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THE ANALYSIS OF THE PHONOLOGICAL SYSTEMS OF ARABIC SPEAKING CHILDREN WITH CLEFT PALATE IN SAUDI ARABIA

Thesis Submitted to the Open University for the Degree of Master of Philosophy

Sponsoring Establishment:

Cardiff Institute of Higher Education

by

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M.D., M.Sc.

1994

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DECLARATION

This is to certify that the work submitted is the result of the candidate's own investigation apart from where indicated. None of the work referred to in this thesis has been submitted in support of an application for another degree at this or any other university of institution of learning.

Supervisors

Candidate

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DEDICATION

This work is dedicated to

My Mother and Father

A simple present with appreciation for every thing you

did for me without waiting for a reward.

My Dearest Husband

Together we started this work, watched it grow up and at

the end it is you who supported me despite your own needs.

My lovely family,

Uncle, Aunts, Husband's Parents, Sisters,

Your prayers were the helpful support that I will never forget all my life.

My precious Brother

You have been so helpful and patient with me.I pray to Allah to be the same

to you in your Ph.D. Degree.

My Heart Beats

Mohammed, Heba, Lujain, Shahad and.....?

I love you, you are my life.

Everybody who shared with me till this work has come to light.

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CONTENTS

		Page No:
Declaration		(i)
Acknowledgements		(ii)
Dedication		(iv)
Contents		(vi)
List of Tables		(x)
List of Figures		(xiii)
Abbreviations		(xiv)
Abstract		(xv)
CHAPTER 1	INTRODUCTION	1
CHAPTER 2	REVIEW OF LITERATURE	4
- 2.1	Embryology	4
- 2.2	Classification	6
	- Cleft Lip Only	7
	- Cleft Lip and Palate	8
	- Cleft Palate Only	8
- 2.3	Etiology	9
- 2.4	Incidence	10

			Page No:
-	2.5	Treatment	11
	2.5.1	Importance of Treatment	11
	2.5.2	Goals of Treatment	11
	2.5.3	Types of Surgical Procedures	12
	2.5.3.1	Primary Surgery for Cleft Palate	14
	2.5.3.2	Post-Operative Result and Complications	15
	2.5.3.3	Secondary Surgery	16
	2.5.4	Timing of Operation	17
-	2.6	Effect of Cleft	21
	2.6.1	On Feeding	21
	2.6.2	On Hearing	24
	2.6.3	On Dental and Occlusal Abnormalities	27
-	2.7	Psychosocial Aspects of Cleft	32
	2.7.1	On the Patient	32
	2.7.2	On Parent-Child Relationship	32
-	2.8	The Development of Speech	34
	2.8.1	Speech Development in 'Normal' Children	34
	2.8.2	The Development of Speech in Children with Cleft Palate	35
CHAPTER 3		THE PHONETICS OF ARABIC	42
-	3.1	General	42
-	3.2	Vowels	44
-	3.3	Consonants	46

			Page No:
-	3.4	Characteristic Features for Arabic	47
	3.4.1	Voicing	47
	3.4.2	Length of the Vowels or Consonants	47
	3.4.3	Consonant Clusters	50
	3.4.3.1	Medial Position Consonant Clusters	50
	3.4.3.2	Final Position Consonant Clusters	50
CHAPTER 4		METHODOLOGY	54
-	4.1	Subjects	54
-	4.2	The Study Requirements	58
-	4.3	Data Collection	66
-	4.4	Data Analysis	72
	4.4.1	Reliability	72
	4.4.2	The Analysis Procedure	73
	4.4.2.1	Phonetic Analysis	73
	4.4.2.2	Phonological Analysis	79
CHAPTER 5		RESULTS	82
-	5.1	Phonetic Analysis	84
	5.1.1	General Phonetic Inventories	84
	5.1.2	Size of the Consonant Inventories	88
	5.1.3	Correspondence Matrices	92
	5.1.4	Phonetic Distribution	101

Page No:

-	5.2	Phonological Analysis	105
	5.2.1	Analysis of Phonological Simplifying Process	105
	5.2.2	Analysis of Constrastive Phonological System	121
CHAPTER 6		DISCUSSION AND CONCLUSIONS	126
		REFERENCES	137
		BIBLIOGRAPHY	146
		APPENDICES	

LIST OF TABLES

Table No:		Page No:
1	The Phonetic Symbols for Arabic Consonants According to Place of Articulation	43
2	Arabic Consonants : Phonetic Inventories	45
3	Arabic Consonants : Phonetic Inventories for the Emphatic Set	48
4	Subject Description According to Age, Gender and Type of Cleft	55
5a	Examples of Target Sounds in the Different Position in Word - Word Initial	62
5b	Examples of Target Sounds in the Different Position in Word - Word Medial	63
5c	Examples of Target Sounds in the Different Position in Word - Word Final	64
6	Sample of the Designed Data Collection Sheet	65
7a	Data Collection Sheets for Subject 1	69
7b	Data Collection Sheets for Subject 1	70
7c	Data Collection Sheets for Subject 1	71
8	General Phonetic Inventories	76
9	Correspondence Matrices Illustrating the Target Sounds and the Child's Realisation of them according to Position in Word	77
10	Example of the Sheet Designed for Analysis of The Final Consonant Clusters	78

Table No:		Page No:
11	General Phonetic Invetory : Subject 1	85
12	Summary of Size of Consonant Inventories for Children with Cleft Palate and Non-Cleft Palate	89
13	Summary of Absolute and Proportional Occurrences of Inveotry Consonants by Manner of Articulation in Children With and Without Cleft Palate	90
14	Correspondence Matrices for Subject 1 - Word Initial Position	91
15a	Correspondence Matrice for Subject 1 - Word Medial Position	93
15b	Correspondence Matrice for Subject 1 - Word Final Position	94
15c	Summary of the Errors for Different Targets Consonant in the Three Positions in the Word	95
16	Phonetic Distribution in Terms of Manner of Production for Children with Cleft Palate	97
17	Phonetic Inveotires in Terms of Manner of Production for Children with Cleft Palate	102
18	The Mean Percentage Occurrence of Individual Process Usage for the Children with Cleft Palate	104
19	The Frequency of Occurrence of Phonological Processes and the Phonological Processes Across the Different Age Group of Subjects	112
20	Mean for Toal Instances of Process Usage for Cleft and Non-Cleft Children by Age	114

Table No:		Page No:
21	The Frequency of Occurrence of Phonological Process Error and the Phonological Process Across the Different Age Group in Controls	116
22	The Mean Percentage Occurrence of Individual Process Usage for the Normal (Non-Cleft) Children	117
23	The Mean Percentage Occurrence of Individual Process Usage for the Normal (Non-Cleft) Children	120

LIST OF FIGURES

Figure No:		Page No:
1	Tracing from A Cineradiagraphic Film of Plain versus Emphatic (Pharyngealised) Allophones of /t/ before /u/, /i/ and /a/	49
2	One Example of the Pictures Used to Illustrate the Target Word	61
3	A Map of Saudi Arabia showing the three Geographic Regions for the Purpose of Data Collection	68
4	Examples of the Sheet Designed for Analysis of Contrastive Phonological Analysis	81
5	Analysis of Contrastive Phonological System for Subject 1	122

ABBREVIATIONS

VPI	Velopharyngeal Insufficiency
OME	Otitis Media with Effusions
CP	Children with Cleft Palate
NC	Normal Children (without Cleft Palate)
M	Male
F	Female
IPA	International Phonetic Association
om	Omitted
SIWI	Syllable Initial Word Initial
SFWW	Syllable Final Within Word
SIWW	Syllable Initial Within Word
SFWF	Syllable Final Word Final

ABSTRACT

Cleft palate is a congenital defect which can affect speech intelligibility, giving rise to delayed and deviant articulatory patterns. Cleft palate speech has universal characteristics so that knowledge acquired about one language can be applied to another. Thus a hypothesis was postulated that cleft palate may affect the intelligibility of Arabic speaking children in a way similar to English speaking.

Despite limited information on Arabic phonology, particularly in children, this study was designed to examine the phonetic and phonologic skills of sixteen children, eight children with surgically repaired cleft palate (subjects) and eight non-cleft children (control) within the age range of 3.3 to 6.9 years of age. Speech samples were audio-taped then subjected to a number of phonetic and phonological analyses.

The results revealed that the cleft palate subjects were a homogenous group. They were similar to one another with respect to their phonetic inventories, frequency and types of phonological processes used. In comparison to the controls, the homogenous group of the subjects were similar only to the four youngest control and not to the oldest four controls. Some processes were identified in the analysis of subjects only that were the same published for English speaking children with cleft palate.

The data has suggested that there is a loss of contrastivity in the cleft palate subjects' speech which could affect their speech intelligibility, but not all of the articulatory problems among subjects can be explained solely on the basis of past structural deficits but there may be other factors that have an implication.

CHAPTER ONE

INTRODUCTION

CHAPTER 1

INTRODUCTION

Cleft palate is a complex problem that occurs world-wide. It affects speech development either directly or indirectly and demands the knowledge and skills from a number of disciplines to provide appropriate management.

The literature review attempts to cover most of these aspects and indicate their relevance to speech. Embryological development is the first step for building up informations as a background for this project. Embryological defects such as cleft palate are presented in variable forms and degrees and have different effects on speech. This will be explored in the "classification" section.

As the communication problems arising from congenital clefts may differ from the acquired, a section on etiology will be included.

The review will also include relevant points in surgical treatment. The types of primary procedures, the post-operative results and the application of secondary surgery to improve the results can be important in relation to effect on speech.

The speech of children with cleft palate may be similar to that of normal children if repair takes place during the critical period for acquiring normal speech and language development. This statement has been the subject of argument and will be discussed in relation to speech patterns under the "timing of the operation" section.

Existent oro-facial abnormality may give rise to several problems that affect speech development directly or indirectly. Feeding, hearing and dental problems are obvious difficulties which may result directly from the defect and have an influence on speech development. The indirect results include psycho-social aspects which may affect the child himself or the parent-child relationship.

This identified anatomical defect may have articulatory sequelae. The deviance in oral structures has the potential to influence subsequent phonetic and phonological development. This raises the question of how children develop speech and what patterns they use. An exploration of developmental issues helps to clarify the effect of cleft palate on phonetic skill and phonological development. More on this topic will be covered under the "effect of cleft on speech" section.

Much of the literature is in English and about English speaking children. But, what about children who speak Arabic? What is the effect of cleft on their speech and how could this affect their communication with others? In order

to answer such questions information regarding the Arabic language is crucial. Very little published knowledge is available especially for phonetics and is based on adult speech. This will be discussed under the Phonetics of Arabic section.

Such information about adults phonetics could not answer the questions previously raised regarding children. However, it can be combined with information gathered from reviewing the literature on English speaking children (the normal and the children with defects) regarding phonetic and phonological development. These together could be used, based on the assumption that children, whatever their language, will pass through similar stages during their speech development to reach the adult targets. Such an assumption is fundamental in designing this project.

Thus identification of the phonetics and phonological disorders in Arabic speaking children with cleft palate (with or without cleft lip) is the aim of this project. The selection of the suitable method and materials, the subjects' characteristics and the sample size will be discussed under "Methodology".

Analysis of the results is a consequence of the methodology.

Conclusions and recommendations are the final steps in attempting to address the main issues raised previously.

CHAPTER TWO

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

2.1. EMBRYOLOGY

Detailed knowledge of embryological development of structures responsible for oral communication may not be necessary for speech and language therapists, but a general knowledge is useful as a background.

For instance, explaining to parents requires some knowledge of embryology. Such explanations are important in view of effect of mother-child relationship on speech.

It is important to explain simply and generally to the parents the condition, the recommended treatment and their implications for speech to orient them to what to expect (*McWilliam, Morris and Shelton, 1990*). Good counselling of parents could influence the speech outcome for those children with clefts (*Bzoch, 1989a; Wells, 1971*).

To return to the embryology, clefting anomalies are malfunctions that occur in utero and are presented at birth.The period between the fourth and sixth week of gestation is a critical period where the

rudiments of future organs of the body emerge, including those used for speech. During this period any teratogenic agents could result in abortions or congenital physical anomalies (*McWilliam, et al 1990; Berkovitz, 1986a).*

These cranio-facial abnormalities can affect several functions such as respiration, phonation, resonation and articulation (*Wells, 1971; Grunwell, 1990; Berkovitz, 1986b).*

2.2 CLASSIFICATION

Cleft formation is the commonest cranio-facial abnormality which affects speech directly or indirectly (*Albery, 1986*).

The mechanism responsible for the development of labial clefts is different from that of palatal as they are embryologically different *(McWilliam et al, 1990)*. This variation may depend on the time of the teratogenic agent introduction in relation to the critical period (*Albery, 1986*).

Understanding of the mechanism of clefting could be used as an aid to classifying the different types of clefts. By this classification the disordered speech pattern could be predicted. This is because different types of clefts influence different patterns of speech (*Albery and Grunwell, 1993*).

The variations of the effects of the cleft on speech are not just due to variation in types, but also to degree of severity (*Albery, 1989*).

Different systems based on various criteria were designed for the classification of clefts (*Grunwell, 1993*a) but none was accepted as a standard classification system (*Bzoch, 1989a; McWilliam et al, 1990).* Detailed discussions of the different classification systems can be

found in *Albery and Russell (1990); Bzoch (1989a); McWilliam et al (1990) and Albery and Grunwell (1993)*

The best classification is probably descriptive in nature and based on embryological development. It has to account for the different variables affecting the outcome of primary palatal surgical reconstruction (*Albery and Grunwell, 1993; Hathorn, 1986; Bzoch, 1989a; McWilliam et al, 1990; Albery and Russell, 1990*). Speech and facial appearance are the two most important outcomes (*McWilliam et al, 1990*).

The classification designed by Kernahan and Stark in 1958 was considered to be a complete embryological classification (*Wells, 1971; Bzoch, 1989a*). However, Albery and Grunwell (1993) criticised this system as it did not recongise the lip as a separate entity and classified it as part of the primary palate. So, some modification was applied to it in order to fulfil this requirement. The modified Kernahan and Stark classification used by Albery and Grunwell (1993) is the one applied in this project:

I ***Cleft lip only***
- o - unilateral (right or left)
  - complete
  - incomplete
- o - bilateral
  - complete
  - incomplete

II ***Cleft lip and palate***

- o - unilateral (right and left)
  - complete
  - incomplete
- o - bilateral
  - complete
  - incomplete
- o - unilateral (right or left) cleft lip and cleft soft palate only
- o - bilateral cleft lip and cleft soft palate only

III ***Cleft palate only***

- o - hard and soft palate
- o - soft palate only

After 17 years of experience in cleft lip and palate in Saudi Arabia, *Diab (1993)* found that cleft of the palate only was the most common type affecting children.

2.3. ETIOLOGY

Identification of etiological factors in cleft lip and palate is a complicated, difficult and limited area as there are great variations in the "normal" developmental process.

Research in this area is difficult to apply for several reasons, ethical reasons being one of them as it is unacceptable and illegal to apply factors suspected of being teratogenic to human experiments (*McWilliam et al, 1990*).

The etiology and the genetics of cleft lip with or without cleft palate is different from that of isolated cleft palate (*Cobley, 1985*). The complex interaction between the multi-factorial genetic and environmental factors plays a significant role in the etiology of these malformations (*Wells, 1971*). Research related to the etiological factors has been discussed thoroughly in *Cobley (1985); McWilliam et al (1990) and Wells (1971).*

Early identification and management of associated factors (such as ear infections) is an important goal for preventing communication disorders. But, this goal will always be limited by other, environmental, factors (such as poor stimulating environment) which are beyond the control of a cleft palate team (*Bzoch, 1989a*).

2.4. INCIDENCE

Incidence gives an idea of the impact of the defect on the health services and speech pathologists (*Sayetta, Weinrich and Coston, 1989*). There is a worldwide variation in its rate as there are factors that affect it, such as racial frequencies, geographical variations in reporting, etc. (*Fraser, 1971; Vanderas, 1987*).

It was reported by *McWilliam et al (1990)* to be one in 750 births, but the source of data was not cited. In the United Kingdom, it is one in 600 births (*Syder, 1992*), but shows a rising trend.

In Saudi Arabia, hospital based data over the period 1981-91 suggests that the incidence was one in 1263 births increasing to one in 1022 live births (*Diab, 1987, 1993*). He also found that cleft of the palate is the most common type of cleft.

2.5. TREATMENT

2.5.1 Importance of Treatment

Cleft palate is not a defect that affects physical development only. It can also have a functional influence on development. As it occurs during the first years of life it can have a significant impact on early communication skills (*Russell, 1989*). So early appropriate management is important in order to prevent communication disturbance (*Harding and Grunwell, 1993*).

2.5.2 Goals of Treatment

There are several reasons and goals for performing a plastic surgery to close a cleft, whether it is of the lip or of the palate. The two main goals are:

(a) to regain the normal or near normal physical appearance of the face;

(b) to provide the mechanism that facilitates normal speech production in a child with the potential for it.

Some of the other goals are:

(a) to create a velopharyngeal valving mechanism and to allow for normal swallowing by separating the oral cavity from the nasal;

(b) to reduce the frequency of upper respiratory infection which allows for improvement of the middle ear condition and, in consequence, improves hearing;

(c) to provide a psychosocial lift for the parents.

To attain these goals without interfering with facial bone growth during its development is the objective of the surgical repair (*McWilliam et al, 1990*).

Sometimes these goals are difficult to reach as they depend upon other factors such as the experiences of the surgeon, the child's condition, type of procedure, age at operation, etc. (*Grabb, 1971; Furlow, 1986*).

2.5.3 Types of Surgical Procedure

Closure of a cleft of the lip palate is not difficult technically, but the skill of arranging the tissue anatomically in order to appear and function normally is not easily acquired (*Cobley, 1985*).

There are a large number of good procedures which are in continuous development in order to bring incremental improvement in

speech (*Roberts, Semb and Shaw 1991*). The choice of a procedure should depend on several factors such as:

(a) fulfilment of the goals of the cleft repair;

(b) understanding of the normal anatomy of the lip and palate;

(c) understanding of the variations in cleft deformities, e.g. extent and types of cleft, availability of adequate tissues for repair;

(d) experience of the plastic surgeon with the surgical procedure;

(e) careful weighing of the advantages and disadvantages of each operation; (*Musgrave, 1971*).

A high risk of disturbance in orofacial growth and development, with a disastrous effect on speech, will result from a badly performed primary surgical repair. This will increase the risk of secondary facial and dental deformity and, consequently, lead to speech impairment (*Roberts, et al 1991*).

The initial closure of any type of cleft can be done by different primary surgical techniques and if it fails, secondary surgery usually follows (*McWilliam et al, 1990*).

2.5.3.1 Primary Surgery for Cleft Palate

In order to restore the normal form and functions of the oral structure primary constructive surgery is usually performed early in life (*Bzoch, 1989b*).

Most of the primary surgical repair procedures for cleft palate come under two catergories: one stage or two stage palate plasty repair, each one having advantages and disadvantages (*Holdsworth, 1970; Kapetansky, 1987*).

There are a variety of surgical techniques, all of which attempt to improve speech results by repairing the palatal cleft while allowing adequate maxillary growth. In the United Kingdom, speech is the principal and important outcome by which selection of a procedure occurs.

Vonlangenback procedure is a one stage repair commonly used in the United Kingdom and Europe (*McWilliam et al, 1990*). It results in a high success rate as measured by speech results, but is associated with high incidence of maxillary deformity and cross bites by scarring of the hard palate (*Bzoch, 1989b*).

The other common procedure is the Schweckendiek operation. It is a two stage palatoplasty achieving a good mid facial growth by delaying the hard palate closure. However, it has a detrimental effect on speech even though it closes the soft palate early in order to stimulate its use in speech (*Dorf and Curtin, 1982; Furlow, 1986*). The operation results in a velopharyngeal incompetence and abnormal articulation patterns.

Double opposing Z-plasty is a new procedure designed by *Furlow (1986)* which could be the best surgical repair to be adopted. It achieves good speech without velopharyngeal insufficiency or compensatory articulation errors. It is completed by the first year or earlier, before articulation is learned. It also permits optimal maxillary growth and dental development by minimising the hard palate scar.

In Saudi Arabia, the procedures used for surgical management of cleft palate are the same as the ones used worldwide (personal communication).

2.5.3.2 Post-Operative Results and Complications

Comprehensive examination of the outcome of treatment should be multifacated, especially as track offs in outcome may occur (*Roberts*

et al, 1991). The outcome should involve speech, facial appearance, dental relationship, cranio-facial growth, ENT status and socio-psychological factors.

Comparisons between the different primary palatal closure procedures on the basis of speech as an outcome are discussed in *Grabb* (*1971*). The degree of individual 'schema' of consonant production pre-operatively will influence the extent by which surgery facilitates good speech (*Harding and Grunwell, 1993*).

An important complication is post-operative fistula which may occur for several reasons. It may affect speech by producing nasal emission, hypernasality and may affect articulation.

2.5.3.3 Secondary Surgery

Failure of the primary surgery for palatal closure could result in velopharyngeal insufficiency (VPI). One in four patients continue to have VPI after the primary palatal repair (*McWilliam et al, 1990*).

Such VPI is hard to compensate for by speech therapy so it has to be corrected surgically in order to achieve normal or near normal speech (*Bzoch, 1989b*).

In Saudia Arabia, as the rest of the world, the most common surgicial procedure used for secondary repair is pharyngoplasty, which corrects the nasalisation of speech resulting from VPI.

Another common method used as a secondary aid is a speech appliance. A prosthesis improves speech without affecting dentition (*Shelton, Hahn and Morris 1968).*

2.5.4 Timing of Operation

Structural integrity of the speech mechanism is needed to enhace the normal speech production pattern. In cleft palate children, this structural integrity is lost. The best time for surgical repair of the defect is a controversial issue (*Chapman and Hardin, 1992*). This controversy is because of the great number of variables that may affect mid facial growth, such as surgical technique, number of surgical procedures to the hard palate and the inherent facial morphology (*Dorf and Curtin, 1982*). Also, assessment of the surgery on the basis of facial growth cannot be made until around 18 years of age when the facial growth is completed (*Harding and Grunwell, 1993*).

The physiological activity of the orofacial structures can be achieved and maintained by early restoration of their normal relationship (*McWilliam et al, 1990*). Decisions regarding age of palatal repair

should be linked to the need for normal speech development with minimal maxillary growth disturbance (*Bzoch, 1989b*). So, the ideal time for palatal repair seems to be that period before speech development and after maximum growth (*Furlow, 1986*).

During the process of speech development in "normal" children, consonant-vowel sequences emerge between 6 and 9 months of age (*Dorf and Curtin, 1982*). Palatal defect should be repaired between 18 and 24 months of age as surgical long term effect on speech could be minimised if done before 3 years of age. This is because most neurological pathways can be redirected and what ever compensatory articulatory strategies children adopted in their consonant production pre-operatively can be changed with little difficulty (*Harding and Grunwell, 1993*). Surgery may need to be combined with speech therapy to achieve good speech development (*Grabb, 1971*).

Closure of the soft and hard palate at the mean age of 1.8-2.1 years seems to have the same effect on the growth and shaping of the dental arches as that at the age of 3 years whether the child has cleft palate only or cleft palate and lip (*Nystrom and Renta, 1990*). Also, delaying palatal repair to after the age of 12 years will be of minimal benefit (*Sell and Grunwell, 1990*).

Children who have early palatal closure tend to develop normal phonetic features earlier than those who have it late. But, there are individual differences with respect to surgical timing and decision making. So a child's phonological development stage rather than the chronological age should determine the optimal age of palatal surgery (*Russell and Grunwell, 1993; Chapman and Hardin, 1992*).

Trost (1981) found that the potential for normal speech without compensatory articulation was significantly better in babies who underwent palatoplasty during the second six months of life than those who had it during the second year or later.

Postponing congenital VPI correction after the time when speech and language development emerge by having late palatal repair will have a deleterious effect on developing voice and exhibit "compensatory" articulation patterns (*Bzoch, 1989b; Chapman and Hardin, 1992; Nystrom and Renta, 1990*).

The timing for repair of the secondary palate has to be decided by the needs of acquiring good speech rather than the fear of lack of subsequent growth and development (*Cobley, 1985*). In other words it is the time for developing V.P. adequacy for speech rather than the age of operation which is the important factor in preventing "cleft palate speech" (*Bzoch, 1989b*).

Finally, in the maturational process the impact of speech problems usually appears earlier than the disturbance in facial growth. On the other hand, cranio facial surgery and surgical orthodontic management of dento-facial abnormalities have remarkably increased in technology and sophistication so they are highly effective in the habilitation of oro-facial structures. By contrast, speech remediation in teenagers and adults usually yields little or no change (*Trost, 1981*).

In the United Kingdom, initial soft palate repair usually takes place between 6 to 18 months and hard palate repair after 5 years of age.

In Saudi Arabia, repair of cleft palate varies from 10 months to 2 years (*personal communication*).

Until there is scientific evidence of improved facial growth as a direct result of delaying palate repair, early complete repair to enable normal development should be a priority (*Harding and Grunwell, 1993*).

2.6. EFFECT OF CLEFT

2.6.1 On Feeding

Feeding constitutes the most obvious problem in infants born with clefts and is one of the potential concerns for parents (*McWilliam et al, 1990*).

There is a relationship between oropharyngeal, psychosocial and speech and language development in children. Early feeding patterns such as sucking and swallowing are parts of this oropharyngeal development (*McWilliam et al, 1990*).

Feeding difficulties depend on the type of cleft so infants with cleft confined to the lip have minor or no difficulties with feeding (*Holdsworth, 1970*), whereas a high proportion of the population with palatal cleft (with or without cleft lip) have feeding difficulties (*Bzoch, 1989b*).

These children have trouble impounding the intra-oral pressure necessary for sucking milk from the breast or the bottle (*Albery and Russell, 1990*). Subsequently, different feeding strategies are usually adopted to allow free flow of milk to the posterior part of the mouth rather than the lips and front of the tongue (*Russell, 1989*).

In cleft palate children, the physical defect together with the abnormal feeding pattern affects the neruomotor encoding skills of feeding.

This results in the development of compensatory abnormal learned neuromotor patterns (*Albery and Russell, 1990*).

These patterns may become habitual and subsequently lead to compensatory articulation patterns (*Russell and Grunwell, 1993*). *Bzoch (1989)* suggested that speech characteristics associated with these abnormal patterns will include glottal stop and pharyngeal fricative articulation and delayed speech development. This abnormal articulation is related to the difference in tongue shape and movement and not to dental or occlusal problems (*Russell and Grunwell, 1993*).

Correct production of speech sounds through the vocal tract depend on correctly regulated air pressure. Compensation for this will be by humping the back of the tongue or constricting the glottis (*Albery and Russell, 1990*; Hewlett, 1990). Consequently, infants with unrepaired cleft palate find it difficult to produce consonants and their pre-speech vocalisation is characterised by "glottal babble" *(Russell, 1989).*

Feeding an infant with a cleft palate can be slow, difficult and frequently interrupted (*Holdsworth, 1970*). Feelings of frustration may affect the psycho-social aspect of feeding by hindering the early mother-child experiences and relations (*Wirls, 1971*). It will be expressed in the forms of anxiety, fear and dissatisfaction in the feeding situation (*Bzoch, 1989a*). The ultimate result is that the early mother-child relationship necessary for speech and language development becomes impaired (*McWilliam et al, 1990*).

Also, loss of the mother's protection during the potentially traumatic events of hospitalisation, surgery, etc. may result in passive behaviour in some children (*Bzoch, 1989a*).

Such undesirable effects, which have a major impact upon development, may be overcome with proper counselling of the parents *(McWilliam et al, 1990)*.

2.6.2 On Hearing

Adequate hearing is essential for the acquisition of speech, language and voice patterns in young children (*Pollock, 1971*). Children with cleft palate are prone to middle-ear disease especially Otitis Media with Effusion (OME) and conductive hearing loss (*Russell and Grunwell, 1993; Maw, 1986*).

It was estimated that 26% - 55% of children with OME have mild to moderate conductive hearing loss (*Wallace, Gravel, McCarton and Ruben, 1988*). The attacks are episodic, of a conductive type and hearing loss is subject to fluctuation (*Bzoch, 1989a; Stengelhofen, 1989*). Hearing problems will interfere with the devleopment of early auditory skills and later language development (*Bzoch, 1971a; Albery and Russell, 1990*). The relationship between OME and expressive language development is close *(Wallace et al, 1988; Teele, Klein, Rosner and The Greater Boston Otitis Media Study Group, 1984*).

The ability to generate a sound system depends on knowledge of the sounds which are needed by that system and this is learned through a good sense of hearing (*Starr, Pearman and Peacock, 1983; Paradise, 1981).*

Logically, system failure will be attributed to faulty information based upon hearing impairment. Also, the confusion caused by the hearing fluctuation would prevent the acquisition of good listening skills *(ByersBrown and Edwards, 1989)*.

As speech is learned mainly by imitation of the speech models available, environmental stimulation such as early verbal stimulation and auditory feedback are important for speech development (*Starr et al, 1983*).

Inability to hear others' speech models commonly results in inappropriate speech patterns. The development of these patterns are proportional to both the degree and the duration of hearing loss. The longer the hearing loss, the more marked the speech deviations.

Children who have frequent attacks early during the first six years of life are at great risk in the acquisition of delay or deviant phonetic and phonological development *(ByersBrown and Edwards, 1989; Russell and Grunwell, 1993)*.

Hearing impairment is also significant in relation to auditory discrimination (*Stengelhofen, 1989*).

Early intervention and determined management of OME is essential as the presence of hearing loss may be a major handicap to the development of communication in children with cleft palate (*Stengelhofen, 1989*). Therefore, the otological and hearing status of these children should be regularly assessed for early identification of hearing impairment (*Pollock, 1971; Russell and Grunwell, 1993*).

2.6.3. On Dental and Occlusal Abnormalities

Patients with cleft of the lip and palate exhibit marked differences in their maxillo-facial growth and development (*Olin, 1971*). Dental abnormalities and malocclusion between mandible and maxilla are frequently presented in these children (*Stengelhofen, 1989*).

There is no general agreement about the potential cause-effect relationship between dental abnormalities and speech *(Bzoch, 1989c)*. Different types of difficulties in the articulation of anterior consonant sounds during speech production are due to dental and occlusal abnormalities experienced in children born with clefts *(McWilliam et al, 1990; Albery and Grunwell, 1993)*.

The type and severity of cleft is of relevance to the type of dental or occlusal abnormalities. This fact could be demonstrated in that cleft of soft palate only should not cause any abnormalities of teeth, alveolar arch or occlusion, whereas complete cleft of lip and palate may cause all of them *(Albery and Russell, 1990)*.

If the cleft involves the alveolar ridge, lateral incisors may be malformed or absent. Their absence may affect speech slightly by forcing the tongue to protrude through this space resulting in a

fronted realisation of fricatives and plosives that are normally articulated against the lveolar ridge *(Albery and Russell, 1990).*

Also, spacing of maxillary incisors is associated with misarticulation of [r, l, n, d] *(Albery and Grunwell, 1993).*

If the cleft involves the alveolus bilaterally, gross protrusion of the pre-maxilla occurs, making precise articulatory placement at the alveolar ridge difficult to achieve and this may affect a number of fricatives and plosives *(Stengelhofen, 1989).*

Alveolar arch collapse is very common in children with clefts which may be congenital or as a result of early radical surgery. It may be linked with the presence of cross bite which may be unilateral or bilateral *(Albery and Grunwell, 1993).*

In the alveolar arch collapse, the intra-oral space for a normal sized tongue may be insufficient and may result in tongue bunching so that the blade rather than the tip will be used as a consequence. The tendency to bunch backwards gives rise to deviant articulatory positioning *(Albery and Russell, 1990).*

As dentition and occlusion play an important role in the size and the configuration of the oral cavity, the relationship between maxilla

and mandible is important for the function of the tongue during rest and speech *(McWilliam et al, 1990).*

Any disturbance between the two dental arches will result in various degrees of malocclusions. Many children with clefts may well have varying degrees of Class III malocclusion by the time they are 5 years old *(Stengelhofen, 1989).*

In severe Class III malocclusion, the labiodental articulatory placement for / f / and / v / may be difficult to achieve and may be substituted by the bilabial fricative [ɸ] [β] *(Stengelhofen, 1989).*

In the presence of overbite in Class III malocclusion, lateralisation and/or palatalisation of /s, z, t, d/ and fronting of / ʃ , ʒ / may occur *(Stengelhofen, 1989; Albery and Grunwell, 1993; Bzoch, 1989b).*

In developing infants, the articulator movement patterns are monitored and maintained by sensory feedback from the oral structures *(McWilliam et al, 1990).* The system of developing speech sounds works by passing auditory and visual information about the characteristics of a target sound to the central nervous system. A matched sound will be produced by a precise motor adjustment of

the oral structures followed by rapid movement required in speech. The performance of this complex articulatory movement needs the oral structure to be intact. This emphasises the importance of the relation between the tongue's sensory-motor function and the other oral structures in speech development and maintenance.

Congenital dental anomalies are more difficult to compensate for as they produce different difficulties in speech *(Bzoch, 1989b)*. If properly designed surgery is applied to correct the dental abnormalities early, it will improve the articulation performance and facilitate rather than hamper speech production even without interventive speech therapy *(McWilliam et al, 1990; Adisman, 1971)*.

But an argument can be raised here as to the effect of treatment on speech as some of the appliances (orthodontic or extra-oral) used for malocclusion treatment can present hazards to clear speech and hamper articulation *(McWilliam et al, 1990)*. Also, due to the frequent changes in oral structural relationship by surgery and orthodontic treatment, children with cleft palate will never have the opportunity to obtain and maintain articulatory behaviours as a normal baseline for speech production *(Bzoch, 1989b)*.

Generally, however, the articulatory deviations originating from dental and occlusal hazards in children with cleft do not generally affect their speech intelligibility *(Albery and Russell, 1990)*.

More will be discussed about the effect of cleft on speech later.

2.7. PSYCHO-SOCIAL ASPECTS OF CLEFT

2.7.1 On the Patient

The environment of a person plays an important part in facilitating or inhibiting several aspects of development, communication skill being one of them *(Smith, 1971)*.

Children with clefts may become socially withdrawn and this may affect their speech. Feedback mechanisms are important for speech development, so by not communicating with others, correct feedback may not be received. Also, when children play they tend to correct others' mistakes.

This playing with sounds and correct feedback are fundamental for developing "normal" speech *(Smith, 1971; Bzoch, 1989c)*.

2.7.2 On Parent-Child Relationship

Verbal stimulation by parental encouragement is important in order to re-inforce children's babbling and cooing sounds - the first signs of speech *(Starr et al, 1983)*.

The birth of a child with cleft anomalies can affect the parent-child relationship. Parental attitudes towards the child may influence responses to him and affect the initiation of communication between them.

The ability of the child to express early social communication or vocal behaviour is limited. So, the parent may be unable to respond appropriately to the child's efforts to communicate *(Chapman and Hardin, 1991).*

Failure of communication at a very early stage as a result of this upset relationship will be experienced by the child. An important end effect can be delayed speech development *(Albery and Russell, 1990).*

2.8. THE DEVELOPMENT OF SPEECH

2.8.1. Speech Development In "Normal" Children

Speech is a natural, complex form of human language behaviour. Its development can be affected by the organic integrity of the central nervous system and of the organs composing the learning and speaking mechanism of the body *(Bzoch, 1971b; 1989c)*.

Children employ a systematic set of simplifying phonological processes during their development from babbling to mature adult-like pronunciation *(Ingram, 1981)*. The processes are said to occur in response to articulatory incompetence resulting from either normal or pathological immaturity of the vocal tract *(Chapman and Hardin, 1992; Hewlett, 1990)*. Simplification processes refer to phonetic-phonemic changes in speech that occur regularly for classes of sounds such as all fricatives or all plosives or articulatory targets such as velars or alveolars *(Hodson and Paden, 1981)*. Normally, these processes are gradually suppressed or limited as children grow up and master the adult system *(Dunn and Davis, 1983)*. Complete maturity of the articulation patterns and hence the spoken phonology of a language is usually reached by eight years of age *(Stengelhofen, 1989)*.

The developmental course of phonologically disordered speech is often broadly similar to that of normally developing children, though

the time scale may be longer and, in some cases, unusual simplification rules may be used *(Hewlett, 1990)*. Phonological processes have, therefore, been used to identify the occurrence of common systematic and structural simplifying processes and also to investigate the occurrence of less common processes *(Grunwell, 1990)*.

2.8.2. The Development of Speech in Children with Cleft Palate

Babies born with abnormal speech mechanisms, like clefts, are at high risk of developing disordered speech *(O'Gara and logemann, 1988)*. The problem of the disordered speech is phonetically based *(Chapman, 1993)*. The structural deviations associated with clefting have the potential to influence the articulatory development which may subsequently influence the phonetic and phonological development *(Albery and Russell, 1990)*. The phonologies of children with clefts are systematic. They show the use of sounds to contrast the meaning of words and use different phonological processes to simplify the production of words.

These phonological processes are similar to those of younger normal children but they may use processes that are not commonly used by normal children *(Ingram, 1976)*. In general, whatever the process

they are using they tend to suppress it later than the normal children. The phonological errors produced by young children with cleft reflect difficulty in the child's organisation and representation of the sound system of the language.

The early simplifications will inevitably be influenced by the speaker's articulatory incompetence resulting from the cleft *(Hewlett, 1990)*. The simplification rules are phonetically motivated and may be developed for the purpose of satisfying the special requirements of a speech regulating system. For example, the child whose sound production is limited may only use words that contain sounds that are easy to produce like /m, n, h/ and avoid those that contain sounds that the child is unable to produce. These are likely to include consonants which require a high pressure build up in order to be realised, particularly fricatives and affricates *(Estrem and Broen, 1989; Warren,1986; Ingram, 1976)*.

Dorf and Curtin (1982) reported typical compensatory articulations in the early speech development of children with cleft lip and palate. These include palatal, glottal, pharyngeal or velar *(Chapman and Hardin, 1992)*. Once these undesirable articulatory patterns develop, they are difficult to correct *(O'Gara and logemann, 1988)*. Also it is known that, normally, the active development of both the phonology

and the dental arch usually takes place in the second postnatal year *(Nystrom and Renta, 1990; Preisser, Hodson and Paden, 1988).*

This emphasises that the chronological age of the patient is the key issue in deciding the time of operation *(Harding and Grunwell, 1993; O'Gara and logemann, 1988).* It is advisable to have the palatal repair as early as six months of age in order to avoid the development of compensatory articulation patterns and to allow normal development of phonetic features to occur *(Chapman and Hardin, 1992; Albery and Russell, 1990).*

But, Dorf and Curtin (1982) argue that the phonological stage of development rather than chronological age should be the one to consider when determining the time of operation. They assume that the pre-operative articulatory pattern of the child with cleft has a link with, and may affect, post-operative patterns. They found that babies who undergo palato-plasty early during the second six months of life have significantly better potential for normal speech, for speech without compensatory articulation, than those babies whose surgery is carried out during the second year of life, or later.

Cleft palate speech is characterised by major distortions of both resonance and articulation *(Warren, 1986).* Both distortions may

inhibit the intelligibility of speech and may result from VPI. This can lead to an inability to create a sufficiently high intra-oral air pressure for the production of oral voiceless plosives and fricatives. As a result,the glottal or pharyngeal place of articulation may be used as an alternative place of articulation because, with these places of articulation, air pressure can be built up before the site of the cleft *(Hewlett, 1990)*. The phonetically motivated articulation errors may therefore become incorporated into the child's phonological rule system and consequently resistant to change the longer they remain *(Chapman, 1993)*.

Articulation problems usually result in phonetic errors which automatically give rise to atypical phonological output. Normally, speakers exploit the existing phonetic resources to match their knowledge of phonology as closely as possible. In cleft palate, the input phonology may be good, but the phonetic resources are limited by the articulatory ability. So, assessment of both the articulatory abilities and how they are used in phonology should be carried out during the assessment of a speaker with cleft palate *(Hewlett, 1990)*.

The sounds most frequently misarticulated by English speaking children with cleft palate according to McWilliam et al (1990) are:

(a) sibilants /s, z, ʃ, ʒ, ʧ, ʤ/.

(b) non-sibilant fricatives /θ ,ð , v , f/

(c) plosives /p, b, t, d, k, g/

(d) glides /r, l/

The types of errors depend on the place and manner of the articulation of the target sound and also the phonetic context within the word in which the target occurs. Therefore in cleft speech, nasal consonants may be correctly articulated followed in order of increasing likelihood of distortions by glides, plosives, then fricatives *(McWilliam et al, 1990).*

Phonetic patterns used to compensate for articulatory inadequacy can subsequently become established as developmentally unusual phonological patterns *(Russell and Grunwell, 1993; Hewlett, 1990).* Because of the regularity of their occurrence phonological process analysis can be used to identify these patterns. The patterns most commonly occurring in normal children have been described by McWilliam et al *(1990).* They are:

1. Final consonant deletion
2. Unstressed syllable deletion
3. Cluster reduction
4. Liquid simplification

5. Assimilation
6. Velar or palatal fronting
7. Stopping

But, as it was indicated on page 35 the children with cleft palate may use the processes listed above. In addition to these processes children with cleft palate may use idiosyncratic processes (such as backing, glottal replacement and initial consonant deletion). These patterns of simplication apparently occur rarely in normally developing children, but may be more common in children with cleft palate *(Powers, Dunn and Erickson, 1990).*

Backing occurs when anteriorly produced consonants are replaced by a more posterior place of articulation like velar or pharyngeal. Glottal replacement occurs when a glottal stop is substituted for another consonant.

These compensatory patterns will affect the speech intelligibility of children with cleft palate by causing the loss of phonemic contrasts. This is the situation of English speaking children with cleft palate where English phonetics contain four (+ back) sounds /h, k, g, & ŋ /: In Arabic there are a number of sounds in the contrastive system which are posteriorly articulated. These are: /χ, ħ, ʕ, ɣ, q, ʔ

ʕ, q, t, d, ʔ /.

It is possible therefore that if Arabic speaking children employ the same or similar processes as English speaking children to their developing phonologies the pattern of available contrasts may be particularly adversely affected.

In the light of this, the idiosyncratic processes related to the development of speech in children with cleft palate are of particular relevance to Arabic speakers as the following chapter will reveal.

CHAPTER THREE

THE PHONETICS OF ARABIC

CHAPTER 3

THE PHONETICS OF ARABIC

3.1. GENERAL

Arabic is a semitic language. Standard written Arabic is used for official communication, but a colloquial form of the same language is used for most spoken interactions.

The study of Arabic phonetics was begun in the 8th Century by Alkhalil. He analysed sounds by establishing their distinctive features. This is similar to more recent phonetic and phonological theory in the West *(Bakalla, 1981)*. Distinctive feature analysis theory assumes that there is a set of universal phonetic features from which a language can select its own. Arabic is not an exception, therefore, the phonology of Arabic will be similar in a number of aspects to the phonologies found within other languages *(O'Connor, 1973)*.

The International Phonetic Alphabet (IPA) has been used to transcribe many languages, including Arabic. The phonetic symbols used to transcribe the sounds of Arabic were taken from that alphabet. Table 1 demonstrates the symbols used to make a broad transcription of the phonetics of Arabic.

Table 1 : The Phonetic Symbols for Arabic Consonants According to Place of Articulation

Symbol	Example for Phonetic Symbol	Arabic Ortho-graphy	English Gloss	Symbol	Example for Phonetic Symbol	Arabic Ortho-graphy	English Gloss
m	malik	ملك	King	ʒ	ʒamal	جمل	Camel
b	ba:b	باب	Door	j	jad	يد	Hand
w	walad	ولد	Boy	k	kita:b	كتاب	Book
θ	θalʒ	ثلج	Ice	s	sa:ru:x	صاروخ	Rocket
ð	ðahab	ذهب	Gold	x	xaru:f	خروف	Sheep
n	naðða:ra	نظارة	Eyeglass	ɣ	ɣazal	غزال	Deer
t	tamr	تمر	Dates	ðˤ	ðˤaraf	ظرف	Envelope
d	daʒa:ʒ	دجاج	Hens	q	qamar	قمر	Moon
r	raʔs	رأس	Head	tˤ	tabla	طبلة	Drum
s	samak	سمك	Fish	dˤ	dˤufdaʕ	ضفدع	Frog
z	zara:fa	زرافة	Giraffe	ħ	ħab	حب	Wheat
l	laban	لبن	Yogurt	ʕ	ʕajn	عين	Eye
ʃ	ʃaʒar	شجر	Trees	ʔ	ʔab	أب	Father
f	fa:r	فار	Rat	h	hadija	هدية	Gift

Arabic, like English, is a stress-timed language but the differences in the force of pronunciation of stressed and unstressed syllable is mild *(Kenworthy, 1987).* The number and order of the consonants, together with the quality of the vowel (i.e. the syllabic structure) will determine the type and place of the stress *(Kenworthy, 1987; Al-Ani, 1983).* The stress can occur in mono or multi syllabic words. In Arabic the maximum number of syllablles is nine, but this is not commonly used and the minimal is monosyllabic. For example;

- o monosyllabic is cv as /bi/ بِ (with)
- o disyllabic is cvv.cvc as /ka:.tib/ كاتب (writer)
- o more than two syllables is cv.cvc.cv.cv. as /mu.ʕal.li.ma/ معلّمة (teacher)

In general the basic structure for the Arabic syllable could be as

C	V	C	V	C
1	1-2	0-2	0-2	0-2

The Arabic sound system will be discussed in terms of its vowel structure followed by an outline of the consonant system.

3.2. Vowels

In Arabic there are both short and long vowels. The main short vowel system found in most of the published datas about arabic was:

i u

a

and the long vowel system was i: u:

a:

Table 2 : Arabic Consonants : Phonetic Inventories

	Bilabial	Labio-Dental	Dental	Alveolar	Palato Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	b			t d (ʈ) (ɖ)			k g	q	(ʡ) (ʢ)	ʔ
Nasal	m			n						
Trill				r						
Fricative		f	θ ð (ðˤ)	s z (ʂ) (ʐ)	ʃ ʒ		x ɣ		ħ ʕ (ʂˤ) (ðˤ) (ʐˤ)	h
Approximant	(w)			l		j	(w)			

1. In the western region of the kingdom, the /ðˤ/ sound is usually pronounced as [zˤ]
   the /θ/ sound is usually pronounced as [t]
2. In most of the kingdom, the /q/ sound is usually pronounced as [g]
3. In the middle region of the kingdom, the /ɖ/ sound is usually pronounced as [ðˤ]
4. When symbols appear in pairs, the one to the right represents a voiced consonant and the one on the left represents a voiceless consonant.

This information is gathered from the author's background experiences with the different dialects in the different regions in Saudia Arabia and from Bakalla (1981).

3.3 Consonants

There are 28 consonants in Arabic. These speech sounds may be classified according to the place and manner or articulation and whether the vocal folds are used in their production or not.

The places of articulation in the vocal tract used in the production of Arabic include bilabial, labiodental, dental, alveolar, palato-aveolar, palatal, velar, uvular, pharyngeal and glottal *(Thelwall and Sa'adiddin, 1990).* The manner of articulation includes nasals, plosives, trills, fricatives, approximants. There are no affricates in Arabic *(Al-Ani, 1983).*

Table 2 illustrates the Arabic consonants phonetic inventory according to the place and manner of articulation of these sounds and the voicing feature of them.

In Arabic four consonants /s, ظ, t, d/ are matched by the so called emphatic set / ص, ظ, ط, د / which differ in that they are velarised. This means that they have the same primary place of articulation as the corresponding non-emphatic set, but have a secondary articulation added by raising of the back of the tongue towards the upper palate *(O'Connor, 1973; Bakalla, 1981).* Al-Ani (1983) argues that the term most commonly used in referring to 'emphasis' is velarisation, but after both acoustic and physiologic examination it appears that the

area involved is not the velar but rather the pharyngeal, so it seems more fitting to classify them as pharyngealisation. Laver (1994) supports this argument. In this study the emphatic set will be considered as pharyngealisation. Figure 2 will illustrate tracing from a cineradiographic film of plain versus 'emphatic' (pharyngealised) allophones of / t / before/ u /, / i / and / a / Table 3 will illustrate these emphatic set.

3.3.4 Charateristic Features for Arabic include:

3.3.4.1 Voicing: It is a feature which is found in all vowels and some consonants, i.e. we can have voiced and voiceless consonants *(Bakalla, 1981)* as seen in Table 2 on Page 45.

3.3.4.2 Length of the vowels or consonants: Examples are the vowels /ka ta ba/ كَتَبَ (he wrote) which has a short vowel / a /; whereas /ka: ta ba/ كَاتَبَ (he sends a letter to) has a long vowel /a:/. The consonant can be lengthened by gemination which could be considered as an identical cluster; for example: /h a m a l a/ حَمَلَ (he carried); and

/h a m m a l a/ حَمَّلَ (he makes others carry)

Length of vowels or consonants is therefore an important phonological feature of Arabic.

Table 3 : **Arabic Consants: Phonetic Inventories for the Emphatic Set**

	Labial	Dental	Alveolar	Palato-Alveolar	Velar	Uvular	Pharyngeal
Plosives			t d (ط) (ض)				(ق) (ظ)
Fricatives		ð (ذ)	s (ص)				(ز) (ع)

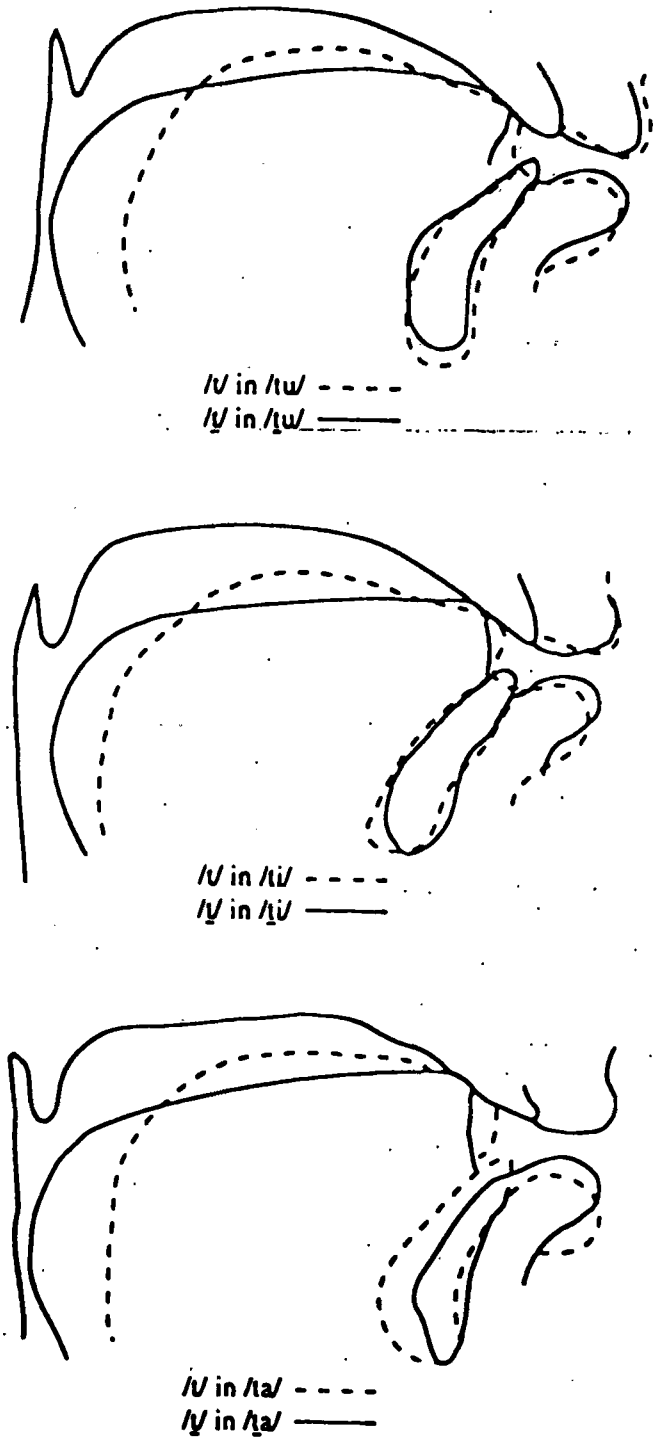


Figure 1 : Tracing from a cineradiographic film of plain versus 'emphatic' (pharyngealized) allophones of / t / before / u /, / i / and / a /
(From: Laver, J. (1994) Principles of Phonetics. Cambridge. Cambridge University Press. pp. 329)

3.4.3 Consonant clusters: In Arabic, clusters are formed by a maximum of two consonants in sequence. Clusters cannot occur word initially but sequences of two consonants can occur word medially and word finally. Word medially and word finally clusters can consist of two different consonants or two identical consonants (gemination).

3.4.3.1 Medial position consonant clusters:

/ʔaxðar/ اخضر (green);

where /x ð/ are unidentical medial consonant clusters.

/naððaːra/ نظّارة (eyeglass);

where /ð ð/ are identical medial clusters.

3.4.3.2 Final position consonant clusters:

/θalʒ/ ثلج (ice) has an unidentical final cluster /l ʒ/

/ʕudd/ عُدّ (count) has an identical final cluster /d d/

The literature on Arabic phonology gives limited guidance on the interpretations of syllabic boundaries for either single or sequential consonants word medially. The syllabic division of English words suggested by Grunwell (1987) and supported by French (1988) for English speaking children has been adopted here for Arabic as being intuitively appropriate. For example: medial cluster /x ð/ will be considered to be not a cluster but simply two separate consonants at

the closing and opening margins of the first and second syllables respectively i.e. / ʔ a x. ð a r/. The same applies to gemination for example / ð̃ ð̃ / is interpreted as / n a ð̃ . ð̃ a:r a /.

In word final position, however, final clusters such as / l ʒ / or / d d / will be regarded as both belonging to the preceding syllable. The relationship of single medial consonants to the neighbouring syllables is similarly ambiguous. Here, it has been decided to link medial single consonants to the following syllable. In this project the word structures were disyllabic except for one word / b a ɣ. b a. ɣ a: n / which has three syllables, and the final cluster only occurs in monosyllabic words.

All the above relate to adult speakers of Arabic.

Any study of developing phonology (normal or abnormal) has to consider not only the inventories of speech sounds, but also the distribution of segments in words and the processes which may affect that distribution.

