THE ROLE OF PHONOLOGICAL AWARENESS AND VISUAL SKILLS IN LEARNING TO READ CHINESE AND ENGLISH

By
Hsiu-Shuang Huang (M.A.)

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy.

May 1993

Department of Psychology
University of Liverpool

ABSTRACT

Hsiu-Shuang Huang, **The role of phonological awareness and visual skills in learning to read Chinese and English.**

This research examined the role of phonological awareness and visual skills in learning to read Chinese and English. There were three studies included in this thesis: a cross-cultural study, a comparative study and a longitudinal study.

Study One (cross-cultural study) compared the performance on phonological awareness, visual skills and reading ability among British children, Hong Kong children, and Taiwan children. The test materials included a Chinese Reading Test, an English Reading Test, a set of Phonological Awareness Tests, a Visual Paired Associates test, a Visual Form Discrimination test, a vocabulary test and an IQ test. 137 eight-year-old primary children in these three areas were involved in this study. It was found that visual skills were significantly related to the Chinese reading ability of the children in Hong Kong and Taiwan. Phonological awareness was significantly related to English reading ability for British children. However, the phoneme deletion test was also correlated with Chinese reading for the Taiwan and Hong Kong subjects, after the effects of IQ had been partialled out.

Study Two was a comparative investigation of the correlation of reading to phonological awareness and visual skills between a *Pinyin* group and a non-*Pinyin* group in Hong Kong. There were 87 eight-year-old children in Hong Kong involved in this study. The *Pinyin* group had better performance on the phonological awareness tests than that the non-*Pinyin* group. Phonological awareness was found to be the best predictor for the *Pinyin* subjects of reading ability in both English and Chinese. Nevertheless, visual skills was the best predictor of Chinese reading for the subjects in the non-*Pinyin* group.

Study Three was a longitudinal study of the first graders at a primary school in Taiwan. The main purpose was to investigate whether early phonological awareness and visual skills before instruction in school had any predictive power for later Chinese reading ability. This study also examined whether phonological awareness and visual skills varied in their relation to reading ability over three testing sections during the first grade. There were 44 six-year-old children in Taiwan involved in this study. At the first stage, phonological awareness was found to be significantly related to Chinese reading ability for the first grade students in Taiwan. Surprisingly, the predictive power of early phonological awareness markedly decreased when the pre-school reading scores were partialled out. Ten weeks of phonological instruction in *Zhu-Yin-Fu-Hao* led to an increase in performance on both Odd Man Out tests and on a test of phoneme deletion. Performance on the Odd Man Out test continued to improve, but scores on the phoneme deletion test remained the same.

The findings from the three studies confirmed that phonological awareness was significantly related to English. By contrary, visual skill was not consequential in

English reading for a native English learner. Visual skill was significantly correlated with Chinese reading for the 8-year-old subjects in Taiwan and Hong Kong. For the beginning readers in Taiwan, phonological awareness was more important than visual skill. From the developmental viewpoint, the results implied that there is a developmental change in the strategies used in reading Chinese. That is, reading development in Chinese involves different skills in different phases.

ACKNOWLEDGEMENTS

I wish to acknowledge most gratefully the enormous help which I have received from my supervisor, Dr. J. R. Hanley. His invaluable guidance and insightful comments throughout the course of the Ph.D. have been much appreciated.

Special thanks are due to the other two members of my thesis supervision committee, Dr. G. Wagstaff and Dr. T. J. Perfect, for their useful advice and encouragement through the three years. I would also like to acknowledge Dr. T. Melamed for his statistical suggestions and Dr. H. R. Dodd for discussion on linguistics.

I indicate my sincere gratitude to the following schools for their kind cooperation in making this study possible: St. Nicholas School, Pleasant Street School, St. Michael-in-the-Hamlet School (in Britain); RosaryHill School, Dr. Catherine F. Woo Memorial School (in Hong Kong); and Ming-Shang Primary School, Hsin-Chuang Primary School (in Taiwan). Sincere appreciation is also due to Prof. Biggs of Department of Education at the University of Hong Kong for his enthusiastic assistance in arranging testing schools in Hong Kong and to Mr. Yang-Ming Chen for his help in data collection of Study Three in Taiwan.

A special mention goes to Ling-Chu, Ming-Jong, Alison, Judith, Kuk-Kyung for their generosity and friendship in this period making my study life easier and more cheerful in Liverpool.

Many thanks go to my husband's and my own families for looking after my daughter, Han-Inn, and their tremendous support throughout the period of my study in England. Finally, my husband, Shang-Liang, and my daughter, Chen-Yue, deserve my special thanks, for their love, encouragement and support, without them the work would not have been completed.

The results of Study One were presented at the 25th International Congress of Psychology, Brussels, Belgium, 19th-24th July, 1992, and the work described in Chapter Nine (Study Two) was presented at the British Psychology Society Conference, London, England, 17th-19th December, 1991.

The results of Study Three will be presented at the Sixth International Symposium on Cognitive Aspects of the Chinese Language, Taipei, Taiwan, 2nd-4th September, 1993.

TABLE OF CONTENTS

SECTION	*TITLE*	*PAGE*
ABSTRACT		i
ACKNOWLEDGEMENTS		iii
TABLE OF CONTENTS		v
LIST OF TABLES		xviii
LIST OF FIGURES		xxiii
LIST OF APPENDICES		xxv

PART ONE

BACKGROUND INFORMATION

CHAPTER ONE

1.1	General statement of the problem	1
1.2	The structure of this thesis	3

CHAPTER TWO CHINESE AND ENGLISH ORTHOGRAPHIES

2.1	Chinese orthography	5
	2.1.1 Six categories of Chinese orthography	7
	2.1.2 Dialects in China	12
	2.1.3 Phonology of Chinese	14
	2.1.3.1 *Initials*	14
	2.1.3.2 *Finals*	15
	2.1.3.3 Tones	16
	2.1.3.4 The old method of Chinese pronunciation systems	17

2.1.3.5 The modern method of Chinese pronunciation systems 18

2.1.4 Characteristics of Chinese orthography 26

2.2 English orthography 27

2.2.1 Levels of English phonic structure 27

2.2.2 Grapheme-phoneme correspondences in English 28

2.3 Comparisons of English and Chinese orthographies 30

CHAPTER THREE LITERATURE REVIEW

3.1 Theory of reading 32

3.1.1 Definition of reading 32

3.1.2 How to measure reading ability 33

3.1.3 How to read in English 34

3.1.3.1 Dual route model 34

3.1.3.2 Analogy theory 38

3.1.3.3 Stages of reading development 40

3.1.3.4 Summary 43

3.1.4 How to read in Chinese 44

3.1.4.1 The way pupils learnt to read in Chinese before the twentieth century 44

3.1.4.2 The developmental stages of Chinese reading 45

3.1.4.3 Recent research into Chinese reading 48

3.1.5 Comparison of English reading and Chinese reading 53

3.2 Review of phonological awareness and reading ability 56

3.2.1 Definition of phonological awareness 57

3.2.2 Measurement of phonological awareness 59

3.2.3 Research on the relationship between phonological awareness and reading an alphabetic system 63

3.2.3.1 Three views of the relation between phonological awareness and reading in an alphabetic system 64

3.2.3.2 Simultaneous correlation research 71

3.2.3.3 Longitudinal studies 71

3.2.3.4 Effects of phonological awareness training on reading 74

3.2.3.5 Effects of reading instruction methods on phonological awareness 77

3.2.3.6 Summary of the section 79

3.2.4 Research on the relationship between phonological awareness and reading in Chinese 79

3.3 Review of visual skills and reading ability 80

3.3.1 English reading and visual skills 80

3.3.1.1 The effects of visual perception training 80

3.3.1.2 The differences in visual skills between backward and normal readers 82

3.3.1.3 Visual deficits in reading disability 85

3.3.2 Chinese reading and visual skills 86

CHAPTER FOUR TEST MATERIALS

4.1 Reading tests 89

4.1.1 English Reading Test 89

4.1.1.1 Description 89
4.1.1.2 Administration 90
4.1.1.3 Scoring 91
4.1.1.4 Norm and reliability 91
4.1.2 Chinese Reading test 91
4.1.2.1 Description 92
4.1.2.2 Administration 93
4.1.2.3 Scoring 93
4.1.2.4 Reliability 93
4.2 Visual skill tests 94
4.2.1 Visual Form Discrimination 94
4.2.1.1 Description 94
4.2.1.2 Administration 95
4.2.1.3 Scoring 97
4.2.1.4 Norm 97
4.2.2 Visual Paired Associates 97
4.2.2.1 Description 97
4.2.2.2 Administration 98
4.2.2.3 Scoring 99
4.2.2.4 Norm and reliability 100
4.3 IQ Test 101
4.3.1 Description 101
4.3.2 Administration 101
4.3.3 Scoring 102

4.3.4 Norm and reliability 102

4.4 Vocabulary test 104

4.4.1 Description 104

4.4.2 Administration 104

4.4.3 Scoring 107

4.5 Phonological awareness tests 108

4.5.1 Odd Man Out tests 108

4.5.1.1 Description 108

4.5.1.2 Administration 109

4.5.1.3 Scoring 109

4.5.1.4 Norm and reliability 110

4.5.2 Phoneme deletion tests 111

4.5.2.1 Description 111

4.5.2.2 Administration 112

4.5.2.3 Scoring 112

4.6 Chapter summary 112

PART TWO

STUDY ONE: A CROSS-CULTURAL STUDY

CHAPTER FIVE THE UK STUDY

5.1 Introduction 115

5.2 Method 117

5.2.1 Description of subjects 117

5.2.2 Description of test materials 117

5.2.3 Procedures of testing 118

5.2.4 Statistical methods 119

5.3 Results 119

5.3.1 Descriptive statistics 119

5.3.2 The relationship between phonological tests, visual skills, and reading in English 120

5.3.2.1 The correlations between the reading test and other tests 120

5.3.2.2 The intercorrelations of phonological subtests 122

5.3.3 Which factor predicts English reading 124

5.3.4 Analyses of phonological tests 127

5.3.4.1 Odd Man Out Tests 127

5.3.4.2 Phoneme Deletion Test 128

5.3.5 The differences between the skilled readers and less skilled readers 130

5.4 Discussion and conclusions 131

CHAPTER SIX THE TAIWAN STUDY

6.1 Introduction 136

6.2 Background information on Taiwan primary education 136

6.3 Method 139

6.3.1 Description of subjects 139

6.3.2 Description of test materials 139

6.3.3 Procedures of testing 140

6.3.4 Statistical methods 140

6.4 Results 141

6.4.1 Descriptive statistics 141

6.4.2 The relationship between phonological tests, visual skills, and reading in Chinese 141

6.4.2.1 The correlations between the reading test and other tests 141

6.4.2.2 The intercorrelations of phonological subtests 143

6.4.3 Which factor predicts Chinese reading 145

6.4.4 Analyses of phonological tests 147

6.4.4.1 Odd Man Out Tests 147

6.4.4.2 Phoneme Deletion Test 148

6.4.5 The differences between skilled readers and less skilled readers 148

6.5 Discussion and conclusions 150

CHAPTER SEVEN THE HONG KONG STUDY

7.1 Introduction 153

7.2 Background information of Hong Kong primary school 155

7.2.1 The age in the primary schools 157

7.2.2 The curriculum in the primary schools 157

7.3 Method 158

7.3.1 Description of subjects 158

7.3.2 Description of test materials 159

7.3.3 Procedures of testing 159

7.3.4 Statistical methods 160

7.4 Results 160

7.4.1 Descriptive statistics 160

7.4.2 The relationship between phonological test, visual skill and reading in Chinese and English 161

7.4.2.1 The correlation between Chinese reading test and other tests 161

7.4.2.2 The correlation between English reading test and other tests 162

7.4.2.3. The intercorrelation of phonological subtests 163

7.4.3 Which factor predicts Chinese and English reading 164

7.4.3.1 Chinese reading 165

7.4.3.2 English reading 167

7.4.4 Analyses of phonological tests 167

7.4.4.1 Odd Man Out Tests 168

7.4.4.2 Phoneme Deletion tests 169

7.4.5 The differences between skilled readers and less skills readers 171

7.4.5.1 The skilled readers of Chinese 171

7.4.5.2 The skilled readers of English 172

7.5 Discussion and conclusions 173

CHAPTER EIGHT COMPARISONS AND CONCLUSIONS

8.1 Comparisons of the U.K., Hong Kong and Taiwan studies 176

8.1.1 Comparison of the relationship between visual, phonological skills and reading ability 177

8.1.2 Comparison of the regression results 179

8.1.2.1 Predicting English reading 179

8.1.2.2 Predicting Chinese reading 181

8.1.3 Comparison of phonological awareness 182

8.1.3.1 Odd Man Out Tests 182

8.1.3.2 Phoneme Deletion Tests 189

8.1.4 Comparison of visual skills between three groups 193

8.2 Discussion 194

8.3 Conclusions 198

PART THREE

STUDY TWO: A COMPARATIVE STUDY

CHAPTER NINE THE COMPARATIVE STUDY ON PINYIN AND NON-PINYIN GROUPS IN HONG KONG

9.1 Introduction 201

9.2 Method 204

9.2.1 Description of subjects 204

9.2.1.1 The *Pinyin* group 205

9.2.1.2 The non-*Pinyin* group 205

9.2.2 Description of test materials 206

9.2.3 Procedures of testing 206

9.2.4 Statistical methods 207

9.3 Results 207

9.3.1 Descriptive statistics 207

9.3.2 The relationship between phonological tests, visual skills and reading in English and Chinese 208

9.3.2.1 The correlation between Chinese reading and other tests 208

9.3.2.2 The correlation between English reading and other tests 210

9.3.2.3 The intercorrelation of phonological tests 211

9.3.3 Which factor predicts Chinese and English reading 212

9.3.3.1 Predicting Chinese reading 212

9.3.3.2 Predicting English reading 214

9.3.4 The differences between the two groups on phonological tests 216

9.3.4.1 Analysis of Odd Man Out Tests 216

9.3.4.2 Analyses of Phoneme Deletion tests 220

9.4 Discussion and conclusions 223

PART FOUR

STUDY THREE: A LONGITUDINAL STUDY

CHAPTER TEN PHONOLOGICAL AWARENESS, VISUAL SKILLS AND CHINESE READING ACQUISITION IN FIRST GRADERS: A LONGITUDINAL STUDY IN TAIWAN

