/ for /ʔ/ and its deviation from the typical acquisition norms.
- Deaffrication especially substituting [ʒ] for [ʤ] and its stylistic implications in JA.
- The rare use of consonant cluster reduction in the atypical SLI speech presents another process reflecting Arabic-specific features, as consonant clusters are not common in Arabic phonology.

## 9.4 Summary of the major findings

Phonological speech impairment in JA has been analyzed with reference to the preference theory of NP and the principles of PHB to test the hypothesis of this thesis. This hypothesis has been falsified because SLI speech does actually represent a deviant phonological system from that in AMN children. Moreover, SLI in JA can be characterized by the frequent application of the simplification lenitive phonological processes. Examples have been provided to explain the phonological processes in the SLI data within the preference quintuple of NP. Therefore, the interaction between the universal properties and the Arabic language-specific rules and its realization in the performance of the SLI children have been described and explained in the preceding chapters.

In addition, SLI has been examined in this study with reference to the parameters and the principles of the theory of Phonology as Human Behaviour. The quantitative results that are derived from the theory of PHB have been applied directly to explain the phonological processes that characterize SLI in JA. More specifically, PHB empirical principles concerning the dynamic interaction between the communication and the human factors and its consequences on the linguistic performance of this sample have been used to illustrate the differences that distinguish between the AMN and SLI children in this study.

The explanations based on the theories of NP and PHB along with explanations from NP have been used as a framework for analyzing the phonological processes found in the typical developmental and the atypical phonology of the Arabic-speaking children in this study. References have been made to NP and PHB's principles in explaining the speech patterns in SLI speech. Therefore, the principle of the mini-max struggle in achieving maximum communication through minimum articulatory effort has been referred to in analyzing the phonotactic distribution of phonemes in both the typical and atypical phonology in JA. This study empirically supports the underlying conclusion of the theory of PHB, Tobin (1997, 2008: 183):

> "Developmental and clinical speech errors may be viewed as an extreme version of the mini–max struggle: there is less than maximum

> communication because of either extreme minimal effort or a lack of control over the articulatory tract or mechanisms. Greater effort will be exerted in order to achieve more efficient or better communication through clinical intervention."

To summarize the findings that have been explained earlier, this analysis of SLI speech also shows that this disorder involves different selections from universal phonological processes; such as the frequent application of fronting, and stopping confirming the maximum constriction preference. The substitutions of glides for fricatives and the gliding of liquids confirming the maximum aperture preference in reducing the degree of articulatory muscle control. The data further show instances of vowel neutralization, unstressed syllable deletion, metathesis, epenthesis, labialization, velarization, nasalization, and pre-vocalic voicing which confirm language universals.

Additionally, the analysis of SLI speech reveals phonological processes that reflect Arabic-specific rules such as de-emphasis. Furthermore, SLI speech has also been demonstrating deviations from Arabic-specific rules and the usual universal phonological processes in some pathologically determined ways. For example the process of backing that has been frequently used in SLI speech and mostly achieved through glottal replacement. Final consonant voicing was also found in SLI speech, which is a completely atypical process. Moreover, SLI speech shows inconsistent pre-vocalic voicing and devoicing patterns that deviate from language universals and Arabic-specific rules have been provided for these atypical phonological patterns that characterize SLI in JA. Finally, these atypical patterns could not be explained within the frameworks of the theories of NP and PHB. These patterns could not be explained according to the principles of PHB concerning the dynamic interaction between the communication and the human factors. Moreover, the explanatory principle of NP, more specifically, the tension between the clarity of perception and the ease of articulation (cf. Donegan and Stampe 1979: 130) fails to explain these atypical patterns such as the process of final consonant voicing and glottal replacement that SLI subjects have presented in their speech.

## 9.5 Recommendations for future research

As previously mentioned, the findings and the observations in this study have been based on a small corpus of data, therefore they can not be generalized to all cases of SLI in JA. Consequently, a further similar study with larger representative data can be recommended to compare and test the applicability of the characterizing features in this study to all SLI cases in JA.

Moreover, this study has been concerned with characterizing SLI in JA based on a production experiment (speech articulation test) to describe the major differences between SLI and AMN children. Therefore, testing the possible perception differences between SLI and AMN children in JA belongs to a future programme of this research. This research would be needed to test the relevance of speech perception to SLI as deficits in the child's speech perception might underlie, precede, or interact with the atypical speech production. Accordingly, a further investigation would be needed to extend the results of this study and to examine if this phonological impairment is a production or perception-specific phenomenon.

Further research can also be recommended on other relevant topics like testing inflection and word formation between SLI and AMN children in JA. This study can be further extended to investigate aspects like narration and speech disorders. This can highly be recommended as studies on the typical morphophonological development in JA this gap in the literature. Thus, this would have to be considered in the future research to investigate morphophonological acquisition in AMN and SLI in JA to provide a scientific account of the typical acquisition of morphology. This recommended study would help in providing an accurate diagnosis and establish the distinction between the delayed and the atypical development in JA.

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# Appendix A

*Table 50: Fieldwork timetable: data collection at pathology centres*

| Date | Tasks at pathology centres |
|---|---|
| 23rd and 24th December 2007 | Visiting the Pathology centre in University of Jordan, and Al-Hussain Medical Centre, Amman.<br>Applying for the formal access to work there. |
| 27th December 2007 | Jordan university of science and technology, formal application. |
| 30th December | Al-Yarmouk University, Irbid, formal application. |
| 2nd and 3rd January 2008<br>4th and 5th weekend | Pathology centre in University of Jordan: attending a therapy session.<br>Al-Hussain Medical Centre, Amman: meetings and discussions. |
| 6th -8th January 2008 | Al-Yarmouk university: meetings and consultations. |
| 9th-11th January 2008 | Jordan university of science and technology; King Abdullah Educational Hospital, pathology centre: recording articulatory disordered cases. |
| 12th-14th January 2008 | Recording the typically developing cases. |