No published studies of the developmental phonology of Arabic could be found. But, every language is spoken using a unique range of pronounciation patterns. Phonological analysis involves the description of these patterns *(Grunwell, 1993b)*. Also, children do not

acquire individual sounds suddenly, but gradually over time, during which they employ a set of systematic phonological processes that serve to simplify the adult target *(Chapman and Hardin, 1992; Schiff-Myers and Klein, 1985).* Ingram *(1976)* has reported that there are general simplification patterns which have been identified across children. The develping phonological system in the child is closely related to universal patterns in the phonologies of languages of the world *(Stoel-Gammon, 1985).* Also, as the phonological processes were designed to look into the diverse aspects of phonological acquisition, they can be utilised to examine the phonological development of young child acquiring a set of speech sounds independently of the adult language *(Ingram, 1981).* Therefore, it is anticipated that children all over the world will display the same phonological simplifying processes during their speech development.

The background phonetic information on Arabic together with what is known about the development of English phonology in children with and without clefts are used in the present set. In consequence, the same set of phonological analysis rules can be applied to the phonological development in the Arabic speaking children.

Furthermore, as these processes are also used by English speaking children with cleft palate so the phonological processes used by the English speaking children with clefts of the palate could be used by

Arabic speaking children with the same defect. One of the characteristic processes is backing which results in [ħ]; [ʕ] and [ʔ] commonly occurring in the speech of English speaking children with cleft palate. If this process occurs in Arabic speaking children it could have particularly serious implications for the intelligibility of such children because of the use of [ħ], [ʕ] and [ʔ] in the phonology of Arabic.

The information gathered regarding:

1. the effect of cleft palate upon the phonology of English
2. the phonological development of English speaking children
3. the adult phonological system for Arabic

has raised several questions such as:

1. How does the congenital cleft palate.defect affect the phonetics of Arabic speaking children?
2. Do Arabic speaking children with cleft palate use the same phonological process as English speaking children with cleft palate?
3. If yes, does it affect contrastivity and intelligibility of their speech?

CHAPTER FOUR

METHODOLOGY

CHAPTER 4

METHODOLOGY

4.1 SUBJECTS

Sixteen children (eight normal and eight with clefts) served as subjects in this study. This number of children was chosen in order to permit an initial analysis of phonological development in both groups of children. There were nine males and seven females in both groups. None of the children with cleft palate had received any speech therapy.

Table 4 lists the two groups according to age, gender and type of cleft palate.

Controls were necessary because there is limited information on the development of phonology in Arabic speaking children.

The age range of these children was from three to six years. They were divided into four groups (3.3 - 3.9; 4.3 - 4.9; 5.3 - 5.9; and 6.3 - 6.9).

The children with cleft palate were chosen according to several criteria. These were:

1. All had their cleft palate repaired prior to the study;
2. No restrictions in subject selection were made on the basis of surgical management as it was the same one used for all of them and the project is not looking at the effect of different surgical technique on the speech;
3 Apart from the cleft anomalies, there were no known physical or neurological factors affecting the children's development;
4. No significant hearing deficits;
5. None of the patients had received speech therapy pre- or post surgery.

From the history:

- Seven of the subjects had clefts of both hard and soft palate and only one had cleft of the lip with the hard and soft palate;

- The cleft lip was repaired in the first few months of life, whereas the palatal repair was done between nine and fifteen months.

- All of the subjects had a history of feeding problems.

Table 4 : Subject Description According to Age, Gender and Type of Cleft

Subjects	Age at Testing	Sex	Cleft Type
CP - 1	3.8	M	Cleft Palate
NC - 1	3.9	M	
CP - 2	3.5	F	Cleft Palate
NC - 2	3.7	F	
CP - 3	4.3	F	Cleft Palate
NC - 3	4.3	M	
CP - 4	4.4	F	Cleft Lip and Palate
NC - 4	4.6	F	
CP - 5	5.6	F	Cleft Palate
NC - 5	5.5	F	
CP - 6	5.3	M	Cleft Palate
NC - 6	5.5	M	
CP - 7	6.3	M	Cleft Palate
NC - 7	6.6	M	
CP - 8	6.7	M	Cleft Palate
NC - 8	6.8	M	

CP = Children with cleft palate
NC = Normal children (without cleft palate)

- All of the children were the product of an uncomplicated full term pregnancy and had a satisfactory post natal period except from the effects of cleft.

- All subjects had histories of middle ear problems, but they had aggressive otological management since birth. Only four had to have a grommet insertion during their first year of life. A subsequent frequent audiological testing showed satisfactory hearing acuity for these four.

- The non cleft children were recruited through personal contacts. They had no history of speech, language or hearing problems, neurologic impairment or intellectual deficits.

- In general, all the children were from middle class socio-economic homes and from a monolingual Arabic speaking background. The socio-economic level was judged according to the income of the father.

- The socio-linguistic variation had been acknowledged as there were differences in the accent through the different parts of the country, but considering this aspect was beyond the scope of this thesis.

4.2 THE STUDY REQUIREMENTS

For the purpose of this study the following equipment and procedures were required:

1. Pictures illustrating the chosen words were selected to be colourful, easily recognised by children and representing a range of the consonants, vowels and consonant clusters of Arabic. The pictures were different in size; they were grouped randomly and mounted on the pages of a 7.5" x 10.5" sketch book. Each picture was on a separate page to prevent confusion for the children.

2. Permission request letters were sent to the hospitals' managers to request permission to use the filing records in order to select the subjects.

3. Permission request letters were sent to the children's parents.

4. The children wore a EM-100omni-directional tie-clip microphone linked to a I.T.T. model SL581 tape recorder in order to audiorecord the children's speech. Each child was recorded on a separate tape.

5. The transcription was made on a sheet designed by the author. This sheet includes the English orthographic gloss of the chosen word, the adult Arabic broad phonetic transcription of it and a space to transcribe the child's pronunciation of the target word.

6. For the purpose of primary analysis a table was designed to illustrate the targeted phoneme and the child's realisation of it. The phonemes examined were either single consonants or consonant clusters. For vowels, the main vowels indicated on Page 44 were not sufficient for the transcriptions of the children's speech, so additional vowels will be used together with the main ones in this study. For consonants the three different positions within words was covered as possible. This approach is considered a useful basis as it guards against unequal distribution of data around certain points in the word structure. Illustrative examples are:

Consonant / d /, at the word initial position / d ʊʒa:ʒa/
دجاجه (hen)

Consonant / d /, at the word medial position /h a d i j a/
هديه (gift)

Consonant / d /, at the word final position / jad/ يد (hand)

The only true consonant clusters considered to exist for the purposes of this study were word final, for example:

Consonant cluster at final position within word / r f /
/ ʕarf/ ظرف (envelope)

Clusters occurring word medially were analysed as described on pages 50 and 51.

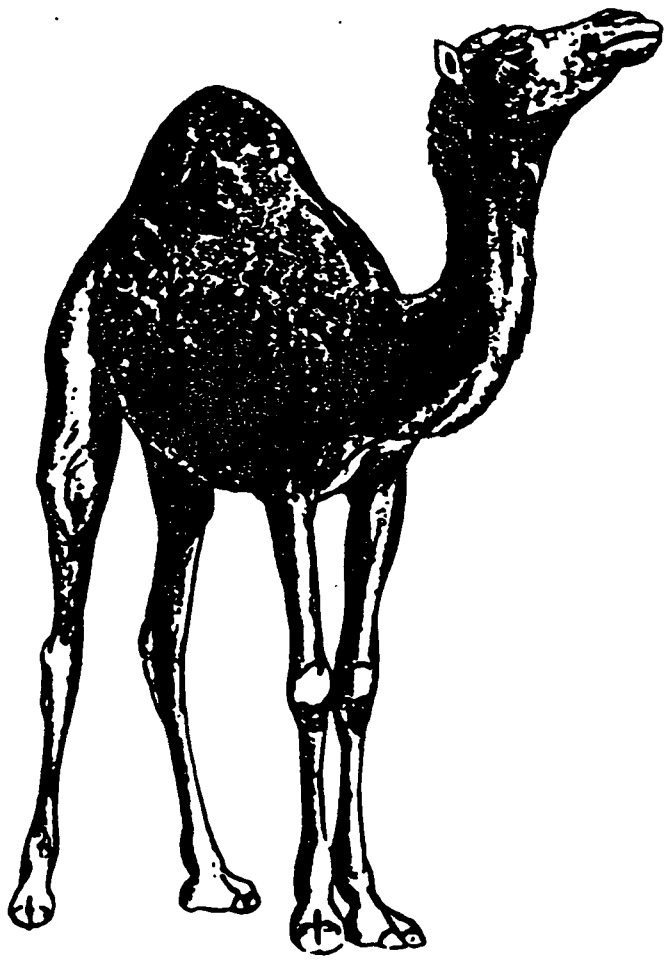


Figure 2 : One Example of the Pictures Used to Illustrate the Target Words

Table 5.a. : Examples of Target Sounds In the Different Position In Word - Word Initial

Phonetic Symbol	Position of Sound In the Word - Word Initial		
	Arabic Gloss	English Gloss	Phonetic Transcript
m	مقص	Scissors	miqaʂ
b	بنت	Girl	bint
w	ولد	Boy	walad
n	نظّاره	Eyeglasses	naẓẓa:ra
t	تفاحه	Apple	tuffa:ħa
d	دجاجه	Hen	duʒa:ʒa
r	رمّان	Pomegranate	rumma:n
s	سمكه	Fish	samaka
z	زرافه	Giraffe	zara:fa
l	ليمون	Lemon	lajmu:n
ʒ	جزر	Carrot	ʒuzar
j	يد	Hand	jad
ʂ	صاروخ	Rocket	ʂa:ru:x
x	خروف	Sheep	xaru:f
q	قطار	Train	qita:r
ŧ	طبله	Drum	ŧabla
ɖ	ضفدع	Frog	ɖufda
ʕ	عنب	Grape	ʕunab

Table 5.b. : Examples of Target Sounds in the Different Position in Word - Word Medial

Phonetic Symbol	Position of sound in the word - Word Medial		
	Arabic Gloss	English Gloss	Phonetic Transcript
m	سمكه	Fish	samaka
b	ثعبان	Snake	θuʕba: n
w	———	———	———
n	عنب	Grape	ʕunab
t	كتاب	Book	Kita:b
d	هديه	Gift	hadija
r	خروف	Sheep	xaru:f
s	اسد	Lion	ʔasad
z	جزر	Carrot	ʒuzar
l	ولد	Boy	walad
ʒ	دجاجه	Hen	duʒa:ʒa
j	ابيض	White	ʔabjaḍ
ħ	حصان	Horse	ħuʕa:n
x	اخضر	Green	ʔaxḍar
q	مقص	Scissor	miqaṣ
ṭ	قطار	Train	qiṭa:r
ḍ	اخضر	Green	ʔaxḍar
ʕ	ثعبان	Snake	θuʕba:n

Table 5.c. : Examples of Target Sounds in the Different Position in Word - Word Final

Phonetic Symbol	Position of sound in the word - Word Final		
	Arabic Gloss	English Gloss	Phonetic Transcript
m	علم	Flag	ʕ alam
b	عنب	Grape	ʕ unab
w	مكواه	Iron	makwa
n	بغبغان	Parrot	baʁbaʁa:n
t	بنت	Girl	bint
d	يد	Hand	jad
r	جزر	Carrot	ʒ uzar
s	شمس	Sun	ʃ ams
z	موز	Banana	muz
l	جمل	Camel	ʒ amal
ʒ	دجاجه	Hen	duʒa:ʒa
j	هديه	Gift	hadija
ɕ	مقص	Scissor	miqaɕ
x	صاروخ	Rocket	ɕa:ru:x
q	ازرق	Blue	ʔazraq
ʈ	خيط	Thread	xeʈ
ɖ	ابيض	White	ʔabjaɖ
ʕ	ضفدع	Frog	ɖufdaʕ

Table 6 : Sample of the Designed Data Collection Sheet

DATA COLLECTION SHEET

Arabic Orthography	English Gloss	Adult Phonetic Transcription	Child's Phonetic Transcription
عنب	Grape	ʕunab	
حصان	Horse	ħusa:n	
أخضر	Green	ʔaxðar	
صاروخ	Rocket	ʂa:ru:x	
يد	Hand	jad	
ذيل	Tail	ðel	
رمّان	Pomegranate	rumma:n	
موز	Banana	muz	
ظرف	Envelope	ðarf	
ليمون	Lemon	lajmu:n	
نظّاره	Eyeglasses	naðða:ra	
جمل	Camel	ʒamal	
علم	Flag	ʕalam	
ورده	Rose	warda	
ابيض	White	ʔabjað	
فار	Rat	fa:r	
بنت	Girl	bint	
ثعبان	Snake	θuʕba:n	
أذن	Ear	ʔuðun	

4.3 DATA COLLECTION

To separate the collection of data from its subsequent analysis is difficult as the type of analysis required will determine the data one acquires. As one of the aims of speech assessment of children with cleft palate is to provide some indication of total speech repertoire, so their abilities must be evaluated.

The data should be selected so that its analysis will fulfill the required aims.

One of the criteria in selecting data is that they should provide the basis for a phonetic analysis involving a description of speech.

The stimulus words are those considered familiar and commonly used in the lexicon of these children and could be presented by a picture. The pictures were choosen to elicit the same targeted word regardless of the part of Saudi Arabia from which the subjects came. The picture naming is designed to elicit 62 Arabic words which are mainly nouns. As stated earlier there may be sociolinguistic variation in the pronounciation of these words in different parts of Saudia Arabia, but the use of picture naming technique tried to minimise these variations as it was difficult to address all of it.

Despite the efforts to gain as comprehensive a set of phonetic information as possible, some consonants were not included for reasons such as: these consonants were infrequenatly occurring in a particular position or could not be easily illustrated, for example, consonants / ʒ̊ /, / ð̊ /, and / ɣ̊ / in word final position.

Data from subjects were collected in a quiet clinic at the hospital and data from controls were collected in their homes. The procedure was the same in both cases.

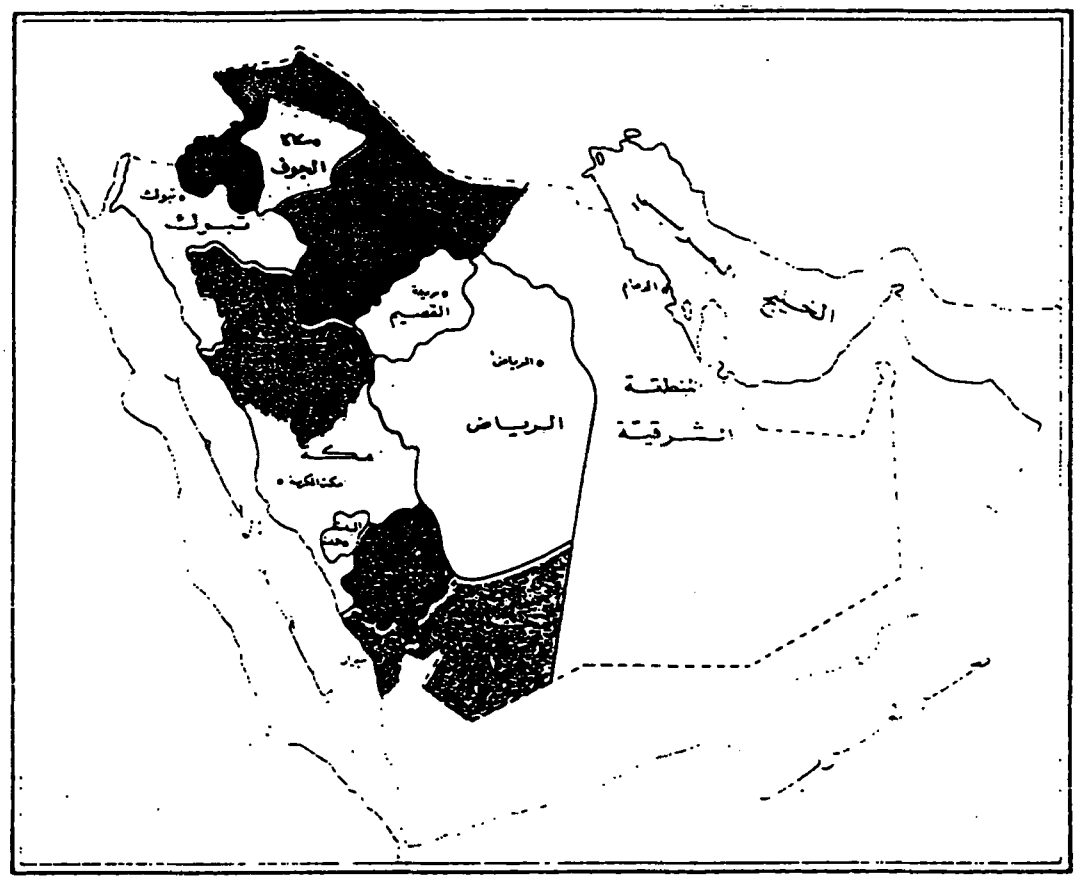


Figure 3 : A Map of Saudi Arabia Showing the Three Geographic Regions for the Purpose of Data Collection

Table 7a : Data Collection Sheets For Subject 1

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʔunab	ʔunab
حصان	Horse	ħuʂa:n	huXa:n
اخضر	Green	ʔaXɗar	ʔaxdar
صاروخ	Rocket	ʂa:ru:x	xa:ru:x
يد	Hand	jad	jad
ذيل	Tail	ðel	de
رمان	Pomegranate	rumma:n	tumma:n
موز	Banana	muz	muΘ
ظرف	Envelope	ðarf	xarf
ليمون	Lemon	lajmu:n	lajmu:n
نظاره	Eyeglasses	naðða:ra	nagga:ra
جمل	Camel	ʒamal	ʒamal
علم	Flag	ʕalam	ʔalam
ورده	Rose	Warda	warda
ابيض	White	ʔabjaɗ	ʔabja
فار	Rat	fa:r	fa:
بنت	Girl	bint	bint
ثعبان	Snake	Θuʕba:n	tuʔba:n
أذن	Ear	ʔiðin	ʔigin
مقص	Scissors	maqaʂ	migax
ضفدع	Frog	ɗufdaʕ	dufdaʔ
طبله	Drum	ṭabla	tabla
قطار	Train	qiṭa:r	gita:r
خيط	Thread	xeṭ	qijat
ببغاء	Parrot	baʁbaʁa:n	baxbaqa:n

Table 7b : Data Collection Sheets For Subject 1

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
ازرق	Blue	ʔazraq	ʔaθrag
ملك	King	malik	mali
هديه	Gift	hadija	hadija
ذهب	Gold	ðahab	dahab
اسد	Lion	ʔasad	ʔaθad
تفاح	Apple	tuffa:ħ	tuffa:h
كتاب	Book	k ita:b	kika:b
جزر	Carrot	ʒuzar	ʒuθə
دجاجه	Hen	duʒa:ʒa	duʒa:ʒa
خروف	Sheep	xaru:f	xaru:f
زرافه	Giraffe	zara:fa	θara:f
سمكه	Fish	samaka	θamaka
شمس	Sun	ʃams	ʃam
فراشه	Butterfly	fara:ʃa	fara:ʃa
غزال	Deer	ɣaza:l	qaθa:l
ولد	Boy	walad	walad
كرسي	Chair	kursi:	kurθi:
باب	Door	ba:b	ba:b
سلم	Ladder	sullam	θullam
مفتاح	Key	mufta:ħ	mufta:h
زهور	Flowers	zuhu:r	θuhu:
طيور	Birds	ṭiju:r	tiju:
قطه	Cat	qiṭṭa	gitta
بقره	Cow	baqara	bagara

Table 7c : Data Collection Sheets For Subject 1

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
مكواه	Iron	makwa	makwa
صور	Pictures	ɣuwar	xuwar
واحد	One	waħid	wahid
اثنين	Two	ʔiθnen	ʔitnen
ثلاثه	Three	θala:θa	tala:ta
اربعه	Four	ʔarbaʕa	ʔarbaʔa
خمسه	Five	xamsa	xamθa
سته	Six	sitta	θitta
سبعه	Seven	sabʕa	θabʔa
ثمانيه	Eight	θama:nja	tama:n:j
تسعه	Nine	tisʕa	tisʔa
عشره	Ten	ʕaʃara	ʔaʃara
هدهد	Bird	hudhud	hudhud

4.4 DATA ANALYSIS

The elicitation of target words was achieved by the researcher showing the picture to the child and asking "What is this?"

Phonetic transcription of the immediate response of each subject was done on site and recorded on tape at the same time. The transcription was made on an especially designed sheet based on broad Arabic phonetic transcription using the I.P.A. *(Duckworth, Allen, Hardcastle, and Ball, 1990).*

4.4.1 RELIABILITY

Intrajudge and interjudge reliability for the phonetic transcription was assessed using the audio recordings of eight (four with clefts and four non-cleft) randomly chosen data sets.

For the interjudge test these recordings were transcribed by a speech therapist other than the researcher and then compared with the live transcription done on site by the researcher.

For the intrajudge test the researcher re-transcribed some of the data after some time had elapsed since the first transcription.

Reliability scores were calculated by dividing the number of agreements by the total number of agreements and disagreements.

Examination of the samples from each group for broad transcription of consonant phones indicates that intrajudge and interjudge reliability scores were 97% and 94% respectively. This indicates a high degree of reliability.

4.4.2 THE ANALYSIS PROCEDURE

The children's 62 response words served as data for the analysis.

Phonetic and phonological analysis were performed on each child's data after the samples were transcribed.

The type of analyses were choosen and designed in a way to address the research questions raised in Page 53.

4.4.2.1 *Phonetic Analysis*

The children's ability to produce the Arabic phonemes regardless of their correct usage was examined.

Because the children repeated words occasionally these repetitions were used to check their consistency in production of identical forms. Phonological characteristics of children's word productions can be analysed in a number of ways, focussing on different aspects of the developing phonological system.

On the basis of the transcriptions, phonetic inventories were compiled for each of the three different positions of the consonant within the word and for each child of the two groups of each age. This will indicate the sounds that the child is capable of producing regardless of their relation to the adult model. This independent analysis will provide a complementary view of the child's phonological system. Normative data from the controls was used for comparison with that of the children with cleft palate. Segments in the sample are grouped by place and manner to facilitate interpretations.

Relational analysis, which includes a sound by sound comparison of the child's productions with an adult standard, was conducted. This may describe the sequence of phones that is produced correctly or that can be assigned to particular phonological processes or error patterns.

These different types of phonetic analysis will give information regarding several aspect about the phonetics of the Arabic speaking children.

The general phonetic analysis will indicate the phonetic repertoire of each child's speech. Also, it will show the distribution of the available sounds, for example wether the child is using more back or front sounds. On the other hand, the correspondance matrices will give

more details about which sounds were incorrectly realised and if this realisation is the same for that phoneme regardless to its position in the word. The same information was gathered for consonant clusters.

No published studies of the phonetic development of Arabic speaking children were found. The analyses in the present study were therefore important and necessary to address the first research question.

Tables 8, 9 and 10 are examples of the different phonetic analyses used in this study.

Table 8 : General Phonetic Inventories

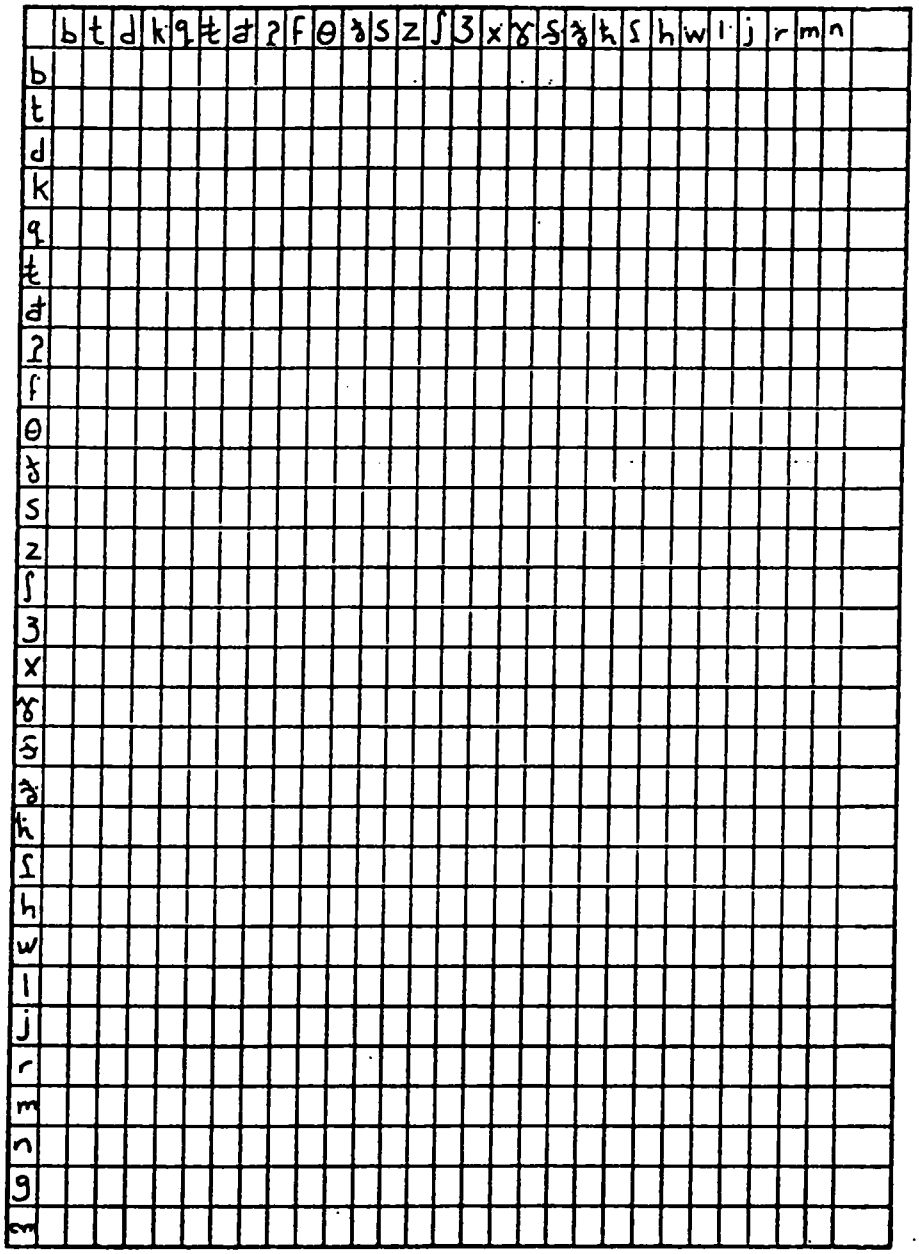
	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal								
Plosive								
Fricative								
Trill								
Approximant								

Affricates are missing from this table as there are no affricates in Arabic

Table 9 :**Correspondance Matrices : Illustrating the Target Sounds and the Child's Realisation of them According to Position In Word**

Target Sounds

Child Realisation



Om = omitted

Table 10 : Example of the Sheet Designed forAnalysis of the Final Consonant Clusters

Correspondence in Consonant Clusters Word Final

For Subject .....

Target Clusters

Child Realisation	nt	ms	rf	kw	rd	rs	tt	ms	bl	tt	bs	ss	nj
	1												
		1											
			1										
				1									
					1								
						1							
							1						
								1					
									1				
										1			
											1		
												1	
													1

4.4.2.2 *Phonological Analysis*

As indicated on Pages 39 and 40 regarding the phonological processes used by the English speaking children and the possibility of their use by Arabic speaking children, the phonological processes identified by McWilliam et al (1990), Ingram (1981), Dunn and Davis (1983) and Chapman (1993) were used to guide the examination of data for the present project.

The phonological process analysis was designed to identify the phonological processes used by the normal children and those with cleft palate and also to identify if there are other processes such as language specific processes or atypical processes. These sort of analyses were important to address the second research question as we can see later.

The frequencies of the phonological processes used by the children without cleft and those with cleft were identified, then both sets of data were compared for each process.

The patterns of processes used by the two groups were also examined in order to identify if the children with cleft palate employ any atypical processes.

Identification of the processes used by the children whether normal or with cleft palate will explain how an error had been formed. A process analysis will not give information regarding the effect of these errors on speech contrastivity and hence on the intelligibility on speech necessary for effective communication. The contrastive analysis will therefore answer the third research question on Page 53.

The contrastive analysis for the subjects and controls was employed to detect loss of contrast between the children's systems of phones* and the adult system of phonemes in order judge intelligibility of their speech with particular reference to the Arabic language (See Figure 4).

* The phones were defined by Grunwell, (1987) page 48 as: "a segment - sized unit" this refers specifically to the realisation of the child's own system.

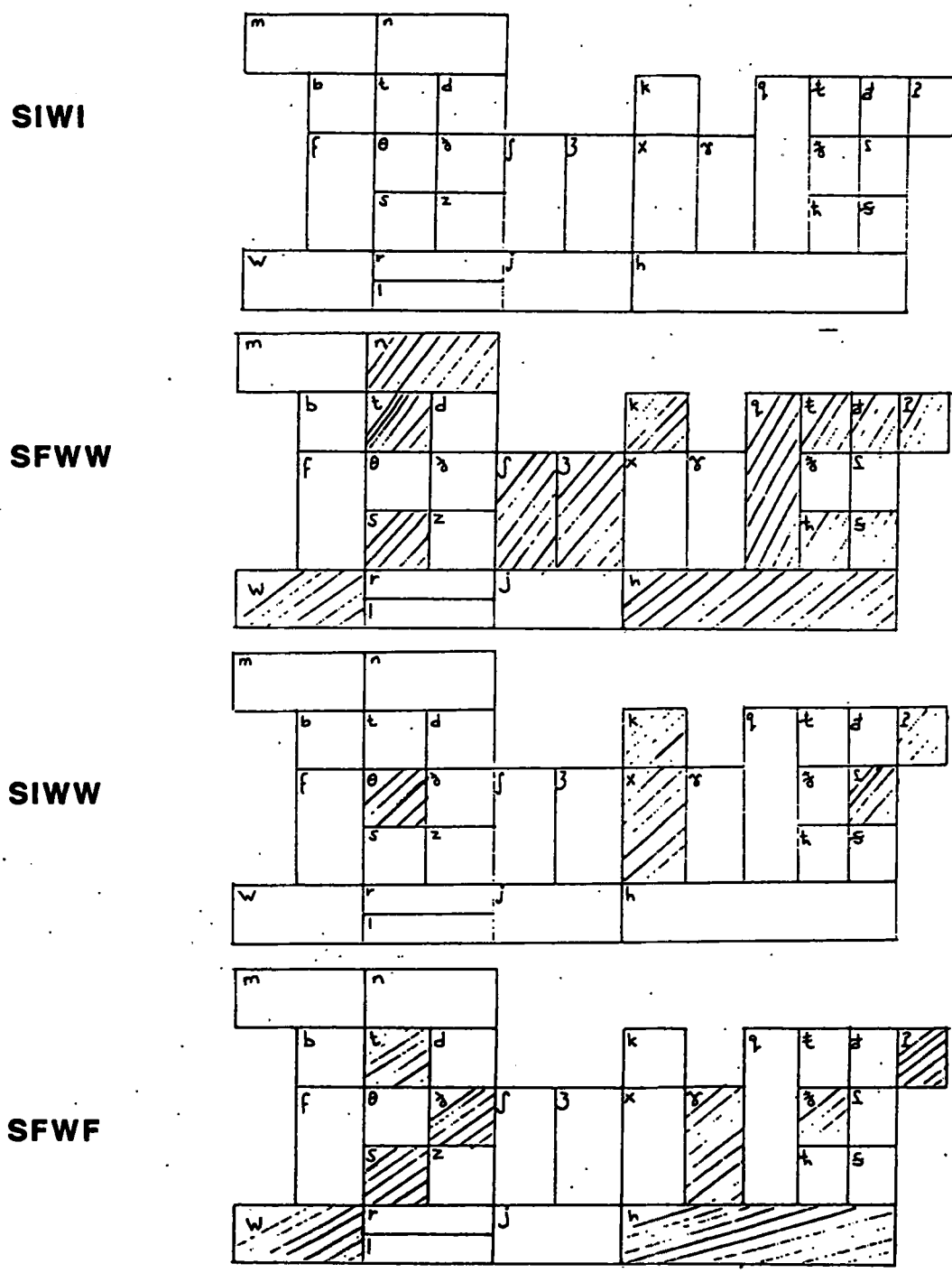


Figure 4 : Example of the Sheet Designed for Analysis of Constrastive Phonological Analyses

CHAPTER FIVE

RESULTS

5. RESULTS

The data collected from both groups was tabulated for the purpose of analysis.

There is general agreement regarding the importance of the phonetic assessment as a procedure in the evaluation of an individual's speech production. But information regarding the pattern of usage of the different types of sounds in spoken language is essential for the evaluation of children with pronounciation problems and this can be assessed by using a phonological assessment. Grunwell (1988) stresses the importance of using both phonetic and phonological assessment to study the speech of children with cleft lip and palate. The inadequacies of a deficient phonetic mechanism may have impact upon the nature of the knowledge acquired at the phonological level.

In view of the previous information, a phonetic as well as phonological assessment will be adopted in analysing the data collected in this study. For the purpose of the analysis there are two groups - Subjects (children with cleft palate with or without cleft lip), and Controls (normal children without cleft). Tables were compiled for a range of analyses for each individual in these two groups.

The complete tables will be presented in text for Subject One. The full details for the remaining subjects may be found in the Appendix. However, summaries of the main trends will be presented here.

Each of the two main groups is further sub-divided according to age levels. This permits intra-group as well as inter-group comparisons.

5.1 Phonetic Analysis

In the phonetic analysis the sounds actually produced by the subjects and controls will be described and classified regardless of whether they are used correctly to signal phonological contrasts. The following phonetic results address the first research question.

5.1.1 The General Phonetic Inventories

This is a descriptive framework where all the different types of sounds that can be produced by the children (regardless of their position in words or syllables and whether they have been used correctly or not) will be recorded according to the place and manner of articulation. This may give an indication of the nature of the child's speech disorder (Grunwell, 1993b).

A. *Subjects' Intra-Group Analyses*

Table 11 presents the general phonetic inventory for Subject 1.

The inventories of the eight subjects from the different age levels have similarities in that they contained the sounds [m, n, b, f, Θ, w, l, j) plus three [+ back] sounds [ʔ, x, h].

There were also similarities across subjects in the absence of [ð, ð, ɑ̃, ʕ] from their inventories.

Table 11 : General Phonetic Inventory : Subject 1

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Nasal	m		n					
Plosive	b		t d		k g	q		ʔ
Fricative	f	ɵ			x			h
Trill			r					
Approximant	(w)		l	j	(w)			

The inventories of most of the subjects contained [r, d, ʕ , k, g, ħ]. Five of the subjects could pronounce [t, ʃ , ʒ , q ,] and four had [ɬ , ɣ] in their inventories. Finally, at least two of the subjects produced [s, z].

The relation between the emergence of consonant articulation and the developmental age of the subjects allows for some predictions. Some consonants like [ħ, ʕ , ɣ , ɬ] were absent from the inventories of the subjects in the 3.3 - 3.9 year age group, but [ħ, ʕ] appeared later in the inventories of the subjects in the 4.3 - 4.9 age group and [ɣ , t] from five years.

No clear pattern of consonant emergence could be seen for [t, d, k, g, q , ʃ ʒ , r] as they were present in the inventories of one subject from the youngest group, but inconsistent through the other age levels. This will become clearer by compairson with the controls in the next section of analysis.

B. Inter-Group Analyses

The inventories of both the subjects and the controls contained Nasals, Glides, Liquids, the Fricatives [f, h] and the Plosives [b, ʔ]. The Fricative [θ] was not present in the controls' inventories until the age of five years, but it was avilable in the inventories of all the subjects from the age of three years.

Also, the phonetic inventories of all the controls had included [t, d, s, z, k, g, ħ, ʕ]. Two of the controls had [ ] and four had [g]. The controls, unlike the subjects, showed a good phonetic development even with this limited sample size. For example [ħ, ʕ , t, d, k, s, z] were present in the controls' inventories from the age of three years and continued, whereas they appeared in the subjects' inventories from the age of four years for [ħ , ʕ] and five years for [s, z,]. Also the consonants [ ] which were absent in the subjects' inventories, were present in the inventories of the controls from four years for [ ] and from five years for [ ]. The sound [ ] had no pattern of emergence in the subjects' inventories but in the controls it was clear that it emerged around the age of five years as it started in that age group and was then used continuously throughout.

5.1.2 The Size of the Consonant Inventories

A. *Subjects' Intra-Group Analyses*

Table 12 presents the number of consonants in both groups of children (CP and NC) at all four age stages. It can be seen that the number of consonants produced by the subjects does not vary in relation to increasing age of the subjects.

B. *Inter-Group Analyses*

From Table 12 comparison of the size of the consonants inventories for the two groups (CP and NC) can be made. The number of consonants produced by subjects ranged from 14 to 25 (median = 19) compared to the number produced by controls, ranging from 19 to 28 (median = 27).

Tables 13 and 14 provide additional information concerning the absolute and proportional occurrence of the different consonants according to the manner of production for the two groups (subjects and controls). Examination of this Table indicates that 33% of the subjects' consonants were classified as Fricatives, 30% were Stops, 18.9% were Liquids and Glides, 12.9% were Nasals and 4.9% were for sounds that had been omitted. On the other hand, the same examination carried out for controls indicates that they have the same order of preference as 33.9% were for Fricatives, 31.5% for Stops, 21.6% for Liquids and Glides, 13.2% for Nasals and only 0.07% for omitted sounds.

Table 12 : Summary of the Consonants Used and Their Total Number for Normal Children and Children with Cleft Palate

	Children's Consonant Realisations																													Total Number of consonants for each Individual
	b	t	d	k	ʔ	q	ʕ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ħ	ʕ	h	m	n	r	w	l	j	p				
CP 1	x	x	x	x					x											x	x	x	x	x	x					19
2	x		x	x	x				x											x	x	x	x	x	x					14
3	x		x	x					x											x	x	x	x	x	x					14
4	x	x	x	x	x				x				x							x	x	x	x	x	x					19
5	x	x	x	x					x				x							x	x	x	x	x	x					22
6	x		x	x					x			x	x							x	x	x	x	x	x					25
7	x		x	x					x			x	x							x	x	x	x	x	x					19
8	x		x	x					x				x							x	x	x		x	x					23
Total No. of Subject	8	5	6	6	5	4	0	5	8	0	1	2	5	5	0	0	4	6	8	8	8	6	8	8	8	6				155 Median = 19
NC 1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				19
2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				19
3	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				26
4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				26
5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				28
6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				28
7	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				28
8	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				28
Total No. of Control	7	8	8	8	6	8	7	8	8	4	8	8	8	8	6	6	8	8	8	8	8	8	8	8	8	8				202 Median = 27

x means the consonant was in the child's realisation

Table 13 : Summary of Absolute and Proportional Occurrence of Inventory Consonants by Manner of Articulation for Children with Cleft Palate

	Plosive										Fricative												Nasal			Liquid/ Glide				Total
	p	b	t	d	k	g	ʧ	ʤ	q	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ʕ	ħ	ɣ	ʜ	ʢ	h	m	n	r	w	l	j	cm	
1	0	12	12	13	4	8	0	0	2	14	8	11	0	0	0	3	4	11	0	0	0	0	0	0	9	13	10	15	4	9	5	4	
2	0	10	0	0	15	0	0	0	13	19	8	12	0	0	0	0	0	15	0	0	0	0	0	0	8	13	8	13	4	9	5	18	
3	0	12	0	0	0	0	0	0	0	15	11	9	0	0	0	0	0	14	0	0	0	0	4	6	36	13	9	12	4	10	5	11	
4	0	10	0	1	23	15	0	0	0	8	7	4	0	0	0	3	4	17	0	0	0	0	4	5	5	12	9	12	4	10	5	13	
5	0	13	4	8	4	1	3	0	5	10	12	12	0	0	0	3	4	17	0	0	0	2	4	6	5	13	9	0	4	10	15	7	
6	0	12	3	6	5	1	4	0	1	8	14	8	0	6	5	3	4	9	0	0	0	4	4	6	4	13	9	12	4	10	5	11	
7	0	12	1	14	0	1	0	0	0	53	5	1	0	0	0	0	0	8	0	0	0	2	4	5	5	12	12	13	4	10	5	4	
8	0	12	4	12	4	1	4	0	4	8	12	11	0	0	6	3	4	9	0	0	0	3	4	6	5	13	10	0	4	26	5	1	
To	0	93	24	54	55	27	11	0	25	*1	77	68	0	6	11	15	20	*2	0	0	0	11	24	34	77	*3	76	77	32	94	50	69	1368
To by Manner					424													444								178			253				1299
% Occurrence					31													32.6								13			18.5		5		

*1 = 135
*2 = 101
*3 = 103
To = Total

Table 14 : Summary of Absolute and Proportional Occurrence of Inventory Consonants by Manner of Articulation for Children without Cleft Palate

	Plosive										Fricative													Nasal			Liquid/ Glide				Total
	p	b	t	d	k	g	ʔ	ʤ	q	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ħ	ʕ	h	m	n	r	w	l	j	ɑm	
1	0	12	9	15	4	5	4	0	0	7	8	0	0	12	13	0	0	0	0	0	0	0	9	9	5	13	10	17	4	10	5		
2	13	0	9	14	4	5	4	0	0	7	8	0	0	12	13	0	0	0	0	0	0	0	9	9	5	13	10	17	4	10	5	1	
3	0	12	9	11	4	5	4	6	0	7	8	0	0	5	6	3	4	5	4	0	1	3	4	5	5	13	10	17	4	10	5		
4	0	12	9	11	4	5	4	6	0	7	8	0	0	5	6	3	4	5	4	0	1	3	4	6	5	13	10	17	4	10	5		
5	0	12	4	9	4	0	4	3	5	7	8	5	3	5	6	3	4	5	4	3	0	3	4	6	5	13	10	17	4	10	5		
6	0	12	4	9	4	0	4	3	5	7	8	5	3	5	6	3	4	5	4	3	0	3	4	6	5	13	10	17	4	10	5		
7	0	12	4	9	4	0	4	3	5	7	8	5	3	5	6	3	4	5	4	3	0	3	4	6	5	13	10	17	4	10	5		
8	0	12	4	9	4	0	4	3	5	7	8	5	3	5	6	3	4	5	4	3	0	3	4	6	5	13	10	17	4	10	5		
To	13	84	52	87	32	20	32	24	20	56	64	20	12	54	62	18	24	30	24	12	2	18	42	54	40	*1	80	*2	32	80	40	1	1368
To by Manner	419										476													184			288				1367
% Occurrence	30.5										34.8													13.5			21.1			0.1	

*1 = 104
*2 = 136
To = Total

5.1.3 Correspondence Matrices

By comparing a child's speech with adult speech, patterns of substitution can be determined and a general phonological process may be easily identified *(Lynch, Fox and Brookshire, 1983).*

This framework illustrates the consonants produced by each child for all word positions - initial, medial and final. Tables 15a, b and c are samples of Subject 1's correspondence matrices. The cells on the point where target and realisation intersect contain the number of correct production of each consonants which the other cells indicate the frequency of each specific error in that phoneme. Also, the horizontal indicate the target sounds and the verticle indicate the child realisations on one end and the total number of frequencies for each consonant realised by the child whether it was correct or not on the other end.

The presentation of the matrices will take place by analysing the different positions of the consonants in the word, also relating this to the different age levels.

A. *Subjects' Intra-Group Analyses*

As indicated earlier the analysis of the matrices in relation to the different age groups considers the different position of the consonants in the word. When a child does not realise the target sound correctly (either by substitution or omission) this is considered as an error. The error rate is

Table 15a : Correspondence Matrices For Subject One Word Final Position

Target Sounds

Child Realisation

	b	t	d	k	q	ʔ	f	θ	ʒ	s	z	ʃ	ʒ	x	ɣ	ʕ	ħ	ɾ	w	l	j	r	m	n	Total
b	4																								4
t		2				2			3														1		8
d			1				1			2															4
k				2																					2
q													1												1
ʧ																									
ɗ																									
ʔ							7										3								10
f								2																	2
θ										4	2														6
ð																									
s																									
z																									
ʃ												1													1
ʒ													2												2
x														3		2	1								6
ɣ																									
ʕ																									
ɦ																									
ħ																									
ʕ																									
h																	1	2							3
w																			3						3
l																				1					1
j																					1				1
r																									
m																							5		5
n																								1	1
ŋ					2																				2
ʒ																									

Table 15b : Correspondence Matrices For Subject One Word Final Position

Target Sounds

Child Realisation

	b	t	d	k	ɡ	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ħ	ʕ	h	w	l	j	r	m	n	Total
b	4																								4
t		1				1																			2
d			3				1																		4
k		1																							1
ɣ															1										1
ʔ																									
ð																									
ʔ																1									1
f							4																		4
θ									1	3															4
ð																									
s																									
z																									
ʃ												1													1
ʒ													1												1
x														1	1	1									3
ɣ																									
ʕ																									
ʒ																									
ħ																									
ʕ																									
h																1		3							4
w																			1						1
l																				6					6
j																					3				3
r																						6			6
m																							6		6
n																								2	2
ɡ				2					1							2									5
ɛ								1																	1

Table 15c : **Correspondence Matrices For Subject One Word Final Position**

Target Sounds

Child Realisation

	b	t	d	k	q	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ʕ	ħ	ħ	h	w	j	l	r	m	n	Total
b	4																									4
t						1			1																	2
d			5																							5
k				1																						1
q																										
ʔ																										
d																										
ʔ						1												2								3
f								2																		2
θ											1															1
ð																										
s																										
z																										
ʃ												1														1
ʒ													1													1
x														1		1										2
ɣ																										
ʕ																										
ħ																										
h																										
ʔ																										
h																		2								2
w																										
l																					2					2
j																						1				1
r																							9			9
m																								2		2
n																									7	7
g					1																					1
ʒ			1																		1		1			3

calculated by relating the number of incorrect realisations of a specific target to the total number of times that target has been produced (correctly or incorrectly). The most common errors for the target consonants in all word position were in relation to / ʃ, ʒ, ɣ, χ /. The error rate for their realisation was 100%.

(i) *Word Initial Position*

Seven of the subjects had problems with the consonant / s /; and six with / z /. Five subjects had problems with /t, q, θ/; four with / t /, three with /ʃ, ʒ, ɣ, r / and two with / d, k, ħ, ʕ /.

None of these errors showed a clear relation to the subjects' ages except may be for / ʕ, ħ / which occurred only in the youngest age group. Most of the errors were of substitution. Omissions were for / b, ʔ, m, n, ɣ / but only once for two of the subjects.

The consistency in the substition errors of the consonant was noticed in the case of /θ, ħ, ʕ / where [x] was substituted for /θ/, [h] for / ħ / and [ʔ]for / ʕ /.

Other consonants had no consistency in their substitutions, as seen in Table 16.

Table 16 : Summary of the Errors for Different Target Consonants In the Three Positions In the Word

Target Sounds

Subjects' Realisations

Position in the Word	t	d	k	q	ʧ	ʤ	f	θ	ð	s	z	ʃ	ʒ	ɣ	ħ	h	r	m
Word Initial	k ʔ h	k h	h ʔ	g ʔ x h	t k q ʔ h	d k q f h		t k ʔ h	d g θ h	ʔ θ x h	ʔ θ x h	ʔ θ	d ʔ h	q x	f θ x n	ʔ	t ʔ	
Word Medial	k ʔ h	k g ʔ x h		g ʔ ɣ h	t k q ʔ h	d k q ʔ f	ʔ	k ʔ	d k g ʔ θ x	θ x	d k θ s	ʔ θ	k ʔ h	b q ʔ x h	k g q ʔ f n		j l	ʔ
Word Final		k g ʔ	h ʔ	g ʔ	t k ʔ	k ʔ f		t k ʔ			d θ x	ʔ θ	d h				j l	

(ii) *Within Word Position*

Seven subjects had errors on / s, z /; six on / t, ظ /; five on / ق, ط /; four on /d/, three on / ث, ʃ , ʒ , ر , r/. Only two had problems with / ح / and one with / f, m /.

Like the word-initial consonants there was no clear association between age and distribution of errors except for / ر , ح / which was a problem only for the youngest group.

The substitution errors are still a common error for the target sounds in this position but inconsistently, as presented in Table 16, except for the following : /غ/ > [x], /ح/ > [h] and /ر/ > [ʔ]. Another type of error for the target sound in this position was omission which occurred with /ق, ث, ظ, ذ, ب/

(iii) *Word-Final Position*

In this position omission was a noticed error for / k, d, ك , ط , r, l, n, g, ʤ, ʒ /. Seven subjects had problems with / r /; six with /ق ,ط, z, d /; four with / k / and three with / h, ث, ʃ , ʒ , l /. Only two subjects had errors with /ح, ر , n /. There is no consistency in the substitutions used for these sounds except for /غ, ح, ر / which have been substituted by [x, h, ʔ]. The other substitutions can be seen in Table 16. None of the final consonant errors show a relation to a special age group.

B. *Inter-Group Analyses*

Comparison of the data from the controls' correspondence matrices with that of the subjects showed a difference between them, both in the correct and incorrect realisations. Controls had fewer incorrect realisations in comparison with subjects (11 incorrect realisations of control v 25 for subjects) and more correct realisations (91% for controls v 63.4% for subjects). The percentage correct realisations of Stops was 89.7% for control against 62% for subjects, and for Fricatives was 83.7% for control against 50.6% for subjects.

Similar to the subjects, the error rate for the incorrect realisation of some target sound in the controls was also 100%, for example / ʒ / had a potential occurrence of two and in all the occurrences it was incorrectly realised. The error types being substitution and omission.

All the different age groups in the subjects had errors in their realisation. On the other hand, the errors in the control group were only in the two youngest age groups and no errors were noticed in the realisation of the controls age groups 5 and 6 years.

The target sounds which were incorrectly realised in the four youngest controls were as follows : / q , ɵ, ʒ,ʒ/ for four controls; / ʤ, ʃ, ʒ, x, ɣ, s / for two of them; and / b / in one control only.

There was inconsistency in the incorrect realisations of target sound by the subjects, but in the above controls the incorrect realisations were consistent and as follows - [t] was substituted for / θ /; [d] for / ð, ɖ /; [g] for / q /; [s] for / ʃ, ʂ /; [z] for / ʒ /; [ħ] for / x /; [ʕ] for / ɣ /; and [p] for / b /. With regard to the target sound / ð / its realisation in the above four youngest controls was as follows -

- in the 3 year age group it was realised with [z] in word initial position and with [d] in word medial position.
- in the 4 year age group it was realised with [ð] in word initial position and with [ɖ] in word medial position.

In both of the controls of three year age group, errors in realisation of target sounds were seen with / ɖ, ʃ, ʒ, x, ɣ, ʕ / but not in the four year age group, whereas the errors with / q, θ, ð, ðˤ / were also seen in the four year old controls and seemed to disappear before five years of age. Only control number two of the three year age group had errors in realising the target sound / b / and one omission of target / d / in word initial position. Controls had correct realisation of Nasals and Glides in the different positions of the word, in contrast to subjects who had errors in their realisation.

5.1.4 Phonetic Distribution

This is an analysis in terms of traditional phonetic categories of manner of articulation of the range of different singleton consonants used in a child's spoken language and their occurrence and distribution across the different positions in the syllable structure - syllable initial word initial; syllable initial within word; syllable final word final; (SIWI, SFWW, SIWW, SFWF). There will be no reference to the adult target pronunciation at this stage, nor a concern with the contrastive functions of the different consonants. The presentation aims to show the phonetic patterns habitually used by the child.

A. *Subject Intra-Group Analysis*

Table 17 represents the phonetic distribution of the subjects' consonants according to the manner of production across the different age groups.

Inspection of the table reveals a moderate restriction with the usage of Plosives and Fricatives in all the different position of the syllable which shows no particular changes across the four age groups.

Also, there was no major difference in the number of the consonants across the three positions in the syllable in subjects of the same age. This was seen across the four age groups.

Regarding Nasals, Liquids and Glides, there were no restrictions on their usage in all positions across all age groups except for two subjects.

Table 17 : Phonetic Distribution in Term of Manner of Production of Children with Cleft Palate

Subjects	Sound Class	Syllable and Word Position		
		SIWI	SF/SIWW	SFWF
1	Nasal Stops Fricatives Liquid/Glides	m n b t d k g q ʔ f θ ʃ ʒ x h w r l j	m n b t d k g q ʔ f θ ʃ ʒ x h w r l j	m n b t d k g ʔ f θ ʃ ʒ x r l j
2	Nasal Stops Fricatives Liquid/Glides	m b k q ʔ f θ x h w r l j	m n b k q ʔ f θ x h w r l j	m n b k ʔ f θ x h r l j
3	Nasal Stops Fricatives Liquid/Glides	m n b ʔ f θ x ħ ʕ h w r l j	m n b ʔ f θ x ħ h w r l j	m n b ʔ f θ x ħ ʕ r l j
4	Nasal Stops Fricatives Liquid/Glides	m b d k g ʔ f θ ʃ ʒ x ħ ʕ h w r l j	m n b k g ʔ f θ ʃ ʒ x ħ h w r l j	m n b k g ʔ f ʃ ʒ x ħ ʕ r l j
5	Nasal Stops Fricatives Liquid/Glides	m n b t d k q ʈ ʔ f θ ʃ ʒ x ħ ʕ h w l j	m n b t d g q ʈ f θ ʃ ʒ x ħ h w l j	m n b d k q ʔ f θ ʃ ʒ x ħ ʕ l j
6	Nasal Stops Fricatives Liquid/Glides	m n b t d k g ʈ ʔ f θ s z ʃ ʒ x ɣ ħ ʕ h w r l j	m n b t d k q ʈ f θ s z ʃ ʒ x ɣ ħ ʕ h w r l j	m n b d k f θ z ʃ ʒ x ħ ʕ r l j
7	Nasal Stops Fricatives Liquid/Glides	m n b d g ʔ f x ɣ ħ ʕ h w r l j	m n b t d ʔ f θ x ɣ ħ ʕ h w r l j	m n b d ʔ f x ħ ʕ r l j
8	Nasal Stops Fricatives Liquid/Glides	m n b t d k g q ʈ ʔ f θ z ʃ ʒ x ɣ ħ ʕ h w l j	m n b t d q ʈ f θ z ʃ ʒ x ɣ ħ ʕ h w l j	m n b d k q ʈ f θ z ʃ ʒ x ħ ʕ l j

B. *Inter-Group Analyses*

In comparing the subjects to the controls, it was clear that controls had no restriction in the use of different consonants across the positions in the syllable. Similar to subjects the distribution of Stops, Nasals, Liquids and Glides was similar in the different positions in the syllable across different age groups (See Table 18).