10.1 Introduction 230

10.1.1 Background 230

10.1.2 Goals of the study 233

10.1.3 Hypotheses of the study 234

10.2 Method 235

10.2.1 Description of subjects 235

10.2.2 Description of test materials 236

10.2.3 Procedures of testing 236

10.2.4 Statistical methods 238

10.3 Results 238

10.3.1 A comparison of performance on the three testing sessions on each task 238

10.3.1.1 Comparison of performance on reading test 239

10.3.1.2 Comparison of performance on the visual skills test 241

10.3.1.3 Comparison of performance on the phonological tests 241

10.3.2 Correlation between reading and each test 244

10.3.2.1 The correlations between phonological tests, visual skills and reading at each session 244

10.3.2.2 The relationship between early phonological tests and later reading ability 247

10.3.2.3 The relationship between early visual skills and later reading ability 247

10.3.3 Prediction of Chinese reading 247

10.3.3.1 The prediction of the early phonological and visual skills for later reading ability 247

10.3.3.2 Early phonological and visual skills as predictors of later reading ability after IQ, BPVS and early reading were controlled 249

10.3.3.3 Prediction of Chinese reading in each testing session 250

10.3.4 The correlations between phonological subtests and reading in each session 252

10.3.5 The correlation between the three testing sessions on each test 254

10.3.6 The intercorrelation between phonological tests 255

10.3.7 Sex differences 256

10.4 Discussion and conclusions 256

PART FIVE

CHAPTER ELEVEN GENERAL DISCUSSION AND CONCLUSIONS

11.1 Summary of main findings 265

11.1.1 The relationship between phonological awareness, visual skills and reading in Chinese 265

11.1.1.1 Visual skills and reading in Chinese 265

11.1.1.2 Phonological tasks and Chinese reading 266

11.1.1.3 The powerful predictor of Chinese reading 266

11.1.2 The relationship between phonological awareness, visual skills and reading in English 267

11.1.2.1 Visual skills and reading in English 267

11.1.2.2 Phonological awareness and English reading 267

11.1.2.3 The powerful prediction of English reading 268

11.1.3 The comparisons of performance on phonological awareness tests 268

11.1.3.1 The comparison of Phoneme deletion tests 268

11.1.3.2 The comparison of Odd Man Out tests 269

11.1.4 Comparisons of the performance on visual skills tests 269

11.1 General discussion and conclusions 270

11.3 Recommendations for further investigation 274

REFERENCES 278

APPENDICES 301

LIST OF TABLES

TABLE	*TITLE*	*PAGE*
Table 2-1	The fixed order of strokes for Chinese characters.	6
Table 2-2	The examples of pictographs category of Chinese orthography.	9
Table 2-3	The comparison of various dialects in China.	13
Table 2-4	The comparison of the four tones in *Putonghua*.	17
Table 2-5	A comparative example of the different pronunciation systems.	21
Table 3-1	Marsh *et al.*'s stage model of reading acquisition.	41
Table 3-2	A summary of training studies.	75
Table 4-1	Means and standard deviations of Visual Paired Associates.	100
Table 4-2	Reliability of Visual Paired Associates.	100
Table 4-3	British Picture Vocabulary Scale record form.	107
Table 4-4	Examples of Odd Man Out Tests.	110
Table 4-5	Norms of English Odd Man Out Test.	110
Table 4-6	Examples of Phoneme Deletion Test.	111
Table 4-7	A summary of the test materials.	113
Table 5-1	Means and standard deviations among the tests for the U.K. subjects.	120
Table 5-2	The pattern of correlation among the reading test and other tests.	121
Table 5-3	The intercorrelation of phonological tests.	123
Table 5-4	The intercorrelations of phonological subtests.	124
Table 5-5	Summary of multiple stepwise regression analysis.	125
Table 5-6	Summary of fixed-order multiple regression.	127

Table 5-7	Mean number of English Odd Man Out test and Chinese Non-word Odd Man Out test.	128
Table 5-8	Mean number of English Phoneme Deletion.	129
Table 5-9	T-test of the skilled and the less skilled subjects on the all tests.	130
Table 6-1	Means and standard deviations among the tests for the Taiwanese subjects.	141
Table 6-2	The pattern of correlation among the tests and Chinese Reading.	142
Table 6-3	The intercorrelation of phonological tests.	144
Table 6-4	The intercorrelations of phonological subtests.	144
Table 6-5	Summary of multiple stepwise regression analysis.	145
Table 6-6	Summary of fixed-order multiple regression.	146
Table 6-7	Mean number of Chinese Odd Man Out and Non-word Odd Man Out tests.	147
Table 6-8	Mean number of the Chinese Phoneme Deletion test.	148
Table 6-9	T-test of the skilled and less skilled subjects on the all tests.	149
Table 7-1	Subjects of the primary school curriculum.	158
Table 7-2	Means and standard deviations among the tests for the Hong Kong subjects.	161
Table 7-3	The pattern of correlation among the Chinese reading test and other tests.	162
Table 7-4	The pattern of correlation among the English reading test and other tests.	163
Table 7-5	The intercorrelation of phonological tests.	164
Table 7-6	Summary of multiple stepwise regression analysis on	

	predicting Chinese reading.	165
Table 7-7	Summary of fixed-order multiple regression on predicting Chinese reading.	166
Table 7-8	Summary of fixed-order multiple regression on predicting English reading.	167
Table 7-9	Mean number of three versions of Odd Man Out tests.	168
Table 7-10	Mean number of English Phoneme Deletion test.	169
Table 7-11	Mean number of Chinese Phoneme Deletion test.	170
Table 7-12	The t-test results of the skilled and the less skilled Chinese readers on all the tests.	171
Table 7-13	The t-test results of the skilled and the less skilled English readers on all the tests.	172
Table 8-1	Means and standard deviations among the tests for the U.K., Taiwan and Hong Kong subjects.	177
Table 8-2	The pattern of correlation between the reading test and other tests.	178
Table 8-3	Summary of stepwise regression analysis for two groups on predicting English reading.	180
Table 8-4	Summary of Multiple Stepwise Regression Analysis for two groups in predicting Chinese reading.	181
Table 8-5	Mean number of the English Odd Man Out.	182
Table 8-6	Mean number of Chinese Word Odd Man Out.	185
Table 8-7	Mean number of the Chinese Non-word Odd Man Out.	187
Table 8-8	Mean number of the English Phoneme Deletion.	189

Table 8-9 Mean number of Chinese Phoneme Deletion test. 193

Table 8-10 Mean number of visual skills tests in three groups. 193

Table 9-1 Means and standard deviations among the tests for all subjects in the two groups. 207

Table 9-2 Means and standard deviations among the tests for thirty subjects in the two groups. 207

Table 9-3 The pattern of correlation among Chinese reading and other tests.209

Table 9-4 The pattern of correlation among English reading and other tests. 210

Table 9-5 The intercorrelation of phonological tests. 211

Table 9-6 Summary of fixed-order multiple regression on predicting Chinese reading. 214

Table 9-7 Summary of fixed-order multiple regression on predicting English reading. 215

Table 9-8 Mean number of three versions of Odd Man Out tests. 216

Table 9-9 Mean number of the English Phoneme Deletion test. 220

Table 9-10 Mean number of the Chinese Phoneme Deletion test. 222

Table 10-1 The testing timetable of Study Three. 237

Table 10-2 Means, standard deviations and significant differences among the tests for the first grader subjects at the three testing sessions. 239

Table 10-3 Mean number of Odd Man Out tests at the different sessions. 242

Table 10-4 Mean number of the Chinese Phoneme Deletion test at different sessions. 243

Table 10-5 The pattern of correlation among the tests and Chinese reading. 244

Table 10-6 Longitudinal prediction of reading ability at the end of the

	first year after IQ, vocabulary were controlled.	249
Table 10-7	Longitudinal prediction of reading ability at the end of the first year after IQ, vocabulary, and early reading were controlled.	250
Table 10-8	Summary of multiple stepwise regression analysis.	251
Table 10-9	The pattern of correlation among phonological subtests and Chinese reading.	253
Table 10-10	The developmental pattern of correlation between the three testing sessions on each test.	254
Table 10-11	The intercorrelation of phonological tests.	256

LIST OF FIGURES

FIGURE *TITLE* *PAGE*

FIGURE	TITLE	PAGE
Fig. 2-1	An example of a Chinese paragraph in horizontal and vertical directions.	8
Fig. 2-2	The symbols of *Zhu-Yin-Fu-Hao*, *Pinyin*, and the pronunciation.	22
Fig. 2-3	An example from the Chinese Language textbook for the first graders in mainland China.	24
Fig. 2-4	An example of correspondences between graphemes and phonemes.	29
Fig. 3-1	Three possible relations between Chinese character, sound and meaning.	48
Fig. 3-2	Three different links between phonological awareness and reading	64
Fig. 4-1	An example of Visual Form Discrimination.	96
Fig. 4-2	An example of Visual Paired Associates.	98
Fig. 4-3	An example of the Coloured Progressive Matrices.	103
Fig. 4-4	An example of British Picture Vocabulary Scale.	106
Fig. 6-1	The current school system in Taiwan.	137
Fig. 6-2	Examples of Zhu-Yin-Fu-Hao and Chinese characters.	138
Fig. 7-1	The education system in Hong Kong.	156
Fig. 8-1	Average level of English Odd Man Out in the U.K. and Hong Kong groups.	183
Fig. 8-2	Average level of Chinese Odd Man Out in the Taiwan and Hong Kong groups.	186
Fig. 8-3	Average level of Chinese Non-word Odd Man Out in the three groups.	188

Fig. 8-4 Average level of English Phoneme Deletion in the U.K. and Hong Kong groups. 190

Fig. 8-5 Average level of Chinese Phoneme Deletion in the Taiwan and Hong Kong groups. 192

Fig. 9-1 The mean scores of three versions of Odd Man Out Tests. 218

Fig. 9-2 The mean scores of three versions of Odd Man Out Tests for two groups. 219

Fig. 9-3 The mean scores of the English Phoneme Deletion Test. 221

LIST OF APPENDICES

TITLE	*PAGE*
A. Schonell Reading Test	301
B. Chinese Reading Test	302
C. Phonological Tests	303
D. A list of abbreviation	306
E. Statistical Tables	307

PART ONE

BACKGROUND INFORMATION

CHAPTER ONE

1.1 GENERAL STATEMENT OF THE PROBLEM

In the last two decades there has been an increasing interest in how children learn to read. Particularly, a large amount of research has focused on the relationship between phonological awareness and reading development. Most of the studies have dealt mainly with alphabetic scripts, more particularly with the acquisition of English orthography. There is, however, a growing interest in comparative investigations of reading in the other main writing systems used in the world.

Chinese is a logographic writing system in which symbols represent lexical morphemes. As Gleitman and Rozin (1977) pointed out, the relationship between orthography and reading is that an alphabetic system uses a small number of abstract elements to represent the spoken form of language and Chinese represents words by a large number of different visual symbols. Consequently, it would appear possible that learning to read English depends on phonological skill, whereas learning to read Chinese may depend more on the ability to make visual distinctions than on phonological skills. **Study One** is an attempt to investigate possible differences between native English children (in the U.K.) and native Chinese children (in Taiwan and in Hong Kong) in the correlation of reading ability with phonological awareness and visual skills.

Read *et al.* (1986) suggested that phonological skill is not acquired naturally. They chose two groups of subjects. One was an non-alphabetic group: adults literate only in Chinese characters. The other one was an alphabetic group who had learned *Pinyin* which is an alphabetic script used to pronounce Chinese characters. The results showed that Chinese adults literate only in Chinese characters found it difficult to add or delete individual consonants in spoken Chinese words; a comparable group of adults literate in an alphabetic system, as well as in characters, could perform the same tasks readily and accurately. Other researchers (e.g., Mann, 1986) also suggest that learning to read an alphabetic writing system can help children to develop phonological awareness. Nowadays, some Hong Kong students have learned *Pinyin*; others have not learned *Pinyin*. From a comparative point of view, therefore, there may be some differences between these children in terms of phonological awareness. **Study Two** in this thesis focused upon comparing the relationship between phonological awareness, visual skills and reading development of the *Pinyin* and the non-*Pinyin* children in Hong Kong.

A great amount of research has claimed that early phonological awareness is crucial for later success on English reading (Bradley & Bryant, 1983; Bryant & Bradley, 1985; Ellis & Large, 1987; Maclean *et al.* 1987; Stanovich *et al.*,1984; Stuart and Coltheart, 1988). **Study Three** was carried out to examine whether early phonological awareness or visual skills play an important role in later success in Chinese reading. It investigated the relationship between phonological awareness, visual skills and Chinese reading at three separate testing sessions during the first school year. The three testing sessions were carried out (1) before children had received any formal instruction in primary schools; (2) after children had been learning a phonetic system for 10 weeks; (3) after children had been taught Chinese characters for 8 months.