In the controls, unlike the subjects, Fricatives showed increase in number with age.

Table 18 : Phonetic Distribution in Term of Manner of Production of Children without Cleft Palate

Controls	Sound Class	Syllable and Word Position		
		SIWI	SF/SIWW	SFWF
1	Nasal Stops Fricatives Liquid/Glides	m n b t d k g ʈ ʔ f s z ħ ʕ h w r l j	m n b t d g ʈ f s z ħ ʕ h w r l j	m n b t d k g ʈ f s z ħ ʕ w r l j
2	Nasal Stops Fricatives Liquid/Glides	m n p t d k g ʈ ʔ f s z ħ ʕ h w r l j	m n p t d g ʈ f s z ħ ʕ h w r l j	m n p t d k g ʈ f s z ħ ʕ r l j
3	Nasal Stops Fricatives Liquid/Glides	m n b t d k g ʈ ɗ ʔ f s z ʃ ʒ x ɣ ʕ ħ ʕ h w r l j	m n b t d k g ʈ ɗ f s z ʃ ʒ x ɣ ʕ ħ ʕ h w r l j	m n b t d k g ʈ ɗ f z ʃ ʒ x ʕ ħ ʕ r l j
4	Nasal Stops Fricatives Liquid/Glides	m n b t d k g ʈ ɗ ʔ f s z ʃ ʒ x ɣ ʕ ħ ʕ h w r l j	m n b t d g ʈ ɗ f s z ʃ ʒ x ɣ ʕ ħ ʕ h w r l j	m n b t d k g ʈ ɗ f z ʃ ʒ x ʕ ħ ʕ r l j
5	Nasal Stops Fricatives Liquid/Glides	m n b t d k q ʈ ɗ ʔ f θ ð s z ʃ ʒ x ɣ ʕ ð ħ ʕ h w r l j	m n b t d q ʈ ɗ f θ ð s z ʃ ʒ x ɣ ʕ ð ħ ʕ h w r l j	m n b d k q ʈ ɗ f θ z ʃ ʒ x ʕ ħ ʕ r l j
6	Nasal Stops Fricatives Liquid/Glides	m n b t d k q ʈ ɗ ʔ f θ ð s z ʃ ʒ ɣ ʕ ð ħ ʕ h w r l j	m n b t d q ʈ ɗ f θ ð s z ʃ ʒ x ɣ ʕ ð ħ ʕ h w r l j	m n b d k q ʈ ɗ f θ z ʃ ʒ x ʕ ħ ʕ r l j
7	Nasal Stops Fricatives Liquid/Glides	m n b t d k q ʈ ɗ ʔ f θ ð s z ʃ ʒ x ɣ ʕ ð ħ ʕ h w r l j	m n b t d q ʈ ɗ f θ ð s z ʃ ʒ x ɣ ʕ ð ħ ʕ h w r l j	m n b d k q ʈ ɗ f θ z ʃ ʒ x ʕ ħ ʕ r l j
8	Nasal Stops Fricatives Liquid/Glides	m n b t d k q ʈ ɗ ʔ f θ ð s z ʃ ʒ x ɣ ʕ ð ħ ʕ h w r l j	m n b t d q ʈ ɗ f θ ð s z ʃ ʒ x ɣ ʕ ð ħ ʕ h w r l j	m n b d k q ʈ ɗ f θ z ʃ ʒ x ʕ ħ ʕ r l j

5.2. Phonological Analysis

The Phonological Assessment of Child Speech PACS or framework *(Grunwell, 1985)* is a comprehensive assessment which includes a variety of specific procedures designed to elucidate the data from different perspectives *(Grunwell, 1988; Grunwell and Russell, 1988).*

Also, it identifies the phonetic relationships underpinning phonological contrasts to form a hypothesis related to the articulatory constraints on the sound system *(Howard, 1993; Grunwell, Yavas, Russell and LeMaistre, 1988).* Phonological analyses of the speech data collected were therefore drawn from PACS.

The procedures selected were a contrastive analysis of phones used, syllable initial word intially (SIWI); syllable final within word (SFWW); syllable initial within word (SIWW) and syllable final word final (SFWF) and an analysis of the phonological simplifying processes operating in the children's speech.

5.2.1 Analysis of Phonological Simplifying Processes

The phonological processes represent descriptions of children's simplification of adult sounds, grouping individual changes into general patterns thus providing more explanatory description of development. In reality, the full range of possible processes is not known *(Ingram, 1981).* As

stated on Page 53 the phonological processes used in the English literature in analysing normal or disordered phonological development will be used in this study.

Processes identified in the literature for analysing English cleft palate speech will be used also for analysing Arabic speaking children with cleft palate as it was found that the active coping strategies in cleft palate speakers are universal and related to the organic condition *(Brondsted, Grunwell, Henningsson, Jansonius, Karling, Meijer, Ording, Sell, Vermeij-Zieverink and Wyatt, 1994).*

The processes used were:-

A. As used in normal phonological development:

1. Palatal Fronting : A palatal fricative is produced at a more forward place of articulation:

   /f a r a :ʃ a/ فراشه (Butterfly) > [f a r a : s a]

2. Velar Fronting : An alveolar consonant is substituted for a velar

   /k i t a : b/ كتاب (book) > [t i t a : b]

3. Uvular Fronting : An alveolar or velar consonant is substituted for a uvular:

   /q i ɬ a : r/ قطار (train) > [d i ɬ a : r]

4. Stopping : Stops are substituted for the fricatives:

/ʒamal/ جمل (camel) > [damal]

5. Context Sensitive Voicing : A voiced consonant replaces a voiceless consonant or vice versa:

/ʔazraq/ ازرق (blue) > [ʔasraq]

6. Liquid Simplification : Glides or vowels are substituted for liquids:

/ʕarf/ ظرف (envelope) > [ʕajf]

7. Final Consonant Deletion : The final consonant is deleted:

/fa:r/ فار (rat) > [fa:]

8. Frication : A fricative is substituted for a stop, liquid or glide:

/rumma:n/ رمان (pomegranate) > [fumma:n]

9. Assimilation : One consonant becomes similar to another consonant in the word in the same place of articulation:

/q idir/ قدر (pan) > [didir]

10. Cluster Reduction : One member of a consonant cluster is deleted:

/θalʒ/ ثلج (ice) > [θal]

11. Cluster Simplification : when a process other than reduction applies to one member of a consonant cluster. It may include

(i) Cluster with Liquid Simplification : Glides or vowels are substituted for the liquid member of the cluster:

/ظarf/ ظرف (envelope) > [ظajf]

(ii) Cluster with epenthesis : A vowel is added between the two consonants of the cluster:

/ʃams/ شمس (sun) > [ʃamas]

(iii) Cluster with consonant simplification: One member of the cluster is changed:

/xamsa/ خمسة (five) > [xamΘa]

12. Dedentalisation : When an alveolar is substituted for a dental consonant:

/ظahab/ ذهب (gold) > [z a h a b] or [d a h a b]

B. Processes found to be used by phonological disordered children and specifically attested in cleft palate children:

1. Initial Consonant Deletion : The initial consonant in a word is deleted:

/qiṭa:r/ قطار (train) > [ṭa:r]

2. Glottal Replacement : A glottal stop is substituted for another consonant:

/ṭabla/ طبله (drum) > [ʔabla]

3. Backing : The sound is produced with a more backward place of articulation such as velarisation, uvularisation, pharyngealisation or glottalisation:

/ṭabla/ طبله (drum) > [qabla]

/xaru:f/ خروف (sheep) > [ħaru:f]

/samaka/ سمكه (fish) > [hamaʔa]

4. Dentalisation : Dental realisation of alveolar stops or fricatives:

/ʔasad/ اسد (lion) > [ʔaθad]

5. Depharyngealisation : Used mainly with the emphatic set where the secondary articulation is missed:

/xeṭ/ خيط (thread) > [xet]

6. Labialisation : A Labial realisation of other consonants:

/n a ʒ ʒ a : r a / نظارة (eye glass) > [n a f f a : r a]

7. Metathesis : The transposition and the sequence alteration of consonants within a word:

/ ʤ u f d a ʕ / ضفدع (frog) > [ʤ u ʕ f a d]

The following results will address the second research question.

A. Subjects' Intra-Group Analyses

The subjects in this analysis varied in their use of certain phonological processes, but none of them used the processes of Velar Fronting, Dedentalisation or Pharyngealisation. There was only one instance of Palatal Fronting or Cluster with Epenthesis. Table 19 presents the mean percentage occurrence among the eight subjects, of the twenty four processes tabulated in this study. The most common phonological process found among this group of subjects was Cluster Simplification. Final Consonant Deletion and Backing in the form of velarisation were other frequently occurring processes among these subjects, ranging in occurrence from 2% to 26.5% and 2% to 26.7% of possible context, respectively. The process of Context Sensitive Voicing was also common and used by all the subject in the frequency of occurrence ranging from 3.9% to 20%

Two processes were used by several of the subjects with similar frequency of occurrence, ranging from 0.6% to 15/15.3%. These were Glottal Replacement and Dentalisation.

The processes of Liquid Simplification, Depharyngealisation, Cluster with Liquid Simplification and Backing by uvularisation were seen in three subjects with their frequency ranging from 4% to 5.2%; 7.1% to 42.9%; 33% to 100% and 0.6% to 5.2% respectively.

Table 19 : The Mean Percentage Occurrence of Individual Process Usage for the Children with Cleft Palate

Subjects

Process	1	2	3	4	5	6	7	8	Mean Overall
Palatal Fronting	0	0	0	28.6	0	0	0	0	3.6
Velar Fronting	0	0	0	0	0	0	0	0	0
Uvular Fronting	100	0	0	0	0	60	20	20	25
Stopping	30.9	36.4	0	20	0	1.8	16.4	5.5	13.9
Context Sensitive Voicing	12.9	20	18.7	11.6	7.8	9	2.6	3.9	10.8
Liquid Simplification	0	0	0	0	4.8	0	4	52	13
Initial Consonant Deletion	0	4.8	0	6.5	0	0	0	0	1.4
Final Consonant Deletion	12	26.5	20	10	14	22	10	2	14.6
Frication	0	0	36.4	0	4.5	11.4	0	4.5	7.1
Glottal Replacement	3.7	9	0	0.6	0.6	0.6	15.3	0.6	3.8
Backing									
- Velarisation	6	13	5.3	26.7	5.7	2	2	2.7	5.3
- Uvularisation	1.9	5.2	0	0	0	0.6	0	0	1
- Glottalisation	2.1	2.1	27.3	0	0.7	0	16.1	0	6
Assimilation	0.6	3	5.2	0	0	0.6	0	0	1.2
Dentalisation	7.3	15	3	2.7	0.6	0.6	0	3.3	4.1
Dedentalisation	0	0	0	0	0	0	0	0	0
Pharyngealisation	0	0	0	0	0	0	0	0	0
Depharyngealisation	42.9	0	0	0	0	0	7.1	42.9	11.6
Labialisation	0	0	1.8	0	2.5	3.8	0	2.5	1.3
Metathesis	0	0	0	0	0	0.6	0.6	0	0.2
Cluster Reduction	7.7	23.1	30.8	0	7.7	7.6	7.7	0	10.6
Cluster Simplification									
With Epenthesis	0	0	0	0	0	30.8	0	0	3.9
With Liquid Simplification	0	0	0	0	100	0	33	100	29.1
With Consonants Simplification	38.5	46.2	38.5	61.5	30.8	7.6	61.5	23.1	38.5

N.B. Percentages refer to the incidences in which the process was used in relation to the number of potential contexts for such usage.

Initial Consonant Deletions were observed only between 4.8% and 6.5% of the time among two subjects only.

In Table 20 the number reflects how often a child used a process relative to the potential number of times it could have been used. All processes had multiple opportunities to occur. This table presents the frequency of occurrence of total error, indicating a difference between the youngest age group and the oldest, with 115 errors for the three year age group, but 68 for the six year age group.

Table 20 : The Frequency of Occurrence of Phonological Processes and the Phonological Processess Across the Different Age Groups of Subjects

Process	Potential Frequency of Occurrence	3 year		4 year		5 year		6 year		% of Total Responses in Error
		1	2	3	4	5	6	7	8	
Palatal Fronting	7	0	0	0	2	0	0	0	0	3.6
Velar Fronting	11	0	0	0	0	0	0	0	0	0
Uvular Fronting	5	5	0	0	0	0	3	1	1	25
Stopping	55	17	20	0	11	0	1	9	3	13.9
Context Sensitive Voicing	155	20	31	29	18	12	14	4	6	10.5
Liquid Simplification	25	0	0	0	0	12	0	1	13	13
Initial Consonant Deletion	62	0	3	0	4	0	0	0	0	1.4
Final Consonant Deletion	49	6	13	10	5	7	11	5	1	14.6
Frication	44	0	0	16	0	2	5		2	7.1
Glottal Replacement	163	6	15	0	1	1	1	25	1	3.5
Backing										
- Velarisation	150	9	20	8	40	13	3	3	4	8.3
- Uvularisation	154	3	8	0	0	0	1	0	0	1
- Glottalisation	143	3	3	39	0	1	0	23	0	6
Assimilation	155	1	5	8	0	0	1	0	0	1.2
Dentalisation	150	11	10	5	4	1	0	0	5	4.1
Dedentalisation	11	0	0	0	0	0	0	0	0	0
Pharyngealisation	69	0	0	0	0	0	0	0	0	0
Depharyngealisation	14	6	0	0	0	0	0	1	6	11.6
Labialisation	160	0	0	3	0	4	6	0	4	1.3
Metathesis	155	0	0	0	0	0	1	1	0	0.2
Cluster Reduction	13	1	3	4	0	1	1	1	0	10.6
Cluster Simplification With Epenthesis	13	0	0	0	0	0	4	0	0	3.9
With Liquid Simplifcation	3	0	0	0	0	3	0	1	3	29.1
With Consonants Simplification	13	5	6	5	8	4	1	8	3	38.5
TOTAL ERROR		93	137	127	93	61	52	84	52	
Mean of Total Error by Age Group (0 = Score Zero)		115		110		56.5		68		

B. Inter-Group Phonologicial Processes Analysis

Table 21 presents the mean for total percentage occurrence of the phonological processes across the different age groups for the subjects and the controls. There was no particular pattern for differences across age groups as they were similar in the subjects. Whereas the mean for total instances of processes used by the controls were showing a decreasing manner with age.

By comparing Table 20 and Table 22 representing the frequency of occurrence of phonological process among subjects and controls some observations can be made.

As indicated for the subjects there was no great difference in the means regarding the frequency of occurrence of the phonological processes in relation to the different age groups. This is true for total use of processes as well as within individual processes.

In the controls, on the other hand, there was a difference between the frequency of the different phonological processes as a whole; i.e. the total error varied across the different age groups. The mean of total error for the three year age group was 45.5 compared to 17 in the four year age group. By looking into each process across the different age groups it was found that processes occurred in the two youngest age groups only.

Table 21 : Mean for Total Instances of Process Usage for Cleft and Non-Cleft Children by Age

	3 year olds		4 year olds		5 year olds		6 year olds	
	CP No=2	NC No=2	CP No=2	NC No=2	CP No=2	NC No=2	CP No=2	NC No=2
Mean	6.5	2.6	6.2	0.9	3.2	0	3.8	0

Table 22 : The Frequency of Occurrence of Phonological Processes and the Phonological Processess Across the Different Age Groups of Controls

Process	Potential Frequency of Occurrence	3 year		4 year		5 year		6 year		% of Total Responses in Error
		1	2	3	4	5	6	7	8	
Palatal Fronting	7	6	6	0	0	0	0	0	0	21 4
Velar Fronting	11	0	0	0	0	0	0	0	0	0
Uvular Fronting	5	5	5	5	5	0	0	0	0	50
Stopping	55	10	12	10	10	0	0	0	0	95
Context Sensitive Voicing	155	0	14	0	0	0	0	0	0	1 1
Liquid Simplification	25	0	0	0	0	0	0	0	0	0
Initial Consonant Deletion	62	0	1	0	0	0	0	0	0	0 03
Final Consonant Deletion	49	0	0	0	0	0	0	0	0	0
Frication	44	0	0	0	0	0	0	0	0	0
Glottal Replacement	153	0	0	0	0	0	0	0	0	0
Backing										
- Velarisation	150	0	0	0	0	0	0	0	0	0
- Uvularisation	154	0	0	0	0	0	0	0	0	0
- Glottalisation	143	0	0	0	0	0	0	0	0	0
Assimilation	155	1	1	1	1	0	0	0	0	0 3
Dentalisation	150	0	0	0	0	0	0	0	0	0
Dedentalisation	11	1	1	1	1	0	0	0	0	2 2
Pharyngealisation	69	8	8	0	0	0	0	0	0	2.9
Depharyngealisation	14	7	7	0	0	0	0	0	0	12 5
Labialisation	160	0	0	0	0	0	0	0	0	0
Metathesis	155	0	0	0	0	0	0	0	0	0
Cluster Reduction	13	0	0	0	0	0	0	0	0	0
Cluster Simplification With Epenthesis	13	0	0	0	0	0	0	0	0	0
With Liquid Simplification	3	0	0	0	0	0	0	0	0	0
With Consonants Simplifiction	13	0	0	0	0	0	0	0	0	0
TOTAL ERROR		37	54	17	17	0	0	0	0	
Mean of Total Error by Age Group (0 = Score Zero)		45.5		17		0		0		

The subjects and the two youngest control groups shared the usage of some processes such as Palatal Fronting, Uvular Fronting, Stopping, Assimilation and Depharyngealisation. Chapman (1993) had found that if a process was found in the speech of the children with cleft palate, it was usually also present in the speech of at least one child from her non cleft group. In this study it was found that Control 2 shares the processes of Context Sensitive Voicing and Initial Consonant Deletion with the subjects. This finding agreed with what Chapman (1993) found. The percentage of total error was similar for both groups for the shared processes except in the process of Uvular and Palatal Fronting which was noted more in the speech of the controls (50% and 21.4% in controls in comparison to 25% and 3.6% in subjects) for each of the two processes respectively. In the opposite, Context Sensitive Voicing was noticed more in subjects (10.8% in subject compared to 1% in controls).

There were processes used by controls and not by subjects; these were Dedentalisation and Pharyngealisation. However, some processes were attested in the subjects' data but not the controls, for example; Liquid Simplification, Final Consonant Deletion, Frication, Glottal Replacement, the three different types of Backing, Dentalisation, Labialisation, Metathesis and the processes related to Clusters.

The majority of the errors used by the subjects were changes which altered the basic structure of the words, for example; Deletion and Glottal Replacement, whereas the processes used by controls were mainly substitution, for example; Fronting, Stopping. In the controls, as seen in Table 23, it was noted that all the processes occurred in children below the age of five. The different types of Fronting were the commonest, for example; Uvular Fronting. They showed 50% of the overall mean percentage and were used by four controls. Following these were Palatal Fronting with 21.4% in the youngest age group. Initial Consonant Deletion and Context Sensitive Voicing were used only by one control. Assimilation, Pharyngealisation and Dedentalisation had a low frequency as they had 0.2%, 1.2% and 2.2% respectively. Stopping was found in four controls with 9.5% and Depharyngealisation had a mean frequency of 12.5%.

Table 23 : The Mean Percentage Occurrence of Individual Process Usage for the Normal (Non-Cleft) Children

Process	1	2	3	4	5	6	7	8	Mean Overall
Palatal Fronting	55.7	55.7	0	0	0	0	0	0	21.4
Velar Fronting	0	0	0	0	0	0	0	0	0
Uvular Fronting	100	100	100	100	0	0	0	0	50
Stopping	18	21.8	18	18	0	0	0	0	9.5
Context Sensitive Voicing	0	9	0	0	0	0	0	0	1.1
Liquid Simplification	0	0	0	0	0	0	0	0	0
Initial Consonant Deletion	0	0.2	0	0	0	0	0	0	0.03
Final Consonant Deletion	0	0	0	0	0	0	0	0	0
Frication	0	0	0	0	0	0	0	0	0
Glottal Replacement	0	0	0	0	0	0	0	0	0
Backing									
- Velarisation	0	0	0	0	0	0	0	0	0
- Uvularisation	0	0	0	0	0	0	0	0	0
- Glottalisation	0	0	0	0	0	0	0	0	0
Assimilation	0.6	0.6	0.6	0.6	0	0	0	0	0.3
Dentalisation	0	0	0	0	0	0	0	0	0
Dedentalisation	9	9	0	0	0	0	0	0	2.2
Pharyngealisation	4.7	4.7	0	0	0	0	0	0	1.2
Depharyngealisation	50	50	0	0	0	0	0	0	12.5
Labialisation	0	0	0	0	0	0	0	0	0
Metathesis	0	0	0	0	0	0	0	0	0
Cluster Reduction	0	0	0	0	0	0	0	0	0
Cluster Simplification									
With Epenthesis	0	0	0	0	0	0	0	0	0
WithLiquid Simplification	0	0	0	0	0	0	0	0	0
With Consonant Simplification	0	0	0	0	0	0	0	0	0

N.B. Percentage refers to the instances in which the process was used in relation to the number of potential contexts for such usage.

5.2.2 Analysis of Constrative Phonological System

For evaluating the communicative adequacy of the children's pronunciation patterns, analysis of each child's own phonological system is needed in order to ascertain which phonetically different consonants function to signal differences in meaning, that is are contrastive. Contrastive assessment can fulfil this aim by mapping the child's contrastive phones onto the adult system of phonemes at different places in word and syllable structure. This procedure is a simple graphic statement in a tabular format stating the correspondences between the adult and child system. The results of this analysis will address the third research question.

A. Subjects' Intra-Group Analyses

Figure 5 presents the Contrastive Analysis of Subject 1. Mapping the subjects' consonants system onto the adult consonant system at the different position in word and syllable structure reveals that there are different matches/mis-matches between the two systems.

The contrastive analysis of Subjects 2, 3, 4 and 7 shows a considerably restricted consonant system with evidence of a Backing process operating on most of the target phonemes, in all different positions in the word and syllable structure. There was, however, relatively variation in the subjects' realisation for the errored target phonemes. The variability was mainly in the realisation of /t, z, ʃ , r /. Examples of this variability in the contrastive

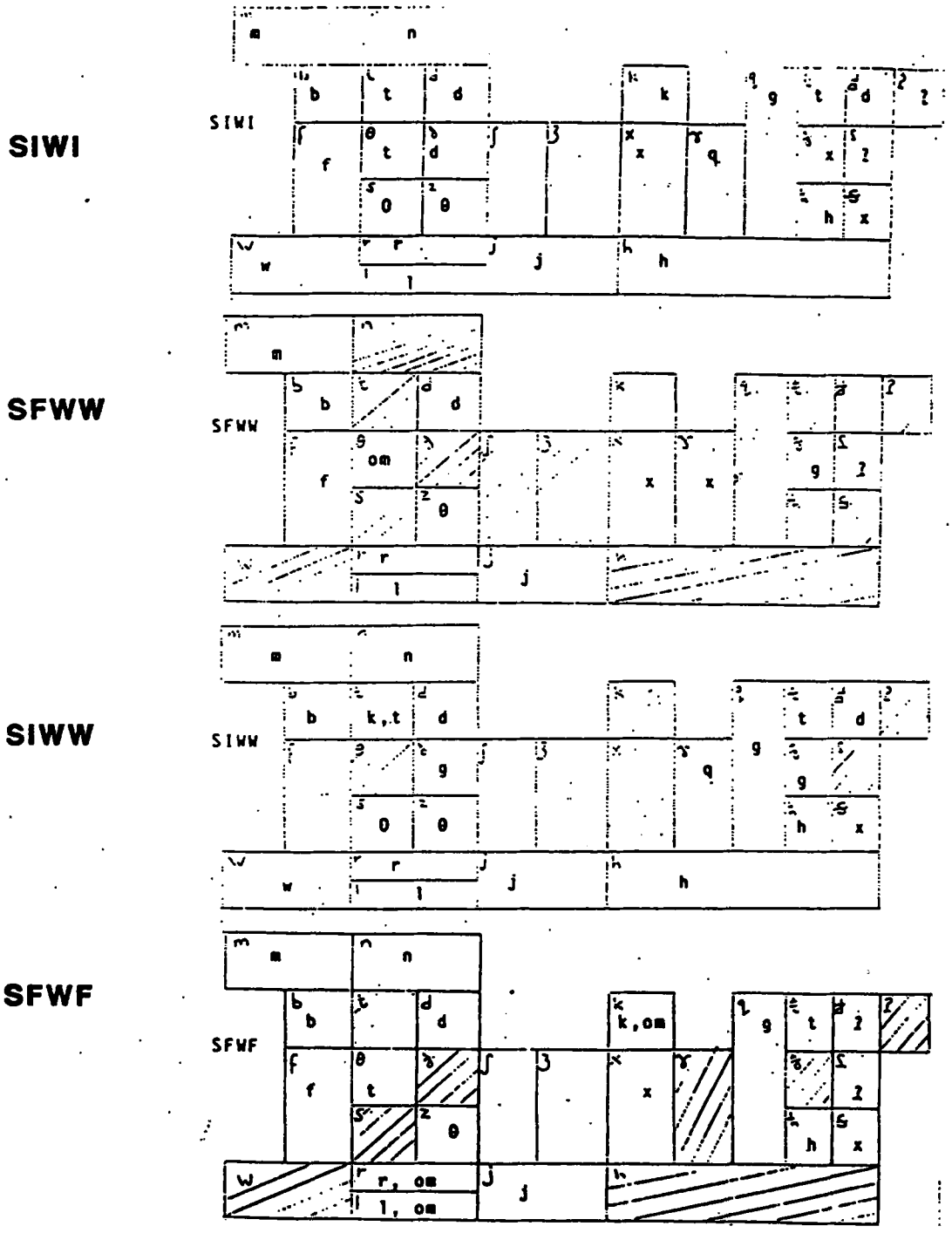


Figure 5 : Analysis of Contrastive Phonological System for Subject 1

assessment of Subject 3 in SIWW position is that both [h] and [ʔ] map on to adult / t /.

In the four subjects mentioned above, there was individual variation in the errored realisation of target phonemes, for example the adult target /ʧ/ was realised differently by these subjects, so it was either realised with [h], [ʔ] or [k]. Also, in each subjects, realisations of target phonemes were affected by position in the word and syllable structure, for example for Subject 3 the adult target /ʤ/ was realised in SIWI position by [h], SIWW by [f] and was ommited at SFWF position.

Another observation is that one phoneme may be used to realise different adult target for example [h] was used by Subject 3 as a realisation for / t, d, θ , s, z, ʒ , k, q , ʧ , ʤ / in SIWI position and for realisation of / t, d, ʒ , q, ʧ, ɣ/ in SIWW position and in SFWF position the same phone was used for realisation of target sound / k / only.

The major communicative Inadequacy of these four subjects' phonological systems lies not only in the lack of contrasts, between the adult and the subject systems, but also in the use of one phoneme for realising more than one target.

The considerable reduction in their systems lead to functional inadequacy in terms of signalling meaning differences.

For the rest of the subjects (1, 5, 6, and 8) the phonetic potential for accuracy, as indicated by their consonant systems, was quite considerable.

In Subjects 1 and 5, the potential was phonologically used at SIWI position in structure mainly. However, there was still a mis-match between their realisations and the adult target (by using [ϴ or x] as a realisation of some consonants) in the four different positions in syllabic structure. In both these subjects variability in realisation of some target sounds was seen in SIWW position, for example: Subject 1 realised / t / with [k, t].

Subjects 6 and 8 showed that their phonetic systems were moving towards the adult pronunciation system. On the other hand, there was some variability and mis-match in their realisations. The usage of processes like Backing (velars were a realisation for alveolars) and Dentalisation or Labialisation in their phonology were aspects of developmentally unusual phonology.

B. Inter-Group Analysis of Contrastive Systems

In the Controls, the oldest four (controls 5, 6, 7 and 8) showed an isomorphic relationship between the units in the two systems. Thus they were using the same system of contrasts as in the adult pronunciation system and signalling all the meaning differences normally signalled in Arabic.

The youngest four controls (1, 2, 3 and 4) had mostly normal patterns although they showed some loss of adult phonemic contrasts. Examples of loss of contrastivity in Control 1 and 2 were as follows:

- [d] was the realisation for / d, ð, ذ /
- [z] was the realisation for / Z, ʒ, ظ /

This realisation was consistent in all SIWI, SFWW, SIWW and SFWF position in the syllable and word structure.

Controls 3 and 4 showed less mis-match such as the use of [d] for realising the target / ð /, [g] for realising / q / and [t] with / θ /.

In all the four youngest controls the realisations were consistent with no variation except for target / ظ / which was realised as follows:

- Controls 1 and 2 realised it in SIWI with [z] and with [d] in SF/SIWW
- Controls 3 and 4 realised it in SIWI with [z] and with [ð] for SF/SIWW

A similarity appeared to exist between all the subjects and the four youngest controls in terms of loss of phonological contrast. However, the systems were not actually similar.

In case of the subjects the loss of contrast was not always developmentally normal as it could be the result of abnormal processes such as Backing.

CHAPTER SIX

DISCUSSION AND CONCLUSIONS

CHAPTER 6

DISCUSSION AND CONCLUSIONS

Many of the children with cleft palate who participated in this study had demonstrated relatively poorer overall speech than the non-cleft comparison group (controls). This agrees with Grunwell, (1988); Grunwell and Russell, (1988) and Grunwell and Dive, (1988).

Comparison of the phonetic data for the two groups (as shown in Tables 12 to 14) indicated that the two groups demonstrated similarities as well as differences. The two groups were relatively comparable with reference to the type of consonants used in their inventories and the order of preference. The inventories of both groups contained Fricatives, Stops, Liquid and Glides and Nasals with the same order of preference. The number of consonants used by the non-cleft controls was more than that used by the children with cleft palate, whereas the total number of absolute occurrence of different consonants produced by the children without clefts and those with clefts showed no great variation. By analysing the accuracy of production for the different manner categories, it was found that the children with cleft palate were less accurate in production of Fricatives and Plosives than their non-cleft peers. (See Tables 15a-c and Appendices of Correspondence Matrices for Subjects 2-8 and for Controls 1-4).

From the literature review it was evidenced that Stops are usually early developing sounds for children with intact structure. But they are likely to be difficult for many children with clefts because they require a build up of intra-oral pressure *(Powers, et al 1990).* McWilliam et al (1990) had reported that children with clefts had difficulties with Fricatives and Stops. In this study, analysis of the consonant inventories of both groups according to the manner of production had shown that difficulties were seen with Stops and Fricatives in the children with clefts. The most obvious explanation is related to the articulatory constraints imposed by the prior anatomic or physiologic deviations associated with palatal clefting. But, a general delay in speech sound acquisition as an explanation cannot be ignored. The information supplied by these phonetic analyses has several explanations.

Firstly, the restriction in the phonetic repertoire found in the cleft palate subjects can be explained by the difficulty in the articulation of the subjects so they tend to articulate less well than the normal controls.

Secondly, the observations demonstrated in the results suggest that the subjects were delayed when compared to their non-cleft peers, but resembled the younger non-cleft children regarding the rate of their phonetic development. (See Table 11 and Appendices of General Phonetic Inventories for Subjects 2-8 and Controls 1-8). These findings were similar to that published in the literature for English speaking children *(Power et al, 1990; Lynch et al, 1983: Russell and Grunwell, 1993; McWilliam et al, 1990).*

Thirdly, the consonants which were most commonly misarticulated by the English speaking children with cleft palate were mainly those which were articulated at the alveolar place of articulation. Arabic phonetics is charaterised by the presence of the emphatic set as a result of secondary articulation, so there are more consonants which have their articulation at the alveolar place of articulation. As a result there are more consonants that could be misarticulated by the Arabic speaking children with cleft palate. This was identified in this study. (See Table 16 and Appendices of Correspondence Matrices for Subjects for more information).

Fourthly, the result of all types of phonetic analyses indicated that the range of consonants used by most of the children with cleft palate were mainly labial, pharyngeal and glottal. In the Arabic language, this restriction on the type of consonant has a particularly adverse effect on the intelligibility of speech of the children and leads to unsuccessful communication.

McWilliam et al (1990) had confirmed the high risk of disordered articulation for children with clefts and at the same time highlighted the occurrence of improvement with age especially in the production of Plosives and Fricatives. In this study there was no marked improvement in the consonant inventories of the cleft palate group with age, (See Tables 17 and 18). There is no conclusive evidence of improvement with age for Plosives and Fricatives as the findings across age levels for /ت، ق، ع، ح/ are inconsistent. But the sample size was small and confirmation of this factor requires examination of a bigger sample size.

In reference to Page 74, the different types of phonetic analysis has yielded information that answered the first research question raised in Page 53. It indicates that the cleft defect has an effect on the speech of Arabic speaking children by affecting their phonetic inventories and the relationships of the sounds to each other.

From the analysis of the simplification processes of both the subjects and controls groups it can be concluded that both groups of Arabic speaking children, like the English speaking children with or without cleft, were creative in their approach to the phonological system of language. The subjects did not appear to follow a single path to the production of speech as the controls did and did not all make the same errors or use the same strategies. The Assimilation in the subjects could be considered to be a delayed pattern as it was found in the controls until four years of age.

Differences between the two groups are best described in terms of their different strategies for dealing with classes of phonemes, and the way in which processes were applied. For example; the three year old controls, together with all the subjects, did not produce the / ʤ / target correctly. But, the above controls maintained consistency for its realisation by applying the Depharyngealisation process only, whereas the cleft palate subjects applied different processes for its realisation. Backing, Labialisation, Glottal Replacement, as well as Depharyngealisation were the processes used by the cleft palate subjects. (See Appendices of Phonological Process Analysis and Data Collection Sheet for Subjects 1-8 and Controls 1-4).

Chapman (1991) had found that children with cleft palate employed almost the same phonological processes as the non-cleft children but for a protracted period of time. It has been suggested that it is their use of phonological processes to simplify adult forms that is responsible for their errors *(McReynolds and Elbert, 1981; Grunwell, 1988)*. An examination of the pattern of processes used by both groups of children coincided with the above findings, (See Table 21). The phonological processes used in this study were drawn from the phonological processes used by the normal English speaking children. This was built upon the premise that phonological system development in children, regardless of their languages, is universal. These universal phonological processes can be used by any language in the world, Arabic being no exception. This could explain why the phonological processes used in the English language had been successfully used in analysing the Arabic language in some aspects. But, the Arabic language is not identical with the English language, so some processes will be in one language and not in the other, or have a different use, (See Tables 19, 20, 22 and 23). Assimilation could be used as an example.

It was reported that Assimilation usually has been dropped by most normal children speaking English by three years of age *(Stoel-Gammon and Dunn, 1985)*. In this study, Assimilation was found in the control group children until four years of age, whereas it was found until the age of five years in the subjects.

The Assimilation in the subjects could be considered to be a delayed pattern as it was found in the controls until four years of age. The explanation given by Grunwell (1987) and Ingram (1976) is that Assimilation is a way of avoiding difficult segments which occur in the earlier stages of acquisition. For the three year old controls this Assimilation was in the direction pharyngealised --> non-pharyngealised (ضوفدaس --> دوفضaس is an example from the Data Collection Sheets of Controls 1 and 2). Interestingly, although Assimilation occurred also in the data for the four year old controls, the direction was non-pharyngealised --> pharyngealised. (دوفدaس --> ضوف ضaس is an example from the Data Collection Sheet of Controls 3 and 4). It appears that the four year olds were moving in the direction of the pattern used by many Arabic speaking adults, where co-occurrence of pairs from the emphatic set leads to non-pharyngealised ----— - - ——— -> pharyngealised Assimilations *(Gairdner, 1925)*.

One of the limitations in this study was that precise explanation was not always possible because there was not enough information about Arabic phonology available and the sample size was small. It is one of the recommendations for future work to identify the phonological processes used in bigger groups of Arabic speaking children.

In this study the subjects demonstrated errors classified by Dorf and Curtin (1982), Chapman and Hardin (1992) as compensatory errors related to the cleft, for example, Glottal Stop Replacement, Dentalisation, and Backing.

Backing is considered as a secondary phonological disorder arising from a primary phonetic deviance. This process illustrates the impact of clefting on the child's developing phonological system. The explanation offered by Chapman and Hardin (1992) and Grunwell and Russell (1993) is the possibility that some of the children with cleft palate may have originally used Backing in an attempt to compensate for an inadequate V.P. mechanism. Over time, the rule may have become incorporated into the developing phonological rule system and simply persisted following palatal surgery. This could be applied in this study for the subjects. The usage of Pharyngealisation as a form of Backing in the three year old control group could be a developmental process as the process did not occur with other age groups of the controls. Confirmation is limited in this study as there was insufficient time to follow up the controls to have a longitudinal result, but it is a potential aim. (See Table 22).

As Backing in the normal children only affected the emphatic set, a phonological explanation may be appropriate. However, for the children with cleft palate, Backing had affected other sounds in addition to the emphatic set, and so a phonetic basis may be postulated.

It would seem therefore that this analysis addresses the second research question (see page 53) in that it allows for comparison across languages of the phonological processes in cleft palate speech. Furthermore, it is possible to identify the processes used by normal Arabic speaking children.

Analysing the phonological system in the children will identify what type of processes were used in a way to explain how the error occurred, but it will not give enough information to explain what happened to the contrast of the children's speech. The analysis of the contrastive phonological system will identify the situation in the contrast.

By mapping the contrastive phones in the subjects' system on to the adult phonemic system developmental unusual matches were found with some variability. Restriction in the subjects' phonological development appeared to be related to the physically based phonetic deviance. In the controls, the mismatch between the two systems could be developmentally normal, reducing effective communication but not to the extent that their speech would be unintelligible. (See Appendices of Contrastive Analysis of Controls 1-4). On the other hand, in the subjects, the reduction in the system of contrasts was considerable. (See Appendices of Contrastive Analysis for Subjects 1-8). In this study, if a child substituted target phonemes it meant that the target phonemes were not in the pronunciation system of the child. On the other hand, it did not mean that the realisation used by the child occurred in relation to appropriate targets. For example, when [ɵ] was used to substitute / s / or / z / the / s, z / were not available in the subjects' phonetic systems, (See Appendices of Contrastive Analysis of Subjects 1-8), but this did not mean that [ɵ] was equivalent to adult / ɵ / (a closer inestigation is needed to explore this). This indicates that subjects are using an inadequate system of distinctive sounds and cannot signal

the meaning differences required in the adult Arabic language. The contrast between the two systems is very important for signalling the meaning differences necessary for the intelligibility of the speech. In Arabic, (as in English) if a target sound is substituted by another, as in the subjects, the meaning of an Arabic word may change with, sometimes disastrous results. The processes that were used by the subjects to simplify the adult target lead to loss of contrastivity and as a result the intelligibility of the speech was affected. For example, subjects used Back sounds and Glottal Stops for other sounds. In English, these substitutions could affect speech intelligibility but as Glottal Stop is not used contrastively in English it will be realised by the listener that it is not the target sound. In Arabic this substitution will hinder communication especially if one phone was used for several target phonemes. This is because Arabic contains many Back sounds including Glottal Stops so the resultant speech may contain much homonomy. Examples were: ðufdaʕ → hifhaʕ ; qiṭa:r → hiha: (Subject 3); jad → jag; ɣel → gel (Subject 4); kursi: → ʔulʔi ; qiṭa:r → ʔuʔa:r (Subject 7). This will cause a confusion on the part of the listener. Therefore the third research question was answered by the findings from the contrastive analysis.

The project is considered as a starting point, hopefully pointing the way to further research.

As stated earlier, knowledge concerning the Arabic language, and developmental processes in particular, is limited as compared with English.

Another limitation was time. It had been hoped originally to study many more cleft palate children but it was not possible within the time allowed. Furthermore, there were practical problems related to contacting the children, and some did not fit the selection criteria for the study.

It is hoped that ideas for future research will address some of these limitations.

A particularly useful avenue for future work would be the establishment of developmental norms for Arabic phonology. This would require a much larger sample than that included in this project.

Another area for investigation would be the application of the proceeding analyses to the speech of children where cleft palate is divided into various types. This would allow for more detailed consideration of the relationship between cleft type and presenting speech patterns.

The data in this study were not subjected to instrumental analysis. Such analysis would be useful to enable finer distinctions of the children's speech to be made.

The importance of medical models in the management of cleft plate is well attested, as witnessed in previous discussions regarding efficacy of surgical procedures. However, as pointed out by Stackhouse and Wells (1993) medical models need to be supplemented by linguistic models. This study has undertaken to provide some information of a linguistic nature. However, recent psycholinguistic models attempt to view children's speech problems in terms of breakdown at various levels.

It would be interesting to analyse the phonetic and phonological production of cleft palate children within such psycholinguistic frameworks. For instance, further knowledge could be useful regarding such areas as cleft palate children's awareness of phonological representations, their ability to detect similarities and differences between words, and their capacity to reject their own erroneous forms.

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APPENDICES

DATA COLLECTION SHEET : SUBJECT. 2..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʔuθar	بقرة	Cow	baqara	baqara
دجاجة	Hen	duʒa:ʒa	kuka	مكواه	Iron	makwa	makwa
خروف	Sheep	xaru:f	xaru:f	صور	Pictures	ṣuwar	xuwa
زرافة	Giraffe	zara:fa	θara:fa	واحد	One	wahid	wahi
سمكة	Fish	samaka	xamak	اثنين	Two	ʔiθnen	θinen
شمس	Sun	ʃams	ʔam	ثلاثة	Three	θala:θa	ʔalaθa
فراشة	Butterfly	fara:ʃa	fara:θa	اربعة	Four	ʔarbaʕa	ʔarbaʔa
غزال	Deer	ɣaza:l	qaθa:l	خمسة	Five	xamsa	xamθa
ولد	Boy	walad	wala	ستة	Six	sitta	xika
كرسي	Chair	kursi:	kurθi:	سبعة	Seven	sabʕa	xabʔa
باب	Door	ba:b	ba:b	ثمانية	Eight	θamanja	ʔamanja
سلم	Ladder	sullam	xullam	تسعة	Nine	tisʕa	kiθʔa
مفتاح	Key	muftaːh	mufka:h	عشرة	Ten	ʕaʃara	ʔaθara
زهور	Flowers	zhuːr	θuhu:	هدهد		hudhud	hukhuk
طيور	Birds	ṭijuːr	qiju:				
قطة	Cat	qitta	qiqa				

DATA COLLECTION SHEET : SUBJECT..2..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʔinab	بنت	Girl	bint	bink
حصان	Horse	ħuʕaːn	ħiʔaːn	ثعبان	Snake	θuʕbaːn	ʔiʔbaːn
اخضر	Green	ʔaxdar	ʔaxqar	اذن	Ear	ʔiðaːn	ʔaxan
صاروخ	Rocket	ʕaːruːx	xaːruːx	مقص	Scissors	maqaːs	maqax
يد	Hand	jad	jak	ضفدع	Frog	ðufdaʕ	qufkaʔ
ذيل	Tail	ðeːl	Oe	طبلة	Drum	ṭabla	qabla
رمان	Pomegranate	rummaːn	rumaːn	قطار	Train	qiṭaːr	qiqaːr
موز	Banana	muz	muθ	خيط	Thread	xeṭ	xe
ظرف	Envelope	ðarf	xarf	ببغاء	Parrot	babbaġaːn	qaqa
ليمون	Lemon	lajmuːn	lajmuːn	ازرق	Blue	ʔazraq	ʔaθra
نظارة	Eyeglasses	naððaːra	qaːra	ملك	King	malik	məli
جمل	Camel	ʒamal	ʔamal	هدية	Gift	hadija	ʔakija
علم	Flag	ʕalam	ʔalam	ذهب	Gold	ðahab	xahab
وردة	Rose	warda	warka	اسد	Lion	ʔasad	ʔaθa
ابيض	White	ʔabjaḍ	ʔabjak	تفاح	Apple	tuffaːħ	kuffaːh
فار	Rat	faːr	faː	كتاب	Book	kitaːb	kikaːb

DATA COLLECTION SHEET : SUBJECT. 3...

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	hiʕara	بقرة	Cow	baqara	bahara
دجاجة	Hen	duza:ʒa	hiha:ha	مكواه	Iron	makwa	mahwa
خروف	Sheep	xaru:f	xaru:f	صور	Pictures	ṣuwar	xuwar
زرافة	Giraffe	zara:fa	haraʃa	واحد	One	wahid	wahi
سمكة	Fish	samaka	hemaha	اثنين	Two	ʔiθnen	ʔiθnen
شمس	Sun	ʃams	θam	ثلاثة	Three	θala:θa	halaθa
فراشة	Butterfly	fara:ʃa	fara:ʃa	اربعة	Four	ʔarbaʕa	ʔarbaʕa
غزال	Deer	ɣazai:l	ɣaʒa:l	خمسة	Five	xamsa	xamha
ولد	Boy	walad	walaʔ	ستة	Six	sitta	niʔa
كرسي	Chair	kursi:	hursi	سبعة	Seven	sabʕa	habʕa
باب	Door	ba:b	ba:b	ثمانية	Eight	θama:nja	hama:nja
سلم	Ledder	sullam	helam	تسعة	Nine	tisʕa	hibʕa
مفتاح	Key	muftaːħ	muʔfath	عشرة	Ten	ʕaʃara	ʕaθra
زهور	Flowers	zhuːr	huhu:	هدهد		hudhud	huʔhuʔ
طيور	Birds	tijuːr	hiju				
قطة	Cat	qitta	hiha				

DATA COLLECTION SHEET : SUBJECT...3...

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕinaba	بنت	Girl	bint	bin
حصان	Horse	ħuʕaːn	ħixaːn	ثعبان	Snake	θuʕbaːn	hiʕbaːn
اخضر	Green	ʔaxðar	ʔaxʃa	اذن	Ear	ʔiðaːn	ʔaxan
صاروخ	Rocket	ʕaːruːx	xaːrux	مقص	Scissors	maqaːs	muxa
يد	Hand	jad	jaʔ	ضفدع	Frog	ðufdaʕ	hifhaʕ
ذيل	Tail	ðel	hel	طبله	Drum	ṭabla	habla
رمان	Pomegranate	rummaːn	rummaːna	قطار	Train	qitaːr	hiṭaː
موز	Banana	muz	muxa	خيط	Thread	xeṭ	xe
ظرف	Envelope	ðarf	xaːf	ببغاء	Parrot	baðbaðaːn	baxbaha
ليمون	lemon	lajmuːn	lajmuna	ازرق	Blue	ʔazraq	ʔaθraʕ
نظاره	Eyeglasses	naððaːra	naffaːra	ملك	king	malik	malʕ
جمل	Camel	ʒamal	hemal	هديه	Gift	hadija	hahija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	ðahab	hahab
ورده	Rose	warda	wacXa	اسد	Lion	ʔasad	ʕaxaʔ
ابيض	White	ʔabjaḍ	ʔabja	تفاح	Apple	tuffaːħ	ʔuffaːha
فار	Rat	faːr	faː	كتاب	Book	kitaːb	hiṭaːb

DATA COLLECTION SHEET : SUBJECT..4..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒuʕa	بقرة	Cow	baqarə	bagara
دجاجة	Hen	duʒaːʒa	diʒaːʒa	مكواه	Iron	makwa	makwa
خروف	Sheep	xaruːf	xaruːf	صور	Pictures	ʂuwar	xuwa
زرافة	Giraffe	zaraːfa	ʒaraːfa	واحد	One	wahid	wahig
سمكة	Fish	samaka	xamaka	اثنين	Two	ʔiθnen	ʔiknen
شمس	Sun	ʃams	ʃamx	ثلاثة	Three	θalaːθa	kalaka
فراشة	Butterfly	faraːʃa	faraʃa	اربعة	Four	ʔarbaʂa	ʔarbaʂa
غزال	Deer	ɣazaːl	kaːl	خمسة	Five	xamsa	xamxa
ولد	Boy	walad	walag	ستة	Six	sitta	xikka
كرسي	Chair	kursiː	kurxiː	سبعة	Seven	sabʂa	xabʂa
باب	Door	baːb	baːb	ثمانية	Eight	θamaːnja	kamanja
سلم	Ledder	sullam	xullam	تسعة	Nine	tisʂa	kixʂa
مفتاح	Key	muftaːh	kaːk	عشرة	Ten	ʂaʃara	ʂaʒara
زهور	Flowers	zhuːr	ʒuhuː	هدهد		hudhud	hughug
طيور	Birds	ṭijuːr	kjuː				
قطة	Cat	qitta	gukka				

DATA COLLECTION SHEET : SUBJECT..4..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʃunab	ʃinaba	بنت	Girl	bint	bink
حصان	Horse	ħuʃa:n	ħuxa:n	ثعبان	Snake	θuʃba:n	kuʔba:n
اخضر	Green	ʔaxđar	ʔaxka	اذن	Ear	ʔiđin	ʔikin
صاروخ	Rocket	ʃa:ru:x	xa:ru:x	مقص	Scissors	maqaʃ	magax
يد	Hand	jad	jag	ضفدع	Frog	đufdaʃ	kufgaʃ
ذيل	Tail	đel	gel	طبله	Drum	ŧabla	kabla
رمان	Pomegranate	rumma:n	rumma:na	قطار	Train	qiŧa:r	gika:r
موز	Banana	muz	mux	خيط	Thread	xeŧ	xek
ظرف	Envelope	đarf	xarf	بغبغان	Parrot	baɣbaɣa:n	axa:n
ليمون	lemon	lajmu:n	lajmu:n	ازرق	Blue	ʔazraq	ʔaʃrog
نظاره	Eyeglasses	nađđa:ra	kara	ملك	King	malik	malik
جمل	Camel	ʒamal	ʒamal	هديه	Gift	hadija	hagija
علم	Flag	ʃalam	ʃalam	ذهب	Gold	đahab	gahab
ورده	Rose	warda	warga	اسد	Lion	ʔasad	ʔaxag
ابيض	White	ʔabjađ	ʔabijak	تفاح	Apple	tuffa:ħ	kuffa:ħ
فار	Rat	fa:r	fa:r	كتاب	Book	kiŧa:b	kika:b

DATA COLLECTION SHEET : SUBJECT..5.

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒuʒa	بقرة	Cow	baqarə	baqaja
دجاجة	Hen	duʒaːiʒa	duʒaːiʒ	مكواه	Iron	makwa	makwa
خروف	Sheep	xaruːf	xajuːf	صور	Pictures	ʂuwar	ɣuwaːj
زرافة	Giraffe	zaraːfa	xajaːfa	واحد	One	wahid	wahid
سمكة	Fish	samaka	xamaka	اثنين	Two	ʔiθnen	ʔiθnen
شمس	Sun	ʃams	ʃamx	ثلاثة	Three	θalaːθa	θalaːθa
فراشة	Butterfly	faraːʃa	fajaːʃa	اربعة	Four	ʔarbaʂa	ʔajbaʂa
غزال	Deer	ɣazaːl	ɣaʕaːl	خمسة	Five	xamsa	xâmxə
ولد	Boy	walad	walad	ستة	Six	sitta	ɣikka
كرسي	Chair	kursiː	kujθiː	سبعة	Seven	saba	xaba
باب	Door	baːb	baːb	ثمانية	Eight	θamaːnja	θamaja
سلم	Ledder	sullam	xullam	تسعة	Nine	tisʂa	tiʕʂa
مفتاح	Key	muftaːh	muftaːh	عشرة	Ten	ʂaʃara	ʂaʃaja
زهور	Flowers	zuhuːr	xuhuː	هدهد		hudhud	hudhud
طيور	Birds	tijuːr	tijuː				
قطة	Cat	qitta	ɢitta				

DATA COLLECTION SHEET : SUBJECT. ك..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʃunab	ʃinab	بنت	Girl	bint	bin
حصان	Horse	ħuʃa:n	hixa:n	ثعبان	Snake	θuʃba:n	ʧuʃban
اخضر	Green	ʔaxðar	ʔaxfa	اذن	Ear	ʔiða:n	ʔiga:n
صاروخ	Rocket	ʃa:ru:x	xaju:x	مقص	Scissors	maqa:ʃ	maqa:x
يد	Hand	jad	jad	ضفدع	Frog	ðufdaʃ	fufxaʃ
ذيل	Tail	ðel	θel	طبله	Drum	ṭabla	ṭ:ala
رمان	Pomegranate	rumma:n	ʔumma:n	قطار	Train	qiṭa:r	qi:ta:
موز	Banana	mu:z	muʤ	خيط	Thread	xeṭ	xe
ظرف	Envelope	ðarf	ðaj	ببغاء	Parrot	baðbaða:n	babaaðaʔ
ليمون	Lemon	lajmu:n	lajmu:n	ازرق	Blue	ʔazraq	ʔaθjaq
نظاره	Eyeglasses	naðða:ra	naffaja	ملك	King	malik	malik
جمل	Camel	ʒamal	ʒamal	هديه	Gift	hadija	hadija
علم	Flag	ʃalam	ʃalam	ذهب	Gold	ðahab	θahab
ورده	Rose	warda	wajda	اسد	Lion	ʔasad	ʔaxad
ابيض	White	ʔabjaḍ	ʔabjaʔ	تفاح	Apple	tuffa:ħ	tuffa:t
فار	Rat	fa:r	fa:	كتاب	Book	kita:b	kita:

DATA COLLECTION SHEET : SUBJECT..b..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	zuzar	بقرة	Cow	baqara	pagara
دجاجة	Hen	duʒaiʒa	zaza	مكواه	Iron	makwa	makwa
خروف	Sheep	xaruf	haruf	صور	Pictures	ṣuwar	suwar
زرافة	Giraffe	zaraːfa	zaraːfa	واحد	One	wahid	wahid
سمكة	Fish	samaka	samaka	اثنين	Two	ʔiθnen	ʔitnen
شمس	Sun	ʃams	sams	ثلاثة	Three	θalaːθa	talaːta
فراشة	Butterfly	faraːʃa	faraːsa	اربعة	Four	ʔarbaʕa	ʔarpaʕa
غزال	Deer	ɣazaːl	ʕazaːl	خمسة	Five	xamsa	tamsaː
ولد	Boy	walad	walad	ستة	Six	sitta	sitta
كرسي	Chair	kursiː	kursiː	سبعة	Seven	sabʕa	sapʕa
باب	Door	baːb	paːp	ثمانية	Eight	θamaːnja	tamanja
سلم	Ledder	sullam	sullam	تسعة	Nine	tisʕa	tisʕa
مفتاح	Key	muftaːh	muftaːh	عشرة	Ten	ʕaʃara	ʕasara
زهور	Flowers	zuhuːr	zuhuːr	هدهد		hudhud	hudhud
طيور	Birds	tijuːr	tijuːr				
قطة	Cat	qitta	gitta				

DATA COLLECTION SHEET : SUBJECT..6..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕunaʔ	بنت	Girl	bint	pint
حصان	Horse	ħuʕa:n	ħusa:n	ثعبان	Snake	θuʕba:n	puʕpa:n
اخضر	Green	ʔaxđar	ʔaħdar	اذن	Ear	ʔiđin	ʔidin
صاروخ	Rocket	ʕa:ru:x	sa:ru:ħ	مقص	Scissors	maqaʕ	migaʕ
يد	Hand	jad	jad	ضفدع	Frog	đufdaʕ	dufdaʕ
ذيل	Tail	đel	del	طبله	Drum	ŧabla	ŧapla
رمان	Pomegranate	rumma:n	rumma:n	قطار	Train	qiŧa:r	giŧa:r
موز	Banana	muz	muz	خيط	Thread	xeŧ	ħeŧ
ظرف	Envelope	đarf	sarf	بغبغان	Parrot	baɣbaɣa:n	pappaʕa:n
ليمون	lemon	lajmu:n	lajmu:n	ازرق	Blue	ʔazraq	ʔasrarg
نظاره	Eyeglasses	nađđa:ra	naddaira	ملك	King	malik	malik
جمل	Camel	ʒamal	zamal	هديه	Gift	hadija	hadija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	đahab	dahaʔ
ورده	Rose	warda	warda	اسد	Lion	ʔasad	ʔasad
ابيض	White	ʔabjađ	ʔapjad	تفاح	Apple	tuffa:ħ	tuffa:ħ
فار	Rat	fa:r	fa:r	كتاب	Book	kiŧa:b	kiŧaʔ

DATA COLLECTION SHEET : SUBJECT..7...

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carret	ʒuzar	dudar	بقرة	Cow	baqara	baʔara
دجاجة	Hen	duʒaːʒa	diʔʒːda	مكواه	Iron	makwa	maʔwa
خروف	Sheep	xaruːf	xaruːf	صور	Pictures	ʂuWar	ʔuwar
زرافة	Giraffe	ʒaraːfa	ʔaraːfa	واحد	One	wahid	wahiʔ
سمكة	Fish	samaka	ʔamaʔa	اثنين	Two	ʔiθnen	ʔiʔnen
شمس	Sun	ʃams	ʔam	ثلاثة	Three	θalaːθa	ʔalaʔa
فراشة	Butterfly	faraːʃa	faraʔa	اربعة	Four	ʔarbaʂa	ʔarʔaba
غزال	Deer	ɣaʒaːl	ɣadiːl	خمسة	Five	xamsa	xamʔa
ولد	Boy	walad	walaʔ	ستة	Six	sitta	ʔiʔʔa
كرسي	Chair	kursiː	ʔulʔi	سبعة	Seven	sabʂa	ʔabʂa
باب	Door	baːb	baːb	ثمانية	Eight	θamaːnja	ʔamanja
سلم	Ledder	sullam	ʔullam	تسعة	Nine	tisʂa	ʔiθʂa
مفتاح	Key	muftaːh	miʔtaːh	عشرة	Ten	ʂaʃara	ʂaʔara
زهور	Flowers	zuhuːr	ʔuhu	هدهد		hudhud	huʔhuʔ
طيور	Birds	tijuːr	ʔiʔuːr				
قطة	Cat	qitta	giʔta				

DATA COLLECTION SHEET : SUBJECT..7..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕunab	بنت	GirL	bint	binʔ
حصان	Horse	ħuʕaːn	ħuʕain	ثعبان	Snake	θuʕbaːn	ʔuʕbain
اخضر	Green	ʔaxḍar	ʔaxʔa	اذن	Ear	ʔiḍain	ʔiʔin
صاروخ	Rocket	ʕaːruːx	xaːruːx	مقص	Scissors	maqaṣ	maʔax
يد	Hand	jad	jaʔ	ضفدع	Frog	ḍufdaʕ	duʔdaʕ
ذيل	Tail	ðel	de	طبلة	Drum	ṭabla	ʔabla
رمان	Pomegranate	rummaːn	rumʔaːn	قطار	Train	qitaːr	ʔiʔaːr
موز	Banana	muːz	mud	خيط	Thread	xeṭ	xeʔ
ظرف	Envelope	ðarf	naʔf	ببغاء	Parrot	babaɣaːn	baʔbaɣan
ليمون	Lemon	lajmuːn	lajmun	ازرق	Blue	ʔazraq	ʔadlaʕ
نظارة	Eyeglasses	naððaːra	naʔnara	ملك	King	malik	maliʔ
جمل	Camel	ʒamal	damal	هدية	Gift	hadija	hadya
علم	Flag	ʕalam	ʕalam	ذهب	Gold	ðahab	dahab
وردة	Rose	warda	warʔa	اسد	Lion	ʔasad	ʔaθaʕ
ابيض	White	ʔabjaḍ	ʔabjaʕ	تفاح	Apple	tuffaːḥ	ʔuʕfaːh
فار	Rat	faːr	faː	كتاب	Book	kitaːb	ʔiʔab

DATA COLLECTION SHEET : SUBJECT..8..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒuzal	بقرة	Cow	baqara	baqala
دجاجة	Hen	duʒaːiʒa	duʒaʒa	مكواه	Iron	makwa	makwa
خروف	Sheep	xaruːf	xaluːf	صور	Pictures	ṣuwar	xuwal
زرافة	Giraffe	zaraːfa	zalaːfa	واحد	One	wahid	wahid
سمكة	Fish	samaka	θamaka	اثنين	Two	ʔiθnen	ʔiθnen
شمس	Sun	ʃams	ʃamx	ثلاثة	Three	θalaːθa	θalaːθa
فراشة	Butterfly	faraːʃa	falaʃa	اربعة	Four	ʔarbaʃa	ʔalbaʃa
غزال	Deer	ɣazaːl	xazal	خمسة	Five	xamsa	xamxa
ولد	Boy	walad	walad	ستة	Six	sitta	θitta
كرسي	Chair	kursiː	kulxi	سبعة	Seven	sabʕa	θabʕa
باب	Door	baːb	baːb	ثمانية	Eight	θamaːnja	θamanja
سلم	Ledder	sullam	θullam	تسعة	Nine	tisʕa	tiθʕa
مفتاح	Key	muftaːħ	muftaːħ	عشرة	Ten	ʕaʃara	ʕaʃara
زهور	Flowers	zuhuːr	zuhul	هدهد		hudhud	hudhud
طيور	Birds	ṭijuːr	ṭijuːl				
قطة	Cat	qiṭṭa	qiṭṭa				

DATA COLLECTION SHEET : SUBJECT...8.

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕunab	بنت	GirL	bint	bint
حصان	Horse	ħuSa:n	ħuXa:n	ثعبان	Snake	ΘuSba:n	ΘuSba:n
اخضر	Green	ʔaxdar	ʔaxfal	اذن	Ear	ʔiða:n	ʔida:n
صاروخ	Rocket	Sa:ru:x	xalu:x	مقص	Scissors	maqa:s	maqaX
يد	Hand	jad	ja	ضفدع	Frog	ðufdaʕ	dufdaʕ
ذيل	Tail	ðel	del	طبله	Drum	ṭabla	ṭabla
رمان	Pomegranate	rumma:n	ʕummain	قطار	Train	qita:r	gita:l
موز	Banana	muz	muz	خيط	Thread	xeṭ	xeṭ
ظرف	Envelope	ðarf	ðalf	ببغاء	Parrot	baṛbaṛa:n	baxbaxa:n
ليمون	lemon	lajmu:n	lajmu:n	ازرق	Blue	ʔazraq	ʔazlaq
نظاره	Eyeglasses	naðða:ra	naffala	ملك	king	malik	malik
جمل	Camel	ʒamal	ʒamal	هديه	Gift	hadija	hadija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	ðahab	dahab
ورده	Rose	warda	walda	اسد	Lion	ʔasad	ʔaθad
ابيض	White	ʔabjaḍ	ʔabjaf	تفاح	Apple	tuffa:ħ	tuffa:ħ
فار	Rat	fa:r	fal	كتاب	Book	kita:b	kitab

DATA COLLECTION SHEET : CONTROL..1..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	zuzar	بقره	Cow	baqara	bagara
دجاجه	Hen	duʒa:ʒa	duza:z	مكواه	Iron	makwa	makwa
خروف	Sheep	xaru:f	ħaru:f	صور	Pictures	ʃuwar	ʃuwar
زرافه	Giraffe	zara:fa	zara:fa	واحد	One	waħid	waħid
سمكه	Fish	samaka	samaka	اثنين	Two	ʔiθnen	ʔitnen
شمس	Sun	ʃams	sams	ثلاثه	Three	θala:θa	tala:ta
فراشه	Butterfly	fara:ʃa	fara:sa	اربعه	Four	ʔarbaʃa	ʔarbaʃa
غزال	Deer	ɣaza:l	ʃaza:l	خمسه	Five	xamsa	ħamsa
ولد	Boy	walad	walad	سته	Six	sitta	sitta
كرسي	Chair	kursi:	kursi:	سبعه	Seven	sabʃa	sabʃa
باب	Door	ba:b	ba:b	ثمانيه	Eight	θama:nja	tama:nja
سلم	Ledder	sullam	sulam	تسعه	Nine	tisʃa	tisʃa
مفتاح	Key	mufta:ħ	mufta:ħ	عشره	Ten	ʃaʃara	ʃasara
زهور	Flowers	zuhu:r	zuhu:r	هدهد		hudhud	hudhud
طيور	Birds	ŧiju:r	ŧiju:r				
قطه	Cat	qiŧŧa	giŧŧa				

DATA COLLECTION SHEET : CONTROL..1...

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʃunab	ʃunab	بنت	Girl	bint	bint
حصان	Horse	ħuʃa:n	ħuʃain	ثعبان	Snake	θuʃba:n	tuʃba:n
اخضر	Green	ʔaxdar	ʔaħdar	اذن	Ear	ʔiða:n	ʔidin
صاروخ	Rocket	ʃa:ru:x	ʃa:ru:ħ	مقص	Scissors	maqa:ʃ	mdgaʃ
يد	Hand	jad	jad	ضفدع	Frog	ðufdaʃ	dufdaʃ
ذيل	Tail	ðel	del	طبله	Drum	ṭabla	ṭabla
رمان	Pomegranate	rumma:n	ruma:n	قطار	Train	qiṭa:r	giṭa:r
موز	Banana	muz	muza	خيط	Thread	xeṭ	ṭeṭ
ظرف	Envelope	ðarf	zarf	ببغاء	Parrot	baṛbaṛa:n	baʃbaʃa
ليمون	lemon	lajmu:n	lajmuin	ازرق	Blue	ʔazraq	ʔazrag
نظاره	Eyeglasses	naðða:ra	nadda:ra	ملك	king	malik	malik
جمل	Camel	ʒamal	zamal	هديه	Gift	hadija	hadija
علم	Flag	ʃalam	ʃalam	ذهب	Gold	ðahab	dahab
ورده	Rose	warda	warda	اسد	Lion	ʔasad	ʔasad
ابيض	White	ʔabjad	ʔabjad	تفاح	Apple	tuffa:ħ	tuffaṭ
فار	Rat	fa:r	fa:r	كتاب	Book	kita:b	kita:b

DATA COLLECTION SHEET : CONTROL..2..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕinab	بنت	GirL	bint	banat
حصان	Horse	ħuʕa:n	ħaʕa:n	ثعبان	Snake	θuʕba:n	θuʕba:
اخضر	Green	ʔaxðar	ʔaxfar	اذن	Ear	ʔiða:n	ʔaθun
مضرب	Racket	ʕa:ru:x	ya:ru:x	مقص	Scissors	maqa:ʕ	maqa:ʕ
يد	Hand	jad	ja	ضفدع	frog	ðufdaʕ	fuʕfad
ذيل	Tail	ðel	θel	طبله	Drum	ṭabla	ṭaka:
رمان	Pomegranate	rumma:n	rumma:na	قطار	Train	qiṭa:r	xaṭa:r
موز	Banana	muz	mu.z	خيط	Thread	xeṭ	xeṭ
ظرف	Envelope	ðarf	ʃarf	ببغاء	Parrot	baʁbaʁa:n	baʁbaʁana
ليمون	lemon	lajmu:n	lajmu:n	ازرق	Blue	ʔazraq	ʔazra
نظاره	Eyeglasses	naðða:ra	naffa:ra	ملك	king	malik	malak
جمل	Camel	ʒamal	ʒamal	هديه	Gift	hadija	ʔadija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	ðahab	θahab
ورده	Rose	warda	warda	اسد	Lion	ʔasad	ʔasa
ابيض	White	ʔabjað	ʔabjaf	تفاح	Apple	tuffa:ħ	tuffa:ṭ
فار	Rat	fa:r	fa:	كتاب	Book	kita:b	kika:o

DATA COLLECTION SHEET : CONTROL. 2..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒusa	بقرة	Cow	baqara	baʔara
دجاجة	Hen	duʒaiʒa	diʒaiʒ	مكواه	Iron	makwa	makwa
خروف	Sheep	xaru:f	xaru:f	صور	Pictures	ʂuwar	xuwa
زرافة	Giraffe	zara:fa	zara:fa	واحد	One	wahid	wahid
سمكة	Fish	samaka	ʂamaka	اثنين	Two	ʔiθnen	ʔiθnen
شمس	Sun	ʃams	ʃamaʂ	ثلاثة	Three	θala:θa	θala:θa
فراشة	Butterfly	fara:ʃa	faraʃa	اربعة	Four	ʔarbaʂa	ʔarbaʔa
غزال	Deer	ɣaza:l	ʔaza:l	خمسة	Five	xamsa	xamaʂ
ولد	Boy	walad	wala	ستة	Six	sitta	sita
كرسي	Chair	kursi:	kuʂi	سبعة	Seven	sabʂa	sabʂa
باب	Door	ba:b	ba:b	ثمانية	Eight	θamanja	ʔamanja
سلم	Ledder	sullam	sullam	تسعة	Nine	tisʂa	tiʂa
مفتاح	Key	muftaːħ	miftaːħ	عشرة	Ten	ʂaʃara	ʂaʃara
زهور	Flowers	zhuːr	zhu	هدهد		hudhud	hudhud
طيور	Birds	ṭijuːr	ṭiju				
قطة	Cat	qiṭṭa	gṭwa				

DATA COLLECTION SHEET : CONTROL..2..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕunab	بنت	Girl	bint	bint
حصان	Horse	ħuʕaːn	ħuʕain	ثعبان	Snake	ʔuʕbaːn	ʔuʕbain
اخضر	Green	ʔaxðar	ʔaxðar	اذن	Ear	ʔiðin	ʔiðin
صاروخ	Rocket	ʕaːruːx	ʕaːruːx	مقص	Scissors	maqaːʕ	maqaʕ
يد	Hand	jad	jad	ضفدع	Frog	ðufdaʕ	ðufdaʕ
ذيل	Tail	ðeːl	del	طبلة	Drum	ṭabla	ṭabla
رمان	Pomegranate	rummaːn	rummaːn	قطار	Train	qiṭaːr	giṭaːr
موز	Banana	muz	muz	خيط	Thread	xeːṭ	xeṭ
ظرف	Envelope	ðarf	ðarf	ببغاء	Parrot	baʁbaʁaːn	baʁbaʁaːn
ليمون	Lemon	lajmuːn	lajmuːn	ازرق	Blue	ʔazraq	ʔazrag
نظارة	Eyeglasses	naððaːra	naððaːra	ملك	King	maliːk	maliːk
جمل	Camel	ʒamal	ʒamal	هدية	Gift	hadija	hadija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	ðahab	dahab
وردة	Rose	warda	warda	اسد	Lion	ʔasad	ʔasad
ابيض	White	ʔabjaḍ	ʔabjaḍ	تفاح	Apple	tuffaːħ	tuffaːħ
فار	Rat	faːr	faːr	كتاب	Book	kitaːb	kitaːb

DATA COLLECTION SHEET : CONTROL..3..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒuzar	بقرة	Cow	baqarə	bagarə
دجاجة	Hen	duʒa:ʒa	duʒaʒa	مكواه	Iron	makwa	makwa
خروف	Sheep	xaru:f	xaru:f	صور	Pictures	ʃuwar	ʃuwar
زرافة	Giraffe	zara:fa	Zara:fa	واحد	One	wahid	wahid
سمكة	Fish	samaka	Samaka	اثنين	Two	ʔiθnen	ʔitnen
شمس	Sun	ʃams	ʃams	ثلاثة	Three	θala:θa	tala:ta
فراشة	Butterfly	fara:ʃa	fara:ʃa	اربعة	Four	ʔarbaʕa	ʔarbaʕa
غزال	Deer	ɣaza:l	ɣaza:l	خمسة	Five	xamsa	xamsa
ولد	Boy	walad	walad	ستة	Six	sitta	sitta
كرسي	Chair	kursi:	kursi:	سبعة	Seven	sabʕa	sabʕa
باب	Door	ba:b	ba:b	ثمانية	Eight	θama:nja	tama:nja
سلم	Ledder	sullam	sullam	تسعة	Nine	tisʕa	tisʕa
مفتاح	Key	mufta:ħ	mufta:ħ	عشرة	Ten	ʕaʃara	ʕaʃara
زهور	Flowers	zuhu:r	zuhur	هدهد		hudhud	hudhud
طيور	Birds	tiju:r	tiyur				
قطة	Cat	qitta	qitta				

DATA COLLECTION SHEET : CONTROL..4.

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒuzar	بقرة	Cow	baqarə	bagara
دجاجة	Hen	duʒa:ʒa	duʒaʒa	مكواه	Iron	makwa	makwa
خروف	Sheep	xaru:f	xaru:f	صور	Pictures	ʃuwar	ʃuwar
زرافة	Giraffe	zara:fa	zara:fa	واحد	One	wahid	wahid
سمكة	Fish	samaka	samaka	اثنين	Two	ʔiθnen	ʔitnen
شمس	Sun	ʃams	ʃams	ثلاثة	Three	θala:θa	tala:ta
فراشة	Butterfly	fara:ʃa	fara:ʃa	اربعة	Four	ʔarbaʕa	ʔarbaʕa
غزال	Deer	ɣaza:l	ɣaza:l	خمسة	Five	xamsa	xamsa
ولد	Boy	walad	walad	ستة	Six	sitta	sitta
كرسي	Chair	kursi:	kursi:	سبعة	Seven	sabʕa	sabʕa
باب	Door	ba:b	ba:b	ثمانية	Eight	θama:nja	tama:nja
سلم	Ledder	sullam	sullam	تسعة	Nine	tisʕa	tisʕa
مفتاح	Key	mufta:ħ	mufta:ħ	عشرة	Ten	ʕaʃara	ʕaʃara
زهور	Flowers	zuhu:r	zuhu:r	هدهد		hudhud	hudhud
طيور	Birds	ṭiju:r	ṭiju:r				
قطة	Cat	qiṭṭa	qiṭṭa				

DATA COLLECTION SHEET : CONTROL..4..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕunab	بنت	Girl	bint	bint
حصان	Horse	ħuʃaːn	ħuʃaːn	ثعبان	Snake	θuʃbaːn	tuʃbaːn
اخضر	Green	ʔaxðar	ʔaxðar	اذن	Ear	ʔiðaːn	ʔiðin
صاروخ	Rocket	ʃaːruːx	ʃaruːx	مقص	Scissors	maqaːʃ	magaʃ
يد	Hand	jad	jad	ضفدع	Frog	ðufdaʕ	ðufdaʕ
ذيل	Tail	ðeːl	del	طبلة	Drum	ṭabla	ṭabla
رمان	Pomegranate	rummaːn	rummaːn	قطار	Train	qitaːr	gitaːr
موز	Banana	muz	muz	خيط	Thread	xeṭ	xeṭ
ظرف	Envelope	ðarf	ẓarf	ببغاء	Parrot	babbaɣaːn	babbaɣaːn
ليمون	Lemon	lajmuːn	lajmuːn	ازرق	Blue	ʔazraq	ʔazraq
نظارة	Eyeglasses	naððaːra	naṭṭaːra	ملك	King	malik	malik
جمل	Camel	ʒamal	ʒamal	هدية	Gift	hadija	hadija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	ðahab	dahab
وردة	Rose	warda	warda	اسد	Lion	ʔasad	ʔasad
ابيض	White	ʔabjaḍ	ʔabjaḍ	تفاح	Apple	tuffaːħ	tuffaːħ
فار	Rat	faːr	far	كتاب	Book	kitaːb	kitaːb

DATA COLLECTION SHEET : CONTROLS...5.

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕunab	بنت	Girl	bint	bint
حصان	Horse	ħuʕaːn	ħuʕaːn	ثعبان	Snake	ʊuʕbaːn	ʊuʕbaːn
أخضر	Green	ʔaxḍar	ʔaxḍar	أذن	Ear	ʔiḍaːn	ʔiḍaːn
صاروخ	Rocket	ʕaːruːx	ʕaːruːx	مقص	Scissors	maqaṣ	maqaːṣ
يد	Hand	jad	jad	ضفدع	Frog	ḍufdaʕ	ḍufdaʕ
ذيل	Tail	ðeːl	ðeːl	طبلة	Drum	ṭabla	ṭabla
رمان	Pomegranate	rummaːn	rummaːn	قطار	Train	qiṭaːr	qiṭaːr
موز	Banana	muz	muz	خيط	Thread	xeṭ	xeṭ
ظرف	Envelope	ðarf	ðarf	ببغاء	Parrot	bəbbəgaːʔ	bəbbəgaːʔ
ليمون	Lemon	lajmuːn	lajmuːn	أزرق	Blue	ʔazraq	ʔazraq
نظارة	Eyeglasses	naððaːra	naððaːra	ملك	King	malik	malik
جمل	Camel	ʒamal	ʒamal	هدية	Gift	hadija	hadija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	ðahab	ðahab
وردة	Rose	warda	warda	أسد	Lion	ʔasad	ʔasad
أبيض	White	ʔabjaḍ	ʔabjaḍ	تفاح	Apple	tuffaːħ	tuffaːħ
فأر	Rat	faːr	faːr	كتاب	Book	kitaːb	kitaːb

DATA COLLECTION SHEET : CONTROL..5..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒuzar	بقرة	Cow	baqarə	baqarə
دجاجة	Hen	duʒa:ʒa	duʒa:ʒa	مكواه	Iron	makwa	makwa
خروف	Sheep	xaru:f	xaru:f	صور	Pictures	ʂuwar	ʂuwar
زرافة	Giraffe	zara:fa	zara:fa	واحد	One	wahid	wahid
سمكة	Fish	samaka	samaka	اثنين	Two	ʔiθnen	ʔiθnen
شمس	Sun	ʃams	ʃams	ثلاثة	Three	θala:θa	θala:θa
فراشة	Butterfly	fara:ʃa	fara:ʃa	اربعة	Four	ʔarbaʂa	ʔarbaʂa
غزال	Deer	ɣaza:l	ɣaza:l	خمسة	Five	xamsa	xamsa
ولد	Boy	walad	walad	ستة	Six	sitta	sitta
كرسي	Chair	kursi:	kursi:	سبعة	Seven	sabʂa	sabʂa
باب	Door	ba:b	ba:b	ثمانية	Eight	θamanja	θamanja
سلم	Ledder	sullam	sullam	تسعة	Nine	tisʂa	tisʂa
مفتاح	Key	mufta:ħ	mufta:ħ	عشرة	Ten	ʂaʃara	ʂaʃa
زهور	Flowers	zhu:r	zhu:r	هدهد		hudhud	hudhud
طيور	Birds	tiju:r	tiju:r				
قطة	Cat	qitta	qitta				

DATA COLLECTION SHEET : CONTROL..6..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒuzar	بقرة	Cow	baqarə̆	baqarə
دجاجة	Hen	duʒaiʒa	duʒaiʒa	مكواه	Iron	makwa	makwa
خروف	Sheep	xaru:f	xaru:f	صور	Pictures	ʂuwar	ʂuwar
زرافة	Giraffe	zara:fa	zara:fa	واحد	One	wahid	wahid
سمكة	Fish	samaka	samaka	اثنين	Two	ʔiθnen	ʔiθnen
شمس	Sun	ʃams	ʃams	ثلاثة	Three	θala:θa	θala:θa
فراشة	Butterfly	fara:ʃa	faraiʃa	اربعة	Four	ʔarbaʂa	ʔarbaʂa
غزال	Deer	ɣaza:l	ɣazzil	خمسة	Five	xamsa	xamsa
ولد	Boy	walad	walad	ستة	Six	sitta	sitta
كرسي	Chair	kursi:	kursi:	سبعة	Seven	sabʂa	sabʂa
باب	Door	ba:b	ba:b	ثمانية	Eight	θama:nja	θama:nja
سلم	Ledder	sullam	sullam	تسعة	Nine	tisʂa	tisʂa
مفتاح	Key	muftaːħ	muftaiħ	عشرة	Ten	ʂaʃara	ʂaʃara
زهور	Flowers	zuhu:r	zuhuir	هدهد		hudhud	hudhud
طيور	Birds	tiju:r	tijuir				
قطة	Cat	qitta	qitta				

DATA COLLECTION SHEET : CONTROL..6..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕunab	بنت	Girl	bint	bint
حصان	Horse	ħuʕaːn	ħuʕaːn	ثعبان	Snake	θuʕbaːn	θuʕbaːn
اخضر	Green	ʔaxðar	ʔaxðar	اذن	Ear	ʔiðaːn	ʔiðaːn
صاروخ	Rocket	ʕaːruːx	ʕaːruːx	مقص	Scissors	maqaːs	maqaːs
يد	Hand	jad	jad	ضفدع	Frog	ðufdaʕ	ðufdaʕ
ذيل	Tail	ðeːl	ðeːl	طبلة	Drum	ṭabla	ṭabla
رمان	Pomegranate	rummaːn	rummaːn	قطار	Train	qitaːr	qitaːr
موز	Banana	muːz	muːz	خيط	Thread	xeṭ	xeṭ
ظرف	Envelope	ðarf	ðarf	ببغاء	Parrot	baṛbaṛaːn	baṛbaṛaːn
ليمون	lemon	lajmuːn	lajmuːn	ازرق	Blue	ʔazraq	ʔazraq
نظارة	Eyeglasses	naððaːra	naððaːra	ملك	king	malik	malik
جمل	Camel	ʒamal	ʒamal	هدية	Gift	hadija	hadija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	ðahab	ðahab
وردة	Rose	Warda	Warda	اسد	Lion	ʔasad	ʔasad
ابيض	White	ʔabjaḍ	ʔabjaḍ	تفاح	Apple	tuffaːħ	tuffaːħ
فار	Rat	faːr	faːr	كتاب	Book	kitaːb	kitaːb

DATA COLLECTION SHEET : CONTROL. 7..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕunab	بنت	GirL	bint	bint
حصان	Horse	ħuʕaːn	ħuʕain	ثعبان	Snake	θuʕbaːn	θuʕbaːn
اخضر	Green	ʔaxdar	ʔaxdar	اذن	Ear	ʔiðain	ʔiðin
صاروخ	Rocket	ʕaːruːx	ʕairuːx	مقص	Scissors	maqaːs	maqaːs
يد	Hand	jad	jad	ضفدع	frog	ðufdaʕ	ðufdaʕ
ذيل	Tail	ðel	ðel	طبله	Drum	ṭabla	ṭabla
رمان	Pomegranate	rummaːn	rummaːn	قطار	Train	qitaːr	qitaːr
موز	Banana	muz	muz	خيط	Thread	xeṭ	xeṭ
ظرف	Envelope	ðarf	ðarf	ببغاء	Parrot	babbaɣaːn	babbaɣaːn
ليمون	lemon	lajmuːn	lajmuːn	ازرق	Blue	ʔazraq	ʔazraq
نظاره	Eyeglasses	naððaːra	naððaːra	ملك	king	malik	malik
جمل	Camel	ʒamal	ʒamal	هديه	Gift	hadija	hadija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	ðahab	ðahab
ورده	Rose	warda	warda	اسد	Lion	ʔasad	ʔasad
ابيض	White	ʔabjaḍ	ʔabjaḍ	تفاح	Apple	tuffaːħ	tuffaːħ
فار	Rat	faːr	faːr	كتاب	Book	kitaːb	kitaːb

DATA COLLECTION SHEET : CONTROL..7..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒuzar	بقرة	Cow	baqara	bəqarə
دجاجة	Hen	duʒaiʒa	diʒaiʒa	مكواه	Iron	makwa	məkwə
خروف	Sheep	xaru:f	Xaru:f	صور	Pictures	Suwar	Suwar
زرافة	Giraffe	zara:fa	zara:fa	واحد	One	wahid	wəhid
سمكة	Fish	samaka	Samaka	اثنين	Two	?iθnen	?iθnen
شمس	Sun	ʃams	ʃams	ثلاثة	Three	θala:θa	θalaːθə
فراشة	Butterfly	faraʃa	faraʃa	اربعة	Four	?arbaSa	?arbəSə
غزال	Deer	ɣaza:l	ɣaza:l	خمسة	Five	xamSa	xəmSə
ولد	Boy	walad	walad	ستة	Six	sitta	sittə
كرسي	Chair	kursi:	kursi:	سبعة	Seven	sabSa	səbSə
باب	Door	ba:b	ba:b	ثمانية	Eight	θamanja	θəmanjə
سلم	Ledder	sullam	sullam	تسعة	Nine	tisSa	tisSə
مفتاح	Key	muftaːh	muftaːh	عشرة	Ten	Saʃara	Saʃarə
زهور	Flowers	zhuːr	zuhuːr	هدهد		hudhud	hudhud
طيور	Birds	tijuːr	tijuːr				
قطة	Cat	qitta	qittə				

DATA COLLECTION SHEET : CONTROL.8...

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
عنب	Grape	ʕunab	ʕunab	بنت	Girl	bint	bint
حصان	Horse	ħuʕa:n	ħuʕa:n	ثعبان	Snake	θuʕba:n	θuʕba:n
اخضر	Green	ʔaxđar	ʔaxđar	اذن	Ear	ʔiđin	ʔiđin
صاروخ	Rocket	ʕa:ru:x	ʕa:ru:x	مقص	Scissors	maqaʕ	maqaʕ
يد	Hand	jad	jad	ضفدع	Frog	đufdaʕ	đufdaʕ
ذيل	Tail	đel	đel	طبله	Drum	ŧabla	ŧabla
رمان	Pomegranate	rumma:n	rumma:n	قطار	Train	qiŧa:r	qiŧa:r
موز	Banana	muz	muz	خيط	Thread	xeŧ	xeŧ
ظرف	Envelope	đarf	đarf	بغبغان	Parrot	baɣbaɣa:n	baɣbaɣa:n
ليمون	lemon	lajmu:n	lajmu:n	ازرق	Blue	ʔazraq	ʔazraq
نظاره	Eyeglasses	nađđa:ra	nađđa:ra	ملك	King	malik	malik
جمل	Camel	ʒamal	ʒamal	هديه	Gift	hadija	hadija
علم	Flag	ʕalam	ʕalam	ذهب	Gold	đahab	đahab
ورده	Rose	Warda	Warda	اسد	Lion	ʔasad	ʔasad
ابيض	White	ʔabjađ	ʔabjađ	تفاح	Apple	tuffa:ħ	tuffa:ħ
فار	Rat	fa:r	fa:r	كتاب	Book	kiŧa:b	kiŧab

DATA COLLECTION SHEET : CONTROL. 8..

Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription	Arabic Ortho. Gloss	English Ortho. Gloss	Adult Phonetic Transcription	Child Phonetic Transcription
جزر	Carrot	ʒuzar	ʒuzar	بقره	Cow	baqara	baqara
دجاجه	Hen	duʒa:ʒa	duʒa:ʒa	مكواه	Iron	makwa	mak:wa
خروف	Sheep	xaru:f	xaru:f	صور	Pictures	ʃuwar	ʃuwar
زرافه	Giraffe	zara:fa	zara:fa	واحد	One	wahid	wahid
سمكه	Fish	samaka	samaka	اثنين	Two	ʔiθnen	ʔiθnen
شمس	Sun	ʃams	ʃams	ثلاثه	Three	θala:θa	θala:θa
فراشه	Butterfly	fara:ʃa	fara:ʃa	اربعه	Four	ʔarbaʃa	ʔarbaʃa
غزال	Deer	ɣaza:l	ɣaza:l	خمسه	Five	xamsa	xamsa
ولد	Boy	walad	walad	سته	Six	sitta	sitta
كرسي	Chair	kursi:	kursi:	سبعه	Seven	sabʃa	sabʃa
باب	Door	ba:b	ba:b	ثمانيه	Eight	θama:nja	θama:nja
سلم	Ledder	sullam	sullam	تسعه	Nine	tisʃa	tisʃa
مفتاح	Key	mufta:ħ	mufta:ħ	عشره	Ten	ʃaʃara	ʃaʃara
زهور	Flowers	zuhu:r	zuhu:r	هدهد		hudhud	hud:hud
طيور	Birds	ṭiju:r	ṭiju:r				
قطه	Cat	qiṭṭa	qiṭṭa				

Table Correspondences In Consonant Clusters - Word Final
Subject ...I....

Target

Child Realisation	nt	ms	rf	kw	rd	rs	tt	ms	bl	tt	bʧ	sʧ	nj
nt	1												
m		1											
rf			1										
kw				1									
rd					1								
rθ						1							
tt							1						
mθ								1					
bl									1				
tt										1			
bʧ											1		
sʧ												1	
nj													1

Table Correspondences in Consonant Clusters - Word Final
Subject ع.....

Child Realisation \ Target	nt	ms	rf	kw	rd	rs	tt	ms	bl	tt	bʃ	sʕ	nj
nk	1												
m		1											
r f			1										
kw				1									
r k					1								
r θ						1							
ʕ							1						
m θ								1					
b l									1				
k										1			
b ʔ											1		
O ʔ												1	
n j													1

Table Correspondences in Consonant Clusters - Word Final
Subject ..3....

Target

Child Realisation	nt	ms	rf	kw	rd	rs	tt	ms	bl	t t	bʧ	sʧ	nj
n	1												
m		1											
f			1										
hw				1									
r x					1								
r x						1							
h							1						
m h								1					
b l									1				
ʔ										1			
bʧ											1		
hʧ												1	
n j													1

Table **Correspondences in Consonant Clusters - Word Final**
Subject ...4....

Target

Child Realisation	nt	ms	rf	kw	rd	rs	t-t	ms	bl	t t	bʃ	sʃ	nj
nk	1												
mx		1											
r f			1										
kw				1									
r g					1								
r x						1							
kk							1						
m x								1					
b l									1				
kk										1			
b ʃ											1		
x ʃ												1	
n j													1

Table Correspondences in Consonant Clusters - Word Final
Subject ..5....

Child Realisation \ Target	nt	ms	rf	kw	rd	rs	tt	ms	bl	tt	bʃ	sʃ	nj
n	1												
mx		1											
jf			1										
kw				1									
jd					1								
jθ						1							
tt							1						
mx								1					
bl									1				
kk										1			
bʃ											1		
θʃ												1	
nj													1

Table **Correspondences in Consonant Clusters - Word Final**
Subject ....6..

Target

Child Realisation	nt	ms	rf	kw	rd	rs	tw	ms	bl	tt	bʃ	sʃ	nj
nat	1												
mas		1											
rf			1										
kw				1									
rd					1								
rs						1							
tw							1						
mas								1					
bal									1				
t										1			
bʃ											1		
sʃ												1	
nj													1

Table Correspondences in Consonant Clusters - Word Final
Subject ...7....

Target

Child Realisation	nt	ms	rf	kw	rd	rs	tt	ms	bl	tt	bʃ	sʃ	nj
nʔ	1												
m		1											
ʔf			1										
ʔw				1									
rʔ					1								
lʔ						1							
ʔt							1						
mʔ								1					
bl									1				
ʔʔ										1			
bʃ											1		
θʃ												1	
nj													1

Table Correspondences in Consonant Clusters - Word Final
Subject ...8..

Target

Child Realisation	nt	ms	rf	kw	rd	rs	tt	ms	bl	tt	bʃ	sʃ	nj
n t	1												
m x		1											
l f			1										
k w				1									
l d					1								
l x						1							
t t							1						
m x								1					
b l									1				
t t										1			
b ʃ											1		
θ ʃ												1	
n j													1

Table **Correspondences in Consonant Clusters - Word Final Control ...ɹ....**

Target

Child Realisation	nt	ms	rf	kw	rd	rs	t̚t̚	ms	bl	tt	bʃ	sʃ	nj
nt	1												
ms		1											
rf			1										
kw				1									
rd					1								
rs						1							
t̚t̚							1						
ms								1					
bl									1				
tt										1			
bʃ											1		
sʃ												1	
nj													1

Table **Correspondences in Consonant Clusters - Word Final Control ..2.....**

Target

Child Realisation	nt	ms	rf	kw	rd	rs	t̚t̚	ms	bl	tt	bʃ	sʃ	nj
nt	1												
ms		1											
rf			1										
kw				1									
rd					1								
rs						1							
t̚t̚							1						
ms								1					
pl									1				
tt										1			
pʃ											1		
sʃ												1	
nj													1

Table **Correspondences In Consonant Clusters - Word Final**
Control ...4...

Target

Child Realisation	nt	ms	rf	kw	rd	rs	~~tt~~	ms	bl	tt	bʃ	sʃ	nj
nt	1												
ms		1											
rf			1										
tw				1									
rd					1								
rs						1							
~~tt~~							1						
ms								1					
bl									1				
tt										1			
bʃ											1		
sʃ												1	
nj													1

Table Correspondences in Consonant Clusters - Word Final
Control ..ʃ....

Target

Child Realisation	nt	ms	rf	kw	rd	rs	tt	ms	bl	tt	bʃ	sʃ	nj
nt	1												
ms		1											
rf			1										
kw				1									
rd					1								
rs						1							
tt							1						
ms								1					
bl									1				
tt										1			
bʃ											1		
sʃ												1	
nj													1

Table Correspondences In Consonant Clusters - Word Final
Control .....7..

Target

Child Realisation	nt	ms	rf	kw	rd	rs	ŧŧ	ms	bl	tt	bʃ	sʃ	nj
nt	1												
ms		1											
rf			1										
kw				1									
rd					1								
rs						1							
ŧŧ							1						
ms								1					
bl									1				
tt										1			
bʃ											1		
sʃ												1	
nj													1

Table **Correspondences in Consonant Clusters - Word Final Control ....8..**

Child Realisation \ Target	nt	ms	rf	kw	rd	rs	t̶t̶	ms	bl	tt	bʃ	sʃ	nj
nt	1												
ms		1											
rf			1										
kw				1									
rd					1								
rs						1							
t̶t̶							1						
ms								1					
bl									1				
tt										1			
bʃ											1		
sʃ												1	
nj													1

Table General Phonetic Inventories

For Subject .....

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal									
Plosive									
Fricative									
Trill									
Approximate									

For Subject ..2..

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b				k	q		ʔ	
Fricative	f	θ			x			h	
Trill			r						
Approximate	(w)		l	j	(w)				

Table General Phonetic Inventories

For Subject ..3...

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b							ʔ	
Fricative	f	θ			x		ħ ʕ	h	
Trill			r						
Approximate	(w)		l	j	(w)				

For Subject ..4....

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		d		k g			ʔ	
Fricative	f	θ		ʃ ʒ	x		ħ ʕ	h	
Trill			r						
Approximate	(w)		l	j	(w)				

Table General Phonetic Inventories

For Subject ...5...

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t d (ʈ)		k g	q	(ʡ)	ʔ	
Fricative	f	θ		ʃ ʒ	x ɣ		ħ ʕ	h	
Trill									
Approximate	(w)		l	j	(w)				

For Subject ...6...

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t d (ʈ)		k g	q	(ʡ)	ʔ	
Fricative	f	θ	s z	ʃ ʒ	x ɣ		ħ ʕ	h	
Trill			r						
Approximate	(w)		l	j	(w)				

Table General Phonetic Inventories

For Subject ...7...

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t d (ʧ)		g		(ʡ)	ʔ	
Fricative	f	θ			x ɣ		ħ ʕ	h	
Trill			r						
Approximate	(w)		l	j	(w)				

For Subject ...8...

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t d (ʧ)		k g	q	(ʡ)	ʔ	
Fricative	f	θ	z	ʃ ʒ	x ɣ		ħ ʕ	h	
Trill									
Approximate	(w)		l	j	(w)				

Table General Phonetic Inventories

For Control One

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t d (ʧ)		k g		(ʡ)	ʔ	
Fricative	f		s z				ħ ʕ	h	
Trill			r						
Approximate	(w)		l	j	(w)				

For Control Two

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	P		t d (ʧ)		k g		(ʡ)	ʔ	
Fricative	f		s z				ħ ʕ	h	
Trill			r						
Approximate	(w)		l	j	(w)				

Table General Phonetic Inventories

For Control Three

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t d (ŧ) (ð)		k g		(ħ) (ʕ)	ʔ	
Fricative	f		s z (ʃ) (ʒ)	ʃ ʒ	x ɣ		ħ ʕ (ʃ) (ʒ)	h	
Trill			r						
Approximate	(w)		l	j	(w)				

For Control Four

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t d (ŧ) (ð)		k g		(ħ) (ʕ)	ʔ	
Fricative	f		s z (ʃ) (ʒ)	ʃ ʒ	x ɣ		ħ ʕ (ʃ) (ʒ)	h	
Trill			r						
Approximate	(w)		l	j	(w)				

Table General Phonetic Inventories

For Control Five

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t (ŧ) d (ð)		k	q	(ŧ) (ð)	ʔ	
Fricative	f	θ ð̌ (ð̌)	s (ʃ) z	ʃ ʒ	x ɣ		h (ʃ) ʕ (ð̌)	h	
Trill			r						
Approximate	(w)		l	j	(w)				

For Control Six

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t (ŧ) d (ð)		k	q	(ŧ) (ð)	ʔ	
Fricative	f	θ ð̌ (ð̌)	s (ʃ) z	ʃ ʒ	x ɣ		ħ (ʃ) ʕ (ð̌)	h	
Trill			r						
Approximate	(w)		l	j	(w)				

Table **General Phonetic Inventories**

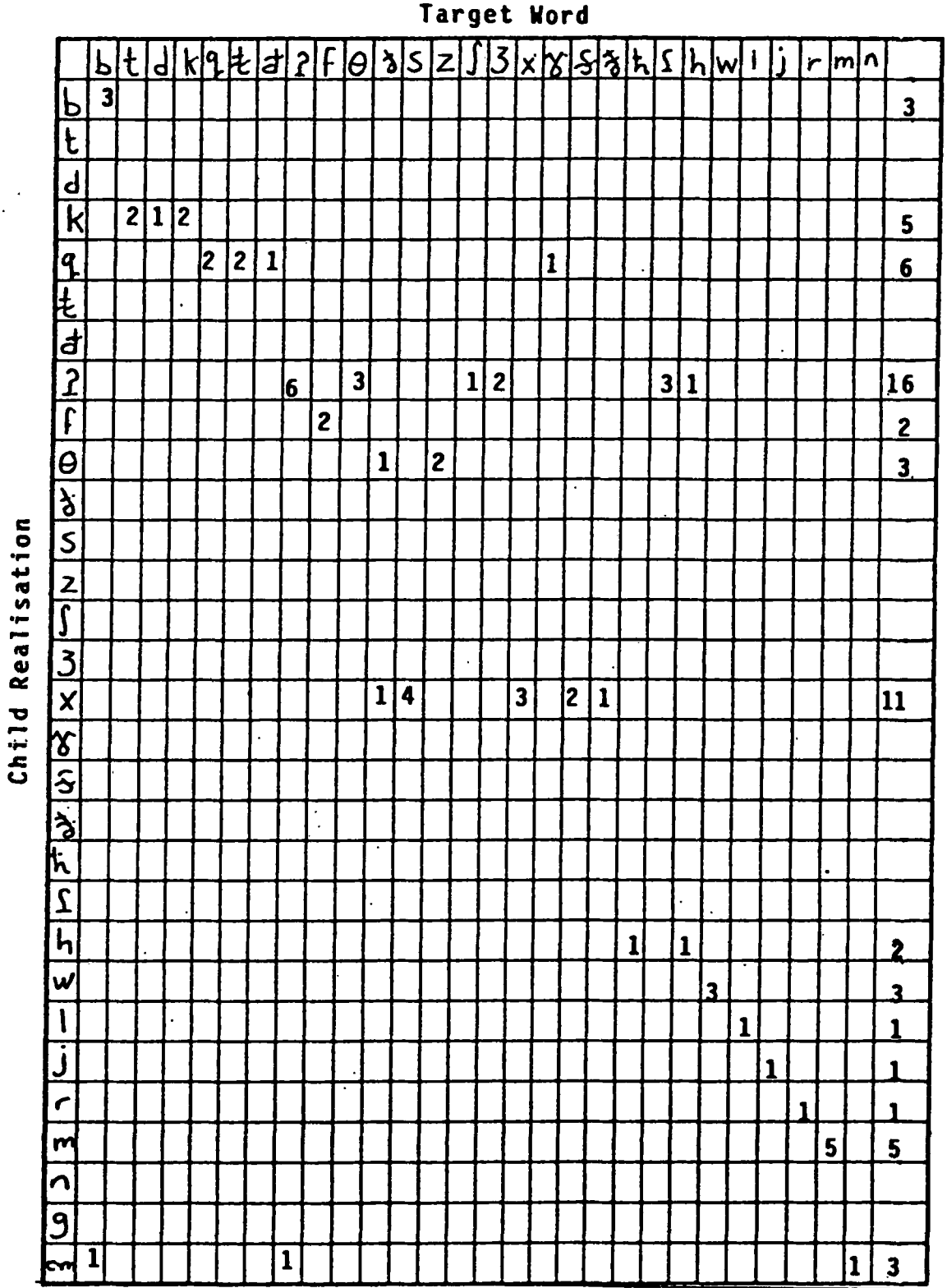
For Control Seven

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t (ʧ) d (ʤ)		k	q	(ʡ) (ɖˤ)	ʔ	
Fricative	f	θ ð (ðˤ)	s (sˤ) z	ʃ ʒ	x ɣ		ħ (ħˤ) ʕ (ʕˤ)	h	
Trill			r						
Approximate	(w)		l	j	(w)				

For Control Eight

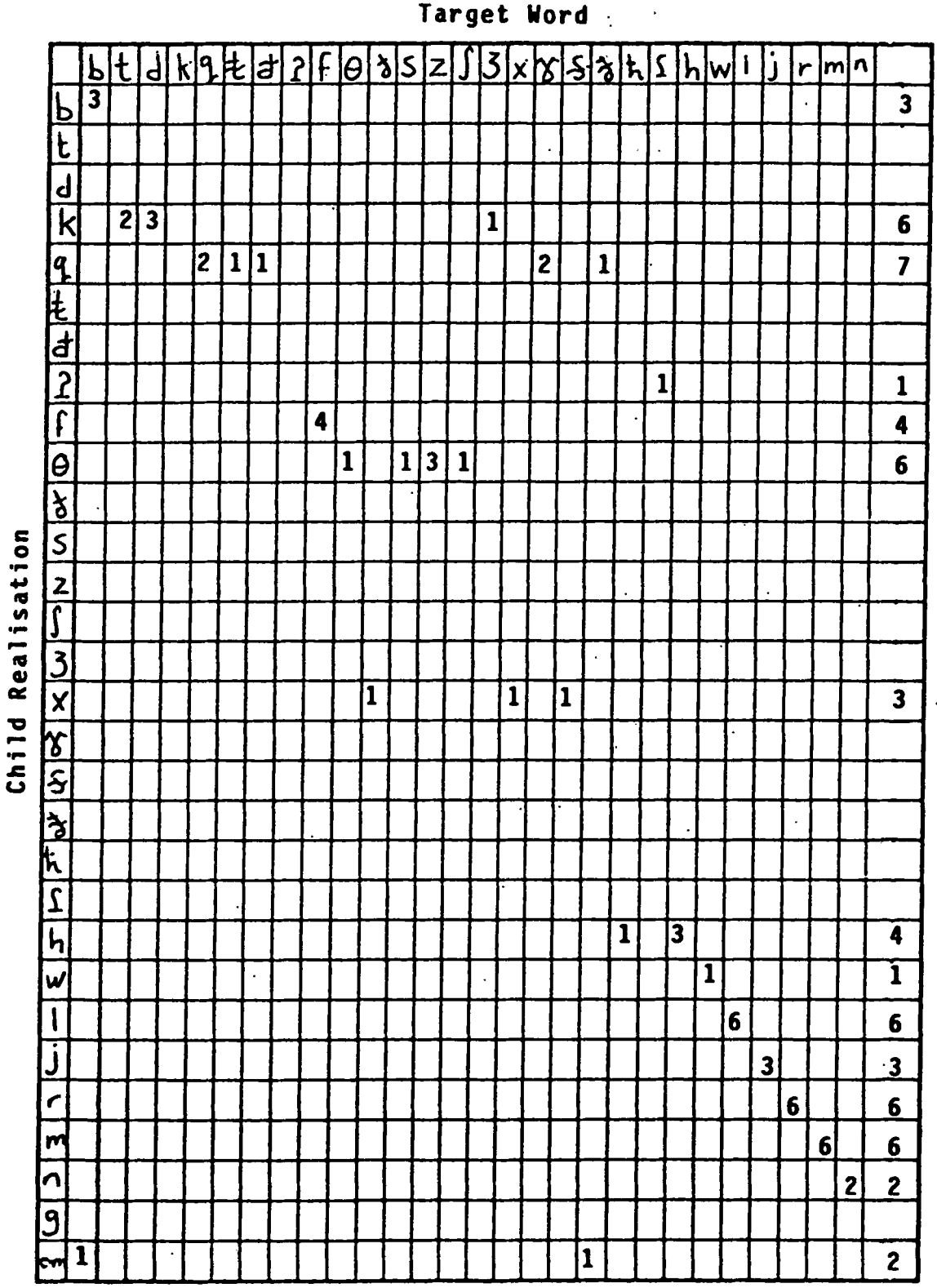
	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal	Other
Nasal	m		n						
Plosive	b		t (ʧ) d (ʤ)		k	q	(ʡ) (ɖˤ)	ʔ	
Fricative	f	θ ð (ðˤ)	s (sˤ) z	ʃ ʒ	x ɣ		ħ (ħˤ) ʕ (ʕˤ)	h	
Trill			r						
Approximate	(w)		l	j	(w)				

Correspondence Matrices for Subject ...2.....



The Analysis of the Phonological Systems of Arabic Speaking Children With
Cleft Palate in Saudia Arabia

Correspondence Matrices for Subject ...2.....