In summary, this thesis consisted of three different, but related studies. The first was a cross-cultural study in Britain, Hong Kong, and Taiwan. Secondly, a comparative study was carried out in Hong Kong between *Pinyin* children and non-*Pinyin* children. Lastly, a one-year longitudinal study was undertaken in Taiwan.

This research had three main goals. The first was to investigate the relation between, and differences in, children's phonological awareness, visual skills and reading ability in Britain, Taiwan and Hong Kong. The second was to examine possible phonological awareness and visual skills differences in Hong Kong ***Pinyin*** children and non-*Pinyin* children. The third set out to discover whether or not early phonological awareness and visual skills could predict the children's later success in Chinese reading in the first grade in Taiwan.

1.2 THE STRUCTURE OF THIS THESIS

A brief introduction is presented in Chapter One. A description and comparison of English orthography and Chinese orthography will be provided in Chapter Two. Chapter Three will review the literature on reading theories, and analyze the role of phonological skills and visual skills in reading acquisition. Chapter Four lists the test materials used in the three studies. There are slight differences in the test materials used in the three studies. These will be indicated in the appropriate chapters. Studies One to Three are presented in Chapters Five to Ten. The last chapter is an overview of the results as a whole.

CHAPTER TWO

CHINESE AND ENGLISH ORTHOGRAPHIES

This chapter is intended to describe the general background of Chinese and English orthographies. It should be noted first that I have not attempted to describe all aspects of the English or Chinese writing systems, but only the aspects that are relevant for the research described later are discussed. Although Chinese is the most widely spoken language in the world (Miao & Zhu, 1992, p.238), readers in England will know more about English orthography than Chinese orthography. Therefore, there is a more detailed introduction on the topic of Chinese orthography. The symbols of IPA (International Phonetic Alphabet) are used to represent the pronunciation of Chinese characters throughout this thesis and are presented in square brackets. Preliminary descriptions of Chinese and English writing systems are introduced in the first two sections (section 2.1 - 2.2). Then, the last section will compare the differences between English and Chinese orthographies.

According to the nature of the linguistic unit, there are three basic types of writing systems, which can be summarized as follows:

1. Logographic writing system:

A writing system in which one symbol represents primarily the meaning of one word or morpheme is called a logography. Gelb (1963) has pointed out that Sumerian, Egyptian and Chinese are historically the three most important logographic systems. Currently, Chinese is the only logography which is still in use.

2. Syllabic writing system:

A syllable is a single vowel or diphthong, which may be preceded and/or followed by one or more consonants (Gleitman & Rozin, 1977, p.15). For instance, *kana* in Japanese is a syllabic writing system. Each symbol represents one syllable and the symbol-sound relationships are entirely regular and symmetrical (Kimura & Bryant, 1983, p.143). A syllabic system consists of far fewer signs than does a logographic writing system, but requires more than an alphabetic system.

3. Alphabetic writing system:

There are two major alphabets, one is the Roman alphabet which is used to write most European languages, such as English. The other is the Cyrillic alphabet which is used to write Russian and Serbo-Croatian. Both are derived from Ancient Greek. In an alphabetic system, the individual graphemes represent the individual phonemes. Phonemes are the smallest significant units of the sound structure of a language.

From the above discussion, it is clear that the two orthographies are different because they present linguistic information in dissimilar forms (i.e. Chinese is a logographic writing system and English is an alphabetic writing system). Both languages are described in detail in the following two sections.

2.1 CHINESE ORTHOGRAPHY

The Chinese writing system was generated in the second millennium B.C.(Leong, 1986, P.84). The exact total number of characters is uncertain. According to a famous dictionary in China, namely *Kang Hsi Tze Tien* (a 42-volume dictionary compiled during the reign of emperor *Kang Hsi*, 1662-1722 AD, in the *Ching* Dynasty), there are more than 47,000 different characters (Hue, 1992, p.95). However, most literate Chinese know only a portion of these. Cheng (1982) has estimated that about 4,600 different characters are actually used. This estimate is based on a huge collection of articles randomly selected from popular novels, newspapers, magazines, and textbooks.

Chinese is written in unique, square visual constructs, known as "characters". Characters are composed of a limited range of basic writing strokes, written in a conventional order. For example, the character, 天, contains 4 strokes written in the sequence shown in Table 2-1.

character	meaning	fixed order of strokes			
天	sky/heaven	一	二	于	天
中	middle	丨	冂	口	中

Table 2-1: The fixed order of strokes for Chinese characters.

Strokes are written from the left hand side to the right hand side and from top to bottom. The number of strokes per character can vary from one up to sixty-four, with around twelve being the average. In each character, there are three codes of information: graphemic, phonetic, semantic, but no simple correspondence exists between them.

Here, it is worth noting the difference between a word and a character in Chinese. As Halliday (1959, p.59) indicated, the category of word is set up to meet the need for a linguistic unit smaller than the clause and larger than the character. In written Chinese, the character is the basic independent unit. Each character represents a single syllable consisting of a single morpheme (Chang, 1992, p.278). Unlike English, a word can be one single character, or a combination of two or more than two characters. The spacing in a sentence is based on characters, not based on words in Chinese language. Therefore, readers' processing systems must arrange characters into words when they read a sentence.

The traditional way to write and read a sentence or paragraph is in a vertical direction (up to down) and from the right hand side to the left hand side. Nowadays, some books (e.g., science or mathematics) and newspapers are printed in horizontal format, and from left to right (similar to the Western style). Fig. 2-1 shows an example of a Chinese text in both directions. Chen and Carr (1926) investigated the ability of Chinese subjects to read different materials in vertical and horizontal directions. Their results revealed that Chinese students apprehend Chinese characters more quickly and accurately when they are vertically arranged. Moreover, they found that the degree of vertical advantage seems to relate to individual subjects' experience. More recently, Chen (1981) found that Chinese subjects favour left-to-right and top-to-down scanning direction. Before the twentieth century, there was no punctuation in Chinese books. Nowadays, sentences are also marked terminally by full stops. Commas, semi-colons, and colons are used to mark off clauses and phrases.

2.1.1 Six categories of Chinese orthography

In general, Chinese characters are conventionally grouped into six categories based on their origins, which in turn provide some information on their sounds and meanings.

1. Pictographs:

Pictographs are the earliest form of Chinese writing which are based on pictures of objects. These pictures are often quite expressive. That is, the oldest category are iconic representations of concrete objects.

A. Traditional way (vertical)

符號起源與文字創始

依「上古結繩而治，後世聖人易之以書契」的說法，文字的起源是書契更替結繩。換句話說，結繩廢止書契肇始。書契若是「聖人」創造的，其代替結繩「而治」卻也順情合理，實際上文字是由符號發展出來的，因此文字的起源不是文字更替結繩，而是符號之一支變成文字，符號仍然應用。拿樹木來比喻，文字起源不像竹幹一節過了是另外一節，而是像旁枝，長出旁枝原枝不廢。

有文字以前必定有三樣事物，經過三次轉變。考究文字起源實在就是探討古人的生活中那些壓力怎麼激起這三次的轉變。三樣事物中第一件最古老的是「標誌」，單爲提醒記憶而無所專指的。最原始的標誌可能是記路徑用的。人一天可以走十幾二十英哩，儘管起點有大樹高石走不上一兩小時就看不清楚了，所以一路須要疊石或折樹爲誌。依陶淵明「晉太元中武陵人捕漁爲業」的發現了桃源之後「便扶向路處處誌之」就是用這種標誌。古人佃獵尋獸飲水求泉都需要尋路，可以推想人猿略能記憶就需標誌，可能是幾十萬年前的事。這是莊子所謂「含哺而熙鼓腹而遊」的時代，現在我們說得比莊子明白一些是農業革命以前遊獵生活的時代。這時代可能也偶爾有人引用有所專指的私用符號，但是即使有之料必無多。農業革命對符號的發展而言有兩層作用。一是食糧供應有保障，生活複雜，一是人口密度增加，人與人的接觸漸繁（一團體之內人與人接觸的次數約與人總數之二次方成正比）。因爲生活複雜，器具、穴窟、佔地、家畜等

B. Horizontal way

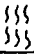
可能毫不留情地認爲這是個可笑的問題。假數在他們的領域中是有效且眞實的，但是在別的領域中却沒有存在實體。這也許正是神經活動和認知活動彼此關連的情況，每一種活動在其領域內的效度是無懈可擊的，出了領域就沒有效用了。

認知心理學家和計算機程式設計師企圖描述心智活動時，在某些方面有共同點。程式設計師的工作是設計策略，讓機器可執行一連續的計算。寫程式時，程式設計師不管電流，也不管其他硬體，只考慮資料結構和其中的運作，這程式最後被轉譯爲硬體程式。軟體程式一般來說多少是獨立於這個機器的。認知心理學家也是同樣情形，他們對心智活動背後的神經活動並不很感興趣，那是硬體問題，原則上是無法解決的。認知心理學家想用心智活動的用詞來描述心智活動，獨立於神經活動外。

Fig. 2-1: An example of a Chinese paragraph in horizontal and vertical directions.

Table 2-2 demonstrates some examples. It can be seen that the forms of this type of character have been considerably changed over the centuries. Nevertheless, the idea represented is the same. For example, in the character,  (ancient form), 木(modern form) [mù] (meaning "tree"), although the ancient form is slightly different from the modern form, both of the forms resemble a true tree in some ways. The character looks like the branches above the trunk of a tree and roots below the trunk of a tree. According to a survey by Tsien (1962), fewer than 3% of all characters are pictographs.

Table 2-2: The examples of pictographs category of Chinese orthography.

Ancient form	Modern form	Pronunciation (in IPA)	Meaning
	日	[zì]	sun
	月	[şuěi]	water
	山	[şān]	mountain
	木	[mù]	tree

2. *Ideographs:*

Ideographs indicate the ideas that they are meant to convey. This type of character expresses relational or abstract concepts that cannot be easily depicted by pictures. For examples, the character  (ancient form), 上 (modern form), [şàŋ], which means "above", uses a point above the horizontal line to express something above the floor. Similarly, the character,  (ancient form), 下 (modern form) [çià] (meaning "below") employs a point under the horizontal line to express something under the floor.

3. Compound ideographs:

Compound ideographs contain two to four ideographs or pictographs. For example, 信 [çìn] (meaning either "believe" or "letter") is a combination of 亻 (people) and 言 (words). The character literally means that:

a. beliefs are words said by people; or

b. a letter is people's words.

Occasionally, a compound ideograph is made up of one character repeated twice or three times. For example, 林[lín] (meaning "wood") was compounded by two trees 木together, and 森 [sən] (meaning "forest") was compounded by three trees 木 together.

4. Phonetic compounds:

The category of *phonetic compounds* is the most numerous and important one. By compounding sound-cuing *phonetics* and meaning-conveying *radicals*, many new characters have been created over the years. An estimate by Zhou (1978) claimed that 82 % of characters are in the category of *phonetic compounds*. Moreover, the percentage of this category in Chinese orthography continues to increase slightly.

Each character in this category is divided into a "*radical*" (visual construct that originally indicated meaning) and a "*phonetic*" (construct that originally indicated pronunciation). That is, if one needs to know the rough meaning, one can look at the semantic *radical*, and one can also find the sound of the character from the *phonetic* part. For instance, in the character of 洋 [iáŋ] (meaning "ocean"), the left part, 氵 [ʂuěi] (meaning "water"), of the character is a *radical*; the right part, 羊 [iáŋ] (meaning "goat"), is a *phonetic*. The two parts are compounded as a character. From the above example, it can be seen that the *radical* provides a cue to the meaning, the *phonetic* part consists of a cue for pronunciation. There are 188 *radicals* in Chinese characters (Zhou, 1978). *Radicals* nowadays are usually used as categorising elements to facilitate references to dictionaries.

Here, it should be noted that the *radical* part and *phonetic* part of a Chinese character are not very reliable as indicators either of meaning or of pronunciation. Because the sound may have changed for historical reasons, the pronunciation of the *phonetic* marker may often be different from the modern pronunciation of characters. Moreover, as Wang (1973) pointed out, some symbols are *phonetic* markers in some characters and semantic *radicals* in others. Therefore, people must guess which is the *radical* and which is the *phonetic*. As Chen and Yuen (1991) mentioned, a common strategy adopted by Chinese readers dealing with an unfamiliar character is to attempt to give a pronunciation that corresponds to the *phonetic* element. In general, but not always the *radical* part is on the left-hand side, whereas the *phonetic* part is usually on the right-hand side. Zhou (1978) estimated that only 39 % of *phonetic compounds* actually provide the correct pronunciation of the *phonetic* part of the characters. Recently, the accuracy of representing sound through the *phonetic* parts has been examined by Yin (1991). The results showed that 36 % of *phonetic* parts completely represent the sounds of characters (e.g., the pronunciation of the character, 洋 [iáŋ] is the same as its *phonetic* part, 羊 [iáŋ]) and 48 % of *phonetic* parts partially represent the sounds of characters (e.g., the pronunciation of the character, 松 [suɜŋ] shares the rime of its *phonetic* part, 公 , [kuɜŋ], for rime, see Sec. 2.2.1). The remaining 16% of *phonetic* parts do not represent the sounds of characters at all (e.g., the pronunciation of the character, 治 [tʂì] is completely different from its *phonetic* part, 台 [t'ái]).

5. Analogous characters:

This category is mainly new characters and applies to only a minute number of characters. The new character is patterned after an old character, and they are analogous in meaning and do not share the same sound. For example, the character 頂 [tǐŋ] (meaning "top") and 巔 [tiān] (meaning "top"). The patterns of these two characters are similar to each other and the two characters share the same right part, 頁. More important, the meaning of the two characters is the same. However, the sounds of the characters are different.

6. Loans:

Another method is to borrow the character of a homophonic word. A new character 來 [lái] (meaning "come") is borrowed from the original character 麥 [mài] (meaning "wheat") and both were evidently homophonic (sounded [lài]) in Ancient Chinese (Karlgren, 1923, p.49). If one looks at the two characters 來 and 麥, it can be seen that the two characters share the same half pattern (來) of the characters. The characters in this category are used to adapt new characters from old characters on the basis of identity of sound.

2.1.2 Dialects in China

There are 7 main dialects in China (the percentage of the population is shown in parentheses): Mandarin (71.5 %), Wu (8.5 %), Gan (2.4 %), Xiang (4.8 %), Hakka (3.7 %), Yue (5.0 %), Min (4.1 %) (Ramsey, 1987, p.87). Despite these different dialects, the writing system is the same throughout China, although with differences of style and grammar. Accordingly, Beijing people who speak Mandarin can easily read a newspaper printed in the Guangdong province where people speak the Yue dialect. Information about the various dialects can be seen in Table 2-3:

Table 2-3: The comparison of various dialects in China

example	本 (base)						
dialects	Mandarin	Min	Wu	Xiang	Yue	Hakka	Gan
pronunciation	[pə̌n]	[p'un]	[p'aŋ]	[p'in]	[p'un]	[p'un]	[p'ən]
area	North of China, e.g., Beijing, Chengdu.	Fu-Jian & Taiwan prov.	Zhè-Jiang prov.	Hu-nan province	Middle & Southeast of Guangdong province	East & North of Guangtong province	Jian-xi prov.

The Yue dialect is popularly known as the Cantonese dialect which is mainly spoken in Guangdong province, Guangxi province and Hong Kong. Cantonese may be the form which preserves best the essential traits of Ancient Chinese (Forrest, 1965, p.230). Mandarin represents the speech of Beijing which for centuries has been recognized as the standard language of China because of the political and cultural significance of the city. This section will only focus on Mandarin and Cantonese which are relevant for Study One and Study Two in this thesis.

The word "Mandarin" as it is generally called by Europeans is used in North China. There are about 420 syllables in Mandarin, and over 1300 syllables if the different tones of each syllable are counted separately (Yin & Felley, 1990, p.76).

In this century, both the Nationalist government in Taiwan and the Communist government in mainland China have promoted a "national language" to unify spoken Chinese. Both governments chose Mandarin for this purpose (Chang, 1992). The national language in China has been known as *Putonghua*, which means the 'common language'. In Taiwan, the uniform language is called *Guoyu*, literally 'national language'. Both *Putonghua* and *Guoyu* are based on Mandarin. The term *Putonghua* is employed through this thesis as the term for the standard spoken language. The main reasons why *Putonghua* is based on the Beijing dialect are:

1. The area in which the dialect is used is the biggest. As mentioned before, 71.5% of people speak it.

2. The high status of Beijing, which has been China's capital city since the Yuan dynasty (late 13th to 14th centuries).

3. Easiness of learning. The number of the syllables in Mandarin is the smallest in any of the dialects (Erbaugh, 1992, p. 379). Therefore, it is easier to learn to speak.

2.1.3 Phonology of Chinese

In terms of traditional Chinese phonology, a syllable is divided into three parts: "*initial*", "*final*" and tone. The *initial* represents the consonantal beginning of a syllable (e.g., [m] in [mù] 木(meaning "tree")); the *final* of a syllable is the part of the syllable excluding the *initial*. In Chinese, the *final* is always a vowel (e.g. [ù] in the above example), or a vowel and nasal consonant. The three main elements are introduced in detail in the following sections.

2.1.3.1 *Initials*

According to where in the mouth they are formed, the 21 initials are divided into six classes (Yin & Felley, 1990), shown as follows. The symbols in square brackets represent the conventions of IPA transcription and the letters are in *Pinyin* transcription (the *Pinyin* system will be introduced in Sec. 2.1.3.5).

1. labial (lips)	b [p], p [p‘], m [m], f [f].
2. apical (tongue tip)	d [t], t [t‘], n [n], l [l].
3. velar (root of tongue)	g [k], k [k‘], h [χ].
4. dorsal (back of tongue)	j [tç], q [tç‘], x [ç].
5. blade-palatal (back of tongue tip)	zh [tʂ], ch [tʂ‘], sh [ʂ], r [z].
6. dental (front teeth)	z [ts], c [ts‘], s [s].

It is important to note that all *initials* in *Putonghua* consist of only one component (*zh*, *ch*, and *sh* are each a single sound). Thus, consonant-clusters, as in English *strong, break, try,* do not exist in Chinese syllables.

2.1.3.2 *Finals*

There are 36 finals in standard Chinese which can be divided into three different types of finals:

1. simple vowels:	a [a], o [o], e [ə], i [i], u [u], ü [y], er [ɚ] (the vowel, er, never follows an initial).
2. vowel constructions:	ai [ai], ei [ei], ao [au], ou [ou], ia [ia], ie [iɛ], iao [iau], iou [iou], ua [ua], uo [uo], uai [uai], uei [uei], üe [yɛ].
3. vowel-nasal constructions:	an [an], en [ɘn], ang [aŋ], eng [ɘŋ], ong [uŋ], ian [iɛn], iang [iaŋ], in [in], ing [iŋ], iong [yŋ], uan [uan], uang [uaŋ], uen [uen], ueng [uɘŋ],

üan [yɛn], ün [yn].

The initials and finals combine to form syllables in the simplest manner:

initial + final = syllable

e.g. [m] + [ǎ] = [mǎ] (horse)

There are some syllables which do not contain a consonant. These are said to begin with the zero consonant. For example,

◯ (zero consonant) + [ī] = [ī] (clothes, or to cure, etc.)

All the final occlusions (e.g., -p, -t, -k) of ancient Chinese are lost in *Putonghua*. The three nasal finals, -n, -m, and -ŋ, are now reduced to two only, all words with the final -m having changed this to -n as early as the fifteenth century (Forrest, 1965, p.196). Therefore, in the *final* of the syllables, every Chinese character (in *Putonghua*) has to end either in a vowel or in n, or ŋ.

2.1.3.3 Tones

Each tone is described as a relative, contrastive pitch pattern. The system of tones is essential to distinguish the considerable number of homophones. Therefore, tones are a vital feature of the language, often serving to differentiate the meanings of characters.

The modern dialects have a varying number of tones. The number of tones in Cantonese, for example, is nine. There are four different tones in *Putonghua*. Table 2-4 shows the comparisons of the four tones in *Putonghua*. The way to mark and describe tones is by the 'five degree' notation. This system divides the range of pitches used in forming tones into five degrees, marked from 1, the lowest pitch to 5, the highest pitch.

1. First tone (high-level tone):

This is a high tone that keeps steadily to the highest of the five pitches throughout its length. The tone is marked by the symbol '¯' over the main vowel of the syllable (e.g., *ā*).

2. Second tone (high-rising tone):

The tone starts at the middle pitch and rises steadily to the highest pitch. It is indicated by the symbol '´' over the main vowel of the syllable (e.g., *á*).

3. Third tone (falling-rising tone):

The pitch first drops, relatively slowly, from the mid-low to the lowest pitch, then rises quickly from the highest pitch. It is indicated by the symbol 'ˇ', over the main vowel of the syllable (e.g., *ǎ*).

4. Fourth tone (high-falling tone):

The tone falls steadily from the highest to the lowest pitch. The symbol is '`'. (e.g., *à*).

Table 2-4: The comparison of the four tones in *Putonghua.*

Type	First tone	Second tone	Third tone	Fourth tone
Tone value	5.—. 55 4. . 3. . 2. . 1. .	5. . 35 4. /. 3./ . 2. . 1. .	5. | 214 4. |. 3. |. 2\ |. 1.V.	5\ . 51 4.\ . 3. \. 2. \. 1. \
Tone marker	¯	´	ˇ	`
Description	high and level	rising from middle to high	first falling, then rising	falling from high to low

2.1.3.4 The old method of Chinese pronunciation systems

Homophone characters have long been used as a method to pronounce Chinese characters. Homophones are words that sound the same but have different meanings. From around 600 AD, the pronunciation of a character in China was represented by a different system known as *'fan-qie'*.

The *fan-qie* method is that two characters are used to indicate the pronunciation of a third character. The first one is called 'the first character in *fan-qie*', the second one is called 'the second character in *fan-qie*'. The *initial* (the onset of the syllable, usually a consonant) of the first character is to be read, the *final* being disregarded; the second character yields the *final*, its *initial* being disregarded. In addition, the tone of the character to be pronounced is the same as that of the second character. The *fan-qie* principle provides a powerful means of pronouncing Chinese characters (Leong, 1991, p.234). For instance, in *fan-qie*, the pronunciation of 東[tuŋ] (meaning "east"), is given as 德 [tə] and 紅 [xuŋ].

德 [tə] + 紅 [xuŋ] ⇒ [t] + [uŋ] ⇒ [tuŋ]

There are two deficiencies in this method. One is that the sound of a character may vary in different dialects. The other is that the characters which are used with *fan-qie* may be unfamiliar to readers. It has therefore been superseded by the systems described in the next section.

2.1.3.5 The modern method of Chinese pronunciation systems

There are five main systems used to represent the pronunciation of modern Chinese. They are:

1. The Wade transcription system.

The system was created by Sir Thomas Wade who first published the system in his *Peking Syllabary* in 1859 (Chang, 1978). In western countries, the Wade transcription is the oldest and the most widely accepted one. The characteristic of the system is that the tones are marked by numbers raised above the line. For example, *ba*^{1} [pā] (in IPA).

2. The Gwoyen Romatzyh (GR) system.

The system literally means "the Romanized script for the national language" which was devised by Y. R. Chao (Halliday, 1959, p.184). The system was completed in the 1920's and was officially supported in 1928. However, the system was never wholly accepted and adopted in China because it was considered unnecessarily difficult. The system used different spellings to distinguish different tones, for example:

a. *ba* for [pā].

b. *bar* for [pá].

c. *baa* for [pǎ].

d. *bah* for [pà].

3. The Pinyin system.

The system was developed by Soviet scholars in the 1950s. Although of relatively recent origin, it has won wide acceptance in mainland China for political reasons. It uses accents (tone-marks) to distinguish tones, for example,

a. *bā* for [pa] in the first tone.

b. *bá* for [pá] in the second tone.

c. *bǎ* for [pǎ] in the third tone.

d. *bà* for [pà] in the fourth tone.

4. The Yale system.

It was developed by scholars at Yale University, U.S.A, for teaching Air Force pilots who needed to speak Chinese during the Second World War. The excellent Chinese-English and English-Chinese dictionaries from Yale with the Yale system made the system popular in the 1950s. This system, however, is no longer so widely used and is not used at all in China or Taiwan today. In the Yale system, the tones are marked by accents or tone marks similar to those of the *Pinyin* system. One of the main differences between the Yale system and the *Pinyin* system is that the third tone in the Yale system is marked by a brevis '˘', not a 'hook', 'ˇ' as in the *Pinyin* system (e.g., *bă* for [pǎ]).

5. The Zhu-Yin-Fu-Hao system.

The system is not well known in the west because the symbols in *Zhu-Yin-Fu-Hao* system are simplified from modern Chinese characters or come from ancient Chinese rather than from Roman letters. For example, ㄉ[t] is the ancient Chinese 刀. This system is widely used in Taiwan today.

From the summary above, the symbols are written in different ways in the five pronunciation systems. Table 2-5 illustrates the different methods of the transcription. One of examples in this Table is worth explaining here. The name of the capital city in mainland China, *Beijing*, used to be officially spelled as *Peking*. It can be seen that the different spellings of the capital name were caused by the different transcripts. In addition, *Pinyin* is superior to the Yale system or the Wade system in that it clearly differentiates between all the sounds that a *Beijing* resident's ear would hear as significantly different.

Table 2-5: A comparative example of the different pronunciation systems.

Chi. character	meaning	*Pinyin*	Wade	GR	Yale	*Zhu-Yin-Fu-Hao*	IPA
北 京	name of capital	Běijīng	Peking	Peijing	Běijīng	ㄅㄟˇ ㄐㄧㄥ	[peitçiŋ]
早	morning	zǎo	tsao³	tzaau	dzǎu	ㄗㄠˇ	[tsǎu]

In this study, all the subjects in Taiwan (in Study One and Three) learnt *Zhu-Yin-Fu-Hao* before they learnt Chinese characters and one group of subjects in Hong Kong (Study Two) learnt *Pinyin*. Therefore, the *Pinyin* system and *Zhu-Yin-Fu-Hao* system will be discussed in more detail here.

The *Pinyin* (literally 'spell sound') system is a pronunciation system used to transcribe *Putonghua*. *Pinyin* is the official pronunciation system of the People's Republic of China. It includes the twenty-six letters of the Roman alphabet. Although all the forms of each letter are all the same as those used in English, the letters used in *Pinyin* have their own names and pronunciation, which are different from the names used in English.

The *Zhu-Yin-Fu-Hao* system (literally "symbols of phonetic pronunciation") was devised by a Committee of Unified National Language in 1913 and was employed officially in 1918. The system consists of 37 phonetic symbols which were derived from the simplification of certain characters.