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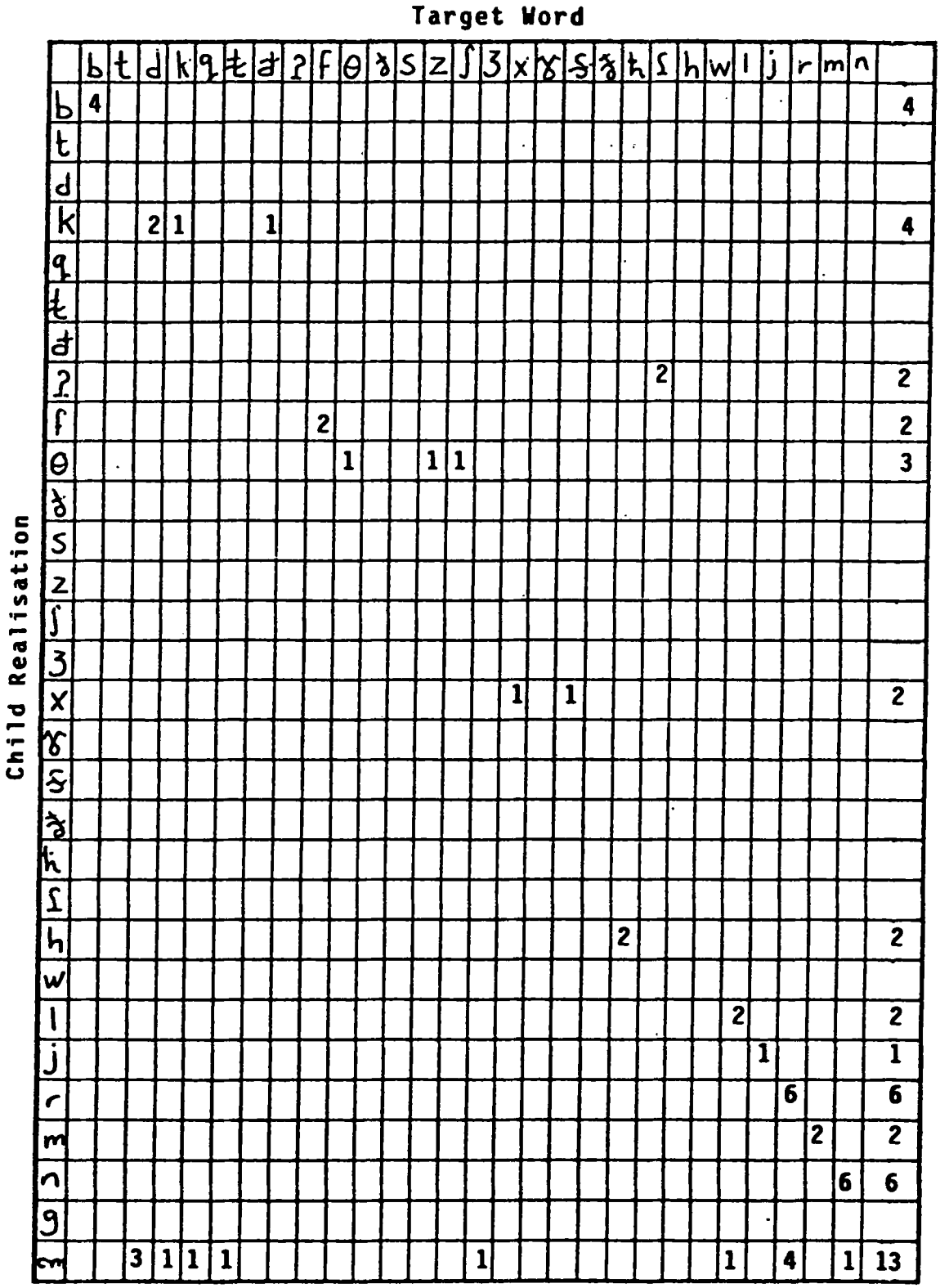
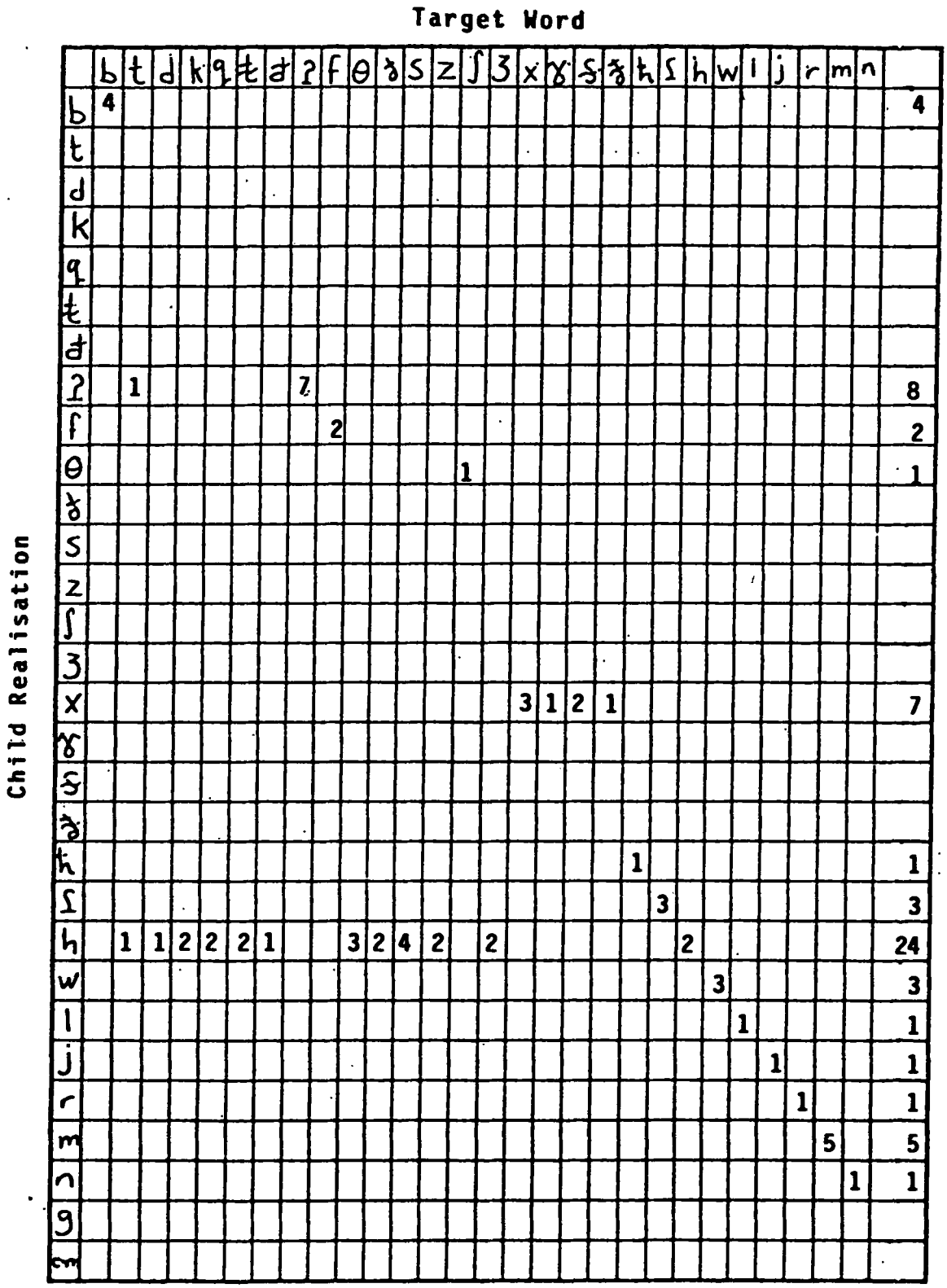
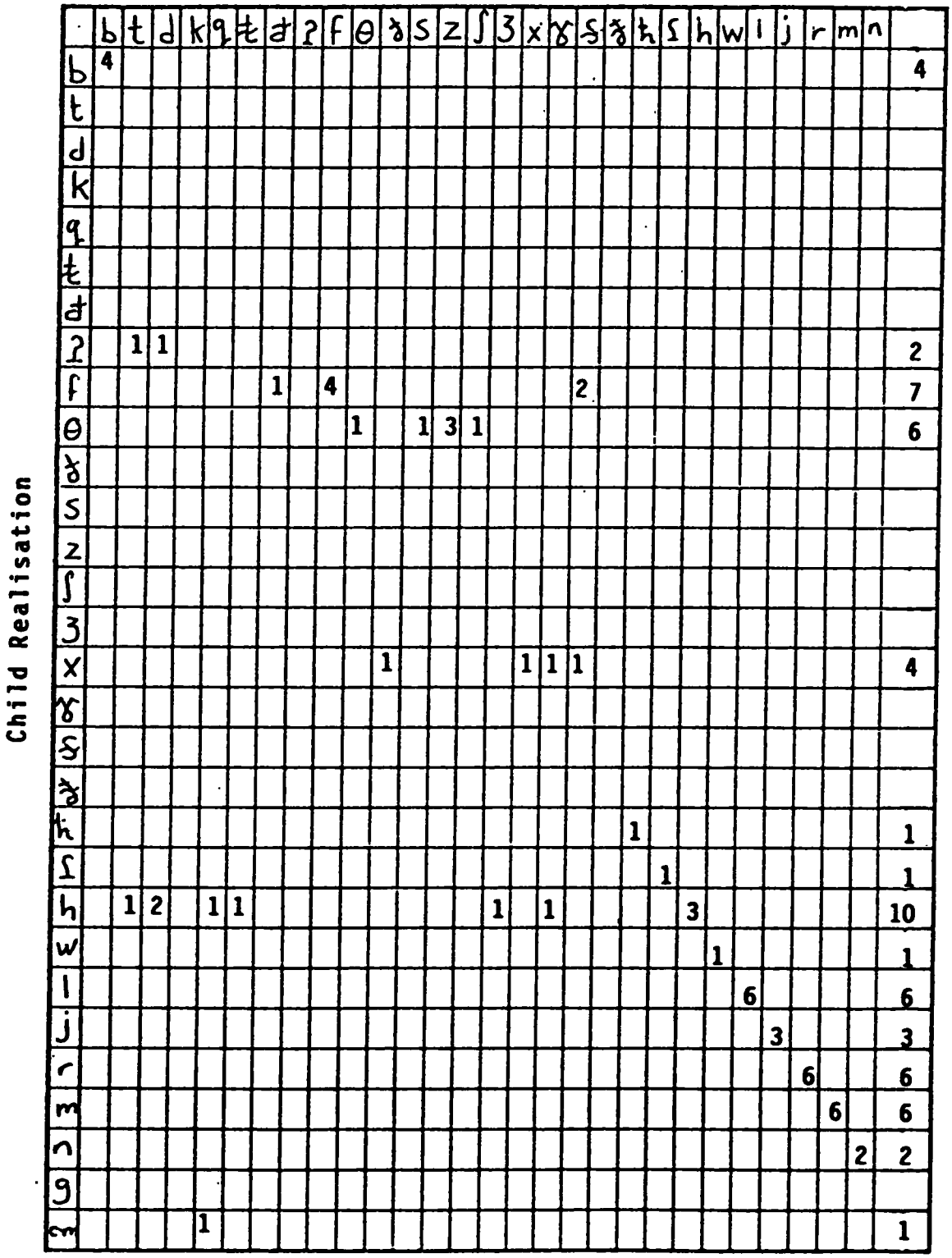


Correspondence Matrices for Subject .....3.....

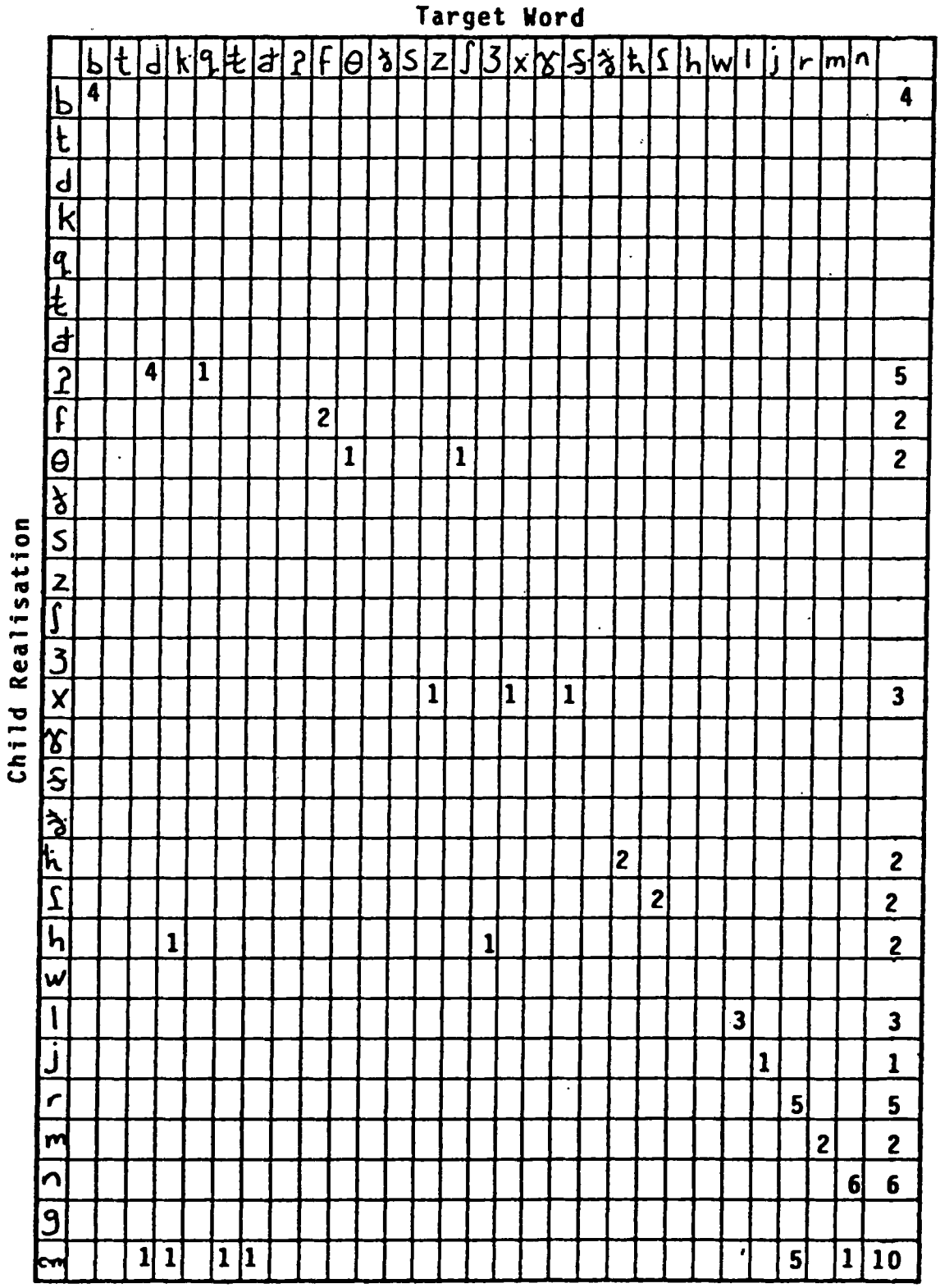


Correspondence Matrices for Subject ...3.....

Target Word



Correspondence Matrices for Subject .....3.....



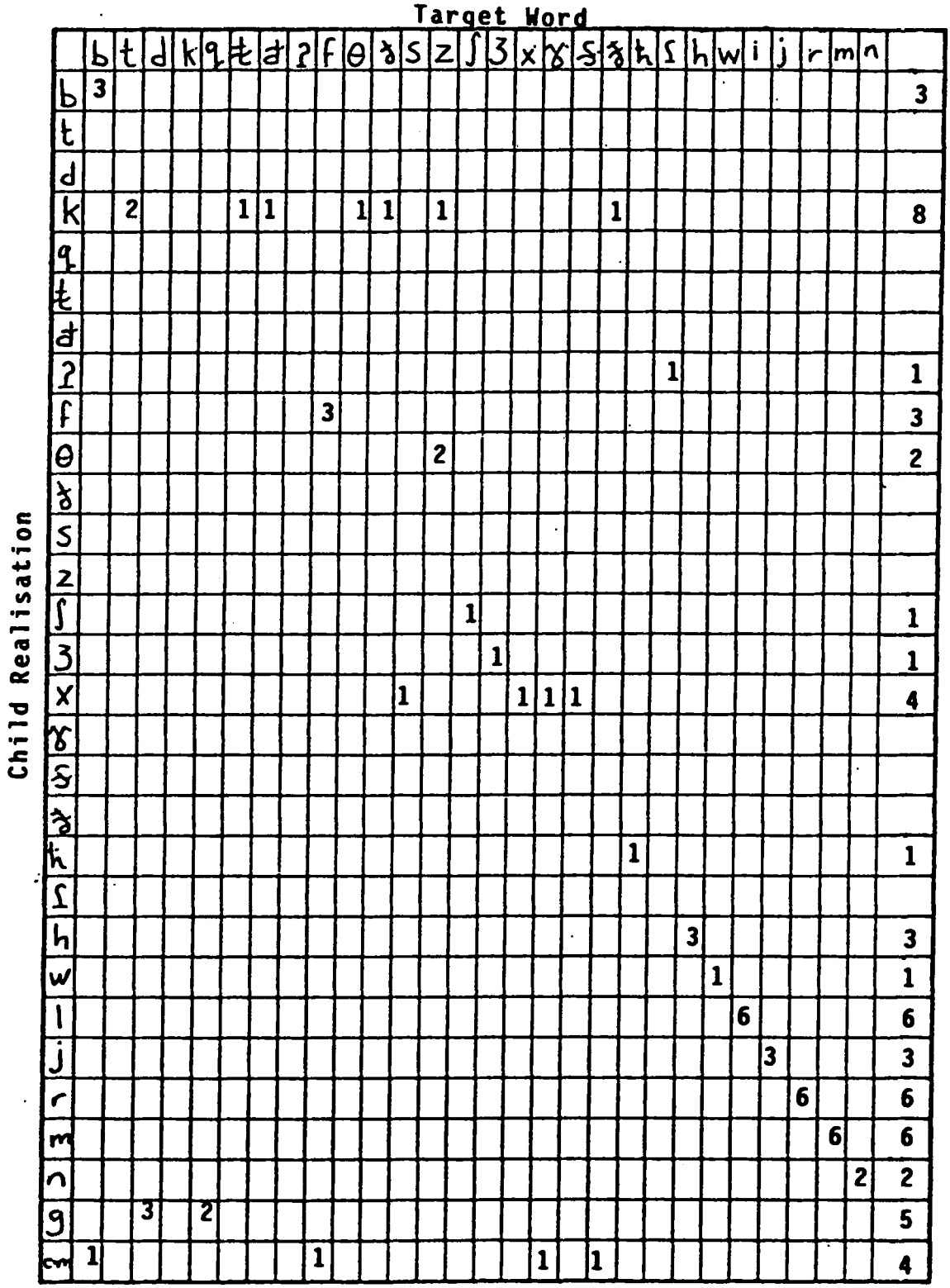
Correspondence Matrices for Subject 4

Target Word

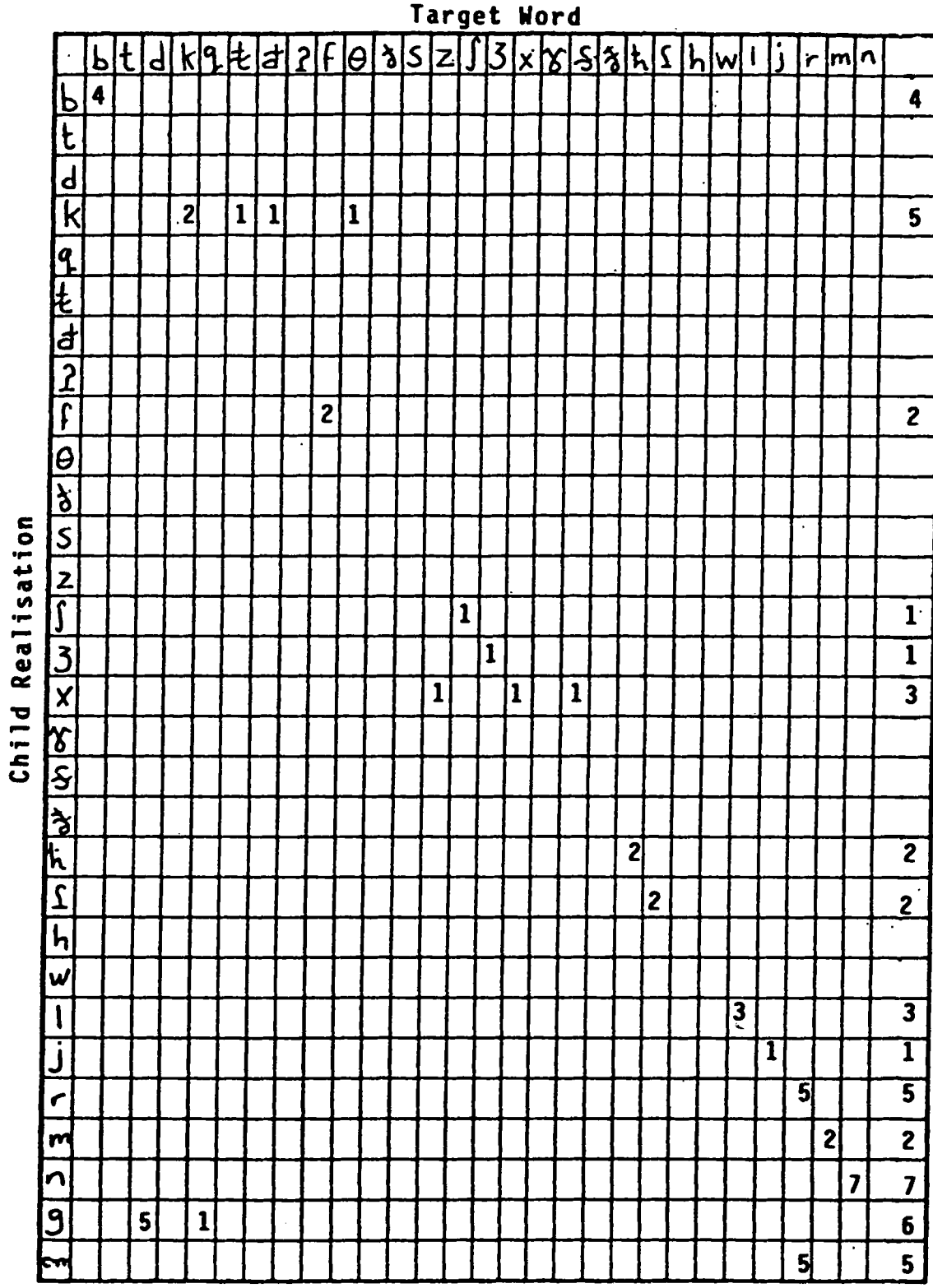
Child Realisation

	b	t	d	k	q	ʧ	ʤ	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ʕ	ʢ	ħ	ʕ	h	w	l	j	r	m	n	
b	3																												3
t																													
d			1																										1
k		2		2		2	1			3																			10
q																													
ʧ																													
ʤ																													
ʔ								7																					7
f									2																				2
θ													2																2
ð																													
s																													
z																													
ʃ														1															1
ʒ															2														2
x												4				3		2	1										10
ɣ																													
ʕ																													
ʢ																													
ħ																				1									1
ʕ																					3								3
h																						2							2
w																							3						3
l																								1					1
j																									1				1
r																										1			1
m																											4		4
n																													
ŋ					2					2																			4
ʔ	1																1										1	1	4

Correspondence Matrices for Subject ....4....



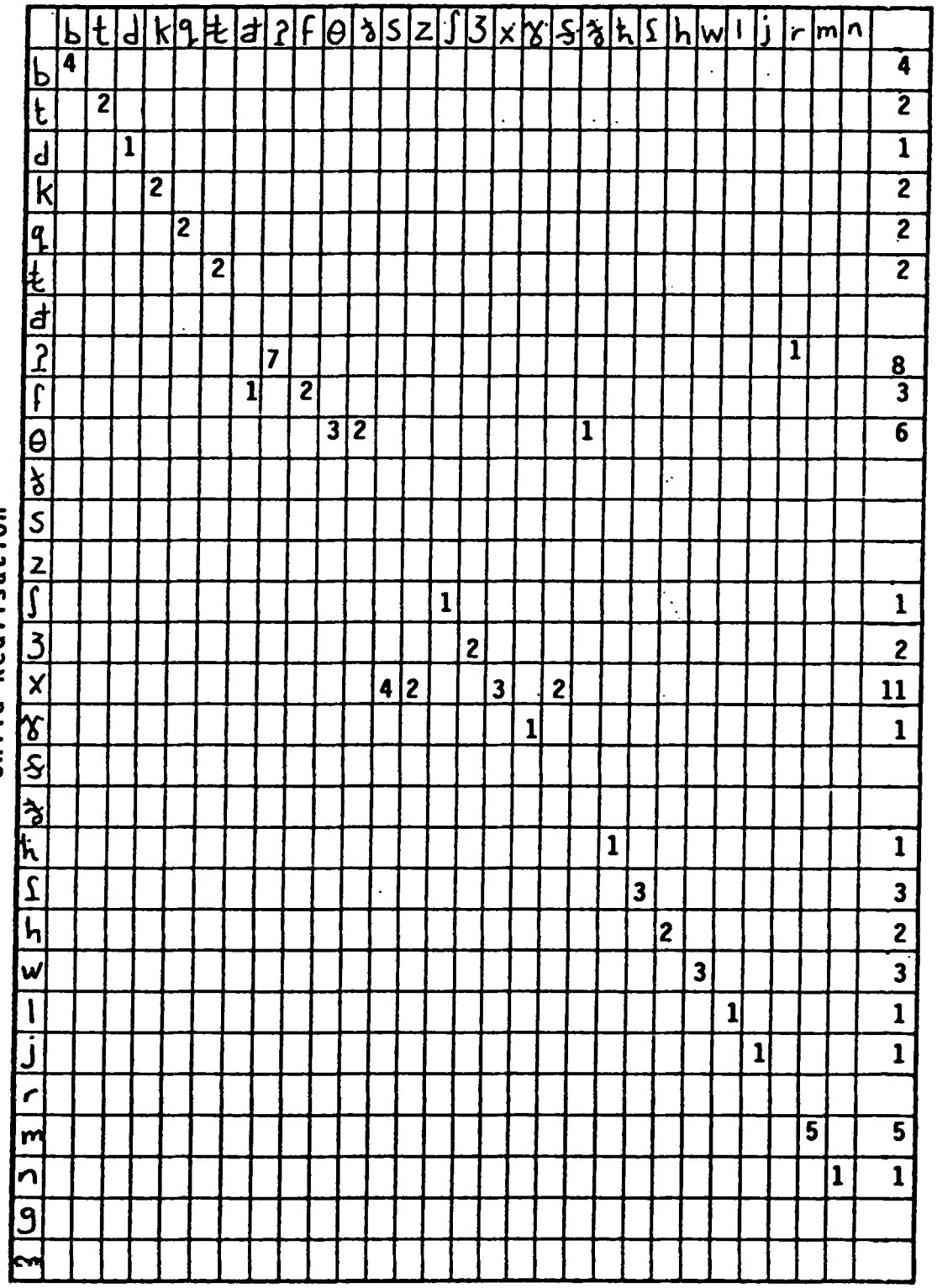
Correspondence Matrices for Subject ....4....



Correspondence Matrices for Subject ...S.....

Target Word

Child Realisation



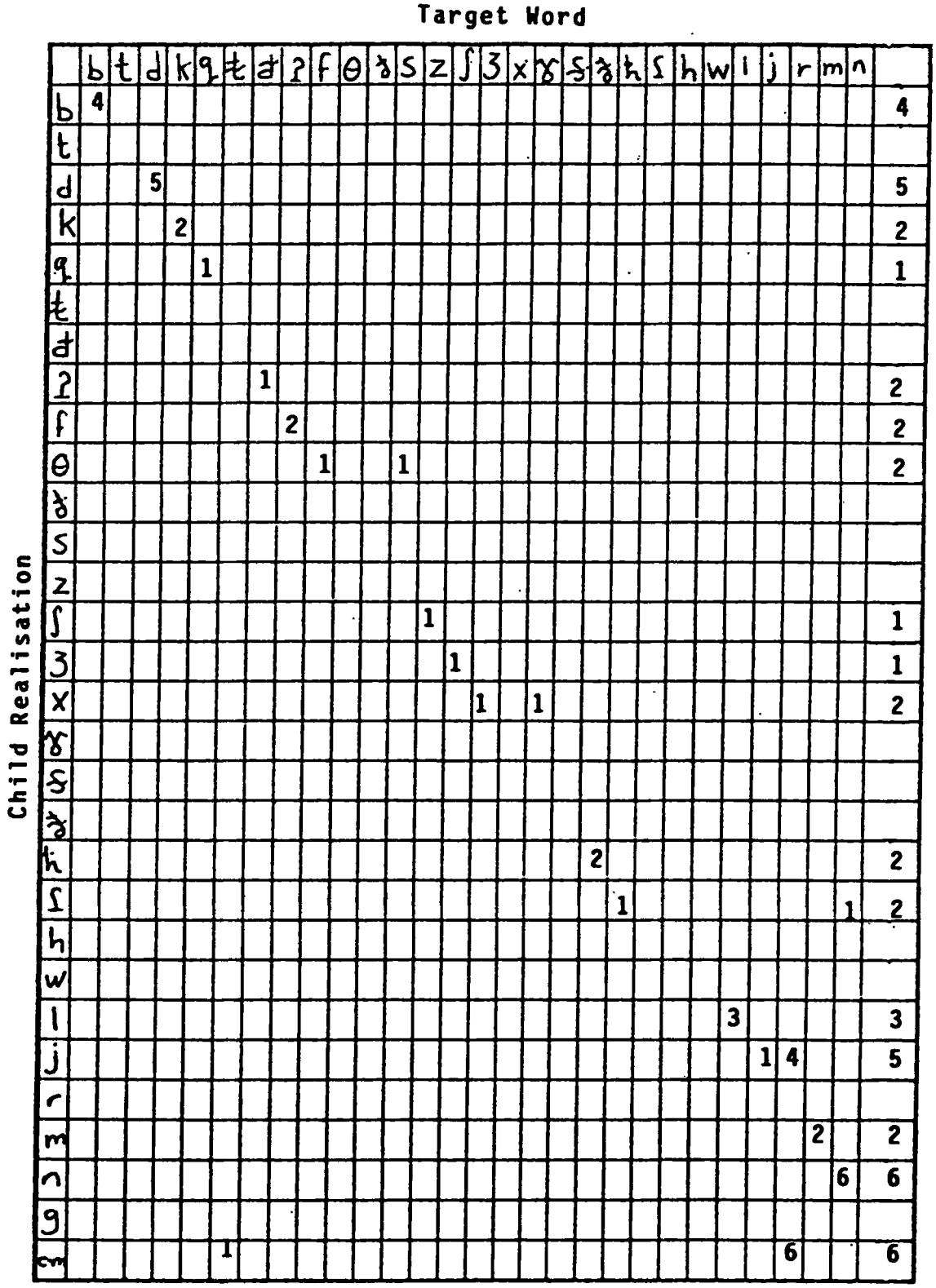
Correspondence Matrices for Subject ...5.....

Target Word

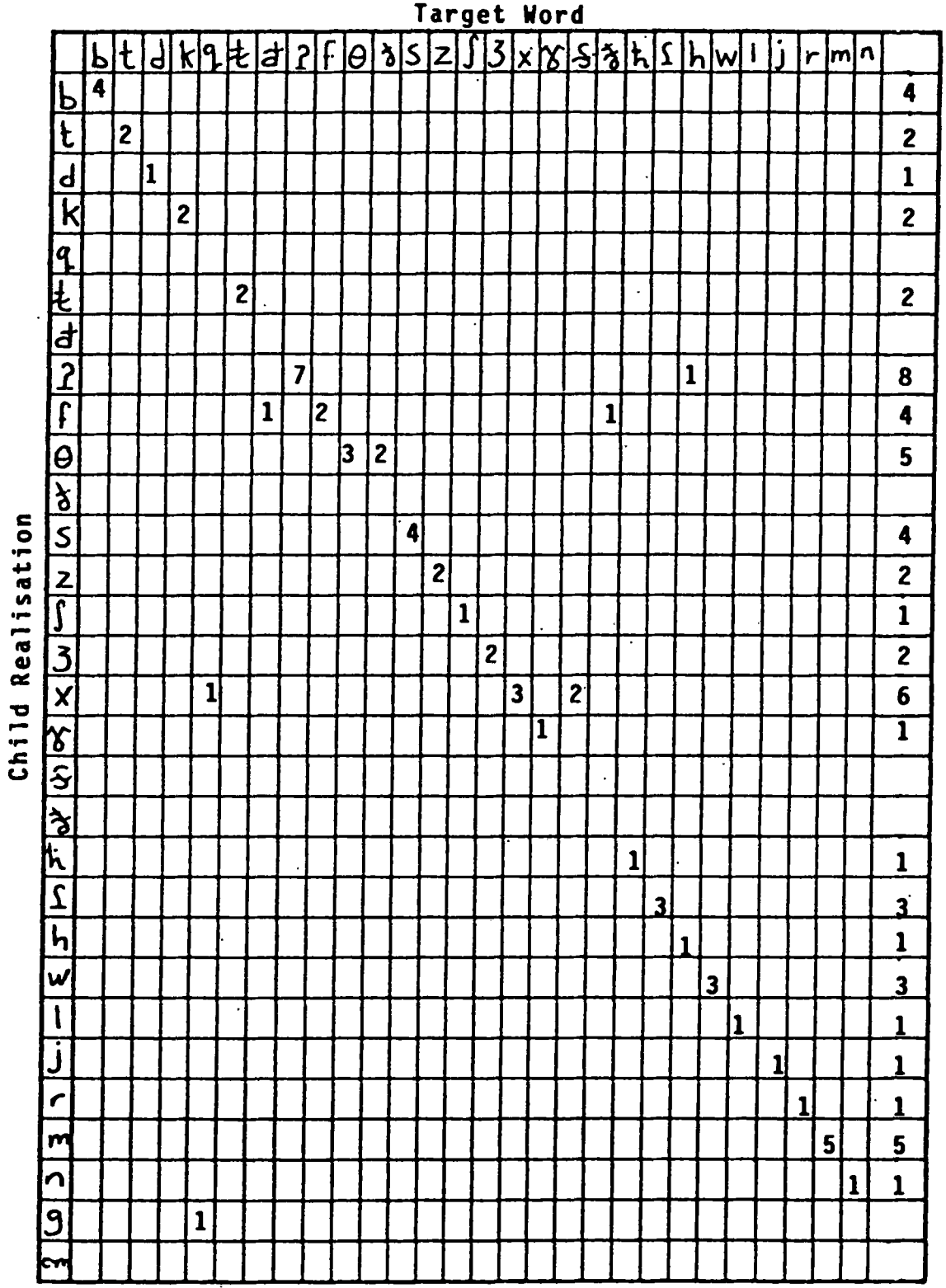
Child Realisation

	b	t	d	k	q	ʈ	ɖ	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ʂ	ʐ	ħ	ʕ	h	w	l	j	r	m	n	
b	4																1												5
t		2																											2
d			2																										2
k																													
q					2																								2
ʈ						1																							1
ɖ																													
ʔ																													
f							1		4									2											7
θ										1			3																4
ð																													
s																													
z																													
ʃ														1															1
ʒ															1														1
x			1									1				1		1											4
ɣ																	1												1
ʂ																													
ʐ																													
ħ																				1									1
ʕ																					1								1
h																						3							3
w																							1						1
l																								6					6
j																									3	6			9
r																													
m																											6		6
n																												2	2
ŋ																													1
ʒ																													

Correspondence Matrices for Subject ....5....



Correspondence Matrices for Subject ....6....



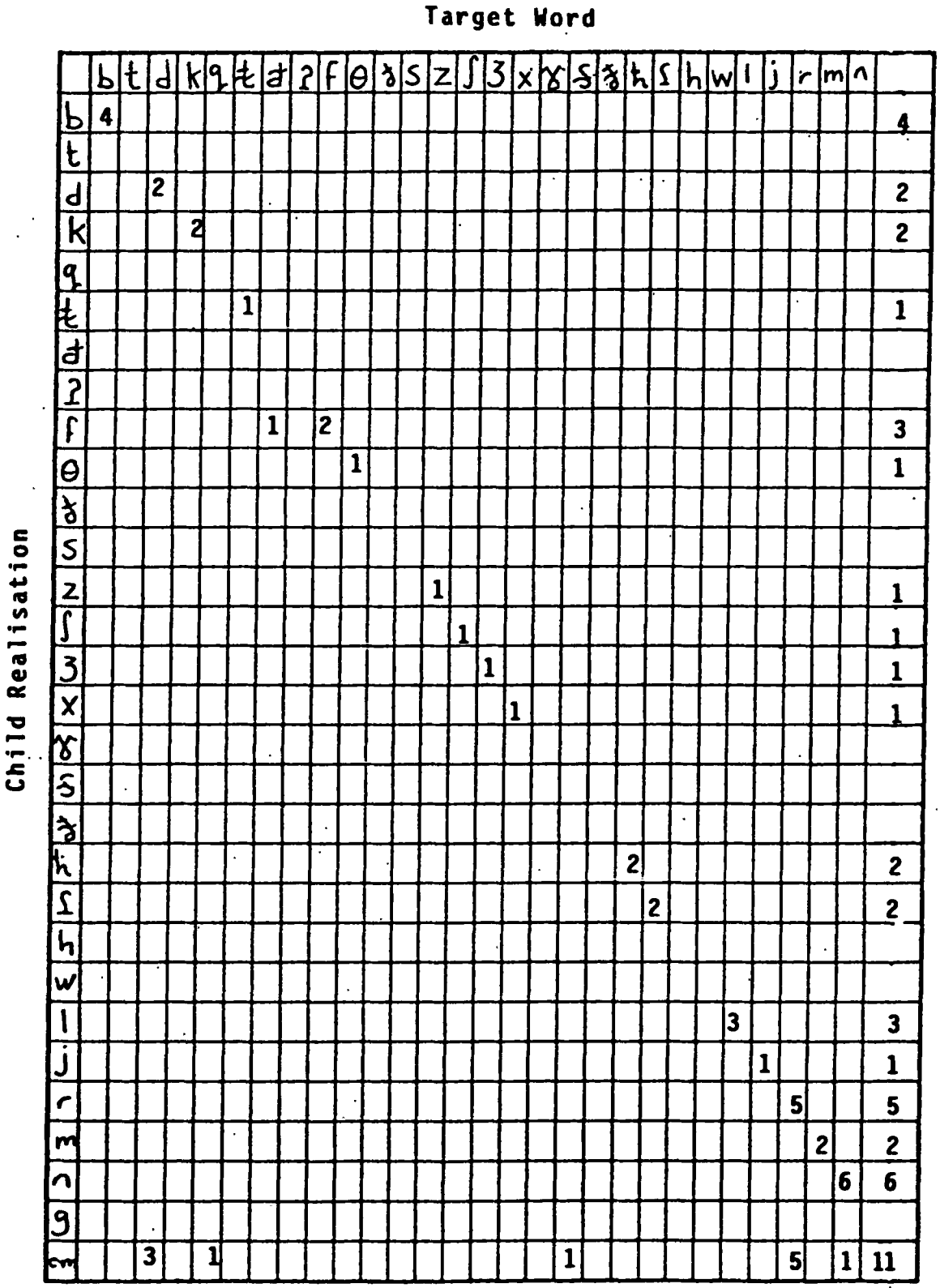
Correspondence Matrices for Subject .....6...

Target Word

Child Realisation

	b	t	d	k	q	ʈ	ɖ	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ʂ	ʐ	h	ʕ	h	w	l	j	r	m	n	
b	4																												4
t		1																											1
d			3																										3
k		1																											1
q					1																								1
ʈ						1																							1
ɖ																													
ʔ																													
f							1		4									2											7
θ										1	1																		2
ð																													
s												1	1																2
z													2																2
ʃ														1															1
ʒ															1														1
x																1		1											2
ɣ					1												2												3
ʂ																													
ʐ																													
h																			1										1
ʕ																				1									1
h																					3								3
w																						1							1
l																							6						6
j																								3					3
r																									6				6
m																										6			6
n																											2		2
g																													
ʔ																													

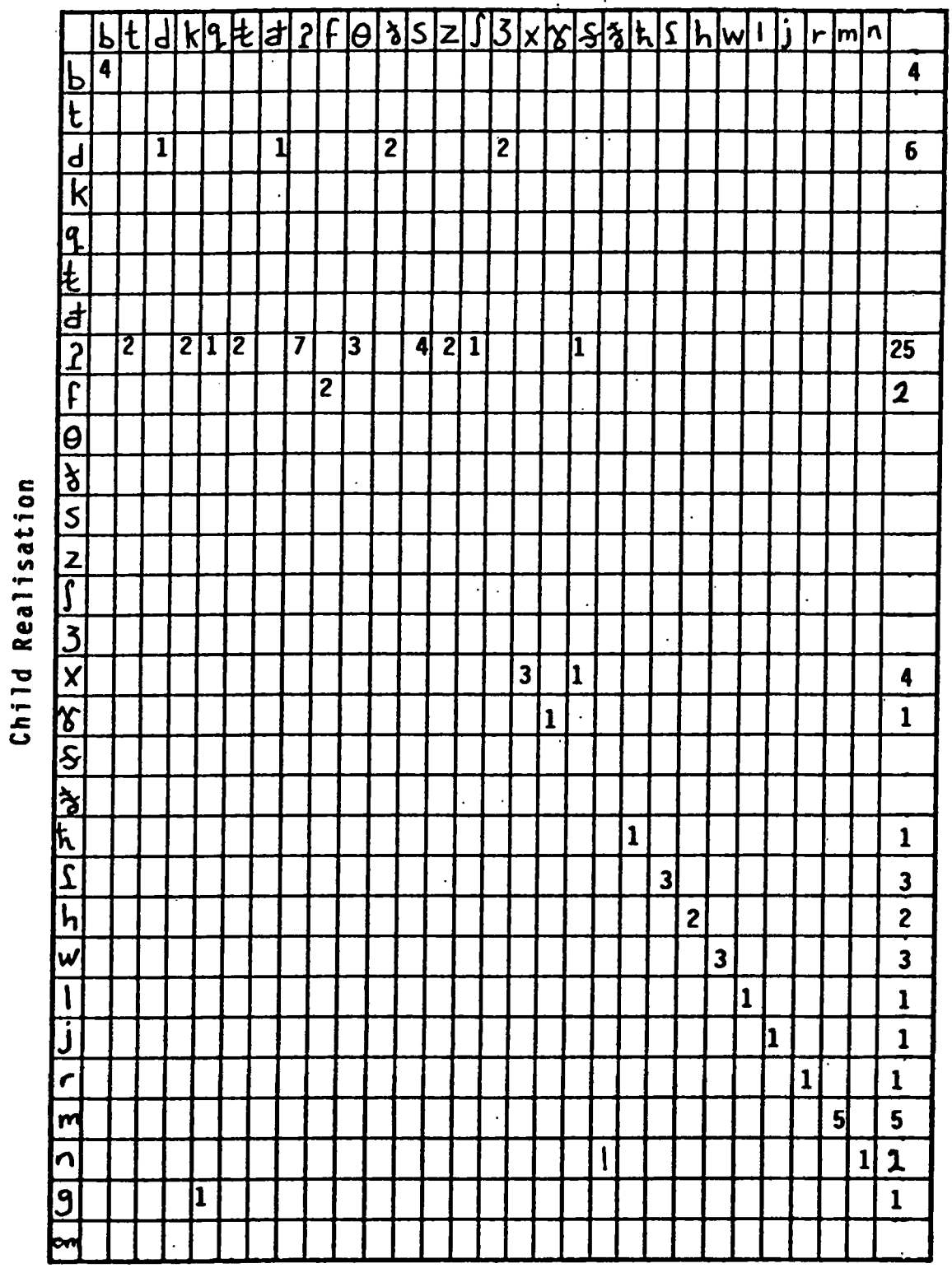
Correspondence Matrices for Subject ....6....



	b	t	d	k	ʔ	ʧ	ʤ	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ʕ	ħ	ʕ	h	w	l	j	r	m	n	
b	4																											4
t																												
d			2																									2
k				2																								2
ʔ																												
ʧ						1																						1
ʤ																												
ʔ																												
f							1		2																			3
θ										1																		1
ð																												
s																												
z													1															1
ʃ														1														1
ʒ															1													1
x																1												1
ɣ																												
ʕ																												
ħ																												
ʕ																					2							2
h																						2						2
ʕ																												
w																												
l																							3					3
j																								1				1
r																									5			5
m																										2		2
n																											6	6
ʔ																												
ʔ			3		1													1							5		1	11

Correspondence Matrices for Subject .....7.....

Target Word



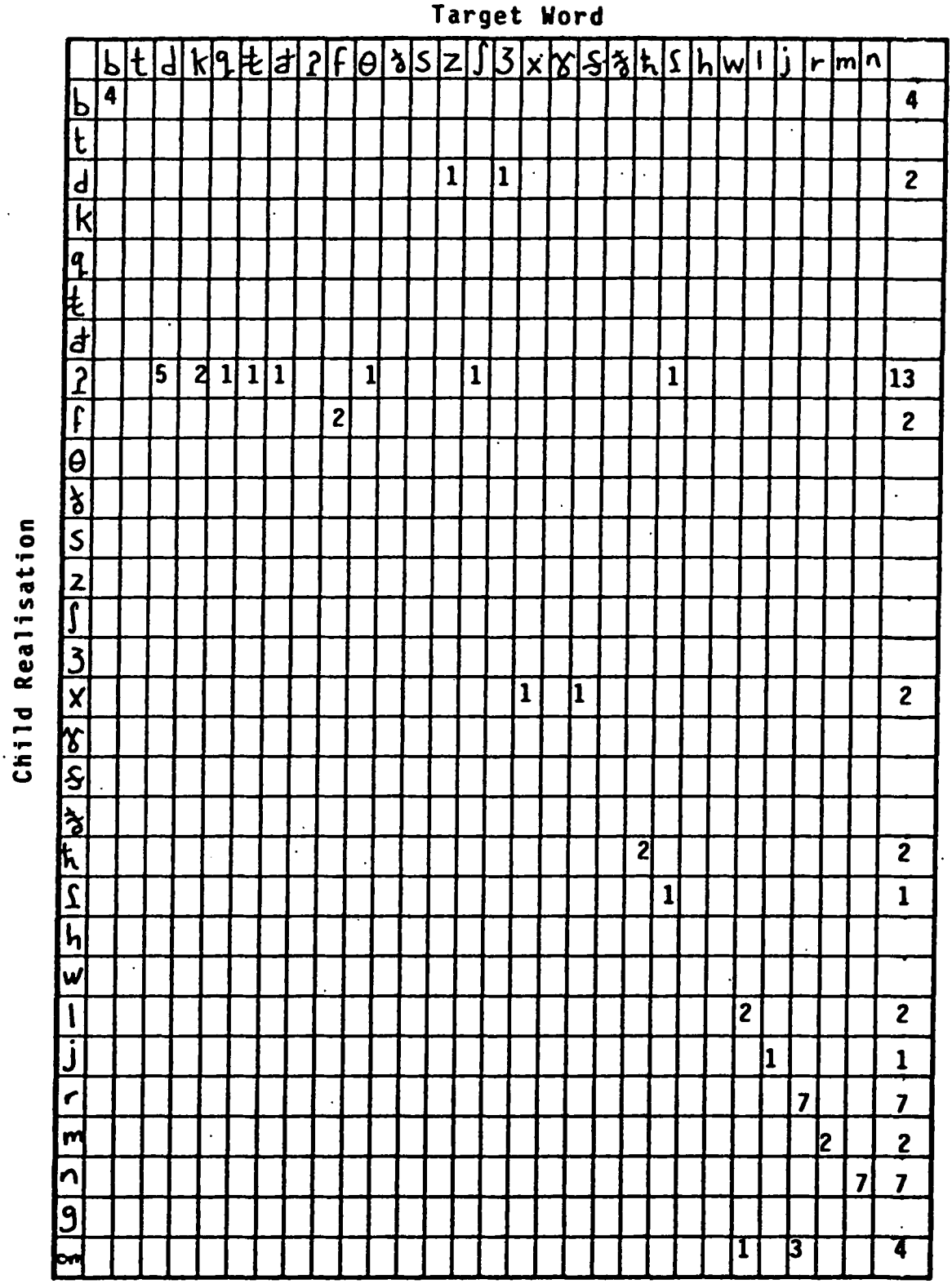
Correspondence Matrices for Subject .....7.....

Target Word

Child Realisation

	b	t	d	k	ʔ	ṭ	ḍ	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ṣ	ẓ	ṯ	ʕ	h	w	l	j	r	m	n	
b	4																												4
t		1																											1
d			3										3																6
k																													
ʔ																													
ṭ																													
ḍ																													
ʔ		1			2	1	1		3	1	1			1	1		1		1								1		15
f									1																				1
θ												1																	1
ð																													
s																													
z																													
ʃ																													
ʒ																													
x																1		1											2
ɣ																	1												1
ṣ																													
ẓ																													
ṯ																			1										1
ʕ																				1									1
h																					3								3
w																						1							1
l																							6		1				7
j																								3					3
r																									5				5
m																										5			5
n																			1								2		3
g																													
ʒ																													

Correspondence Matrices for Subject ....7....



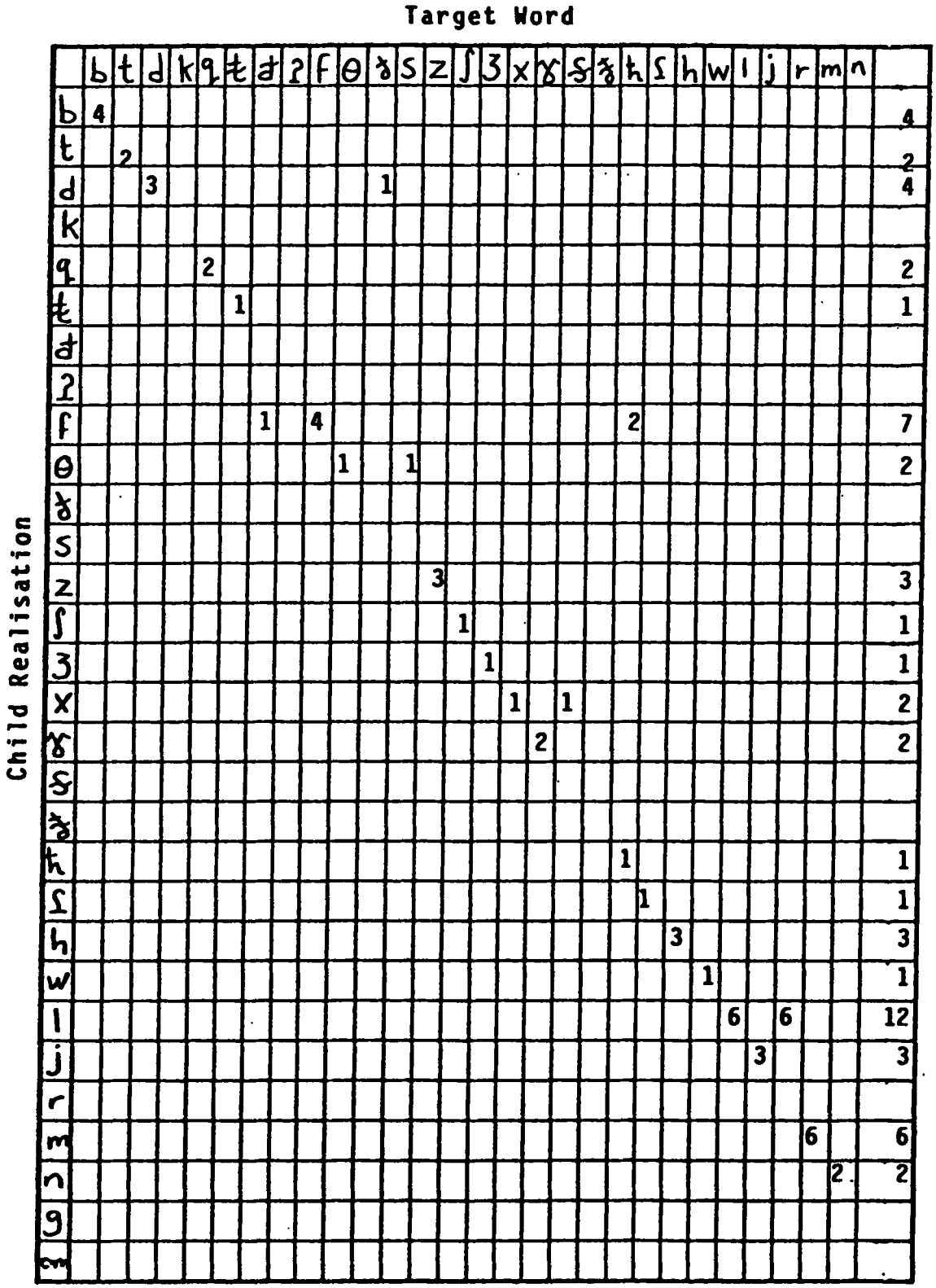
Correspondence Matrices for Subject ....8....

Target Word

Child Realisation

	b	t	d	k	q	ʧ	ʤ	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ʕ	ʢ	ħ	ʕ	h	w	l	j	r	m	n	
b	4																												4
t		2																											2
d			1				1				2																		4
k				2																									2
q					1																								1
ʧ						2																							2
ʤ																													
ʔ								7																		1			8
f									2																				2
θ										3		4								1									8
ð																													
s																													
z													2																2
ʃ														1															1
ʒ															2														2
x																3		2											5
ɣ																	1												1
ʕ																													
ʢ																													
ħ																				1									1
ʕ																					3								3
h																						2							2
w																							3						3
l																								1					1
j																									1				1
r																													
m																										5			5
n																											1		1
ŋ					1																								1

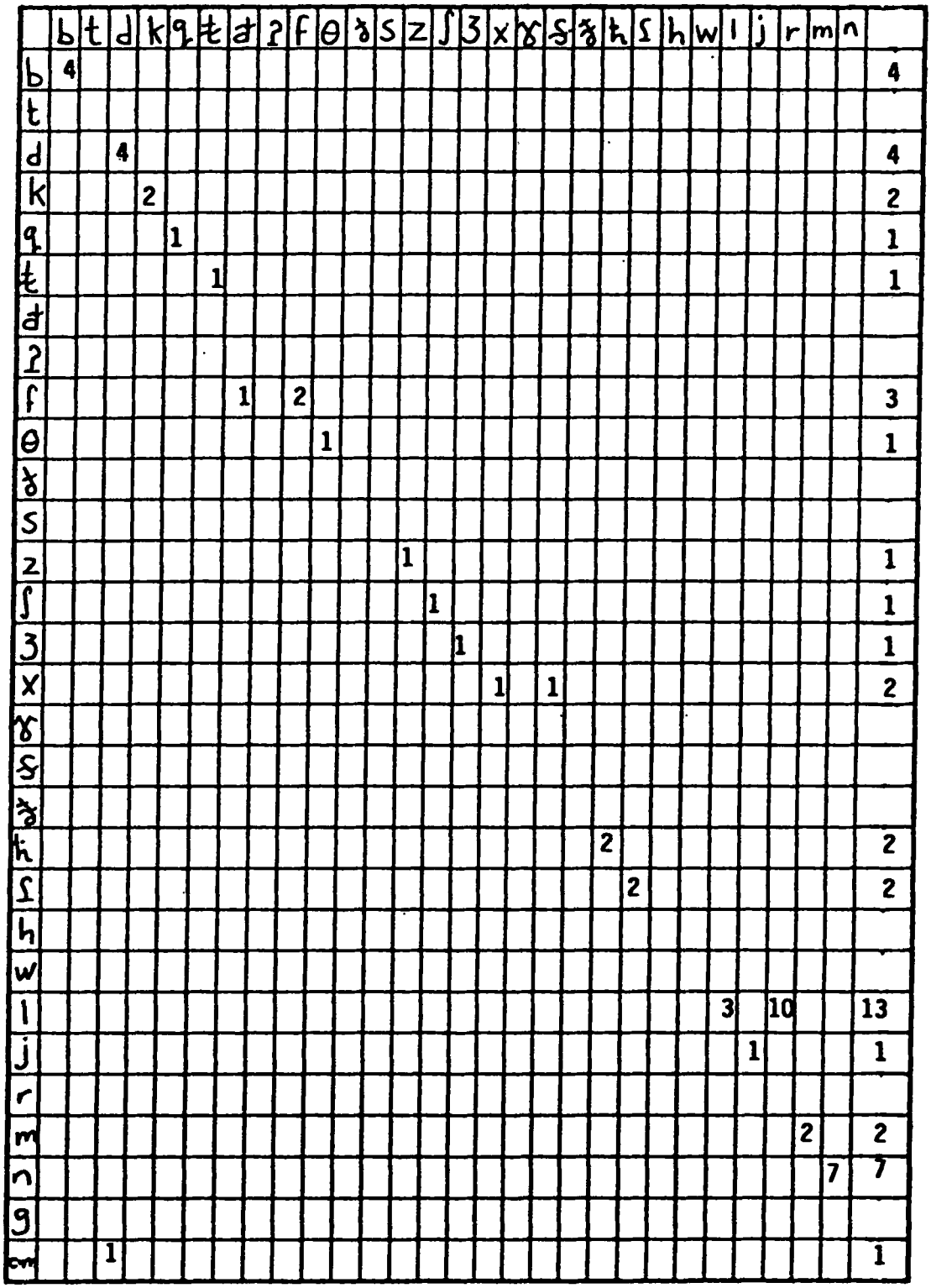
Correspondence Matrices for Subject ...8....