Fig. 2-2 presents all the symbols and sounds in the *Pinyin* system and the *Zhu-Yin-Fu-Hao* system. Although the symbols of *Pinyin* and *Zhu-Yin-Fu-Hao* are quite different from each other, the sounds represented by the symbols in the two systems are the same.

A	B	C	A	B	C	A	B	C
ㄅ	b	p	ㄓ	zh	tʂ	ㄞ	ai	ai
ㄆ	p	p'	ㄔ	ch	tʂ'	ㄟ	ei	ei
ㄇ	m	m	ㄕ	sh	ʂ	ㄠ	ao	au
ㄈ	f	f	ㄖ	r	ʐ	ㄡ	ou	ou
ㄉ	d	t	ㄗ	z	ts	ㄢ	an	an
ㄊ	t	t'	ㄘ	c	ts'	ㄣ	en	ən
ㄋ	n	n	ㄙ	s	s	ㄤ	ang	aŋ
ㄌ	l	l	ㄧ	i	i	ㄥ	eng	əŋ
ㄍ	g	k	ㄨ	u	u	ㄦ	er	ɚ
ㄎ	k	k'	ㄩ	ü	y			
ㄏ	h	x	ㄚ	a	a			
ㄐ	j	tɕ	ㄛ	o	o			
ㄑ	q	tɕ'	ㄜ	ě	ə			
ㄒ	x	ɕ	ㄝ	e	ɛ			

Fig. 2-2: The symbols of *Zhu-Yin-Fu-Hao* (A), *Pinyin* (B), and the pronunciation, IPA (C) (revised from Chen and Yuen, 1991, P.431).

2.1.3.5.1 The differences between Pinyin and Zhu-Yin-Fu-Hao

The main differences between *Pinyin* and *Zhu-Yin-Fu-Hao* can be described as follows:

1. in terms of consonants and vowels:

The symbols in *Pinyin* are Roman letters, and each stands for a different phoneme. By contrast, the symbols in *Zhu-Yin-Fu-Hao* are based on Chinese characters. Chen and Shan (1989) argued that the *Zhu-Yin-Fu-Hao* is not so accurate as *Pinyin*, because two letters are used to represent a diphthong in *Pinyin*, whereas in *Zhu-Yin-Fu-Hao*, a diphthong is represented by one symbol.

2. in terms of tones:

The tones and the markers for various tones (¯, ´, ˇ, `) in *Pinyin* and *Zhu-Yin-Fu-Hao* are the same. The only difference is that the first tone (¯) can be unmarked in *Zhu-Yin-Fu-Hao* while the first tone should be marked as '¯' in *Pinyin*.

2.1.3.5.2 The functions of Pinyin or Zhu-Yin-Fu-Hao

The reasons for learning characters via a phonetic system are:

1. to identify words written in *Pinyin* or *Zhu-Yin-Fu-Hao* by using phonological recoding.

2. to reduce the learning difficulty of Chinese, then in turn to reduce illiteracy.

Before the phonetic transcription was devised, learning to read Chinese by self-teaching in the early stage was difficult because of the difficulty in the pronunciation of characters. If one cannot recognize a character, but has learnt *Pinyin* or *Zhu-Yin-Fu-Hao*, then one can pronounce the character and understand its meaning, so long as the *Pinyin* representation is presented next to the character. For instance, after pupils have learned *Pinyin* or *Zhu-Yin-Fu-Hao*, they can easily recognise the short prose in Fig. 2-3 (which is copied from the first volume of Chinese Language textbook for the first graders) and understand the meaning from the sound of the words, even though they can not recognize the characters.

dà gōng jī wō wō jiào
大公鸡，喔喔叫，

xiǎo péng yǒu men qǐ de zǎo
小朋友们起得早。

qǐ de zǎo shàng xué xiào
起得早，上学校，

pái qǐ duì lái zuò zǎo cāo
排起队来做早操。

shēn shēn shǒu wān wān yāo
伸伸手，弯弯腰，

tiān tiān zuò cāo shēn tǐ hǎo
天天做操身体好。

Fig. 2-3: An example from the Chinese Language textbook for the first graders in mainland China.

3. to unify the standard spoken language in China.

Both *Pinyin* and *Zhu-Yin-Fu-Hao* are aids for learning *Putonghua*. If speakers of other dialects can master the method of transcription, it will be easier for them to learn *Putonghua* because they can pronounce Chinese characters in *Putonghua* via *Pinyin* or *Zhu-Yin-Fu-Hao* without outside help. This may eventually promote increasing standardization of the spoken language and make it easier for people from different areas to understand one another.

All in all, to learn *Pinyin* or *Zhu-Yin-Fu-Hao* seems a useful approach for children learning Chinese characters. If, however, written Chinese came to rely exclusively on an alphabetic system, the Chinese would be compelled to discard the literature of some 4,000 years and with it the basis of an entire civilization.

2.1.3.5.3 The teaching of Pinyin or Zhu-Yin-Fu-Hao

The teaching of *Pinyin* began as the result of a decision by the National People's Congress in 1958 (Unger, 1977). All schools were requested by the Congress to teach *Pinyin* as a means of learning Chinese characters and *Putonghua* throughout China.

The method of teaching first graders to learn *Pinyin* or *Zhu-Yin-Fu-Hao* is known as a "direct method". When practising *Pinyin*, teachers always speak out the sound of a consonant (*initial*), and speak out the sound of a vowel, then combine the two sounds together as a syllable. In this situation, children are asked to repeat the syllable which has been spoken by class teacher. After practising several times, the teacher will ask children to pronounce the consonant and vowel together.

Pinyin is taught in the primary schools of mainland China in the first 8 weeks of the first grade without accompanying Chinese characters when children are 6 years old. After 8 weeks of training, children can normally read *Pinyin* and use *Pinyin* to spell out utterances. Chinese characters are then taught with *Pinyin* (Chen & Yuen, 1991). In Taiwan, *Zhu-Yin-Fu-Hao* is also taught to the first-graders (aged 6 years) in primary schools for the first ten weeks before the children begin to learn to read Chinese characters. After 10 weeks of instruction, pupils learn Chinese characters via *Zhu-Yin-Fu-Hao*. That is, every character is accompanied by the symbols of *Zhu-Yin-*

Fu-Hao until pupils are fifth graders.

2.1.4 Characteristics of Chinese orthography

The characteristics of Chinese are as follows:

1. Each character is pronounced as a monosyllable. Unlike certain other languages, it has no dissyllabic or polysyllabic stem-words (e.g. kitchen, anchor).

2. Chinese is isolating. That is, it treats the words as if they were isolated unities, without modifying them according to their function in the sentence (Leong, 1973). Therefore, it has no words varied by inflectional affixes (e.g., pull-ed). For instance, the character, 人 means "man", "man's", or "men", etc..

3. Each character has a unique structure and form. Its structure is often symmetrical. For example, in the character, 林, two parts of this character are structured in a horizontal way, whereas the character, 尖, two parts of this character are structured in a vertical way.

4. There are no regular correspondences between sounds and characters. Each character possesses an independent sound and has to be learned separately (see Harris & Coltheart, 1986 for discussion).

5. A character may have several slightly different forms or different sounds in some special cases. For instance, the character, 峯[fəŋ] (peak) can be written as another form 峰 with the same meaning and pronunciation. In another example, the character 被 can be pronounced in two ways and has two different meanings: [pèi] (quilt or bedding) and [p'ī] (to put on or to wear).

6. Characters of different meaning and form may have the same sound and tone. For example, the pronunciations of the character 衣[ī] (clothes) and another character 醫

[ī] (to cure) are the exactly the same.

2.2 ENGLISH ORTHOGRAPHY

The earliest writing using the English orthography is based upon an alphabetic principle derived from the fourth and sixth century Roman grammarians (Venezky, 1970, p.16). The 26 letters in English are divided into vowels and consonants. Vowels are produced when the vocal tract is open and the vocal folds are vibrating. Consonants are produced by constricting the vocal tract (Wagner & Torgesen, 1987).

2.2.1 Levels of English phonic structure

Phonologically, English can be divided into three levels: syllables, intra-syllabic units, and phonemes. Syllables are built round vowel nuclei. The vowel may exist on its own, or may be preceded, followed or surrounded by consonants (Henderson, 1982).

A syllable can be broken up into two phonological units: onset and rime. Each is made up of one, or more than one, phoneme(s). Onset is the opening unit and rime refers to the end unit. That is, a rime consists of a vowel and any consonant(s) that come after it. An onset consists of any consonant(s) preceding the vowel. For example, in the word "*clear*", "*cl*" is the onset, and "*ear*" is the rime.

Phonemes are the basic structural elements of spoken English. As Ellis (1984) pointed out, the term 'phoneme' is used for sounds which distinguish words with different meanings. The majority of languages employ a range of between 15 to 50 phonemes. Russian uses about 43 phonemes, French and German about 35 (Gatherer, 1980). A limited number of phonemes can be combined to produce words.

Phonemes are divided into consonants and vowels. English can be represented as having a total of 44 phonemes consisting of 20 vowel phonemes and 24 consonant phonemes (Roach, 1991).

2.2.2 Grapheme-phoneme correspondences in English

It is not true to say that each letter stands for a phoneme in English, whereas, there is apparently always an one-to-one relationship between letters and phonemes for Serbo-Croatian (Harris & Coltheart, 1986). A phoneme is a phonological unit, and a letter is an alphabetic unit. In English, a phoneme is represented by a sequence of one or more letter(s). In general, a grapheme is the written representation of a phoneme. Coltheart (1980) indicated that "grapheme" means any letter or letter cluster which corresponds to a single phoneme. Thus, the word *sherry* contains six letters but only four graphemes, these graphemes being *sh*, *e*, *rr*, and *y*. Accordingly, a grapheme is a "functional spelling unit" defined by Venezky (1970). The rules relating graphemes and phonemes are known as "grapheme-phoneme correspondences" (GPCs).

Various graphemes can be mapped onto single phonemes in the English writing system. There are some special grapheme clusters that operate as single units, like *th* and *ch*. The correspondences between graphemes and phonemes are not always one-to-one, with a single grapheme representing a single phoneme. Haas (1970) illustrated the correspondences in both directions between graphemes and phonemes. The grapheme *C* can be pronounced as /s/ (as in *cider*) or /k/ (as in *cat*). The phoneme /k/ can be correspond to *K* (in words such as *kitten*) or *C* (in words such as *cat*). Fig 2-5 shows an example of correspondences between grapheme and phonemes. This, however, is not true of all alphabetic writing systems. In Italian, each phoneme is invariably associated with a particular grapheme.

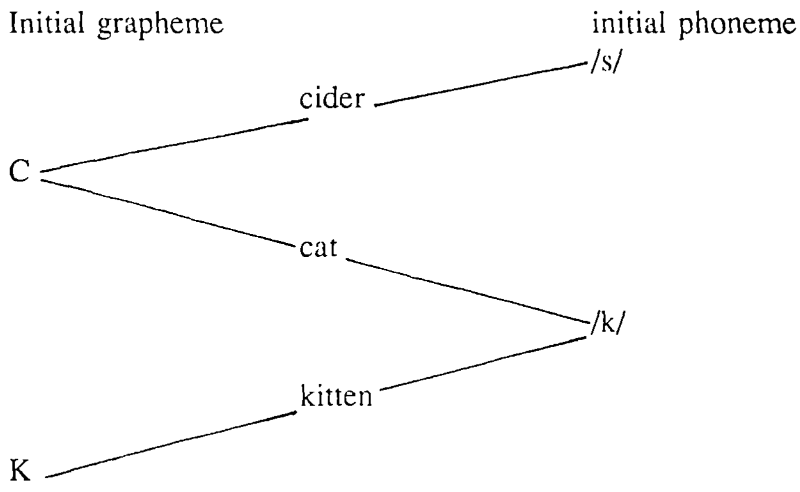


Fig. 2-4: An example of correspondences between graphemes and phonemes (From Haas, 1970).

According to Coltheart (1978), there are about 70% of English words which are regular according to grapheme-phoneme conversion rules. However, the correspondences are not uniform across all words. Words which do not have regular correspondences are known as irregular or exception words. For example, in the following words *splint, hint, mint,* and many others, the grapheme *i* maps onto a short [i] sound, but there is one word, *pint*, for which this is not true. The grapheme *i* of *pint* maps onto the [ai] sound (Harris & Coltheart, 1986). In some cases, there are silent graphemes such as the final *b* in "*bomb*". Irregular words can be found in French, but not in Spanish or Italian, where there are no exception words.

Kay and Lesser (1985) showed that whereas the non-word 'gean' was pronounced as /gi:n/ (similar to 'bean'), the nonword 'gead' was sometimes pronounced irregularly as /ged/ (similar to 'h<u>ead</u>'). It seems as though it is not just the phoneme *ea* in the unit of letter-sound conversion that determines pronunciation. It seems to be the ending "body segment" (defined as vowel plus terminal consonant by Patterson & Morton, 1985) or "rime" segment that is critical in this example. Parkin (1984) also found this effect in a speeded naming task. Irregular words like *health* are relatively quick to name even though the *ea* pronounced as /e/ is irregular. This is because all endings of *ealth* are consistently pronounced like *health* (e.g., wealth). Regularity seems to depend on regularity of the ending, as well as regularity of the GPC. Patterson and Morton (1985) suggest that both GPC's and body segments are used in assembled phonology in which the phonological representation of a word is build up from sub-lexical units (defined by Patterson, 1982).

2.3 COMPARISONS OF ENGLISH AND CHINESE ORTHOGRAPHIES

It is therefore clear that there is a striking difference between English and Chinese writing systems. The main differences between the Chinese and English writing systems are as follows:

1. Chinese is a logographic writing system and English is an alphabetic writing system. The written symbol-sound mapping in Chinese is diverse, whereas in the English script the relations between graphemes and phonemes and between rimes and their pronunciations are more regular.

2. English is composed of 26 letters which are mirror imaged or reversed/inverted forms in some cases, for example, b/p, /p/q/g, m/w, t/f, *etc.*. However, Chinese is not composed of fixed units.

3. In English, a word consists of one or more morphemes. A morpheme is the

smallest unit of meaning. A multi-morpheme word usually contains a "root morpheme", plus one or more "bound morphemes" such as dis-,-s, -ed, which can not occur in isolation (Ellis, 1984). Conversely, in Chinese, each character stands for a morpheme, and a word consists of one or more characters.

4. In English, there are many consonant clusters. These do not occur in Chinese.

5. Unlike English, Chinese is a tonal language. Its four tones differentiate the meaning of characters. In English, the phoneme sequence can be used to distinguish the meanings.

6. English characters are remote from any perceptual picture of the word. On the contrary, the Chinese writing system contains some pictographic characters.

7. English is said to have at least 8000 syllables in its phonology. The number for Chinese is far smaller (DeFrancis, 1989) because of the absence of consonant clusters and terminal consonants.

CHAPTER THREE

LITERATURE REVIEW

In this chapter, a review of previous studies of phonological awareness, visual skills and reading ability will be given. The theories of reading are introduced in Section 3.1. Research on the topic of reading and phonological awareness is summarized and evaluated in 3.2. A review of visual skills and reading ability is included in 3.3.

3.1 THEORY OF READING

This section is intended first to clarify the meaning of reading. Secondly, methods used to measure reading ability will be surveyed. Thirdly, the reading process in English will be examined. Finally, learning to read in Chinese will be described and compared with reading in English in the last two sections.

3.1.1 Definition of reading

Reading has a multiplicity of meanings. Harris and Sipay (1980) pointed out that:

> Reading is a complex process in which the recognition and comprehension of written symbols are influenced by readers' perceptual skills, decoding skills, experience, language backgrounds, mind sets, and reasoning abilities as they anticipate meaning on the basis of what has been read (p.10).

Smith (1971) states that reading is a specialized and complex skill involving a number of more general skills. Stones (1979, p.168) declared that "reading is responding to graphic symbols in similar ways to the ways in which the reader responds to the equivalent spoken symbols".

In this study, reading is defined as a response to the graphic signals in terms of the words or Chinese characters they represent. The operational definition is the performance of the subjects in the Schonell Reading Test or in the Chinese Characters Recognition Test.

3.1.2 How to measure reading ability

There are various types of reading tests available. They include:

1. word recognition test.
2. sentence completion test.
3. cloze type test.
4. questions on texts test.
5. re-arranging sentences test.
6. matching words with similar meanings test.
7. matching sentences or phrases with similar meanings test.

From the viewpoint of testing procedure, reading tests can be divided into two different categories: group tests and individual tests. The Edinburgh Reading Tests, Stage I, Section A, and Carver Word Recognition Test employ group testing of word recognition. The Bullock Report, 1975 which surveyed 936 infant and middle schools in England and Wales, stated that the Schonell Graded Word Reading Test and the Burt Word Reading Test, which are individual word recognition tests, were being used in 72.5 % and 34 % respectively of primary and middle schools (Goodacre, 1979). Both tests are measures of a pupil's ability to pronounce isolated words without hints from context. The word recognition tests take little time to manage and mark.

Therefore, they have become popular in schools. Moreover, individual tests allow the students to make oral responses. Consequently, the Schonell Reading Test was selected as the reading test to be used in this study to assess a child's word recognition attainment.

3.1.3 How to read in English

Learning to read is a complex procedure and depends on many factors. How to read in English words has been widely investigated by psychologists. Different reading theories or models have been proposed in the last two decades. This section attempts to describe and summarise the most notable models and theories.

3.1.3.1 Dual route model

The question of how adults recognise words during reading is equally widely debated. One of the most significant models is the dual route model (Coltheart, 1978; Goswami & Bryant, 1990; Harris & Coltheart, 1986; Morton & Patterson, 1980). In this model, there are two possible ways to read a word.

1. Visual route:

This is a whole-word procedure in which there is a direct procedure from print to meaning. People recognize a word as a visual pattern and learn a direct correspondence between the letters and the meaning representation without intermediate phonological coding.

2. Phonic route:

The other possible way to read a word is an indirect phonic procedure. People may gain lexical access from a print stimulus by using grapheme-phoneme conversion rules. The indirect route makes reading comprehension parasitic upon speech comprehension and enables people to read words they have never seen in print before.

In fact, accessing meaning via the phonic route involves the following three main steps (Ellis, 1984):

a. identifying the graphemes in a printed word.

b. applying a knowledge of sublexical correspondences such as grapheme-phoneme rules to create an internal phonological or phonemic form.

c. identifying the phonemic code by means of auditory recognition units.

The question of whether phonological recoding is *necessary* for reading is an old and much debated issue and there is an enormous literature on this issue. As defined by Gough (1984), the phonological recoding hypothesis is that the recognition of a printed word is mediated by its phonological form (p.235). English orthography allows children to identify unfamiliar words using phonological recoding. For example, if one tries to pronounce a nonword, the procedure may be as follows (Coltheart, 1985):

e.g. theam	theam
↓	↓
graphemic parsing	(th) + (ea) + (m)
↓	↓
phoneme assignment	/θ/ + /i:/ + /m/
↓	↓
blending	/θi:m/

Jorm and Share (1983) recommended that phonological recoding is not only a back-up mechanism for the identification of unfamiliar words, but also a self-teaching mechanism in reading for children. They claimed that when children read English words, the ability to identify an unfamiliar word by phonological recoding becomes important to reading acquisition. If children can not identify an unfamiliar word through phonological recoding, they will have to ask an adult or rely on top-down cues from sentence context (Stanovich, 1980). However, if a child is able to recode each new word phonologically, then the child can become familiar with the printed words. Therefore, phonological recoding has a self-teaching function which allows the child to become an independent reader.

A number of researchers suggested that phonic mediation may be necessary or obligatory even when a skilled reader is reading a word. In 1874, Wernicke, a German neurologist, was among the first to make the suggestion that it is obligatory in normal adult reading of English that the phonic route is used. Subsequently, Rubenstein *et al.* (1971) as well as Gough (1972) restated the argument (mentioned by Ellis, 1984). However, there are two main types of evidences against this suggestion: one is from studies of "acquired phonological dyslexics". Here, patients seem to have lost the ability of grapheme-phoneme conversion but they could understand (Patterson, 1982) and pronounce (Funnell, 1983) almost any familiar real word. Another piece of evidence comes from studies of the normal reading of homophones which are words with different meanings but the same sound. When reading a word entirely from phonic mediation, one could not assign the correct meanings to a homophone. For instance, *pear* and *pair* sound the same, yet one can still get the right meaning from the word's printed form. Therefore, it would appear that the obligatory phonological mediation theory is not true.

Nowadays, it is widely accepted that skilled readers recognise familiar words by the visual rather than by the phonic route (Coltheart, 1985). The visual route is used primarily in silent reading. The phonological route is involved in the pronunciation of unfamiliar words, or in reading nonwords. In general, most skilled adult readers use both routes or they can access their mental lexicons without necessarily using phonological processing.

However, each of these strategies has its own problems. The disadvantages of the phonic route are that:

1. It is a more abstract task to learn the correspondences between letters and sounds.
2. It is difficult to teach letter-sound rules in an explicit way. For example, the sounds of the stop consonants *p, t, k, b, d* and *g* can not be properly pronounced in isolation.
3. When a child employs the phonic procedure, the irregularity of English spelling can easily cause errors. The problem would not occur in reading Italian or Finnish because the letter-to-sound relationships are extremely regular in both languages.

The disadvantage of the direct route is that it does not allow the process of reading to be parasitic upon a skill already possessed by the child. The direct route does not offer a way for a child to read a new word (Harris & Coltheart, 1986). Therefore, if a reader sees a new word, s/he can not read the unfamiliar word.

This model of reading has been criticised by a number of researchers. Glushko (1979, 1981), for example, claimed that the dual route model is incorrect and is based more on ideology than on data. He suggested that both regular and exception words, and familiar and unfamiliar words are pronounced through a unitary process of activation and synthesis and in part by analogy with known words. For example, when a reader sees a nonword "t*ove*" in which the pattern of "-*ove*" has multiple pronunciations, he or she might use /ov/ as a pronunciation because the reader might be directly reminded of c*ove* or st*ove* and pronounce it by analogy without a mediating "rule". Furthermore, Glushko argued that nonwords like *n<u>ink</u>* are named more quickly than *nint*, because visual neighbours are pronounced in a consistent way (*rink, sink, link*). In contrast, *int* words have a heretic amongst them (*mint, lint, pint*). There is no way of explaining these differences in pronouncing the different nonwords on the basis of the dual route model. Analogy theory explains the difference by the inconsistency in the spelling of the words in the lexicon. The following section will focus on the analogy strategy.

3.1.3.2 Analogy theory

It is claimed that there is only one route in reading, called "analogy" (Glushko, 1979; Kay & Marcel, 1981). The idea is that readers use larger and more specific units of orthographic and phonological structure in a process of analogy (Glushko, 1979).

The strategy of analogy is dependent on shared orthography. That is, the words must share a similar spelling pattern. In fact, the choice of lexical items which are used as the analogy depends upon the strength of activation of items in the lexicon. Kay and Marcel (1981) showed that the pronunciation of a non-word can be influenced by the pronunciation of a preceding word with a matching segment. In other words, the representation of a recently presented word will still be active in the lexicon and so will strongly influence which pronunciation is chosen. In addition, they emphasised that the processes of analogy operate automatically (p. 410).

Marsh *et al.* (1977) declared that an analogy is different from the use of grapheme-phoneme rules because analogy is about a sequence of several letters. In this strategy, two words are held to be analogous if they share a similar spelling pattern. Thus, if a reader knows how to pronounce the written word "*light*", s/he may work out pronunciation of the new word "f*ight*". It can be seen that "l*ight*" and "f*ight*" share the sequence of several letters "*-ight*".

Marsh *et al.*'s study provided evidence that whereas adults can use the analogy strategy, but the fifth grade subjects had a deficiency in using the analogy strategy in reading an unknown word. On the other hand, Baron (1979) found that children in second grade can be successfully instructed in the use of the analogy strategy. Similarly, it was shown that children were able to make analogies between the spelling patterns of words and use their knowledge of a word to pronounce a new word in Goswami's experiments (1986, 1988). She also claimed that children start to make orthographic analogies from the early stages of learning to read. Moreover, the ability to use orthographic analogy is related to a child's phonological knowledge. Orthographic analogies are initially based on onset-rime units (as explained in Sec. 2.2.1, in the word "snack", *sn* is the onset and *ack* is the rime), and the pre-school knowledge of onsets and rimes predicts reading development.

In Goswami's study (1986), the child was shown one written "clue" word, like "*beak*" and was told how it was pronounced. After that, the experimenter asked the subject to read other trial words. Some of the words shared the clue word's rime (e.g., "b*eak*"--"w*eak*"); some of words shared a spelling pattern with the clue words' onset and half of rime ("*bea*k"--"*bea*n"), and "control" words simply had some letters in common (such as "beak"--"bask"). Her results showed that all the three age groups (five, six, seven year olds) performed better on the analogy words which shared a rime (b*eak*-w*eak*) than on control words. However, the group of 5 year-old children did not do better with words which shared the same onset and half of the rime (*bea*k-*bea*n) with clue words than they did on the control words. Therefore, rime seems an important factor in the way children make an analogy. These results implied that when children learn words, they also learn rimes, and that rime is more important than grapheme-phoneme correspondences.

Later, Goswami (1990) also showed that children can make analogies as they read stories. Subjects performed better with analogous words than with the control words in reading stories. Once again, Goswami (1991) showed that the analogous effect from onset (*tr*im-*tr*ap) is greater than that from part of the rime (w*ink*-ta*nk*). Moreover, children learned more words that shared a rime (w*ink*-p*ink*) than the beginnings of words (*tri*m-*tri*p) in which the vowel extended the onset. The author concluded that onsets and rimes play an important role in children's analogies. Goswami and Mead (1992) further revealed that onset and rime awareness is specifically related to end analogies, while beginning analogies seemed to be related to higher levels of phonological skills.

3.1.3.3 Stages of reading development

There are a number of reading stage models. In 1981, Marsh *et al.* proposed a four-stage theory of learning to read. Their theory emphasized children's cognitive development in reading acquisition. Then, Frith (1985, 1988) proposed a three-phase theory, corresponding to the acquisition of logographic, alphabetic, and orthographic skills. At each phase, a new skill is introduced with either reading (input processes) or writing (output processes) acting as the pacemaker. Each stage is divided into two steps. Thus, it can be called a 3 phase and six step theory. Seymour and MacGregor's (1984) also suggested that the three stages in reading development are the same as the three phases in Frith's reading theory. Harris and Coltheart (1986) proposed a four phase theory of learning to read English based upon ideas proposed by Marsh *et al.*(1981), Seymour & McGregor (1984), and Frith (1985). They were summarised as follows: (1) the sight-vocabulary phase, (2) the discrimination-net phase, (3) the phonological-recoding phase, (4) the orthographic phase.