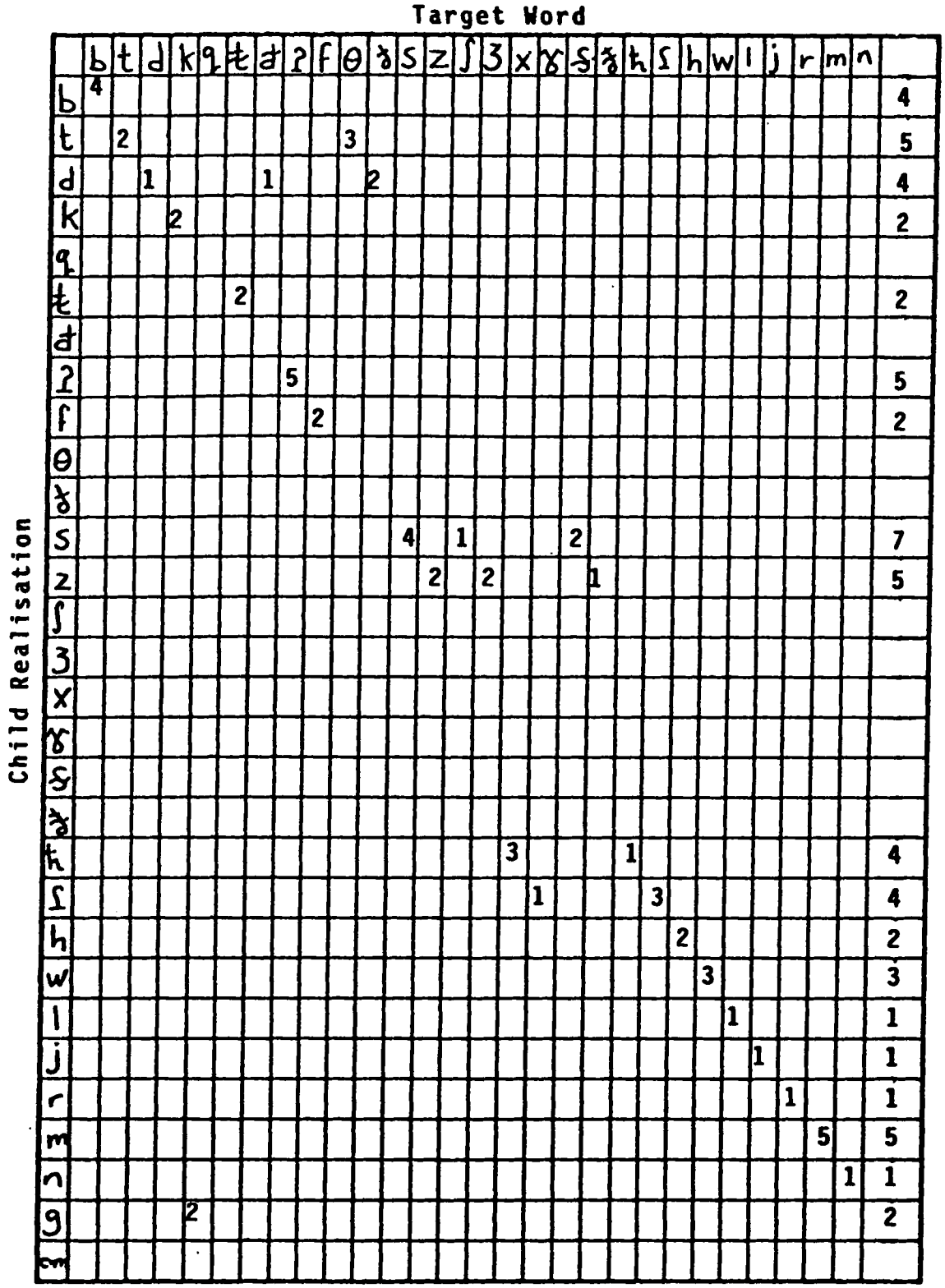
Correspondence Matrices for Subject ....8...

Target Word

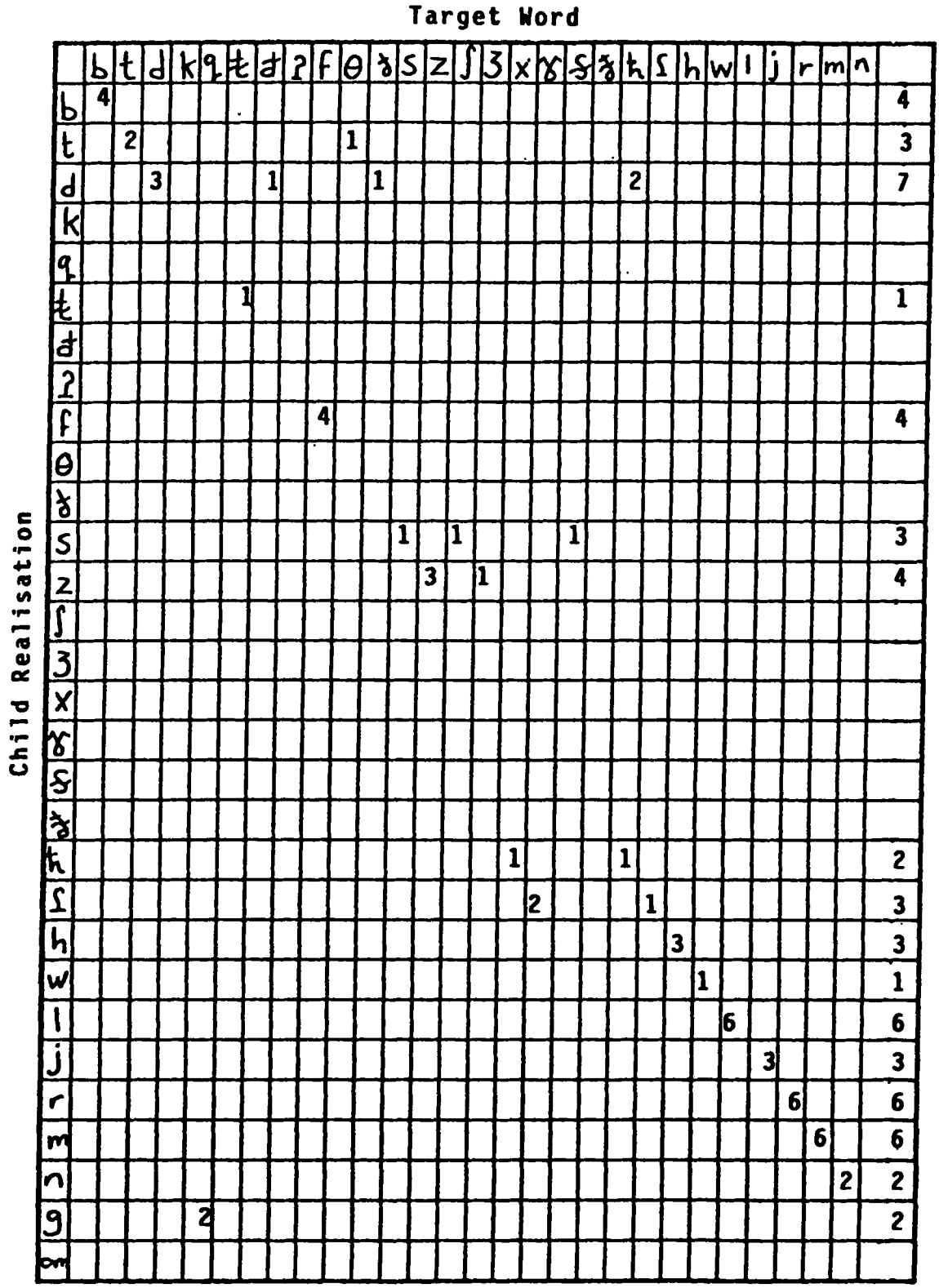
Child Realisation



Correspondence Matrices for Control .....I.....



Correspondence Matrices for Control .....1.....



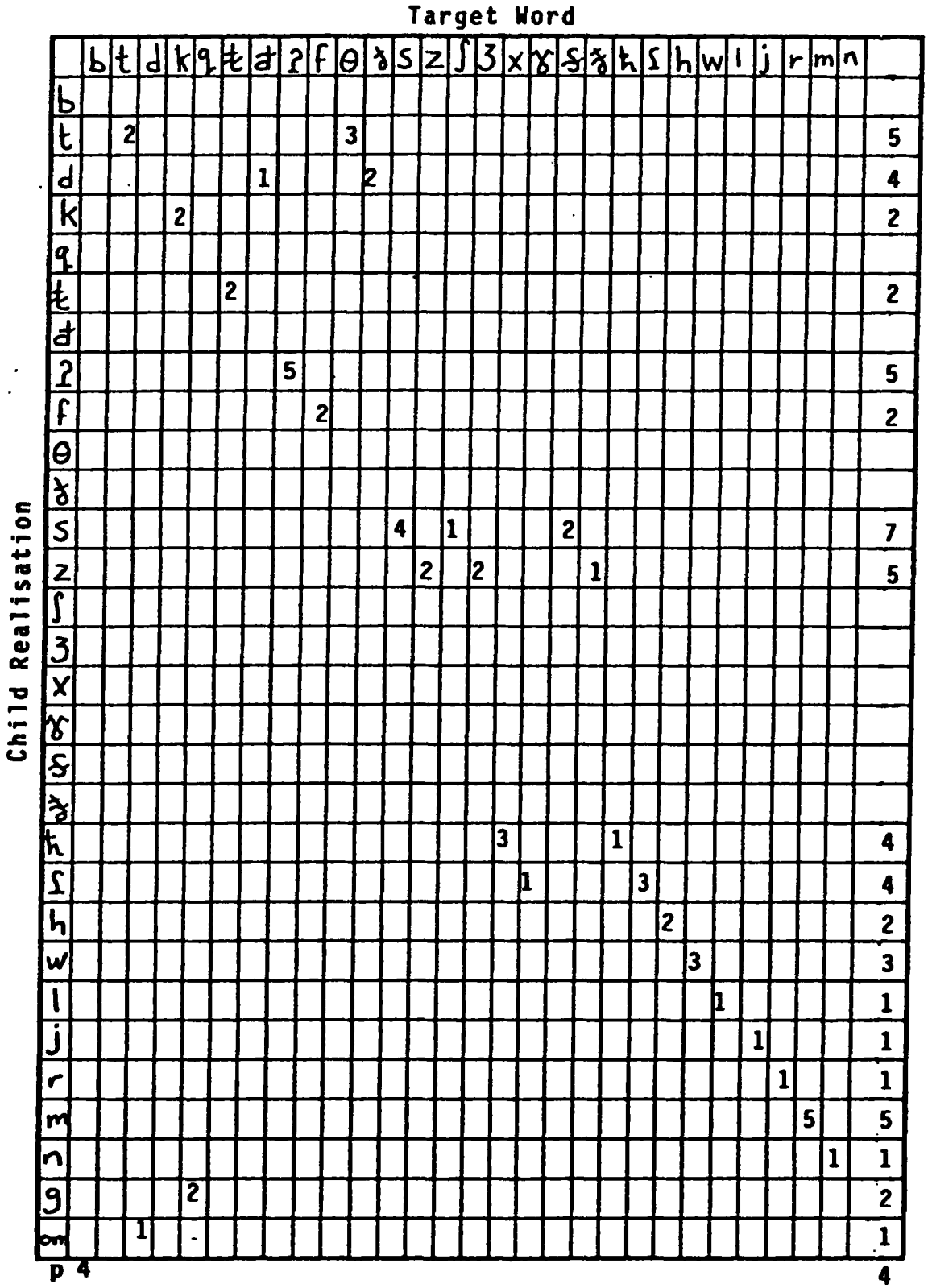
Correspondence Matrices for Control .....1.....

Target Word

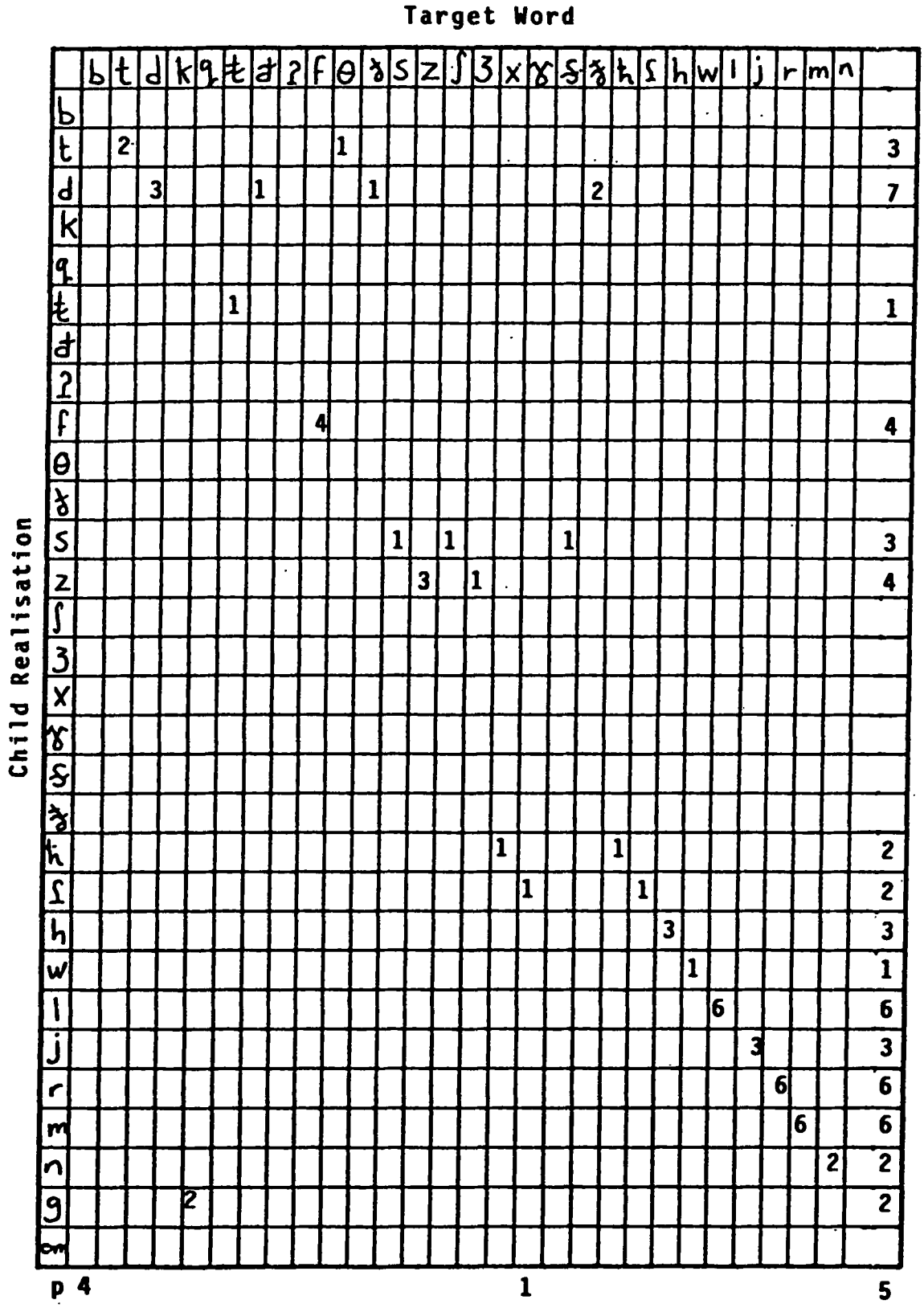
Child Realisation

	b	t	d	k	ʔ	ʈ	ɗ	ʔ	f	θ	ð	s	z	ʃ	ʒ	x	ɣ	ʂ	ʐ	ħ	ʕ	h	w	l	j	r	m	n	
b	4																												4
t										1																			1
d			5				1																						6
k				2																									2
ʔ																													
ʈ						1																							1
ɗ																													
ʔ																													
f									2																				2
θ																													
ð																													
s														1				1											2
z													1		1														2
ʃ																													
ʒ																													
x																													
ɣ																													
ʂ																													
ʐ																													
ħ																	1				2								3
ʕ																						1							1
h																													
w																													
l																							3						3
j																								1					1
r																									10				10
m																										2			2
n																											6		6
ŋ					1																								1
ʔ																													

Correspondence Matrices for Control ....2....

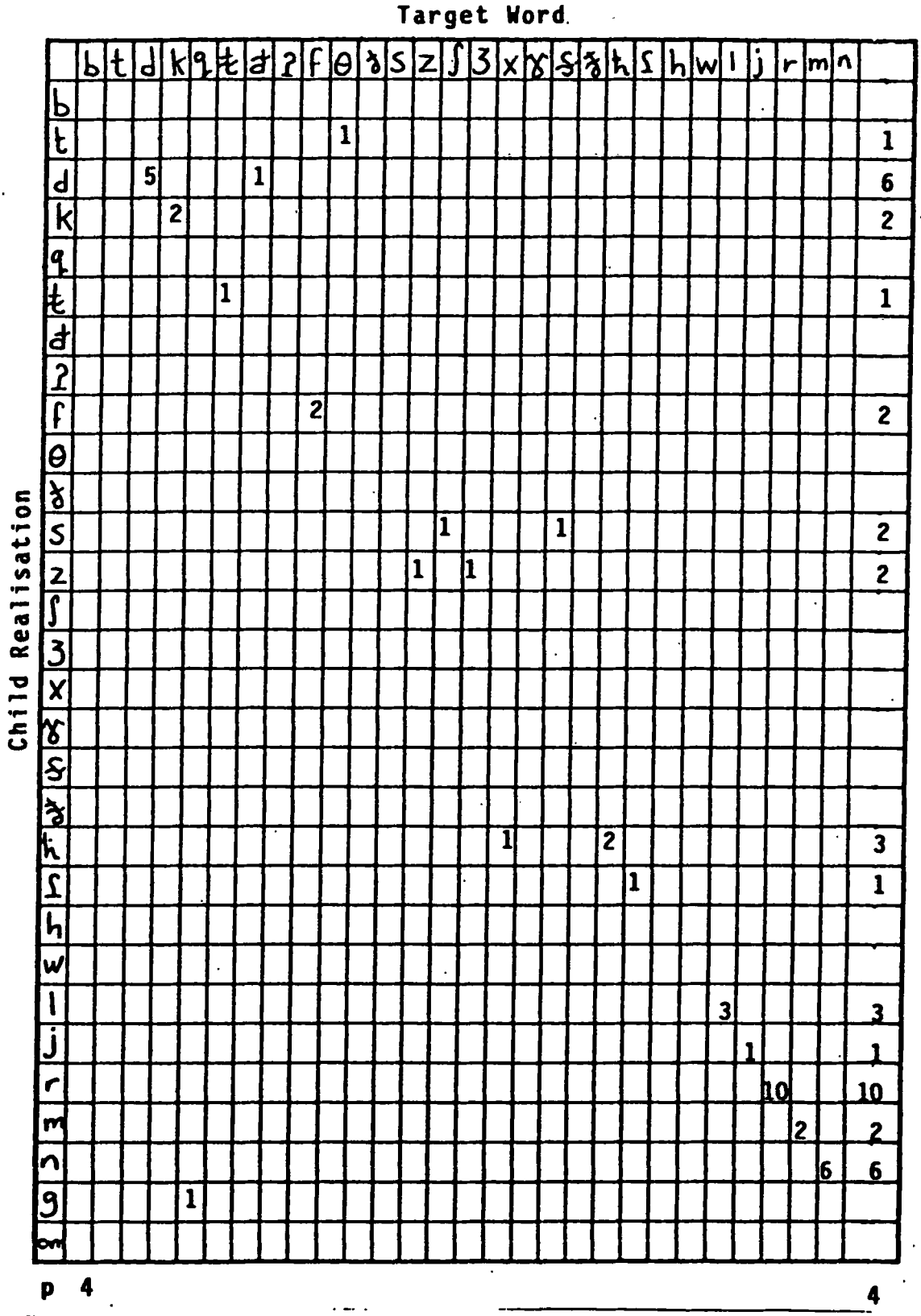


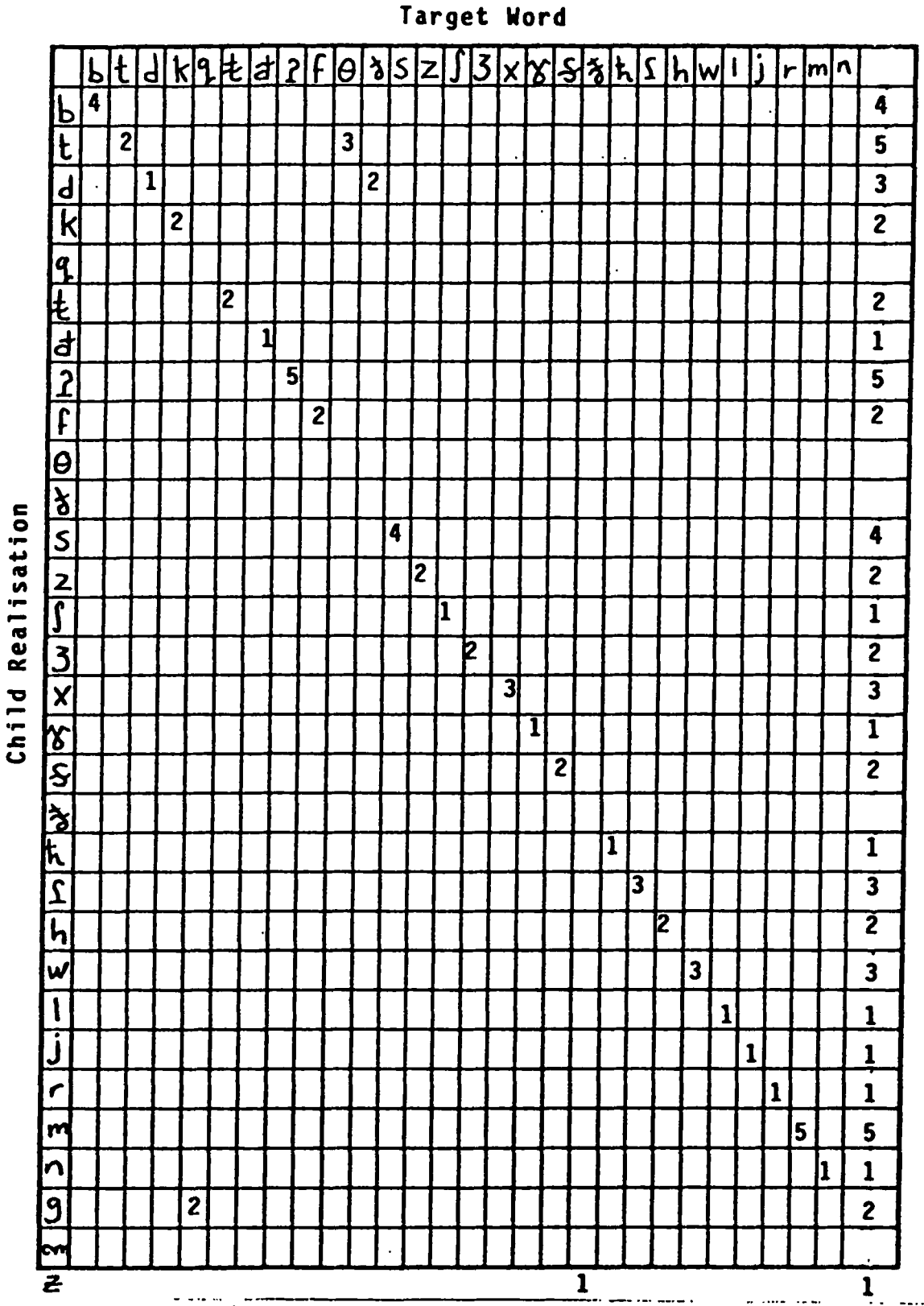
Correspondence Matrices for Control ...2.....



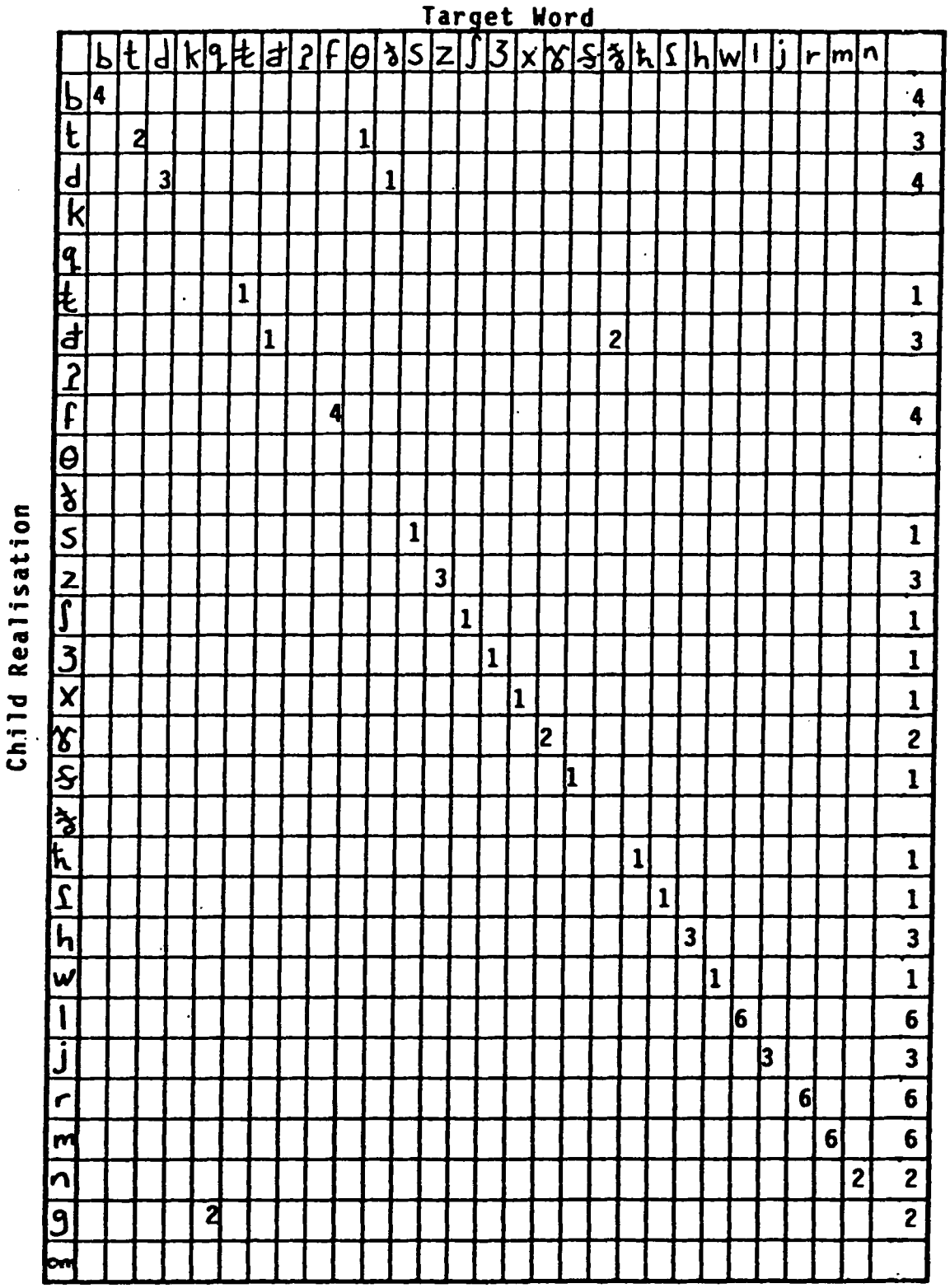
The Analysis of the Phonological Systems of Arabic Speaking Children With Cleft Palate in Saudia Arabia

Correspondence Matrices for Control ...2.....

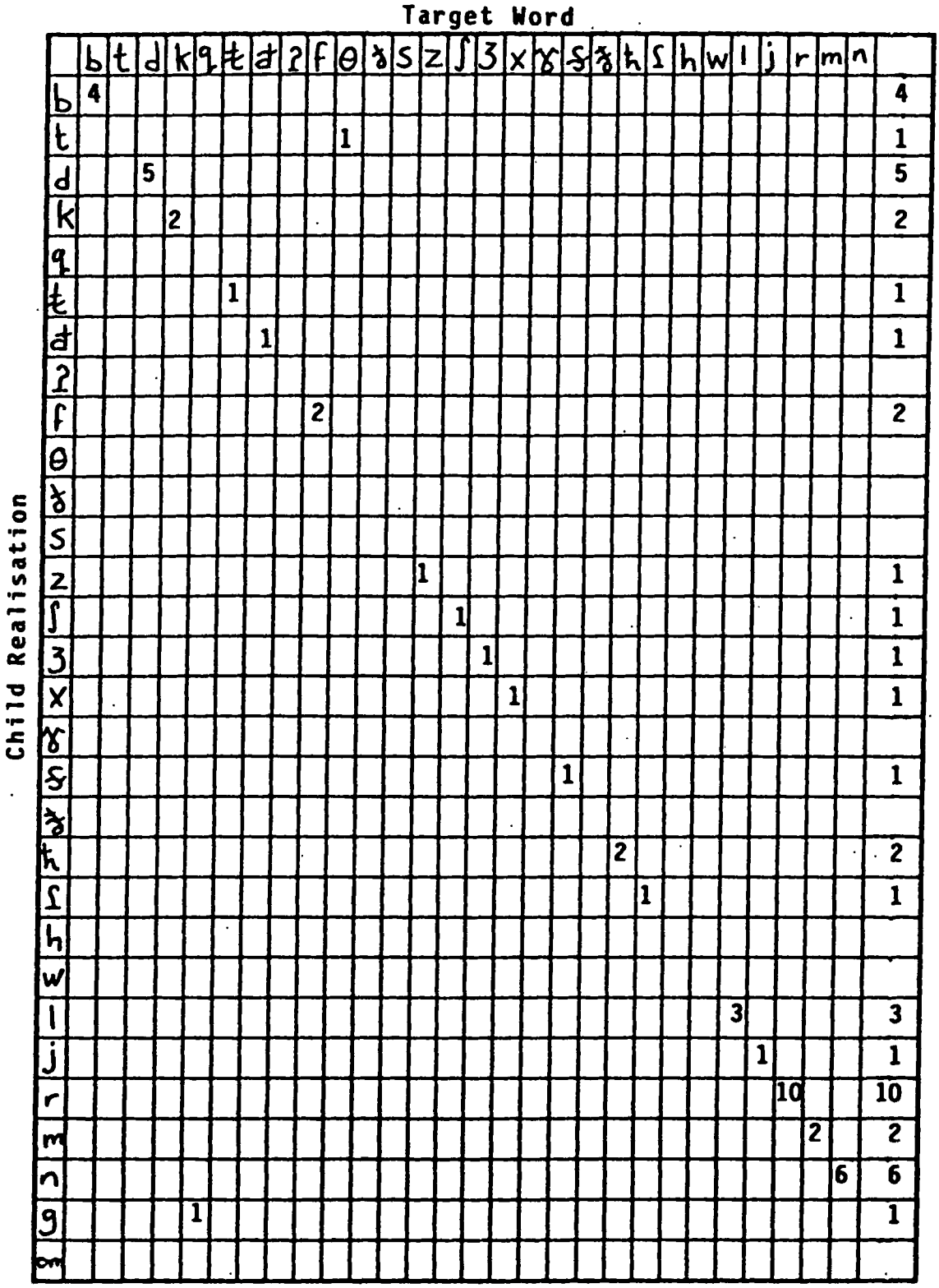



Target Word
Child Realisation
b t d k ʔ ʈ ɖ ʔ f θ ð s z ʃ ʒ x ɣ ʂ ʐ h ʕ h w l j r m n
1
1

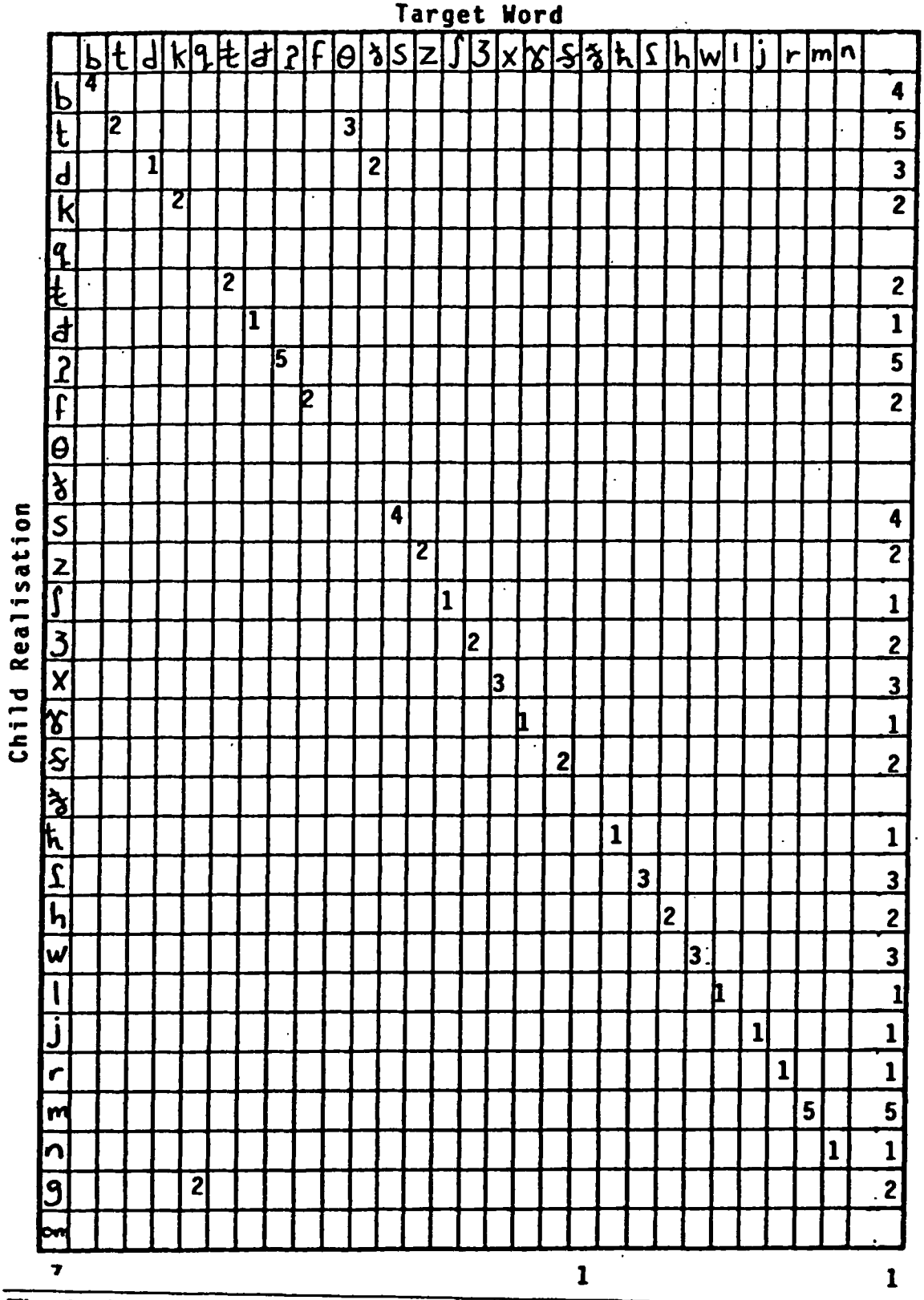
Correspondence Matrices for Control ....3....



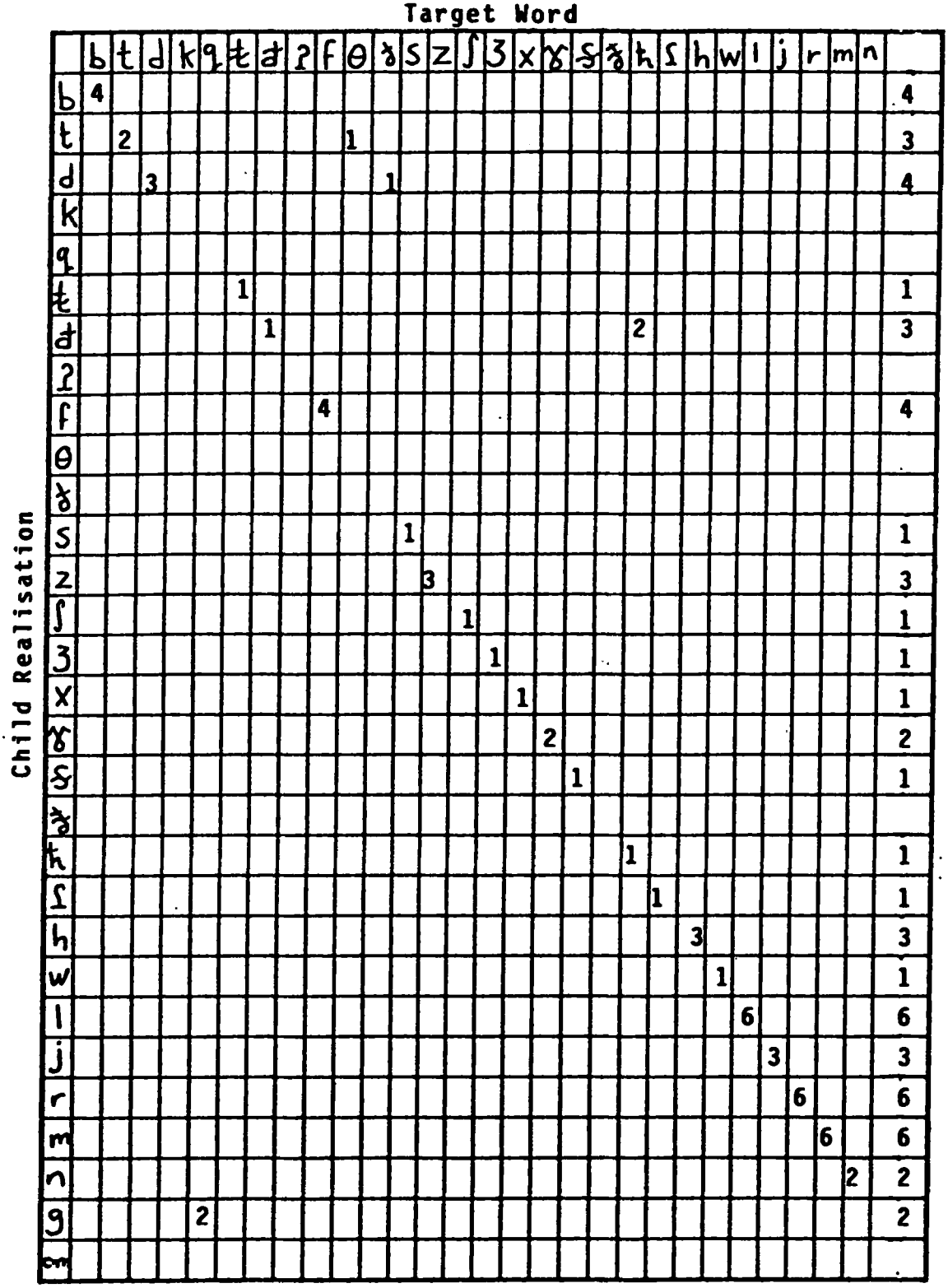
Correspondence Matrices for Control ...3....



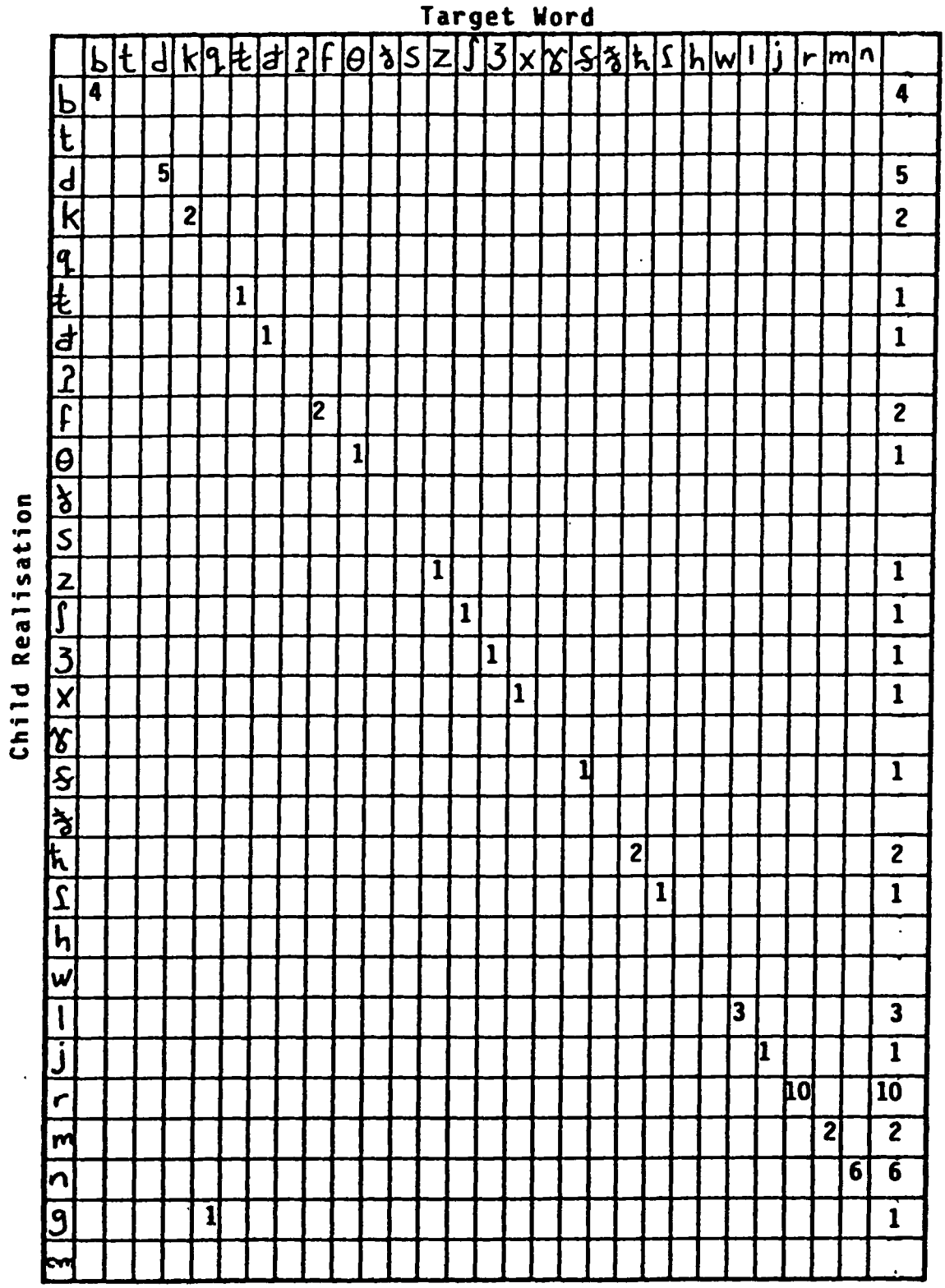
Correspondence Matrices for Control ...4...



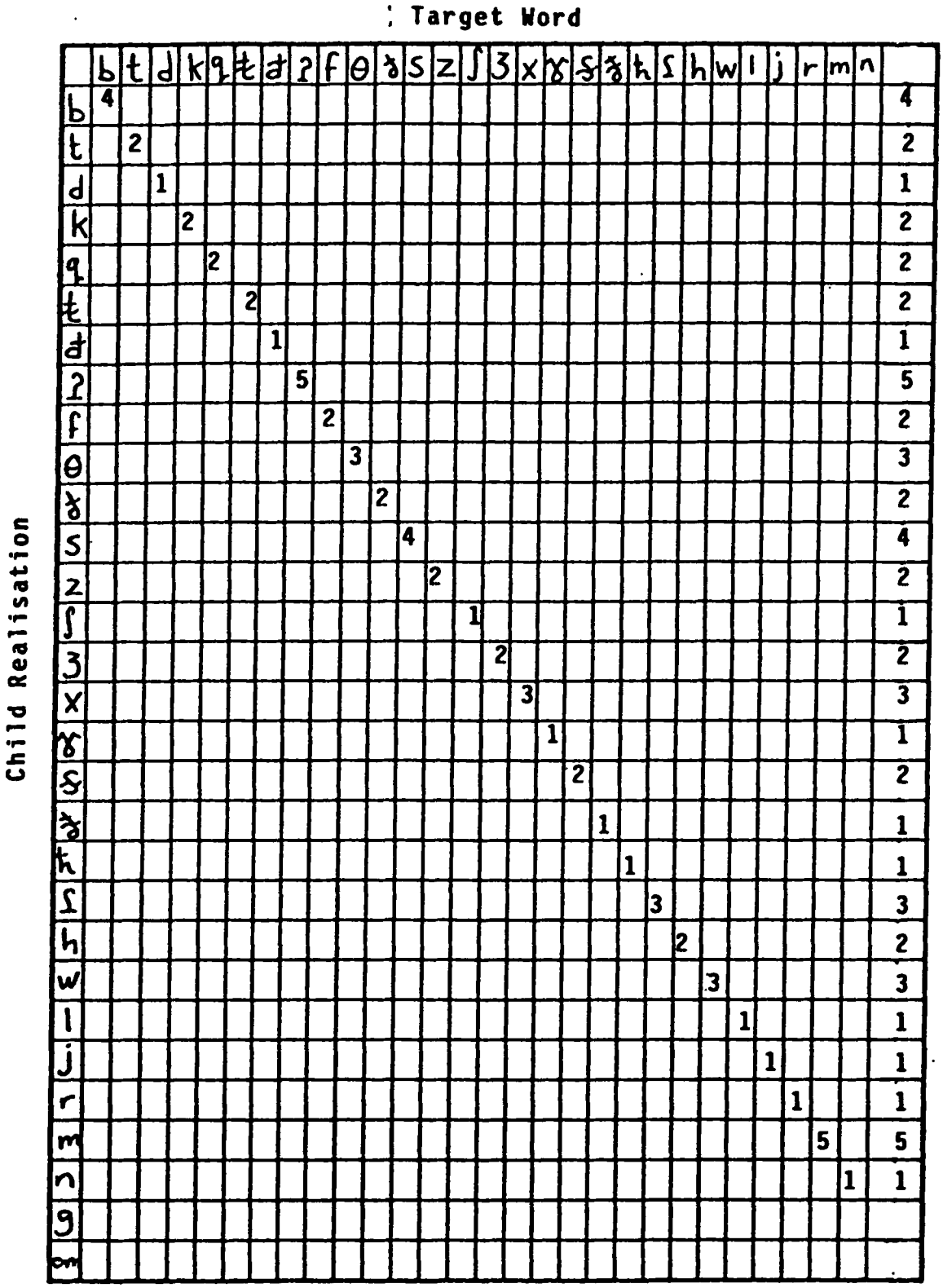
Correspondence Matrices for Control ...4....

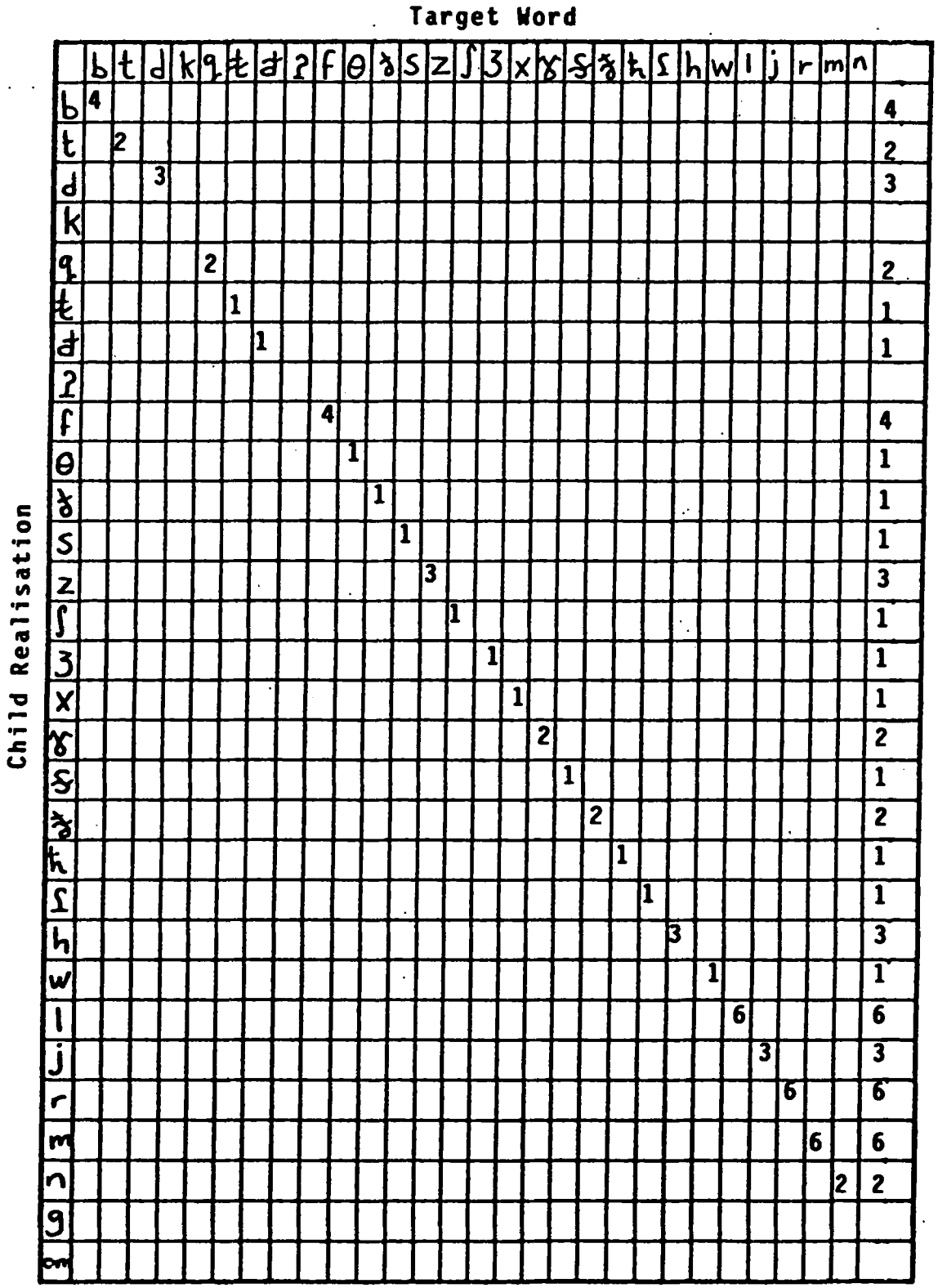


Correspondence Matrices for Control ..4...

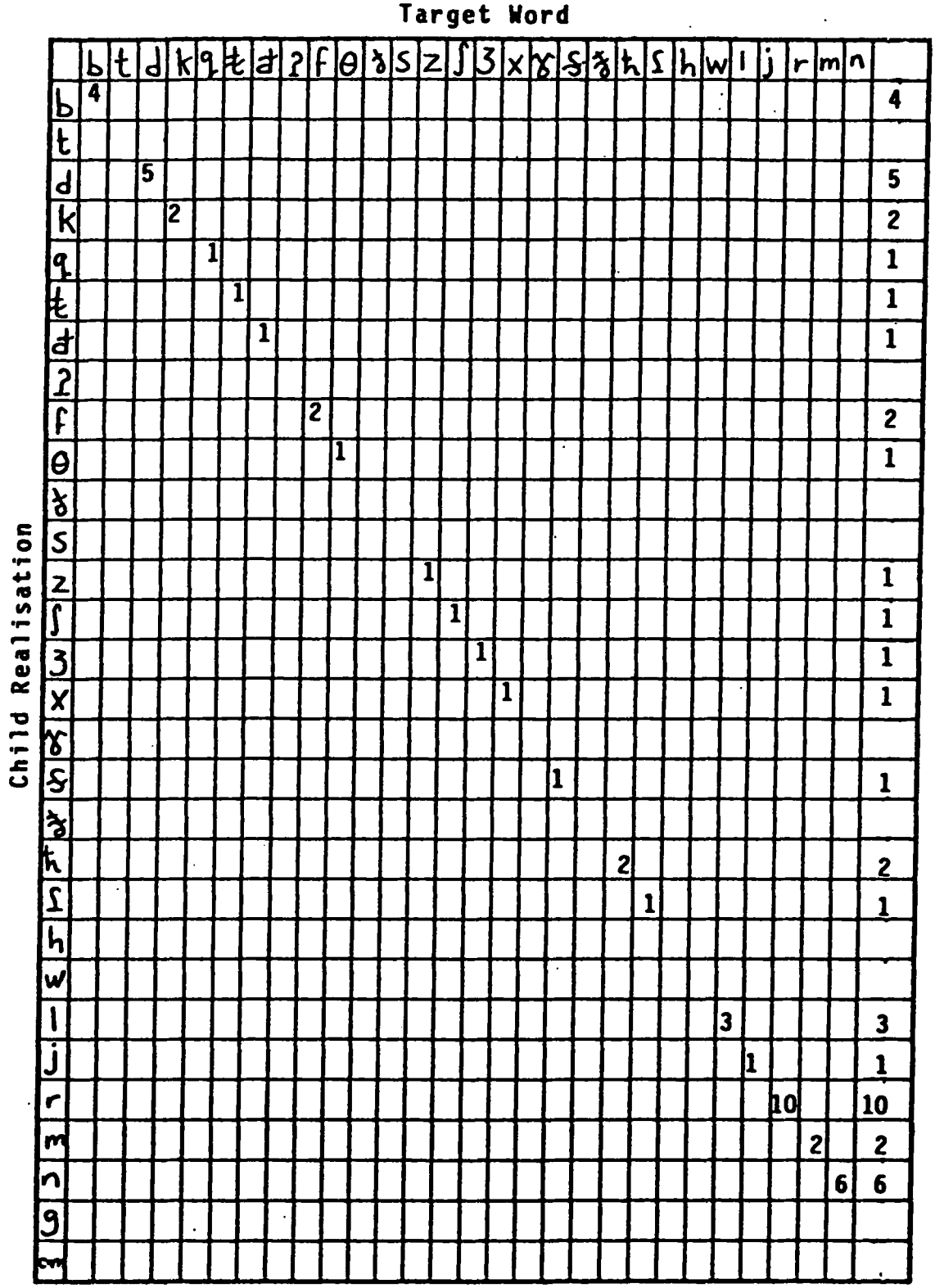


Correspondence Matrices for Control ...5....