In 1988, Høien and Lundberg proposed another four stage model for the early acquisition of reading. The sequence of steps which are included in the model are: (1) pseudo-reading step, (2) logographic-visual step, (3) alphabetic-phonemic step, (4) orthographic-morphemic reading step.

It can be seen that there are many similarities between the above stage theories. Because Marsh *et al.* was the first to propose the stage theory, their stage theory will be introduced here.

Marsh et al. four stage theory

According to this theory, the stage that a child can reach in reading is dependent on intellectual development. Table 3-1 summarises the 4 stages of reading acquisition.

Table 3-1: Marsh *et al.*'s stage model of reading acquisition (summarised from Marsh *et al.*, 1981).

stage	strategy
1. linguistic guessing	a. rote learning, b. linguistic guess.
2. discrimination net guessing	a. rote learning, b. guess based on visual similarity, c. guess based on linguistic and visual cues.
3. sequential decoding	a. rote or decode for known words, b. decode from left to right for unknown words.
4. hierarchical decoding	a. rote or decode, b. decode by using higher order rules, c. analogy.

The four stages are briefly reviewed as follows:

1. the first stage: linguistic guessing stage.

In this stage, the child is establishing a set of visual letters and word recognition units, and pupils often glance and guess an unfamiliar word using the linguistic context. Also, the child has few or no phonic skills at this time. Therefore, children read words as logographs at this stage. The main strategies used in this stage are rote learning and linguistic guessing. Rote association is between an unsynthesized visual stimulus and an unanalysed oral response.

2. the second stage: discrimination net guessing stage.

In this stage, children identify words from visual similarity and linguistic cues. Thus, they may respond to an isolated unfamiliar word with a visually similar word which shared graphemic features. The main strategies used in the second stage are visual similar guessing and rote learning.

3. the third stage: sequential decoding stage.

In this stage, children always use rote learning and decoding letter by letter from left to right. Children can read unfamiliar words as long as they are regular CVCs (C stands for a consonant and V stands for a vowel) because they have acquired a simple grapheme-phoneme correspondence. Moreover, because children can decode a new word at this stage, they become more independent in reading.

4. the fourth stage: hierarchical decoding stage.

In this stage, pupils can decode words using higher order rules and analogies. Accordingly, they can become skilled readers.

Both Marsh *et al.*'s stage theory and other stage theories emphasize the stages of reading development and are consistent in that the logographic strategy dominates the first phase of reading acquisition. However, some parents of early readers mentioned having taught children letter-sound relations. Therefore, these early readers excelled in the kinds of knowledge that relate to an alphabetic phase rather than to a logographic phase.

Learning to read may be treated as a sequence of stages. However, it may not be the case that all children pass through the same sequence of stages. Stuart and Coltheart (1988), examined these three reading models proposed by Marsh *et al.*, Frith, and Seymour and MacGregor by testing English-speaking nursery school children. Their study results showed that phonological skills can play a role in the first stage of learning among phonologically adept children and that not all children begin reading "logographically". Moreover, Goswami and Bryant (1990) disagree that children take a series of discrete and identifiable steps of learning to read. Goswami (1986) claim that children can make analogy strategies as soon as they begin to learn to read. That is, it is possible for young children to read new words by analogy at a very early stage in reading.

3.1.3.4 Summary

The dual route model of reading contains two different routes: the direct visual route and the indirect phonic route. The direct route accesses a word from print to meaning, and the phonic route uses grapheme-to-phoneme conversions. However, there are criticisms of the model. For example, Glushko (1979, 1981) argued that regular and exception words are pronounced through a unitary process of activation and synthesis.

Marsh *et al.* (1981) proposed a four-stage model of reading development. In stage one, children identify a word as a whole unit. In stage two, children still recognise a word by the visual route without any phonics and their guesses bear an increasing visual similarity to the target word. Then, children employ GPCs to decode a new word. In stage four, complex rules of orthographic structure and analogy strategy are utilised. A number of researchers have not accepted (e.g., Stuart and Coltheart) this pattern of developmental sequence and suggested that not all children follow the four stages in learning to reading.

3.1.4 How to read in Chinese

This section is a review of the psychological data dealing with reading in Chinese. Compared with English reading, research on Chinese reading is in its early stage. Recently, however, studies in Chinese reading have become more prevalent. Here, it is intended to give an overview of recent findings.

3.1.4.1 The way pupils learnt to read in Chinese before the twentieth century

Before the twentieth century, Chinese children learnt to read a text by recitation and learnt to write by copying. Sometimes, young children had little idea of the meaning of what they were reading. The curriculum included reading lessons from simple primers to more difficult texts. While pupils became familiar with the characters, the teacher gave them some ideas of the meaning of these texts at a more advanced stage. The advantage of the method is that the children had stored a lot of characters in the form of text from their early years at school. Relatively, the disadvantage of the rote learning was that children had to spend a lot of time remembering what they were reading and might not comprehend what they were memorizing. They were simply to memorize blindly.

Then, the next phase of traditional education introduced Wen-Yan (classical Chinese), which also employed rote memorization as the main teaching method. Students would learn three or four pages of a classical text by heart every day. The teacher required pupils to recite the passage or copy it in acceptable calligraphy. This reading curriculum had been followed for two thousand years.

The question of why memorization was stressed in Chinese learning may be answered by the nature of the Chinese language. The child is not confronted with twenty-six letters but with almost endless streams of characters, the majority of which can only be remembered by rote learning.

3.1.4.2 The developmental stages of Chinese reading

Van and Zian (1962) studied 160 first-graders learning characters in Shanghai (south of China) primary schools during the first semester. They claimed that the beginners in learning to read Chinese characters have to go through the following three stages:

1. First stage: as global visual patterns

Children learn Chinese characters in their global shapes of written characters. That is, characters are learned by the look-say or whole-word method as a whole visual pattern.

2. Second stage: analyzing a whole character into subparts

Children are taught to analyze the subparts (phonetic and radical, as described in Sec. 2.1.1) of characters. In this phase, they often wrongly substitute subparts from similarly shaped characters in writing and confuse characters sharing a subpart in reading. For example, the subject may write a pseudo-character, 很, which shares the similar subparts of the correct character, 很 .

3. Third stage: as whole patterns, now made from correct subparts.

Children are able to make a correct assemblage of strokes when they learn more characters and understand more rules of character structure. At this stage, children develop the permanent and specific differentiation between the different parts of characters and are able to understand the relation between the sound, grapheme and meaning of the characters.

From this description, it can be seen that learning Chinese characters throughout these three stages is dominated by the visual aspects of the characters. This is the only phase theory of learning to read in Chinese which I have been able to find. The theory, however, has been overtaken by the fact that nowadays children are first introduced to an alphabetic script (*Pinyin*) which is used to pronounce the Chinese characters in China (see Sec. 2.2.4.5 for a detailed introduction on *Pinyin*). In addition, the duration of Van and Zian's study seems too short: one term of observation is not enough to cover the entire learning developmental pattern. Therefore, bearing in mind research in both Taiwan and mainland China, the development of learning to read Chinese may be divided into these three phases:

1. Phonetic phase:

First of all, children are taught a phonetic system. As described in Chapter Two, *Zhu-Yin-Fu-Hao* is introduced to all beginners in Taiwan, and *Pinyin* is taught to all first graders in mainland China. The child, therefore, learns to recognize words written in the phonetic system by using phonological recoding in the first stage of learning to read.

2. Mixed phase:

After learning the phonetic system, a child begins to learn Chinese characters which are accompanied by the transcription in *Pinyin* or *Zhu-Yin-Fu-Hao*. The phonetic signs appear on the right side of characters written vertically in Taiwan or on the top of characters written horizontally in China (as shown in Chapter Two, Fig. 2-1). In this phase, children memorize *Pinyin* (or *Zhu-Yin-Fu-Hao*) and the characters simultaneously. That is, they need to remember the connection between the symbol and the sound of the character. In general, they start with easier characters and then progress onto more complex ones. Students are required to write *Pinyin* and characters together repeatedly as their homework for half an hour or one hour per day. It is through this means that children learn to write and read.

As Unger (1977) visited primary schools in mainland China, he reported that a vast quantity of rote learning remains a part of the primary school syllabus and character writing is regularly assigned as homework in the procedure of primary schooling.

3. Visual phase:

After pupils have learned Chinese characters for a period, the phonetic system only accompanies new characters and is not presented with characters which have been taught already. Generally speaking, a set of reading books to be used over a 6-year-period contains about 3500 different words. During the 6 years of primary and the 6 years of secondary school, one learns about 5000 characters.

3.1.4.3 Recent research into Chinese reading

Coulmas (1984) proposed three possible relations between Chinese characters, their sound and their meaning. Fig. 3-1 shows that path 1 corresponds to phonologically mediated reading. Path 2 describes reading Chinese directly from print to meaning, then there is transfer to the sound system.

Path 1

characters → sound ↓ meaning

Path 2

character → meaning ↑ sound

Path 3

character → sound ↕ meaning

Fig. 3-1: Three possible relations between Chinese character, sound and meaning.

Coulmas pointed out that the majority of Chinese characters are composed of a phonetic and a radical as explained in Sec. 2.1.1. Thus, it is possible that Chinese readers may rely on either path 1 or path 2. Path 3 suggests that when one reads a Chinese character, the sound and meaning of the character come simultaneously. In the last two decades, the question of whether reading Chinese characters is phonologically mediated or not has been investigated by an increasing number of researchers.

The traditional viewpoint assumed that reading Chinese characters should depend on the direct route (e.g., Morton & Sasanuma, 1984; Sasanuma, 1974, Wang, 1973). It was supposed that reading Chinese characters might completely bypass phonological encoding and require essentially the direct route since it was assumed that Chinese characters are not translated into a phonological code, they are read "globally". Coltheart (1978) concluded that lexical access through phonological mediation is impossible for an logographic script such as Chinese, because a Chinese character is not alphabetical and counterparts of the English grapheme-phoneme conversions do not exist in Chinese characters. Smith (1985) also argued that Chinese reading allows no role for phonology.

Some findings on processing Chinese characters in Japan supported this 'traditional' viewpoint (e.g., Sasanuma, 1974). It is well known that there are two types of writing systems in Japan: *kana* which represents a syllable, and *kanji* which is Chinese characters used in Japanese to represent morphemic units. A patient mentioned by Sasanuma (1974) who was diagnosed as having Broca's aphasia was asked to write a set of high-frequency words designating common objects in *kana* and *kanji* with stimuli which were a set of pictures together with their names spoken by the examiner. The results revealed that the patient would write *kanji* characters and sentences while the patient performed poorly in writing *kana*. It seems that *kana* and *kanji* processing represent distinctively different modes of operations of linguistic behaviour. The dissociations between *kana* and *kanji* in the experiment indicated that the strategies for the processing of the two systems can be differentially impaired. The results from Sasanuma (1974) suggest that reading Chinese characters is independent of phonological mediation.

There are even more homophonic characters in Japanese *kanji* than in Chinese because of the lack of tones. Accordingly, Morton and Sasanuma (1984) supposed that when readers recognized single characters, the phonological code would not be helpful. They also argued that there is direct access to semantics from *Kanji* stimuli but the *kana* symbols have to be translated into a phonological code before lexical access is possible. However, it should be noted that the argument was based on their subjective impression of Japanese readers, not on experimental data.

In contrast, a number of studies argue for the reverse (Hung & Tzeng, 1981; Tzeng *et al.*, 1977; Tzeng & Hung, 1980; Yin & Butterworth, 1992). Since Chinese characters have not only inherent meanings (in the radical part of a character), but also sub-lexical phonological representation (in the phonetic part of a character), it may be assumed that phonological activity may occur when a reader processes Chinese characters. Tzeng *et al.* (1977) showed that processing Chinese characters is affected by the sound of characters and that phonological processes play a role in memory and comprehension of Chinese. In their experiments, they found that the processing of Chinese characters in short-term memory and in a Chinese sentence judgement task involved phonic recoding. In this task, Chinese subjects recoded words phonologically when they decided whether a sentence was meaningful or anomalous. Unfortunately, their research did not answer the question of whether recognizing a Chinese character is phonologically mediated or not, since the sentence verification task may depend on post-lexical phonology.

Hung and Tzeng (1981) also focused on the facets of phonological recoding, lexical access, and cerebral lateralization, and found that phonetic recoding in Chinese may be needed sometimes at the working memory stage to aid text comprehension in reading Chinese.

The results of Perfetti and Zhang (1991) suggested that the identification of Chinese characters is not only mediated by phonemic processes but that the identification of a printed character immediately causes the activation of its pronunciation. In one of their experiments (Exp. 4), subjects were asked to view a prime character for 180 ms, followed immediately by a target character to be named as quickly as possible. There were four different types of prime characters: (1) homophonic type which has the same sound as the target character, but is not visually similar to it; (2) graphic type which had substantial visual overlap with the target character; (3) semantic type which was closely related in meaning to the target character; and (4) control type which is irrelevant to the target character. Their results revealed a clear priming effect for phonemic primes which were homophonic to the target character and a smaller semantic priming effect. There was no graphic priming effect. They argued that the prime character has been accessed and its pronunciation is activated. Then, this activation affected a different character that shares the same pronunciation.