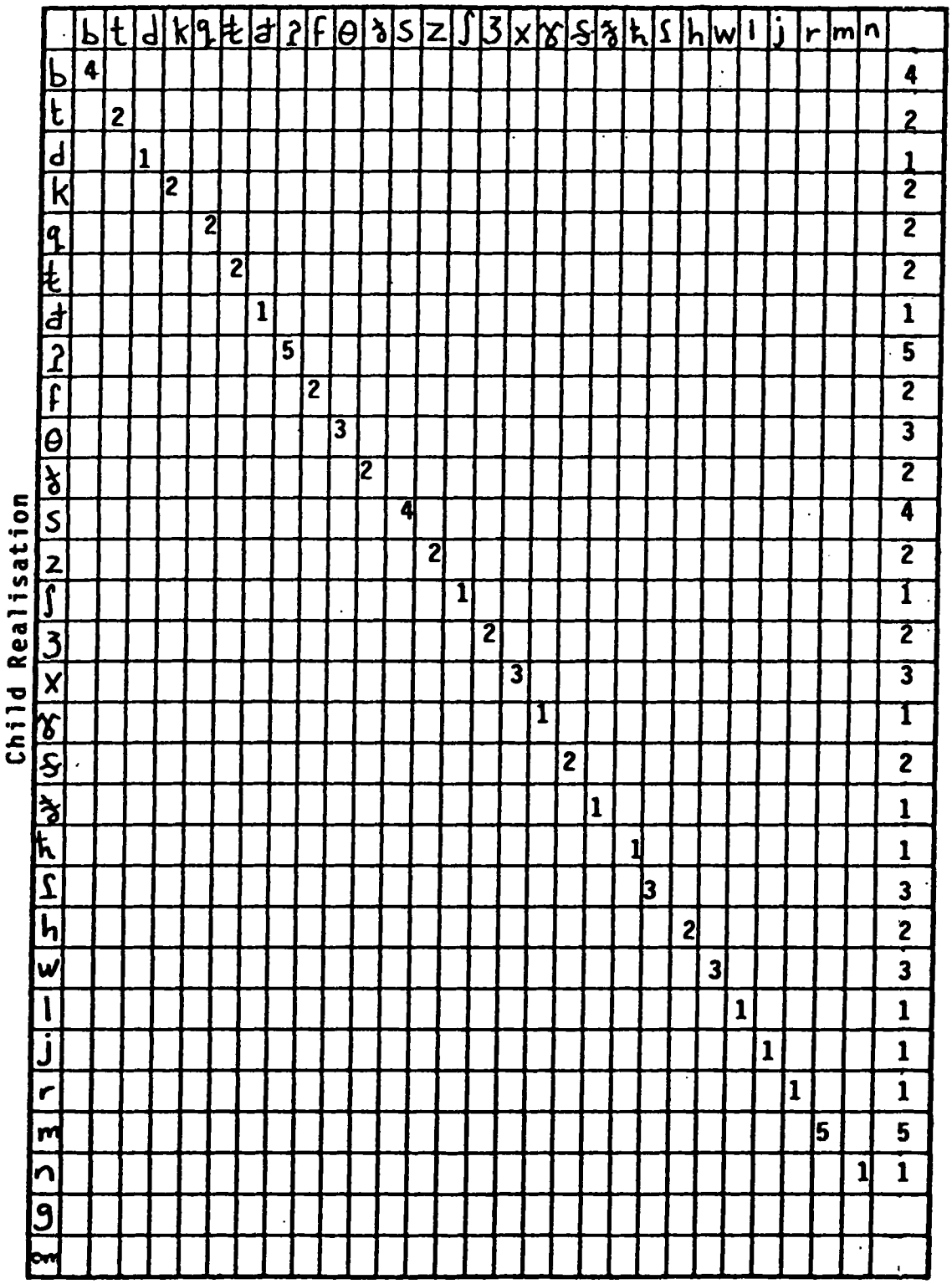

Target Word
Child Realisation
b t d k ʔ ʧ ʤ ʔ f θ ð s z ʃ ʒ x ɣ ʕ ʢ ħ ʕ h w l j r m n
4 2 3 2 1 1 4 1 1 1 3 1 1 1 2 1 2 1 1 3 1 6 3 6 6 2

Correspondence Matrices for Control ....5...

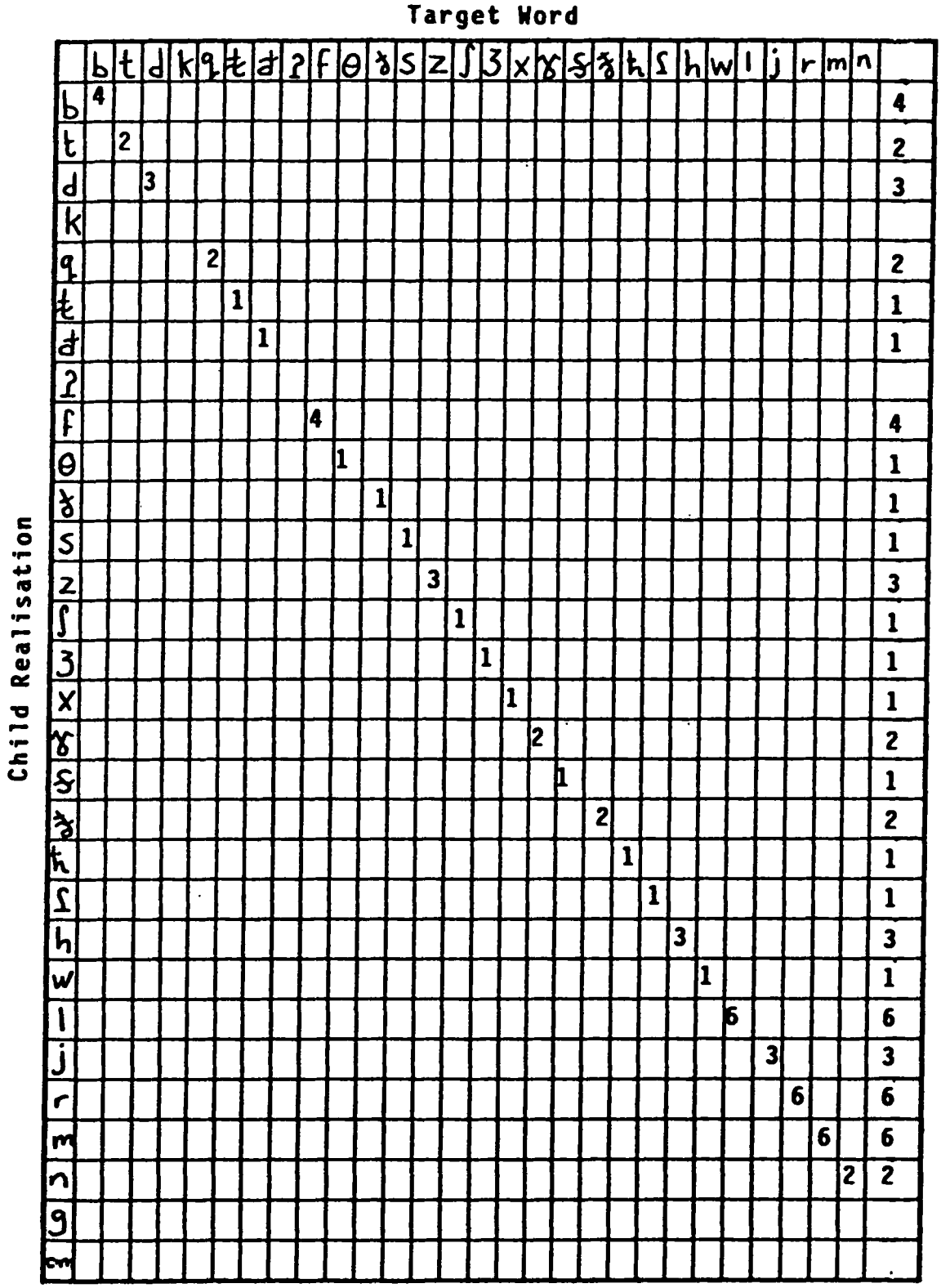


Correspondence Matrices for Control ...6....

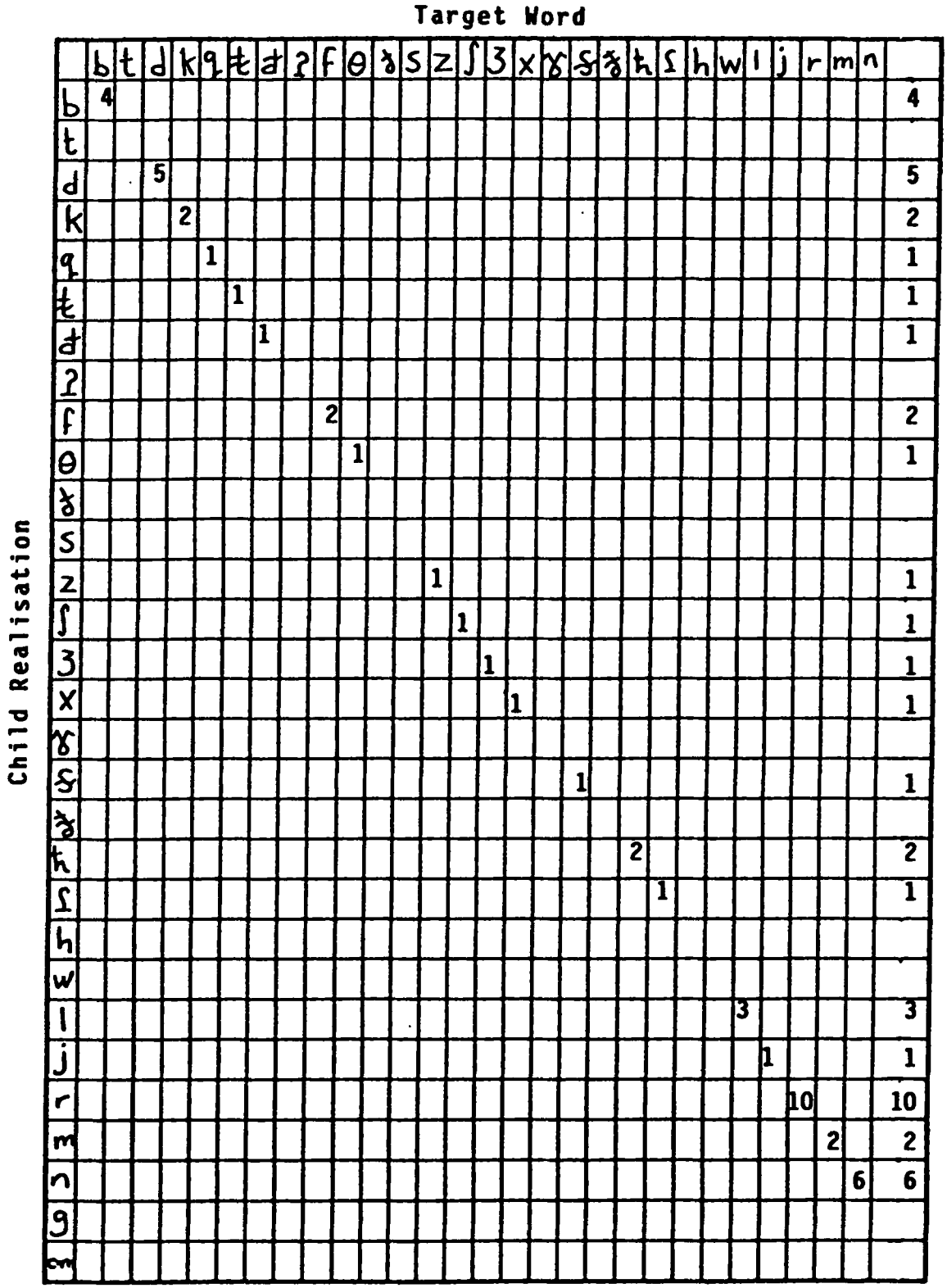
Target Word



Correspondence Matrices for Control ....6...

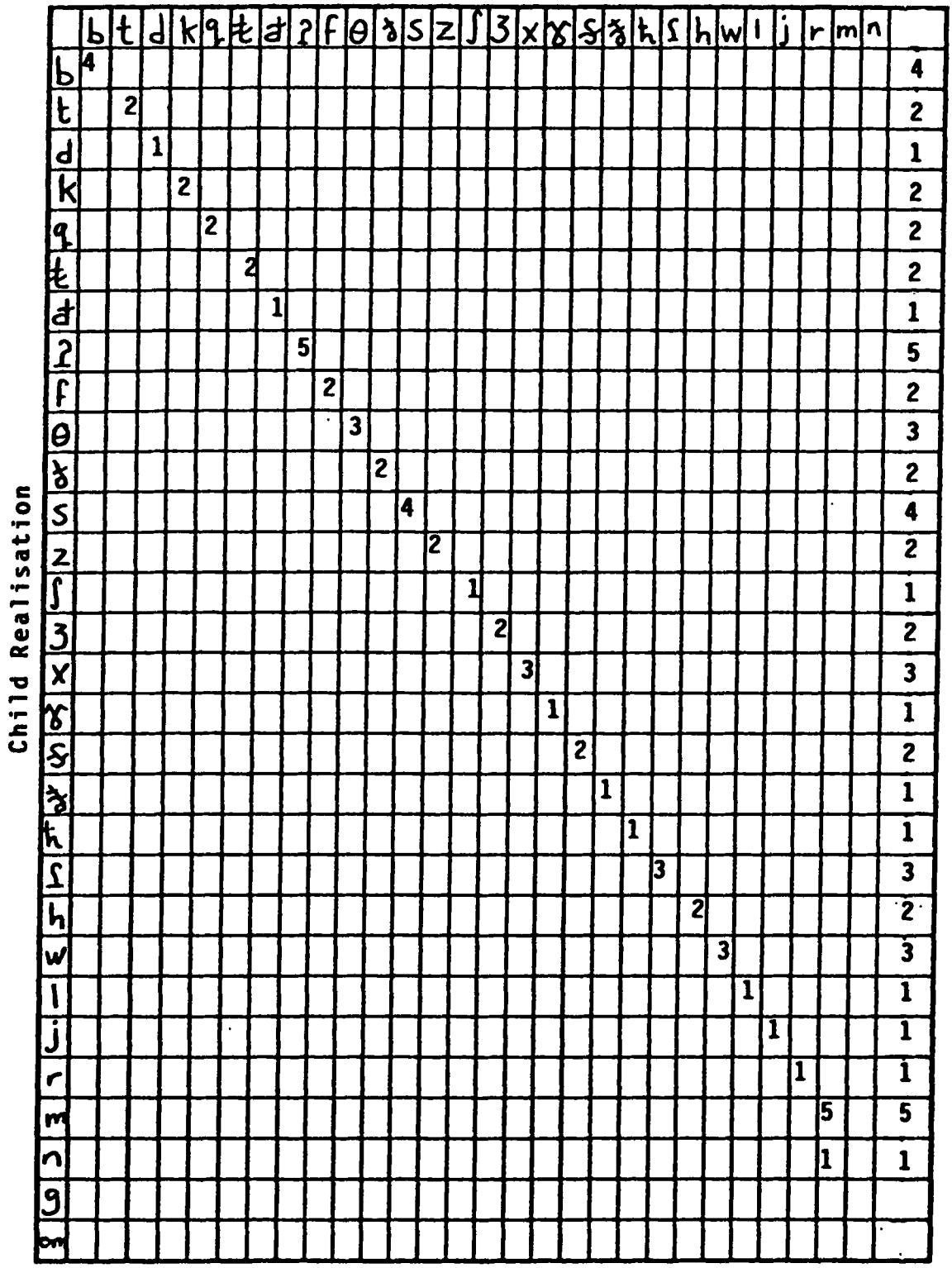


Correspondence Matrices for Control ....6....



Correspondence Matrices for Control ...7....

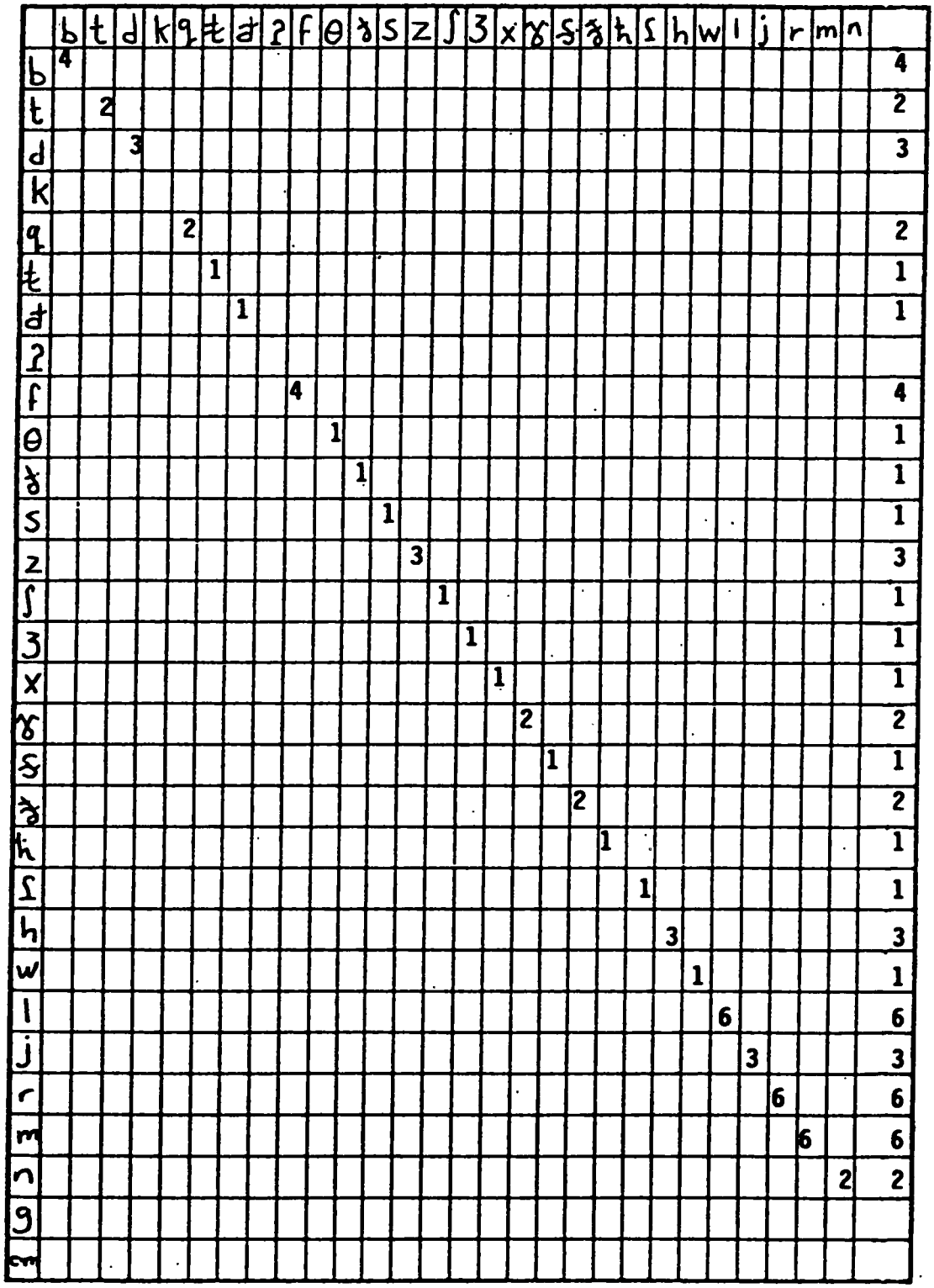
Target Word



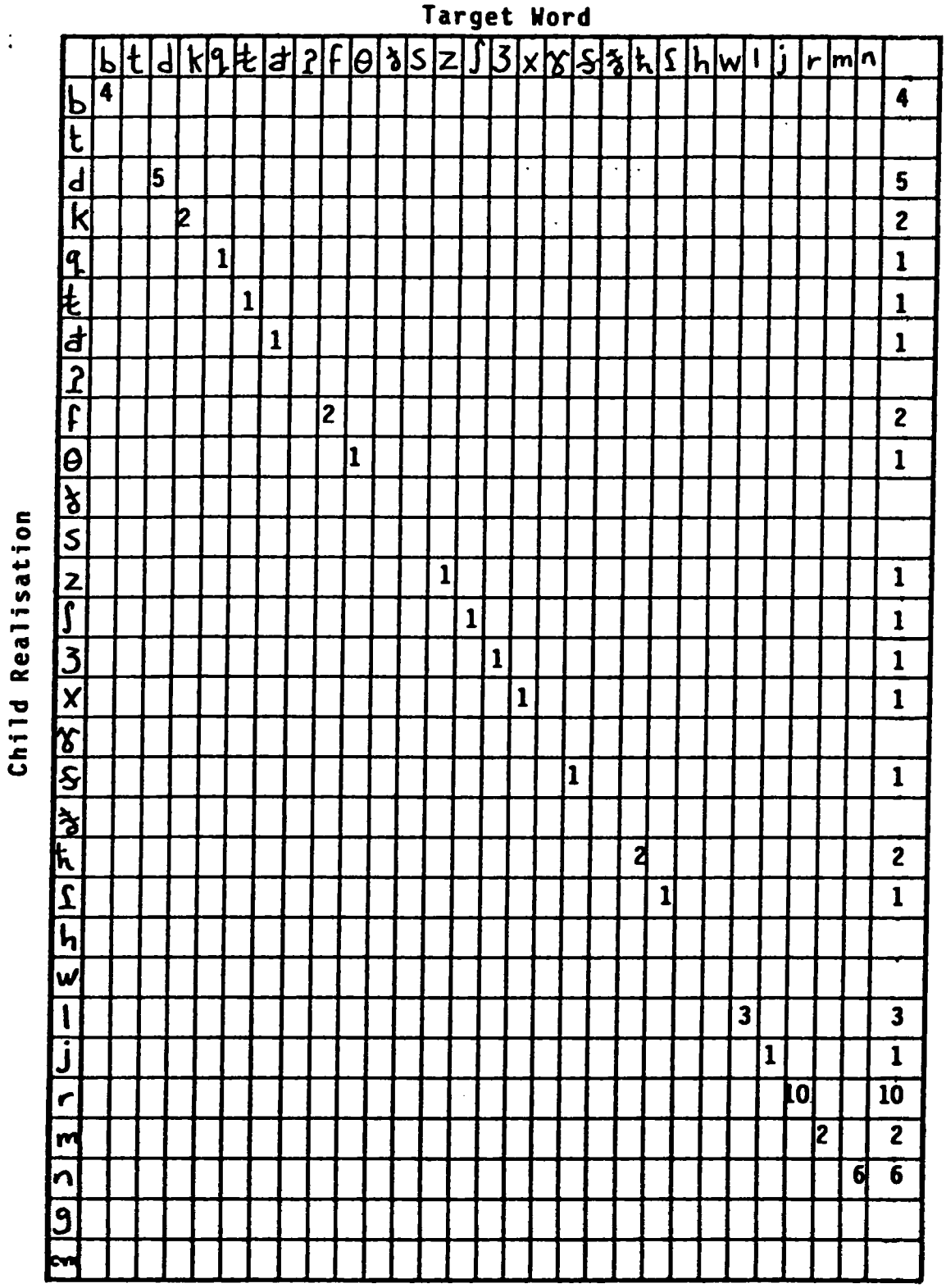
Correspondence Matrices for Control ...7...

Target Word

Child Realisation



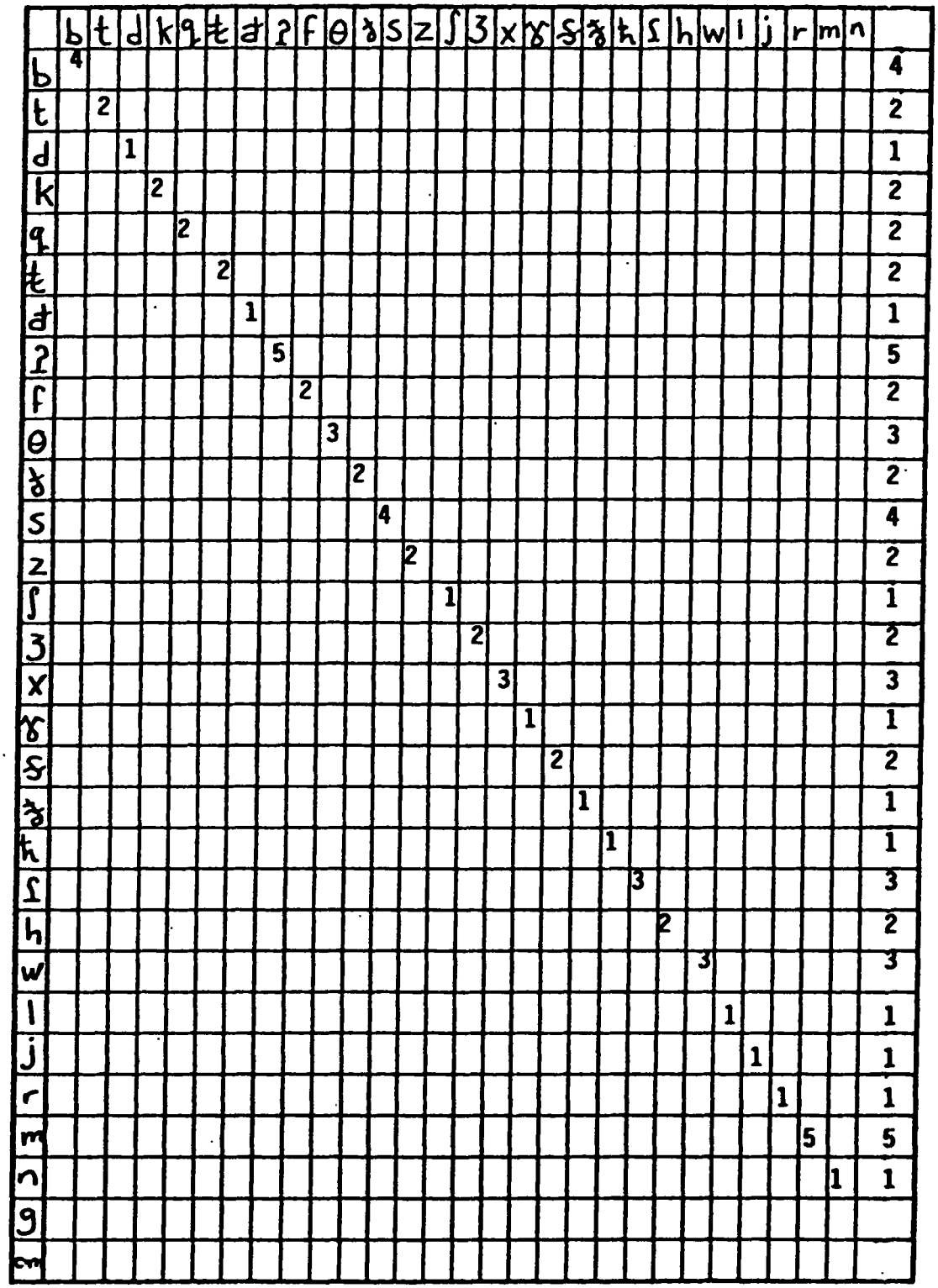
Correspondence Matrices for Control ...7....



Correspondence Matrices for Control ....8....

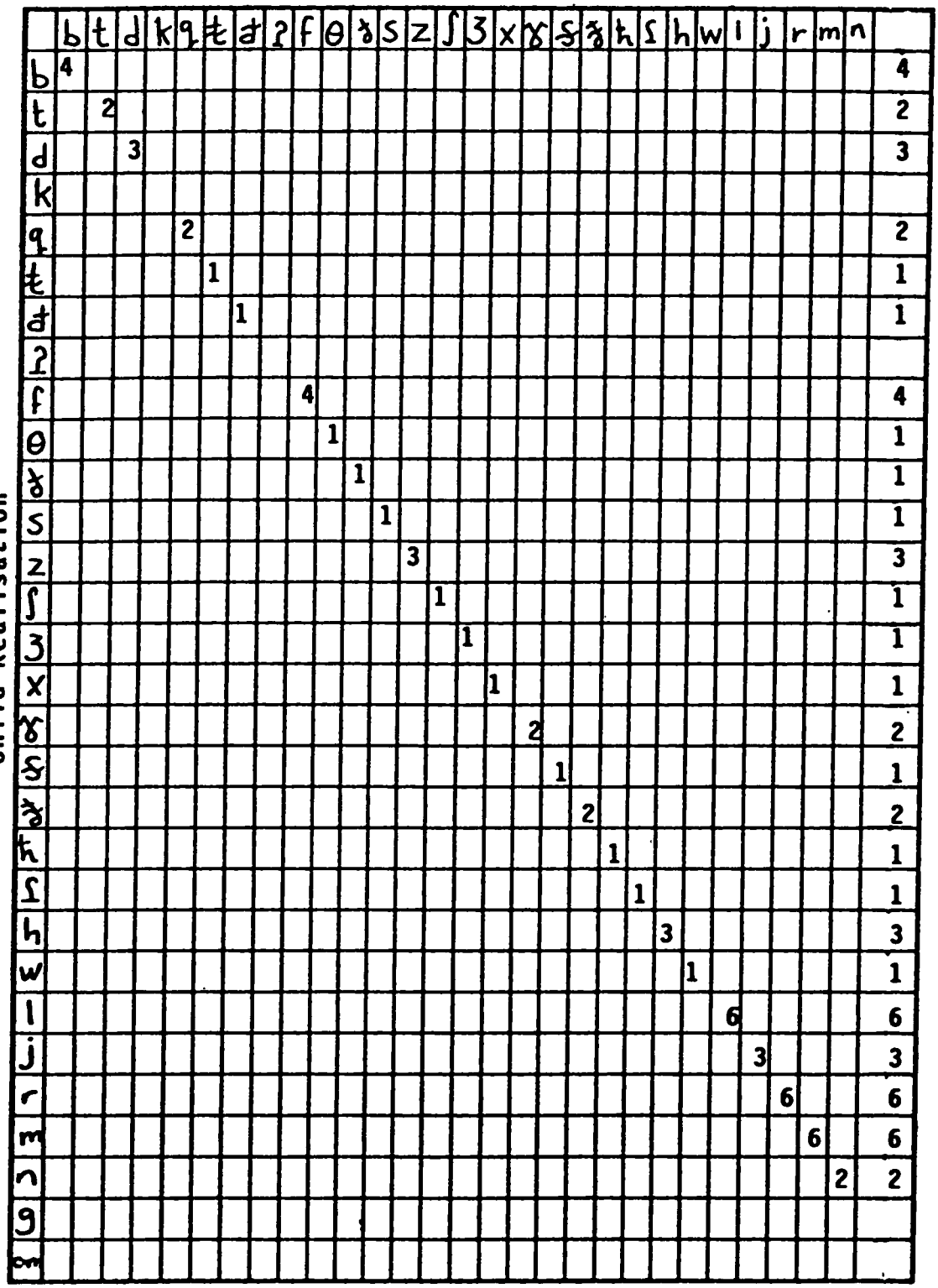
Target Word

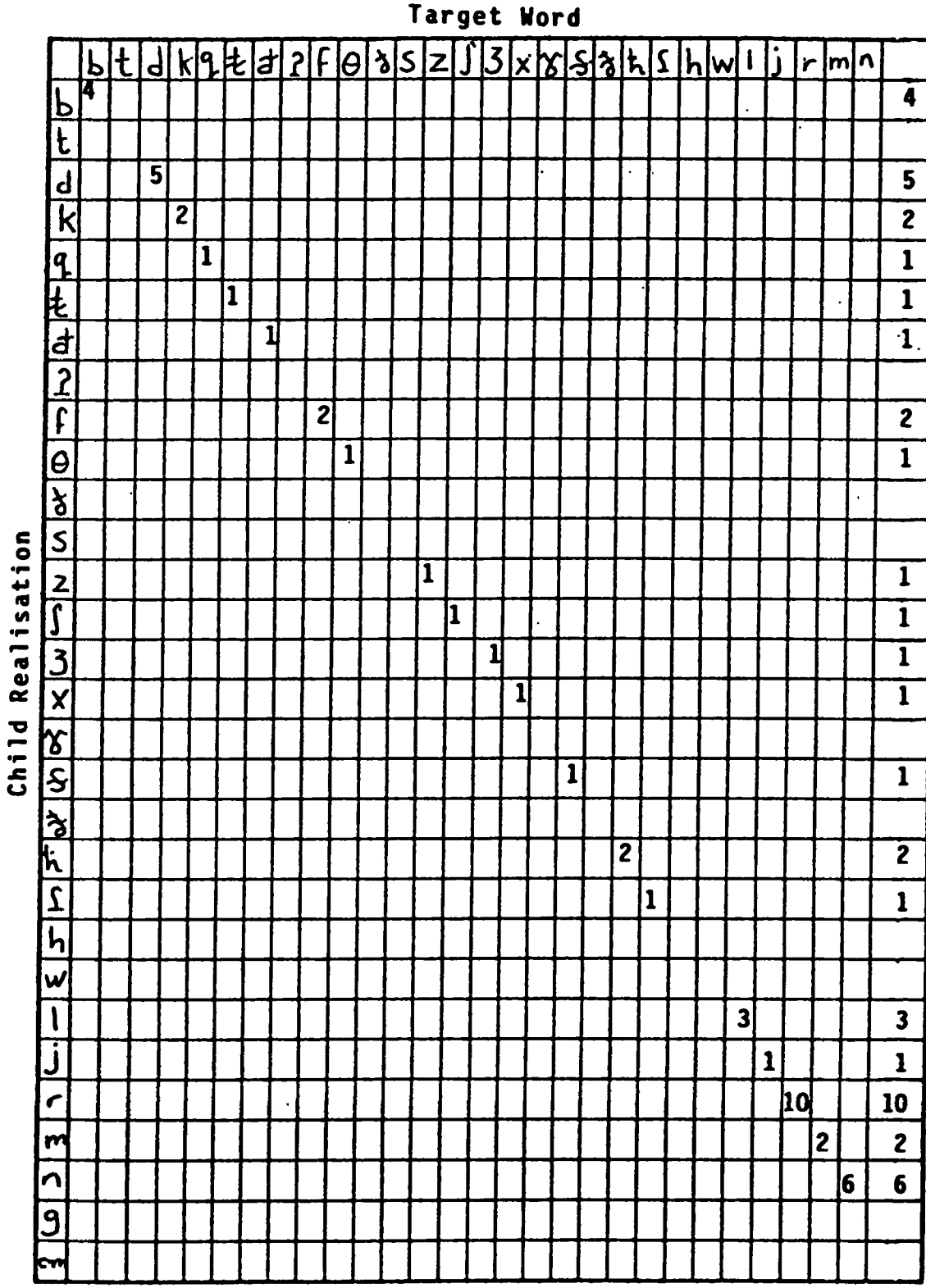
Child Realisation



Target Word

Child Realisation




Target Word
Child Realisation
b t d k q ʈ ʤ ʔ f θ ð s z ʃ ʒ x ɣ ʂ ʐ h ʕ w l j r m n
4
5
2
1
1
1
2
1
1
1
1
1
2
1
3
1
10
2
6

Phonological Processes Analysis : For Subject...1...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	2	2	2	2	1	1	5	5	100	qitair - gita:r
Stopping	9	22	6	21	2	12	17	55	30.9	θala:θa- tala:ta
Context Sensitive Voicing	9	49	8	57	3	49	20	155	12.9	ʒuzar - ʒuθar
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-	6	49	6	49	12	malik - mali
Frication	0	17	0	13	0	14	0	44	0	fa:r - fa:
Glottal Replacement	3	55	1	59	2	49	6	163	3.7	ʕunab - ʔunab
Backing										
- Velarisation	3	46	5	58	1	46	9	150	6	naǯǯa:ra-nagga:
- Uvularisation	2	48	1	58	0	48	3	154	1.9	ɣaza:l - qaza:l
- Glottalisation	1	39	1	55	1	49	3	143	2.1	
Assimilation	0	49	1	57	0	49	1	155	0.6	
Dentalisation	6	45	4	57	1	48	11	150	7.3	ʔasad - ʔaθad
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	3	6	2	5	1	3	6	14	42.9	ħusa:n-hasan
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-	1	13	1	13	7.7	ʃams - ʃam
- Simplification										
- Liquid Simplification		-		-	0	3	0	3	0	
- with Epenthesis		-		-	0	13	0	13	0	
		-		-	5	13	5	13	38.5	qitta - gitta

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Subject..2...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	0	2	0	2	0	1	0	5	0	
Stopping	12	22	6	21	2	12	20	55	36.4	naʒʒa:ra- qa:r
Context Sensitive Voicing	13	49	12	57	6	49	31	155	20	ʒel - θe
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	3	62		-		-	3	63	4.8	naʒʒa:ra-qa:ra
Final Consonant Deletion		-		-	13	49	13	49	26.5	xeʈ - xe
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	11	55	2	59	2	49	15	163	9	θuʃ ba:n-ʔuʔba:n
Backing										
- Velarisation	10	46	6	58	4	46	20	150	13	ʔabjaɗ - ʔ abjal
- Uvularisation	3	48	5	58	0	48	8	154	5.2	ɗufdaʃ - qufka
- Glottalisation	0	39	1	55	2	49	3	143	2.1	ħusa:n - hixa:n
Assimilation	1	49	4	57	0	49	5	155	3	qiṭa:r - qiqa:r
Dentalisation	3	45	5	57	2	48	10	150	15	ʔasad - ʔaθa
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation	-	-	-	-	3	13	3	13	23.1	sitta - xika
- Simplification										
- Liquid Simplification	-	-	-	-	0	3	0	3	0	
- with Epenthesis	-	-	-	-	0	13	0	13	0	
	-	-	-	-	6	13	6	13	46.2	bint - bink

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Subject..3...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	0	2	0	2	0	1	0	5	0	
Stopping	0	22	0	21	0	12	0	55	0	
Context Sensitive Voicing	10	49	13	57	6	49	29	155	1.87	jad - ja?
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-		62		
Final Consonant Deletion		-		-	10	49	10	49	20	malik - mali
Frication	9	17	6	13	1	14	16	44	36.4	kita:b - hiha:b
Glottal Replacement		55		59		49		163		
Backing										
- Velarisation	3	46	3	58	2	46	8	150	5.3	?iðin - ?axan
- Uvularisation	0	48	0	58	0	48	0	154	9	
- Glottalisation	23	39	10	55	6	49	39	143	27.3	qiṭa:r - hiha:
Assimilation	2	49	5	57	1	49	8	155	5.2	ðahab - hahab
Dentalisation	1	45	3	57	1	48	5	150	3	fara:ʃ a - fara
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	00	6	0	5	0	3	0	14	0	
Labialisation	0	60	3	55	0	45	3	160	1.8	
Metathesis										
Cluster										
- Reducation		-		-	4	13	4	13	30.8	bint - bin
- Simplification										
- Liquid Simplification		-		-	0	3	0	3	0	
- with Epenthesis		-		-	0	13	0	13	0	
		-		-	5	13	5	13	38.5	makwa - mahwa

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Subject...4..

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	1	3	0	2	1	2	2	7	28.6	qita:r - gika:r
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	0	2	0	2	0	1	0	5	0	
Stopping	5	22	5	21	1	12	11	55	20	ʔiðin - ʔikin
Context Sensitive Voicing	5	49	10	57	3	49	18	155	11.6	muz - mux
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	4	62		-		-	4	62	6.5	ʕaza:l - ka:l
Final Consonant Deletion		-		-	5	49	5	49	10	ʔaxðar - ʔaxka
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	0	55	1	59	0	49	1	163	0.6	θuʕba:n - kuʔba
Backing										
- Velarisation	16	46	13	58	11	46	40	150	26.7	ðel - gel
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	0	49	0	57	0	49	0	155	0	
Dentalisation	2	45	2	57	0	48	4	150	2.7	ʔazraq - ʔaθrag
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-	0	13	0	13	0	
- Simplification										
- Liquid Simplification		-		-	0	3	0	3	0	
- with Epenthesis		-		-	0	13	0	13	0	
					8	13	8	13	61.5	warda - warga

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Subject...5..

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	0	2	0	2	0	1	0	5	0	
Stopping	0	22	0	21	0	12	0	55	0	
Context Sensitive Voicing	5	49	5	57	2	49	12	155	7.8	
Liquid Simplification	0	2	9	10	3	13	12	25	48	
Initial Consonant Deletion	0	62		-		-		62		
Final Consonant Deletion		-		-	7	49	7	49	14	xet - xe
Frication	0	17	2	13	0	14	2	44	4.5	
Glottal Replacement	1	55	0	59	0	49	1	163	0.6	rumma:n - ʔumma:n
Backing										
- Velarisation	8	46	4	58	1	46	13	150	8.7	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	1	49	1	143	0.6	
Assimilation	0	49	0	57	0	49	0	155	0	
Dentalisation	0	45	3	57	1	48	1	150	0.6	
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	1	60	3	55	0	45	4	160	2.5	
Metathesis										
Cluster										
- Reducation		-		-	1	13	1	13	7.7	bint - bin
- Simplification										
- Liquid Simplification		-		-	3	3	3	3	100	warda - wajda
- with Epenthesis		-		-	0	13	0	13	0	
		-		-	4	13	4	13	30.8	xamsa - xamxa

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Subject...6...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	2	2	1	2	0	1	3	5	60	qitta - gatwa
Stopping	1	22	0	21	0	12	1	55	1.8	ʕaza:l - qaza:l
Context Sensitive Voicing	7	49	6	57	1	49	14	155	9	ʔið in - ʔaθun
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-	11	49	11	49	22	ʔasad - ʔasa
Frication	1	17	1	13	1	14	5	44	11.4	baqara - baʕara
Glottal Replacement	1	55	0	59	0	49	1	163	0.6	hadija - ʔadija
Backing										
- Velarisation	1	46	2	58	0	46	3	150	2	
- Uvularisation	1	48	0	58	0	48	1	154	0.6	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	0	49	1	57	0	49	1	155	0.6	kita:b - kika:b
Dentalisation	0	45	0	57	0	48	0	150	0	
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	2	60	3	55	1	45	6	160	3.8	
Metathesis					0	0	1	155	0.6	ʤufdaʃ - d u ʃ fa
Cluster										
- Reducation		-		-	1	13	1	13	7.6	
- Simplification										
- Liquid Simplification		-		-	0	3	0	3	0	
- with Epenthesis		-		-	4	13	4	13	30.8	ʃ ams - ʃ amas
		-		-	1	13	1	13	7.6	qitta - gatwa

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Subject.₹....

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	1	2	0	2	0	1	1	5	20	
Stopping	4	22	3	21	2	12	9	55	16.4	muz - mud
Context Sensitive Voicing	1	49	2	57	1	49	4	155	2.6	
Liquid Simplification	0	2	1	10	0	13	1	25	4	ʔazraq - ʔadlaʔ
Initial Consonant Deletion	0	62		-		-		62	0	
Final Consonant Deletion		-		-	5	49	5	49	10	ʤel - de
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	11	55	11	59	3	49	25	163	15.3	
Backing										
- Velarisation	1	46	1	58	1	46	3	150	2	ħuʕa:n - ħuxa:n
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	7	39	6	55	10	49	23	143	16.1	ʔaxʤa:r - ʔaxʔa
Assimilation	1	49	1	57	0	49	2	155	1.3	naʧ ʤ a:ra- naʔn
Dentalisation	0	45	1	57	0	48	1	150	0.6	ʔasad -ʔaθaʔ
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	1	6	0	5	0	3	1	14	7.1	ʤufdaʕ - duʔdaʃ
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis							1	155	0.6	
Cluster										
- Reducation		-		-	1	13	1	13	7.7	ʃ ams - ʃam
- Simplification										
- Liquid Simplification		-		-	1	3	1	3	33	kursi: - ʔulʔi:
- with Epenthesis		-		-	0	13	0	13	0	
		-		-	8	13	8	13	61.5	makwa - maʔwa

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Subject...8..

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	1	2	0	2	0	1	1	5	20	qiṭa:r - gita:l
Stopping	2	22	1	21	0	12	3	55	5.5	ʔiðin - ʔidin
Context Sensitive Voicing	2	49	3	57	1	49	6	155	3.9	
Liquid Simplification	0	2	6	10	7	13	13	25	52	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-		49	1	49	2	jad - ja
Frication	0	17	1	13	1	14	2	44	4.5	
Glottal Replacement	1	55	0	59	0	49	1	163	0.6	
Backing										
- Velarisation	1	46	1	58	2	46	4	150	2.7	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	0	49	0	57	0	49	0	155	0	
Dentalisation	4	45	1	57	0	48	5	150	3.3	sabʂa - θabʂa
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	1	6	0	5	0	3	1	14	7.1	ḍufda ʕ - dufdaʕ
Labialisation	0	60	3	55	1	45	4	160	2.5	
Metathesis										
Cluster										
- Reducation		-		-		13	0	13	0	
- Simplification										
- Liquid Simplification		-		-	3	3	3	3	100	warda - walda
- with Epenthesis		-		-	0	13	0	13	0	
		-		-	3	13	3	13	23.1	xamsa - χamxa

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Control...1...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	3	3	1	2	2	2	6	7	85.7	duʒa:ʒ - duza:z
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	2	2	2	2	1	1	5	5	100	ʔazraq - ʔazrag
Stopping	5	22	4	21	1	12	10	55	18	naðð a:ra-nadda:
Context Sensitive Voicing	0	49	0	57	0	49	0	155	0	
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-	0	49	-	49	0	
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	0	55	0	59	0	49	0	163	0	
Backing										
- Velarisation	0	46	0	58	0	46	0	150	0	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	1	49	0	57	0	59	1	155	0.6	
Dentalisation	0	45	0	57	0	48	0	150	0	
Dedentalisation	1	6	0	4	0	1	1	11	9	ðarf - zarf
Pharyngealisation	4	58	3	57	1	54	8	69	4.7	ʃaza:l - ʕaza:l
Depharyngealisation	3	6	2	5	2	3	7	14	50	ʕa:ru:x-sa:ru:ħ
Labialisation	0	60	0	55	00	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-		13	0	13	0	
- Simplification										
- Liquid Simplification		-		-		3	0	3	0	
- with Epenthesis		-		-		13	0	13	0	
		-		-		13	0	13	0	

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Control...2...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	3	3	1	2	2	2	6	7	85.7	ʒuzar - zuzar
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	2	2	2	2	1	1	5	5	100	
Stopping	6	22	5	21	1	12	12	55	21.0	θalaθa-tala:ta
Context Sensitive Voicing	5	49	5	57	4	49	14	155	9	bint - pint
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	1	62		-		-	1	62	0.2	duʒa:ʒa-za:za
Final Consonant Deletion		-		-	0	49	0	49	0	
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	0	55	0	59	0	49	0	163	0	
Backing										
- Velarisation	0	46	0	58	0	46	0	150	0	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	1	49	0	57	0	49	1	155	0.6	
Dentalisation	0	45	0	57	0	48	0	150	0	
Dedentalisation	1	6	0	4	0	1	1	11	9	ʒarf - zarf
Pharyngealisation	4	58	3	57	1	54	8	69	11.6	xeṭ - heṭ
Depharyngealisation	3	6	2	5	2	3	7	14	50	miqaṣ - magas
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-		13	0	13	0	
- Simplification										
- Liquid Simplification		-		-		3	0	3	0	
- with Epenthesis		-		-		13	0	13	0	
		-		-	1	13	1	13	7.7	ṭabla - ṭapla

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Control.....3

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	2	2	2	2	1	1	5	5	100	qiṭa:r - giṭa:r
Stopping	5	22	4	21	1	12	10	55	18	θama:nja - tama
Context Sensitive Voicing	0	49	0	57	0	49	0	155	0	
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-		49	0	49	0	
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	0	55	0	59	0	49	0	163	0	
Backing										
- Velarisation	0	46	0	58	0	46	0	150	0	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	0	49	1	57	0	49	1	155	0.6	ḏufdaʕ - ḏufḏaʕ
Dentalisation	0	45	0	57	0	48	0	150	0	
Dedentalisation	1	6	0	4	0	1	1	11	9	ðahab - dahab
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-		13	0	13	0	
- Simplification										
- Liquid Simplification		-		-		3	0	3	0	
- with Epenthesis		-		-		13	0	13	0	
		-		-		13	0	13	0	

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Control...4...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	2	2	2	2	1	1	5	5	100	qiṭṭa - giṭṭa
Stopping	5	22	4	21	1	12	10	55	18	θala:θa - tala:t
Context Sensitive Voicing	0	49	0	57	0	49	0	155	0	
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-		49	0	49	0	
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	0	55	0	59	0	49	0	163	0	
Backing										
- Velarisation	0	46	0	58	0	46	0	150	0	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	0	49	1	57	0	49	1	155	0.6	ḏufdaʕ - ḏufḏ aʕ
Dentalisation	0	45	0	57	0	48	0	150	0	
Dedentalisation	1	6	0	4	0	1	1	11	9	ðahab - dahab
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-		13	0	13	0	
- Simplification										
- Liquid Simplification		-		-		3	0	3	0	
- with Epenthesis		-		-		13	0	13	0	
		-		-		13	0	13	0	

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Control...5...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	0	2	0	2	0	1	0	5	0	
Stopping	0	22	0	21	0	12	0	55	0	
Context Sensitive Voicing	0	49	0	57	0	49	0	155	0	
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-	0	49	0	49	0	
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	0	55	0	59	0	49	0	163	0	
Backing										
- Velarisation	0	46	0	58	0	46	0	150	0	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	0	49	0	57	0	49	0	155	0	
Dentalisation	0	45	0	57	0	48	0	150	0	
Dedentalisation	0	6	0	4	1	0	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-	0	13	0	13	0	
- Simplification										
- Liquid Simplification		-		-	0	3	0	3	0	
- with Epenthesis		-		-	0	13	0	13	0	
		-		-	0	13	0	13	0	

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Control...6..

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	0	2	0	2	0	1	0	5	0	
Stopping	0	22	0	21	0	12	0	55	0	
Context Sensitive Voicing	0	49	0	57	0	49	0	155	0	
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-		49		49		
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	0	55	0	59	0	49	0	163	0	
Backing										
- Velarisation	0	46	0	58	0	46	0	150	0	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	0	49	0	57	0	49	0	155	0	
Dentalisation	0	45	0	57	0	48	0	150	0	
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-	0	13	0	13	0	
- Simplification										
- Liquid Simplification		-		-	0	3	0	3	0	
- with Epenthesis		-		-	0	13	0	13	0	
		-	-	-	0	13	0	13	0	

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Control...7...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	0	2	0	2	0	1	0	5	0	
Stopping	0	22	0	21	0	12	0	55	0	
Context Sensitive Voicing	0	49	0	57	0	49	0	155	0	
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-		49	0	49	0	
Frication	0	17	0	13	0	14	0	44	0	
Glottal Replacement	0	55	0	59	0	49	0	163	0	
Backing										
- Velarisation	0	46	0	58	0	46	0	150	0	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	0	49	0	57	0	49	0	155	0	
Dentalisation	0	45	0	57	0	48	0	150	0	
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-		13	0	13	0	
- Simplification										
- Liquid Simplification		-		-		3	0	3	0	
- with Epenthesis		-		-		13	0	13	0	
		-		-		13	0	13	0	

A = Actual Number of Occurrences
P = Possible Number of Occurrences

Phonological Processes Analysis : For Control...8...

Processes	Actual Possible Scores According to Syllable Position						Total Scores		% Occurrence	Example
	SIWI		SF/SIWW		SFWF					
	A	P	A	P	A	P	A	P		
Palatal Fronting	0	3	0	2	0	2	0	7	0	
Velar Fronting	0	5	0	3	0	3	0	11	0	
Uvular Fronting	0	2	0	2	0	1	0	5	0	
Stopping	0	22	0	21	0	12	0	55	0	
Context Sensitive Voicing	0	49	0	57	0	49	0	155	0	
Liquid Simplification	0	2	0	10	0	13	0	25	0	
Initial Consonant Deletion	0	62		-		-	0	62	0	
Final Consonant Deletion		-		-	0	49	0	49	0	
Frication	0	17		13	0	14	0	44	0	
Glottal Replacement	0	55	0	59	0	49	0	163	0	
Backing										
- Velarisation	0	46	0	58	0	46	0	150	0	
- Uvularisation	0	48	0	58	0	48	0	154	0	
- Glottalisation	0	39	0	55	0	49	0	143	0	
Assimilation	0	49	0	57	0	49	0	155	0	
Dentalisation	0	45	0	57	0	48	0	150	0	
Dedentalisation	0	6	0	4	0	1	0	11	0	
Pharyngealisation	0	58	0	57	0	54	0	69	0	
Depharyngealisation	0	6	0	5	0	3	0	14	0	
Labialisation	0	60	0	55	0	45	0	160	0	
Metathesis										
Cluster										
- Reducation		-		-	0	13	0	13	0	
- Simplification										
- Liquid Simplification		-		-	0	3	0	3	0	
- with Epenthesis		-		-	0	13	0	13	0	
		-		-	0	13	0	13	0	

A = Actual Number of Occurrences
P = Possible Number of Occurrences

FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM

Subject Two

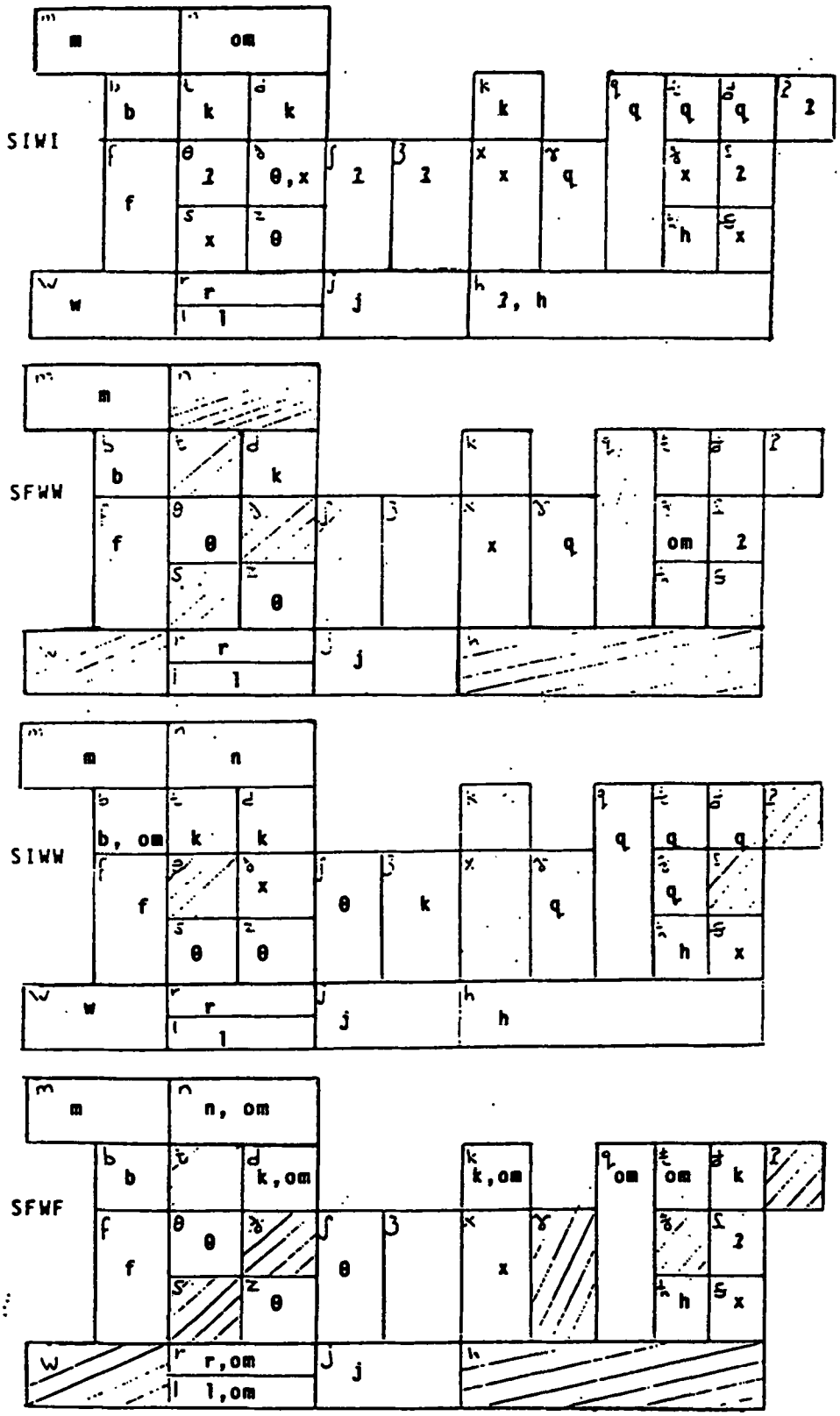


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM
For Subject Three

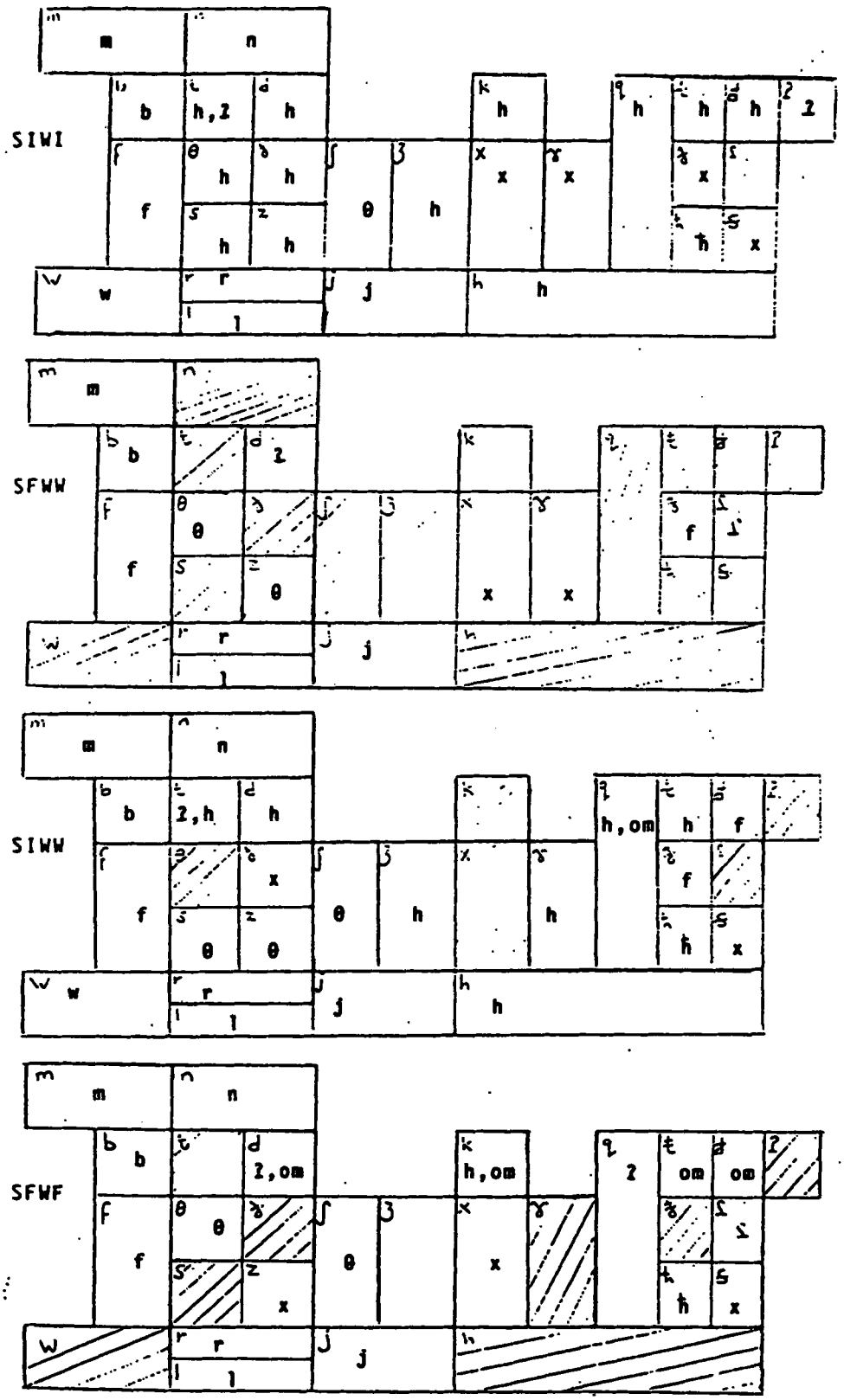


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM
For Subject Four

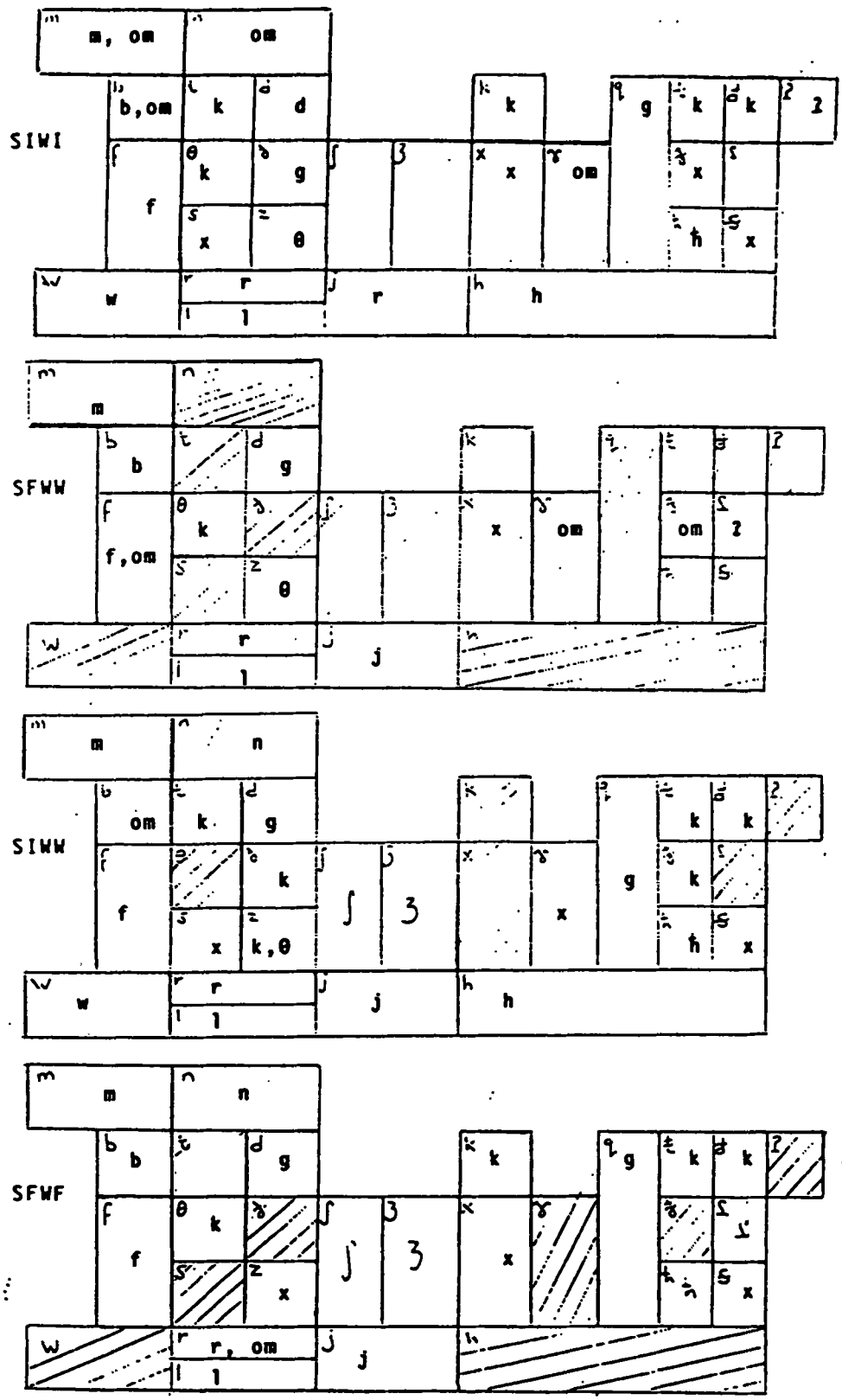


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM

For Subject Five

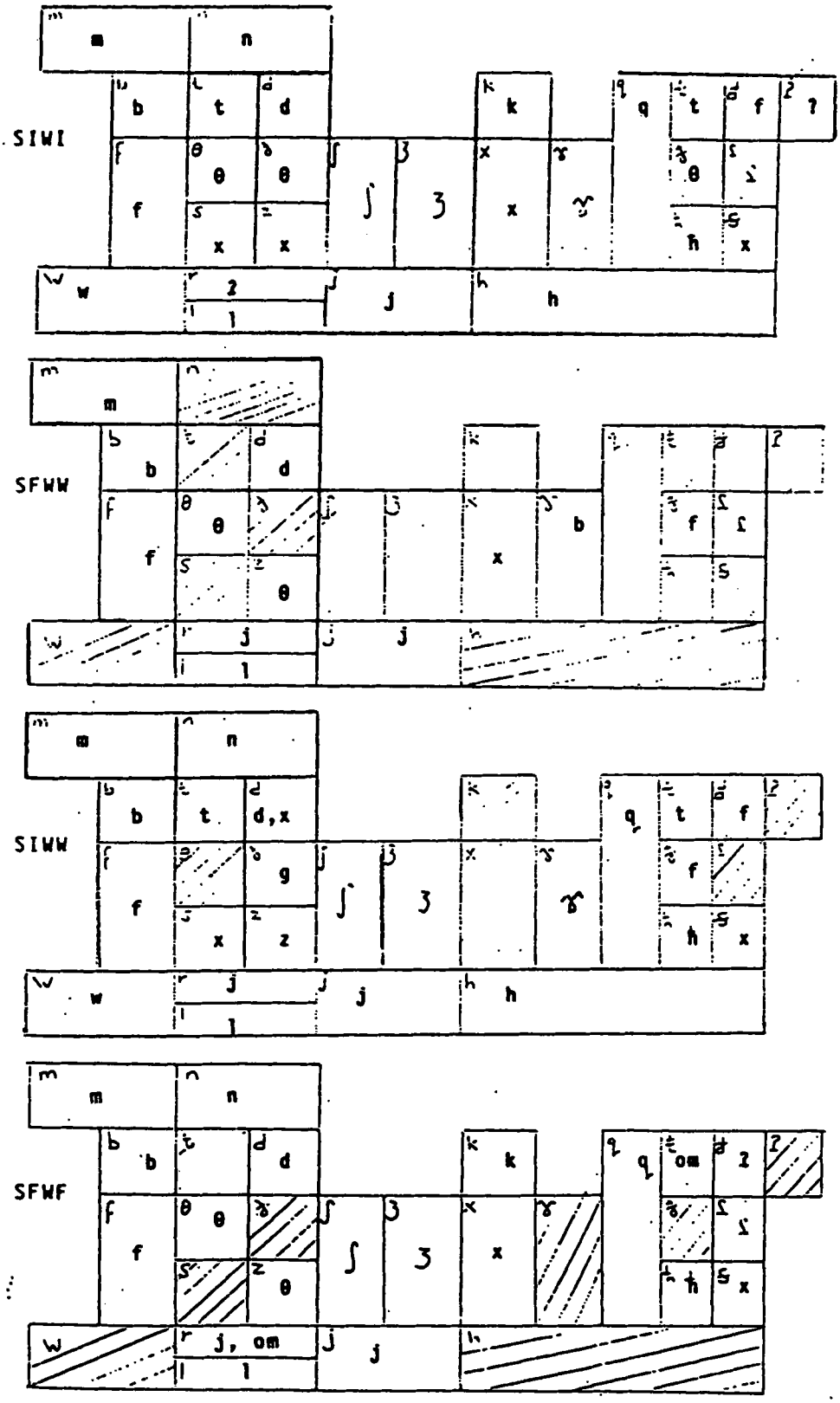


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM
For Subject Six

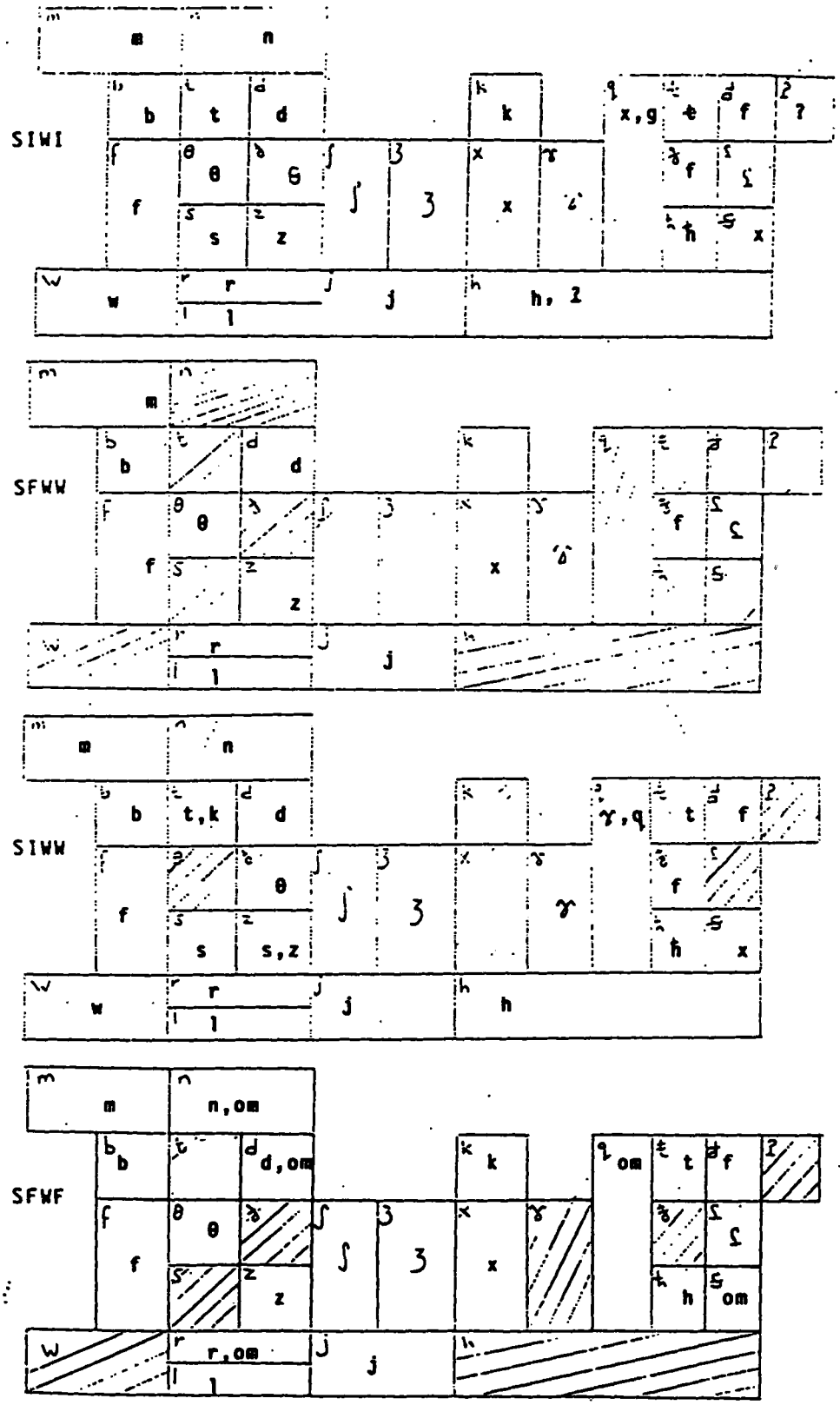


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM
For Subject Seven

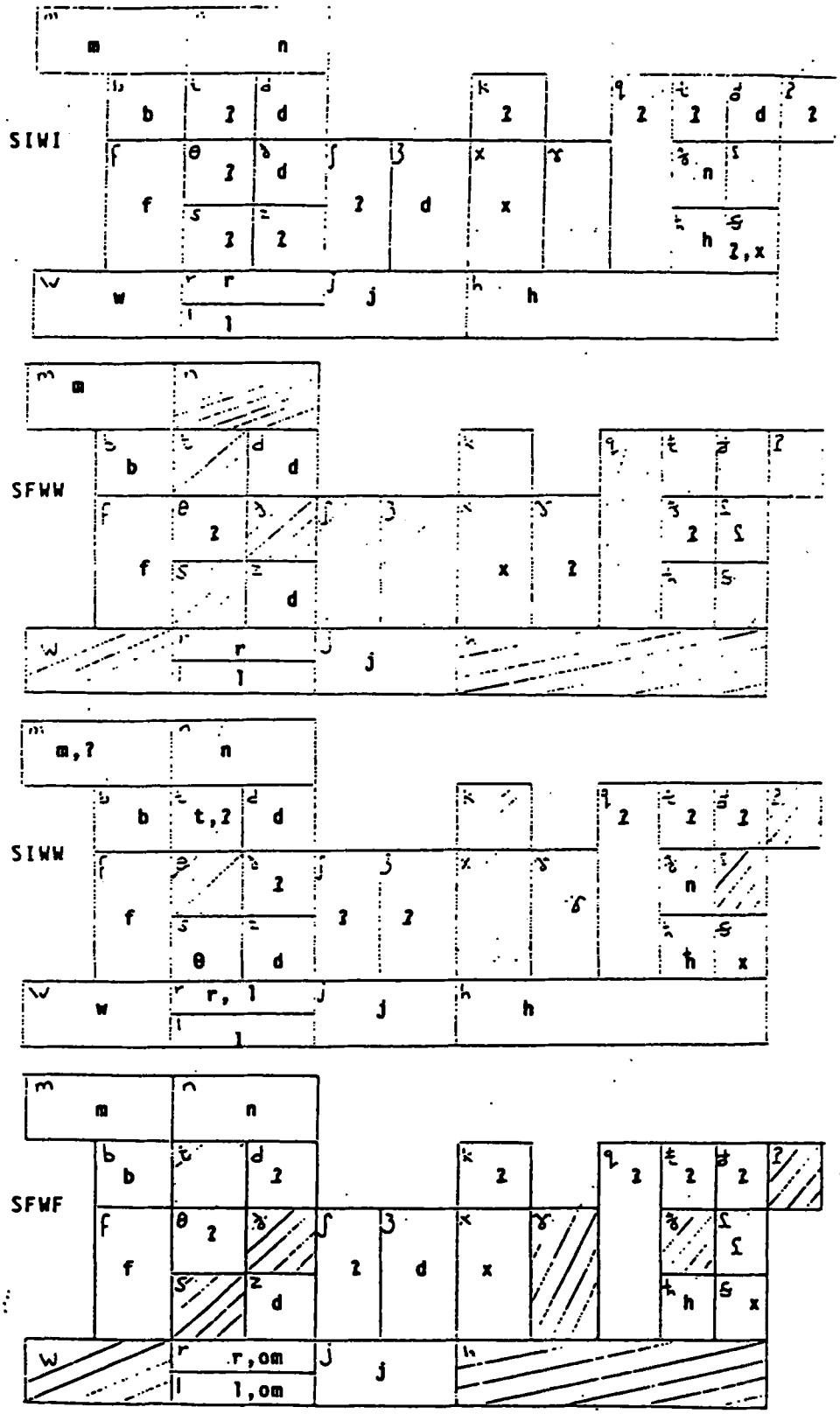


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM
For Subject Eight

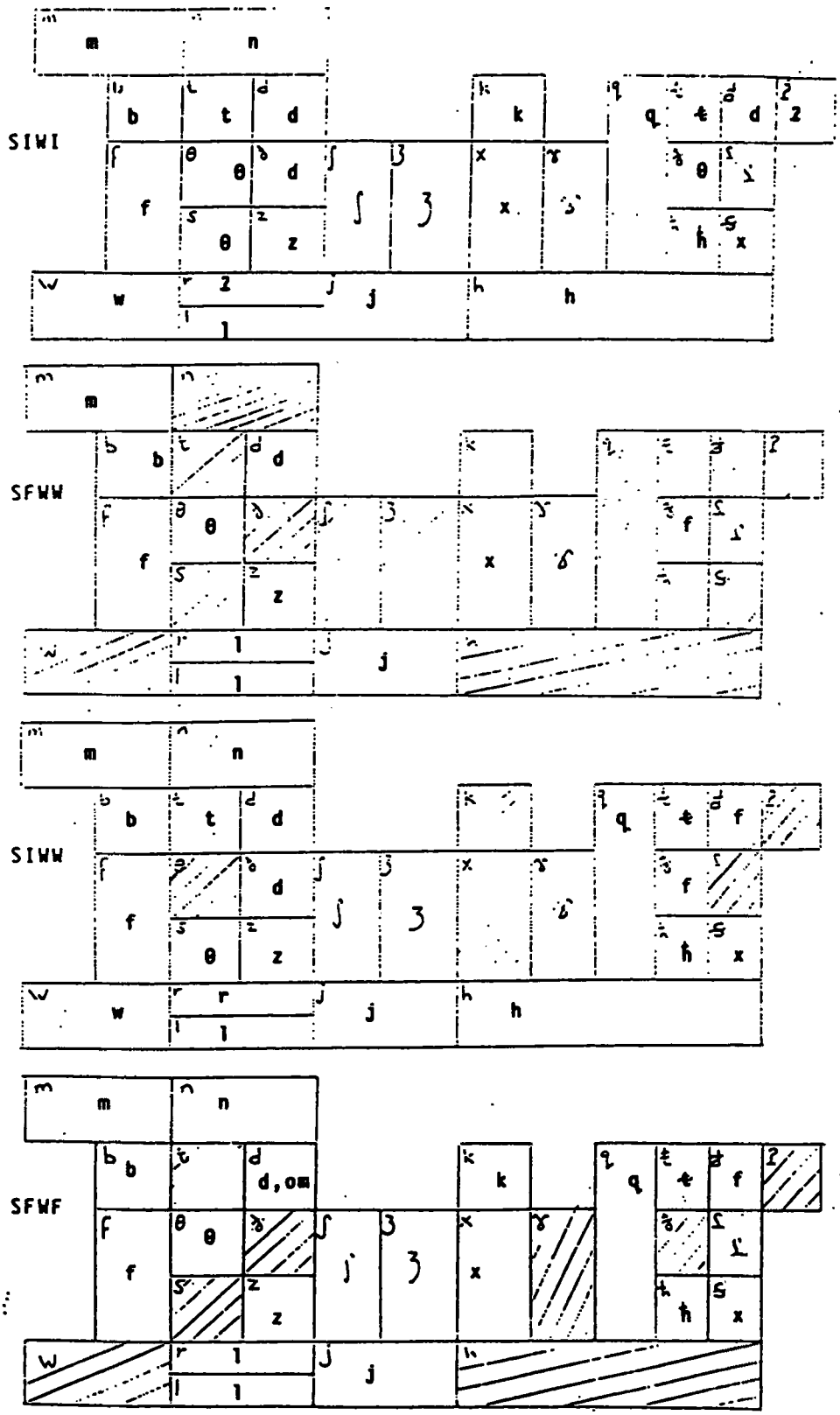


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM

For Control One

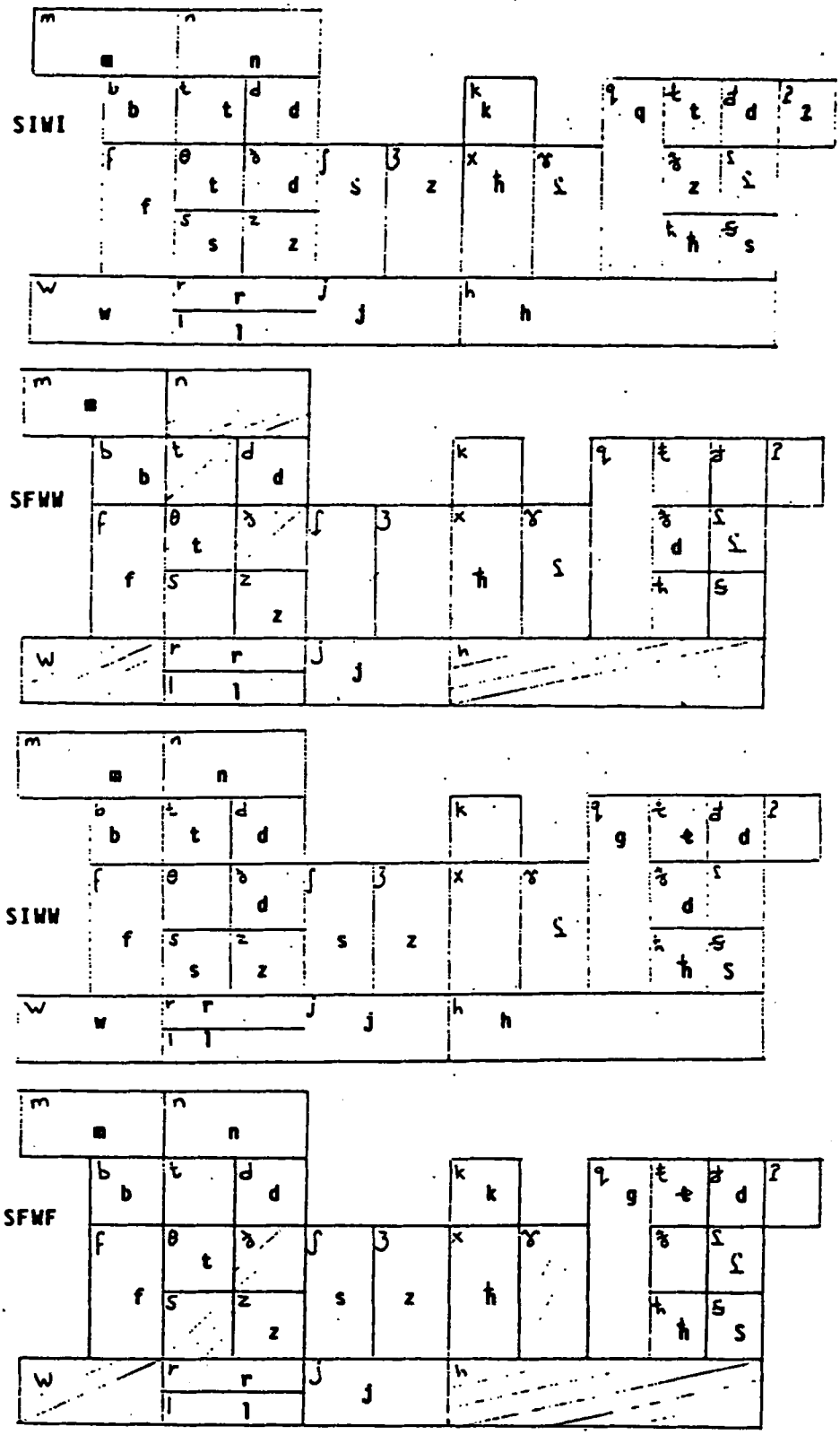


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM

For Control Two

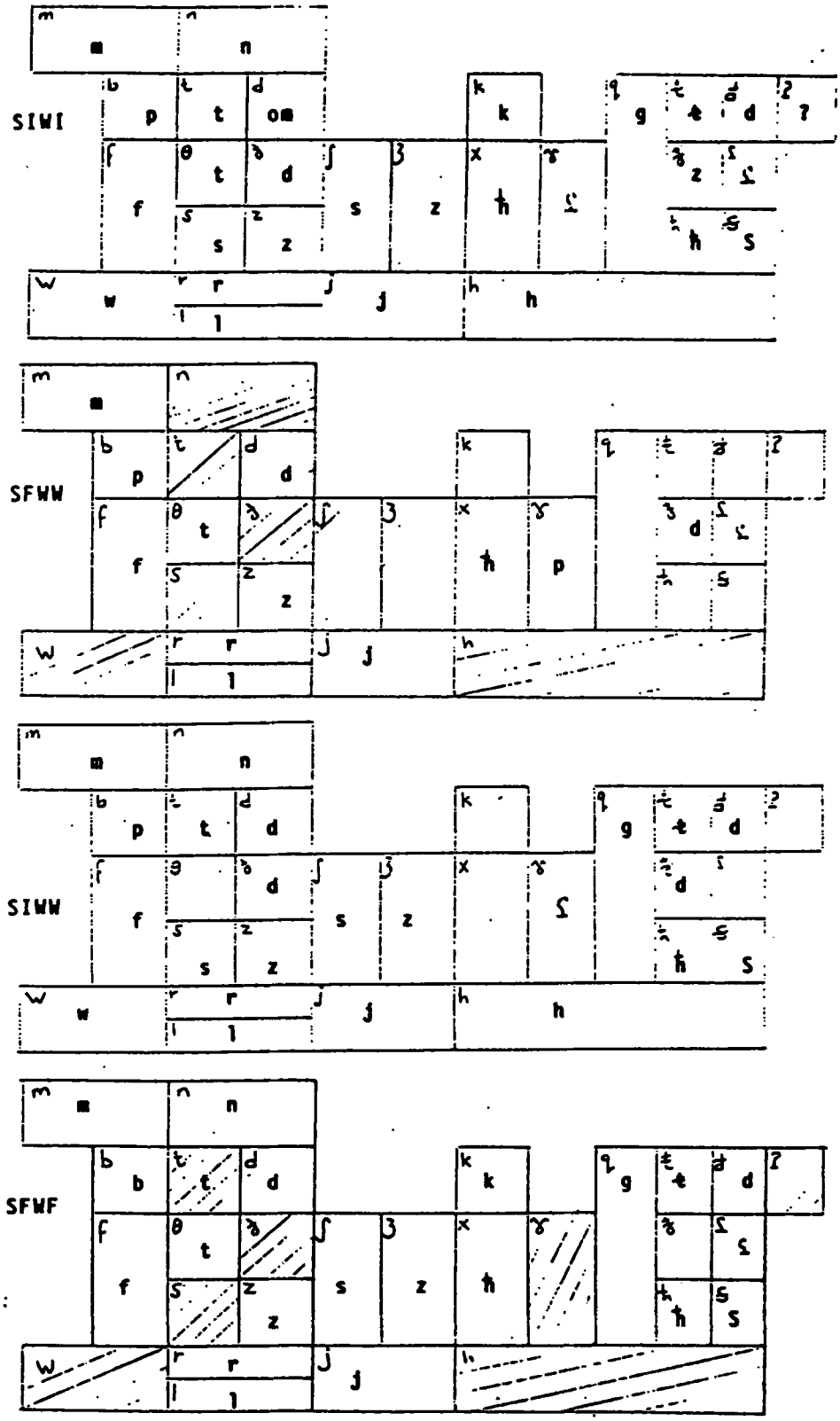


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM

For Control Three

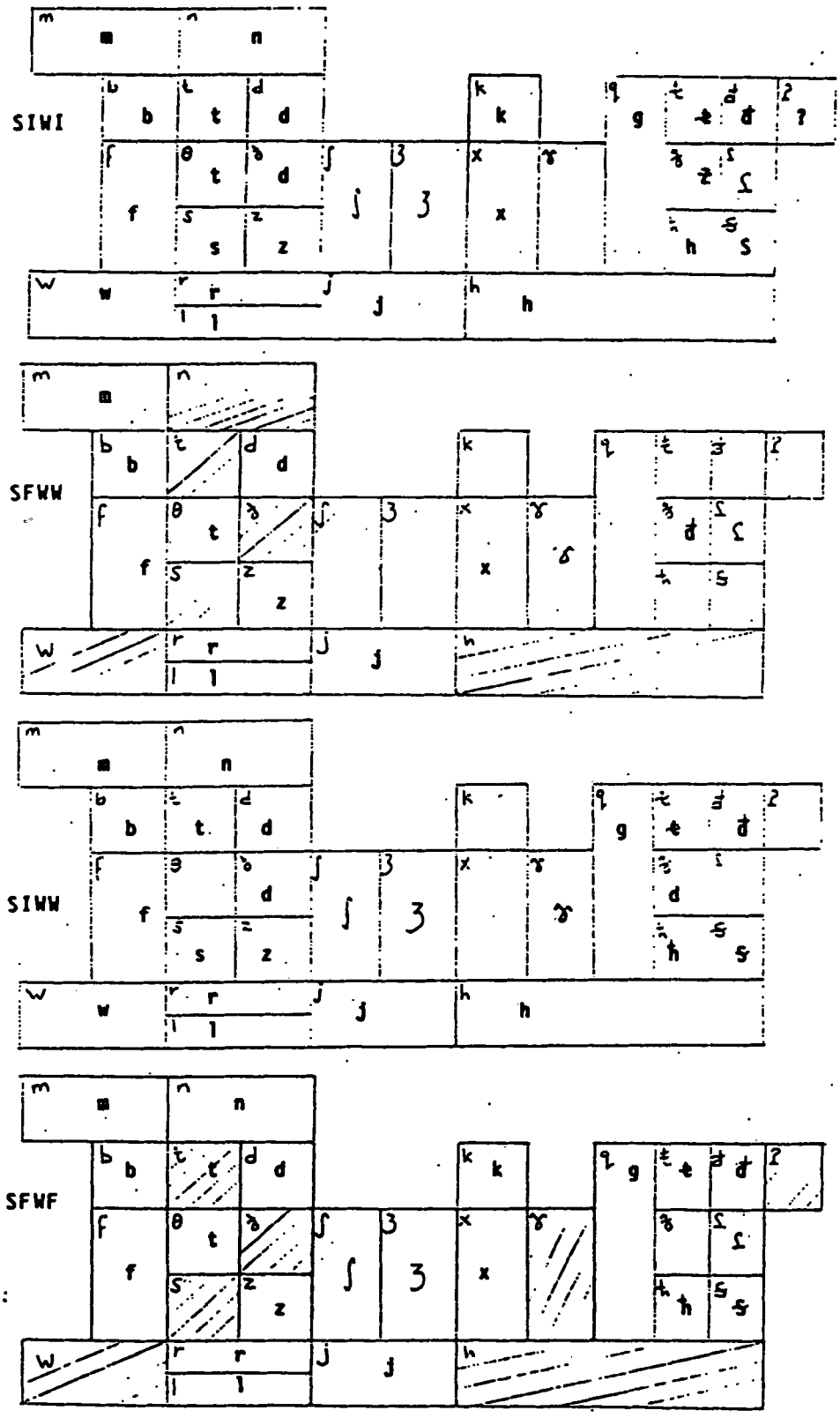


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM
For Control Four

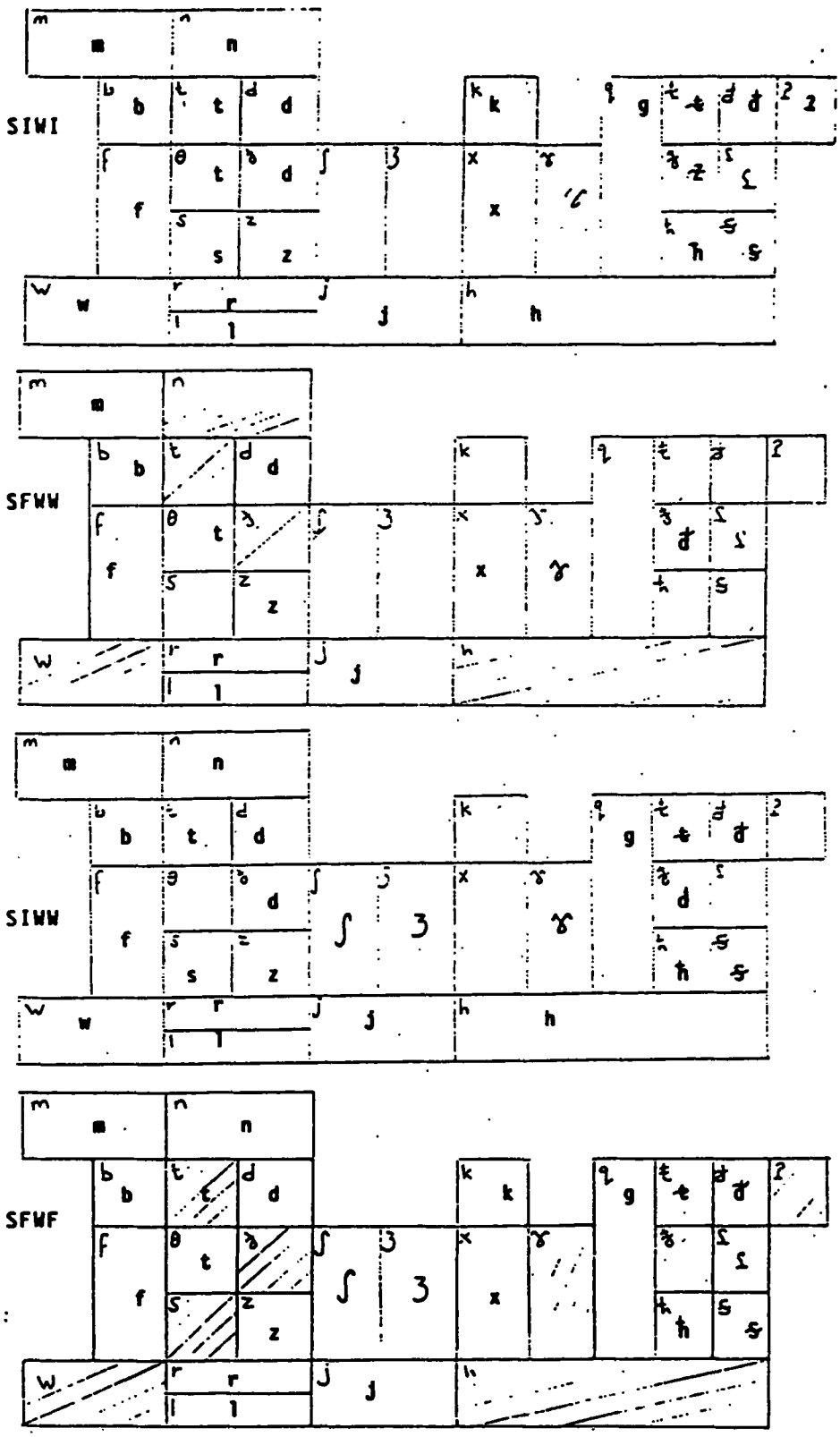


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM

For Control Five

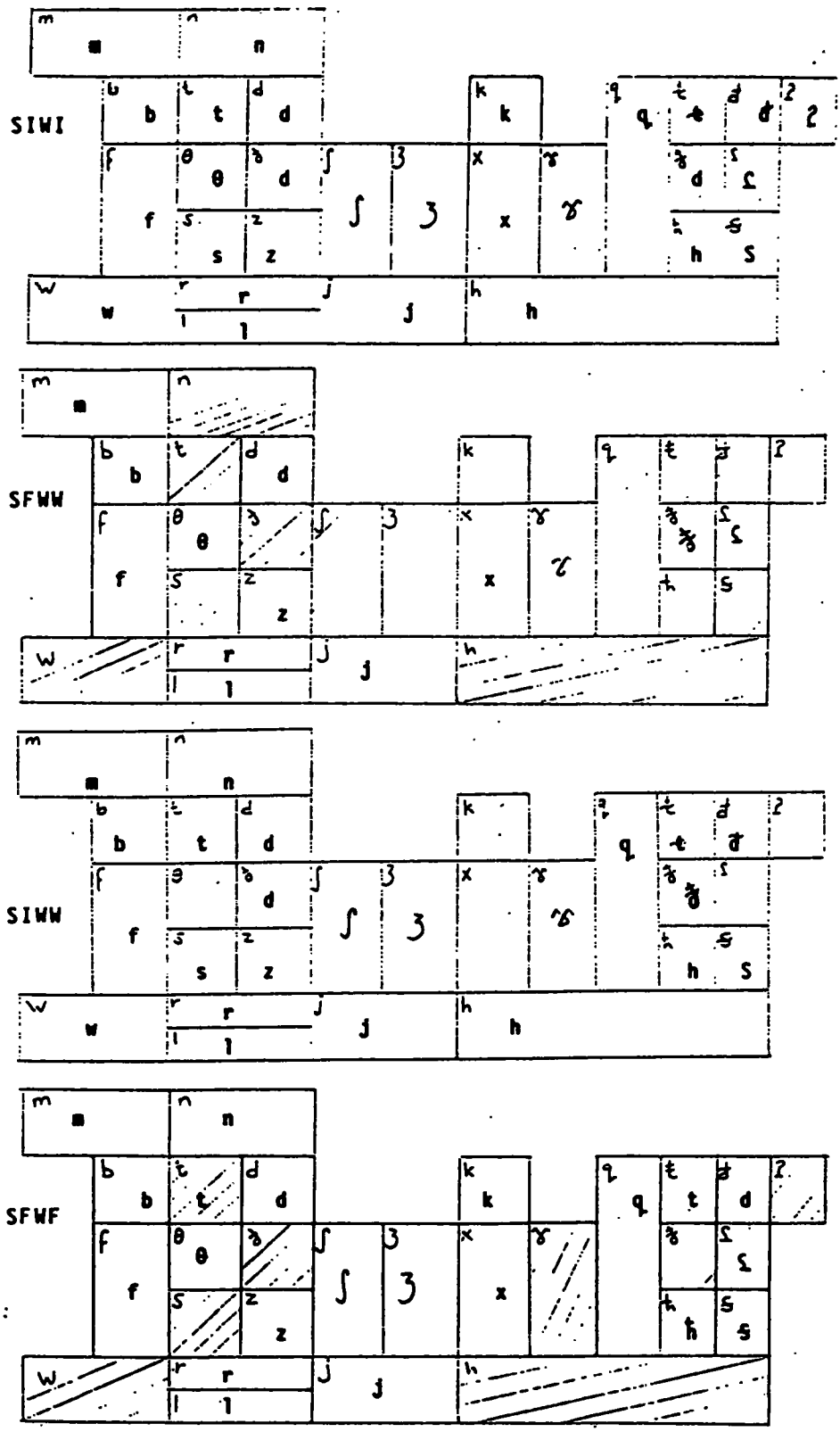


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM
For Control Six

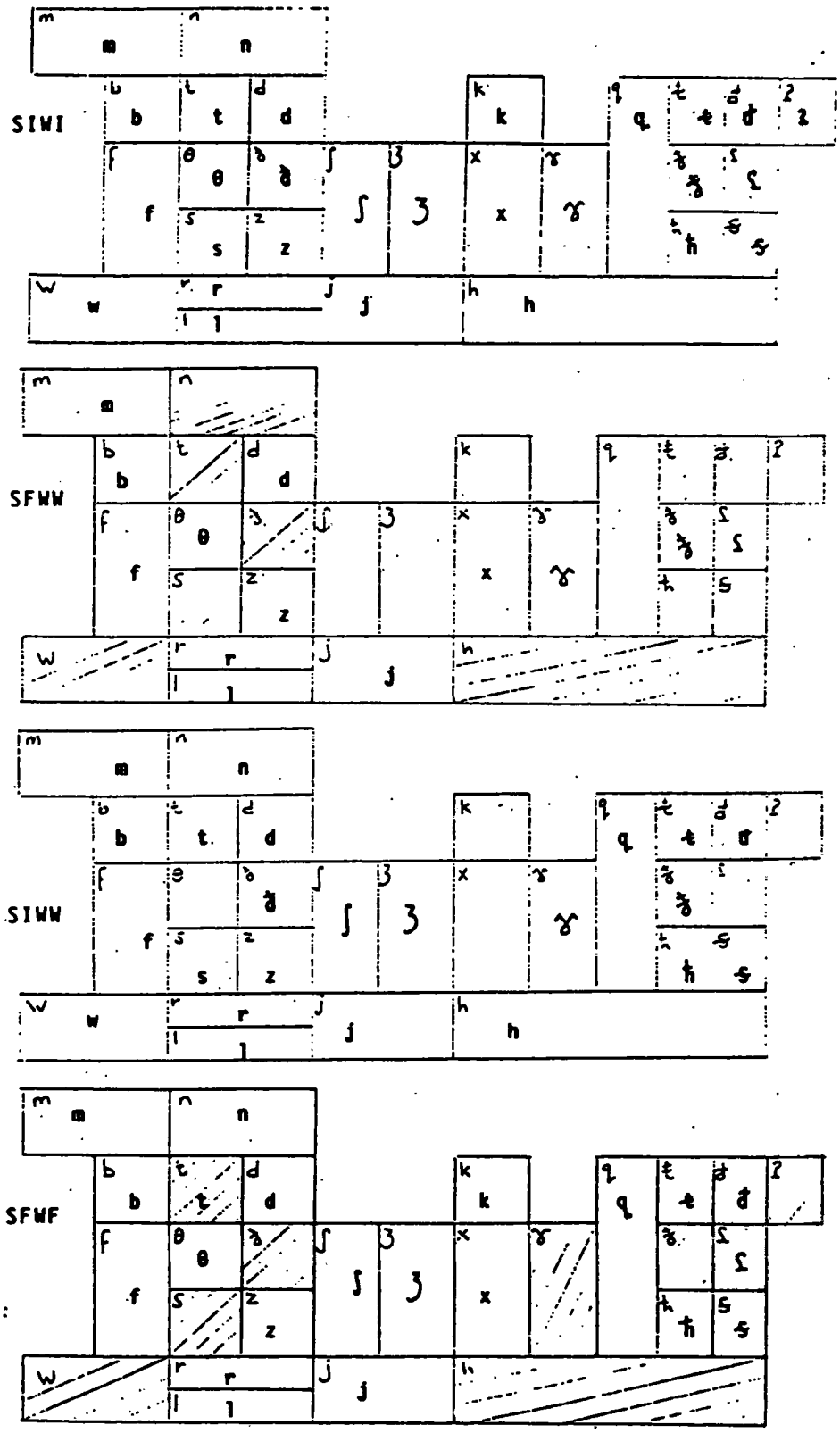


FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM

For Control Seven

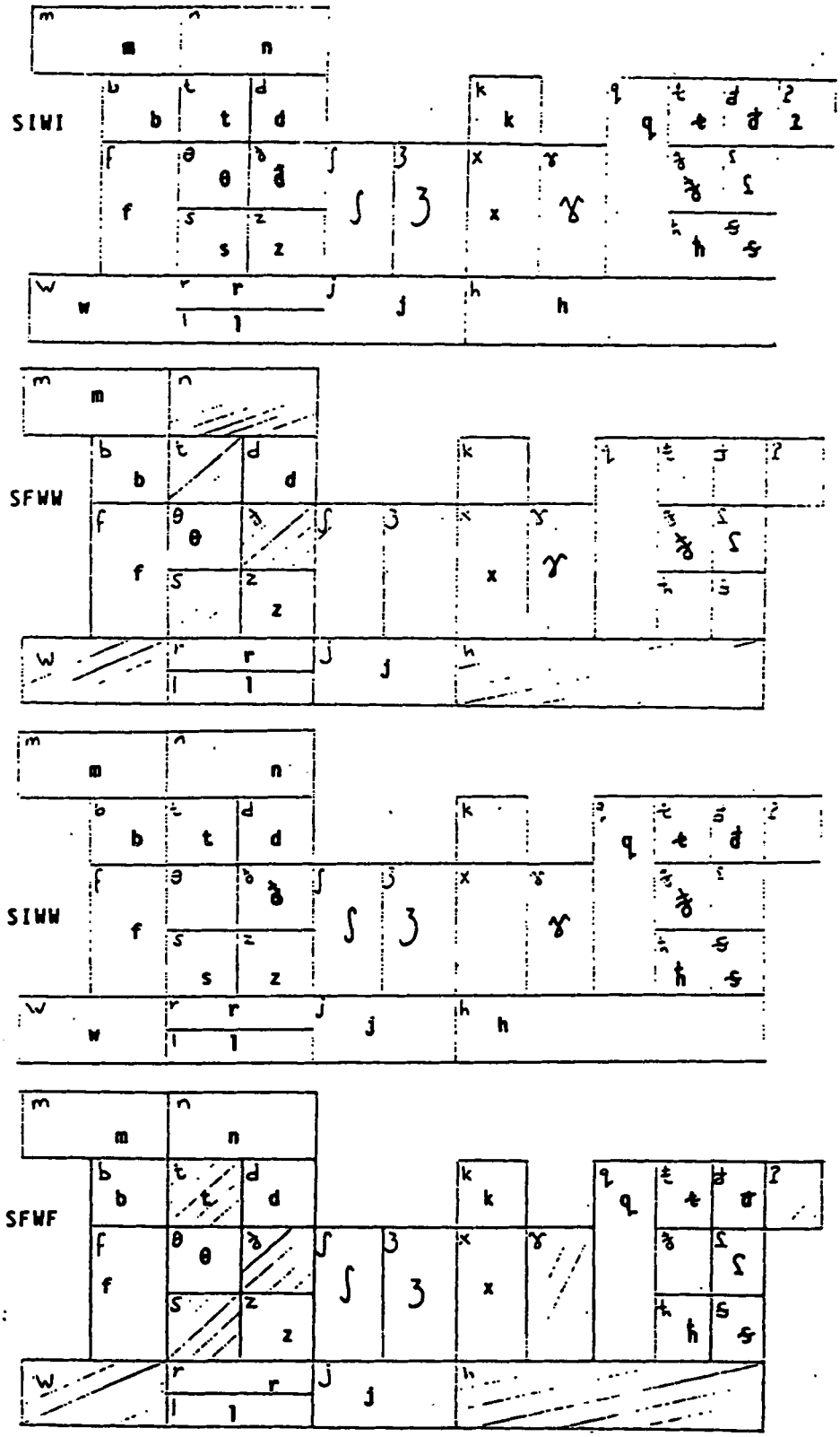
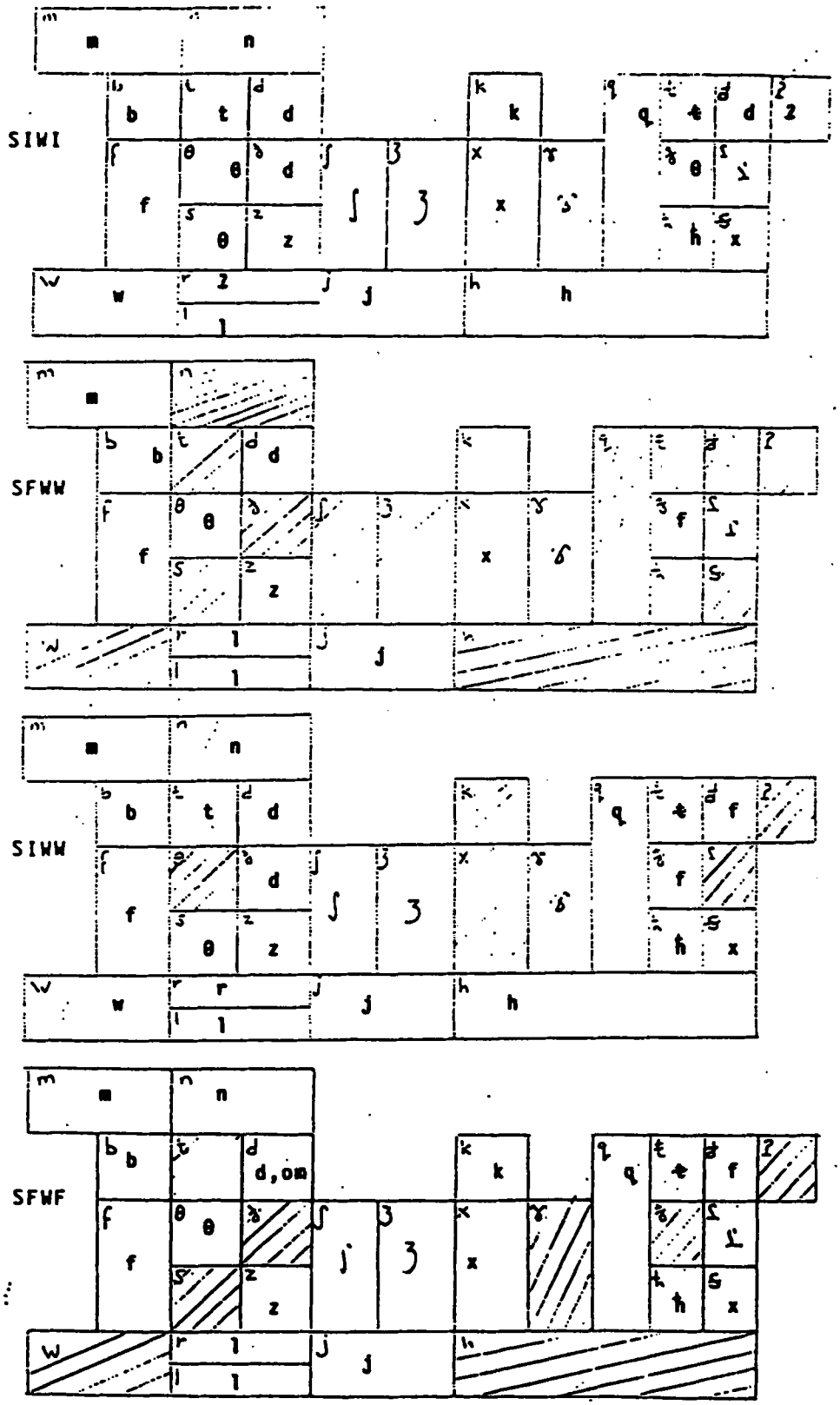



FIGURE : ANALYSIS OF CONTRASTIVE PHONOLOGICAL SYSTEM
For Subject Eight