Cheng (1992) conducted three experiments on Chinese lexicality judgement to assess whether a character serving as a cue or a prime would result in an automatic activation of its phonological information. The results showed that the lexical decision to a target character was faster when preceded by a homophonic character cue than when preceded by a phonological-dissimilar character cue. Cheng claimed that this was because homophonic characters provide a phonological cue for target characters. Moreover, the homophonic priming effect was independent of the visual similarity between the cue character and the target character. The results implied that phonological information about the prime character is encoded automatically which is then used to prime its subsequent target. He claimed that the mechanism underlying this phonological mediation appeared to be based on character-sound correspondences which are well developed through years of extensive practice. Such phonological transformation should apply indifferently to all writing systems.

The naming task, however, is not ideal to explain the real reading procedure in general. More recently, Wydell, Humphreys, and Patterson (1992, cited by Patterson, 1992) showed that phonological effects in Japanese *kanji* reading are similar to those in English. In their semantic categorisation experiments, Japanese readers made a significant number of errors to the characters that were homophones of correct category instances. This is similar to Van Orden's studies (1987, 1988), in which English subjects also produced more false positive errors in a semantic categorization task when the stimulus foils were homophonic to category exemplars (e.g., HARE for a part of the human body) than control words which were equally close in spelling. The homophonic effect in semantic categorisation task provides evidence of phonological coding in written word recognition.

To sum up, on the one hand, some results of the Chinese studies suggest that word identification involves phonology as a part of the reading process. Consequently, Perfetti (1992) suggested that the use of phonology is a general characteristic of reading that exists across writing systems. On the other hand, some findings suggest that reading Chinese characters is independent of phonological mediation (e.g., Sasanuma, 1974). Therefore, the issue still remains open.

3.1.5 Comparison of English reading and Chinese reading

English and Chinese are utterly different from each other as written languages. It would not be surprising if the enormous differences between Chinese and English produced significant differences in cognitive processes involved in reading the two languages. In recent years, there has been a growing interest in comparative research on reading in the main writing systems. A number of studies have tried to compare the differences between the reading processes in English and Chinese.

Some research (e.g., Sasanuma, 1974) revealed that reading in logographic systems is different from processing alphabetically printed words. It has been proposed that learning to read Chinese is a global, holistic process because Chinese characters represent morphemes, as compared to learning to read English, which requires an analytic process because English words contain letters. In contrast, a number of researchers argue the reverse. For example, Flores d'Arcais (1992) claimed that reading words written in a logographic system such as Chinese does not involve processes substantially different from those involved in reading words written in alphabetic systems such as English. In Flores d'Arcais's opinion, a Chinese reader might use the phonological information which in most Chinese characters is specified by the "phonetic" part of characters in the category of phonetic compounds (see Sec. 2.1.1 for details) or might use the direct route from character to meaning. Hence, the process seems equivalent to reading an English word, which can be read by both routes.

Rozin *et al.* (1971) reported the interesting result that a group of second-grade school children who were having serious difficulty in learning to read English were found to be successful in reading Chinese characters with which English words had been associated. They pointed out that "the success of this program can be attributed to the novelty of the Chinese orthography and to the fact that Chinese characters map into speech at the level of words rather than phonemes" (p.126). On the other hand, Stevenson *et al.* (1982) disagrees with Rozin *et al.* that different orthographies play a role in the development of reading disabilities and suggests that it is unlikely that any particular form of writing is conducive to the production of severe reading problems. In their cross-national study, they found that reading disabilities exist among Chinese and Japanese as well as among American children.

Turnage and McGinnies (1973) investigated the effects of language (Chinese or English), mode of stimulus presentation (visual or auditory), and noun frequency on short-term serial recall. The subjects comprised 60 American students at the University of Maryland and 60 Chinese students at National Taiwan University. It was found that the Chinese subjects learned faster with visual input, but auditory input facilitated learning for American subjects.

Seidenberg (1985) examined the issue of phonological coding in naming Chinese characters and English words. In the Chinese experiment, native Chinese subjects were asked to name characters which were presented tachistoscopically using a slide-projector for a maximum of 3 seconds. There were four different types of Chinese characters, a result of crossing the factors type (phonograms which provide clues to pronunciation, non-phonograms which do not contain a phonetic part) and frequency (high, low). In the English experiment, native English subjects were showed tachistoscopically four different types of words, each crossing the word frequency (high, low) and type (regular, exception). It was found that in both English and Chinese the naming latencies did not differ between regular (phonogram) and exception (non-phonogram) words in higher frequency. However, low frequency words exceptions (non-phonograms) took longer to name than regular words (phonograms). The results suggested that in both English and Chinese, high frequency words are read aloud without phonological mediation, while phonological coding enters only into processing of low frequency words, for both orthographies. According to his study, in both English and Chinese, high frequency words would be read "logographically" via the direct route, while low frequency words would be read "analytically" via a phonological route. His study also concluded that the available evidence did not seem to indicate dramatic processing differences for words written in alphabetic or in logographic orthographies.

In contrast, Treiman *et al.* (1981) compared English and Chinese readers in speech recoding during silent reading and presented interesting results. In their study, subjects were asked to judge whether sentences made sense or not. They found that English readers took longer and make more errors on homophone sentences than on control sentences. However, Chinese readers were significantly less impaired by homophone sentences relative to control sentences than were English readers. Their results implied that speech recoding is used less by Chinese readers because the relations between characters and sounds are less available to them.

Neuropsychological differences between Chinese and English reading are one of the main findings in the area. The typical finding is a left hemisphere processing advantage in an alphabetic system (e.g., Geschwind, 1972). Left hemisphere superiority was found for *kana* (Hatta, 1977, Sasanuma *et al.*, 1977), while right hemisphere superiority was found for *kanji*. Sasanuma (1971) found that some acquired dyslexics could recognize Chinese characters but not *kana*. Some of the patients showed the reverse results. The research is consistent with the claim that different parts of the brain deal with different writing systems.

An investigation by Tzeng and Wang (1983) showed that a Left Visual Field

(LVF) advantage is observed when Chinese readers were presented with a single character, whereas a Right Visual Field (RVF) superiority is consistently found for alphabetic scripts. Their results suggested that the right hemisphere is more active in processing Chinese characters. Hatta (1977) tachistoscopically exposed *kana* and *kanji* to the RVF or the LVF, and found the RVF superiority for *kana* symbols and a LVF superiority for *kanji* characters. An experiment with Chinese characters conducted by Tzeng *et al.* (1979) revealed that the LVF superiority was obtained only for the recognition of single Chinese characters; a RVF advantage was observed when two or more Chinese characters in a linguistic term were displayed. Once more, Tzeng and Hung (1980) also showed a left visual field superiority for the identification of single Chinese characters but a right visual field superiority effect for making semantic decisions on multiple-character items.

3.2 REVIEW OF PHONOLOGICAL AWARENESS AND READING ABILITY

This section reviews the evidence relevant to the issue of phonological awareness and reading ability. The first part clarifies the definition of the meaning of phonological awareness; the second part describes the different measures of phonological awareness. The relationship between phonological awareness and reading in English and Chinese will be further considered in the two succeeding sections.

3.2.1 Definition of phonological awareness

Many researchers have assumed that phonological awareness is critical for learning an alphabetic writing system (e.g., Bryant & Bradley, 1985; Treiman, 1991;

Wagner & Torgesen, 1987). However, the definition of phonological awareness varies among the researchers in this field.

What is phonological awareness? Bentin (1992) stated that the term 'phonological awareness' refers to knowledge of the phonological structure of spoken words. Cossu *et al.* (1993, p.129) claimed that phonological awareness implies overt knowledge of how spoken words can be analysed into their constituent sounds. It differs from the phonological knowledge used in perceiving words. The importance of phonological awareness was first pointed out by Mattingly (1972). In his definition, phonological awareness is one's awareness of and access to the phonology of one's language. However, the description by Mattingly seems very vague.

Tunmer and Rohl (1991, p.8) suggest that phonological awareness is awareness solely of phonemes. For them, the term does not include awareness of syllables, awareness of intrasyllabic units, or awareness of words. They believe (p.2) that phonological awareness is the ability to reflect on and manipulate the phonemic segments of speech. They also point out that phonological awareness is one of four general types of meta-linguistic ability, which is the ability to use control processing to perform mental operations on the products of the mental mechanisms involved in sentence comprehension, where 'products' refers to phonemes, words, structural representations of sentences, and sets of interrelated propositions. However, in their definition, the term of phonological awareness is synonymous with phonemic awareness. Yopp (1992) defined phonemic awareness as an understanding that speech is composed of a series of individual sounds, and Stanovich (1986, p.362) also suggested that phonemic awareness is the "conscious access to the phonemic level of the speech stream and some ability to cognitively manipulate representations at this level". Similarly, Leong (1991, p.217) suggested that phonemic awareness refers to the ability to progress from the transparent to the opaque forms of speech and to attend to them in and for themselves. As Ehri *et al.* (1987, p.394) affirmed, the term of phonemic awareness has been used to refer to a variety of capabilities, all of which require the listener to analyze speech sound in some way.

In contrast, Treiman (1991, p.159) proposed that the term 'phonological awareness' refers to the awareness of any of the phonological units of the spoken language, which includes syllables, intrasyllabic units, phonemes, and phones. Goswami and Bryant (1990) defined phonological awareness as the child's ability to hear the component sounds in a word and proposed that phonological awareness can be divided into three forms:

1. syllables;
2. intra-syllabic units: onset and rime;
3. phonemes.

In the opinion of Morais (1991, p.34; Morais *et al.*, 1987, p.425), phonological awareness refers to conscious representations of the phonological properties and constituents of speech. Moreover, phonological awareness includes awareness of syllables. A major difference between phonemes and syllables is that syllables are said to be "naked acoustically" whereas phonemes have no physical analogue in the spectrographic representation of speech (Tunmer & Rohl, 1991, p.5). Wagner and Torgesen (1987) stated phonological awareness as awareness of the sound structure of language. Similarly, Jorm and Share (1983, p.116) suggested that the term of phonological awareness referred to the child's explicit knowledge that speech consists of syllabic and phonemic segments.

Bentin (1992) reviewed the research on phonological tests and concluded that there are two forms of phonological awareness: one is "phonemic awareness" which is demonstrated by the ability to isolate segments and manipulate single phonemes, the second one is "early phonological awareness" which is reflected indirectly in the detection of oddity and commonality between words on the basis of subsyllabic segments.

In summary, phonological awareness is not a single homogeneous entity. The numerous definitions by researchers can be reduced to two categories: one is that phonological awareness is concerned only with phonemes; the other is that phonological awareness includes the conscious awareness of phonemes, intrasyllables, and syllables. In this thesis, the operational definition is that phonological awareness is demonstrated by the successful performance of tasks such as oddity tasks and phoneme deletion tests. This implies that phonological awareness involves an awareness of the abstract units of which speech is composed.

3.2.2 Measurement of phonological awareness

A great number of different experimental paradigms have used various phonological tests to assess phonological awareness, including oddity tasks, phoneme segmentation tasks, matching tasks, phoneme deletion tasks, blending tasks, and phoneme counting tasks.

In recent years, a number of psychologists have tried to summarize the various phonological awareness tests (e.g., Adams, 1990). Lewkowicz (1980) described ten popular phonological tests: (1) sound to word matching, (2) word to word matching, (3) recognition or production of rhyme, (4) pronunciation of an isolated sound in a word, (5) pronouncing in order the sounds corresponding to the phonemes in words, (6) counting phonemes, (7) blending, (8) deletion of a phoneme from a word, (9) specifying which phoneme has been deleted, (10) phoneme substitution. On the other hand, Leong (1991) assigned the phonological tests to three levels: word, syllable, and phoneme. Bentin (1992) suggested that phonological awareness tests included three aspects: detecting, isolating or manipulating the segments. It is evident that phonological awareness is tested in different ways, and that different tasks may require different levels of representation.

Based on the survey of the numerous commonly used phonological tests, they can be sorted into 3 levels:

1. at the syllable level:

One way to determine the young child's level of phonological awareness is to examine his or her ability to segment words into constituent syllable units. This kind test includes syllable counting, syllable detection, syllable segmentation (Lundberg *et al.*, 1980), syllable synthesis (i.e., the ability to combine isolated phonemes into syllables. e.g., /k/, /æ/, /t/ add up to *cat* in Perfetti *et al.*, 1987).

2. at the intrasyllable level:

Such tests include detection or production of rhyme (e.g., "Does *fish* rhyme with *dish*?") and phonological oddity tasks (e.g., "Which word doesn't have the same first sound as the others: *sun, sea, sock, rag*?" in Bradley & Bryant, 1978).

3. at the phoneme level:

Most research examines the phoneme level. There are various types of test that are summarized as follows:

a. counting the number of phonemes, e.g., How many sounds do you hear in the word "*cake*"? (Liberman *et al.*, 1974; Yopp, 1985).

b. deleting a phoneme: the test requires the subject to produce what would be left if a phoneme was taken out of the word, e.g. *cat* without the /t/ (Bruce, 1964; Morais *et al.*, 1979; Rosner & Simon, 1971; Stanovich *et al.*, 1984).

c. judging the similarity of sounds in orally presented words or nonwords.

d. isolating a phoneme, e.g., What is the first/last sound in "*desk*"? (Wallach & Wallach, 1976).

e. reversing phonemes, e.g. say *on* with the first sound last and the last sound first, "If I say *pat*, you say *tap*" (Alegria *et al.*, 1982).

f. segmenting phonemes, for example, what sounds do you hear in the word "*hot*"? (Fox & Routh, 1975; Hohn & Ehri, 1983; Liberman *et al.*, 1974; Williams, 1980).

g. vowel substitution:

Children are asked to replace a particular vowel by a different vowel. For instance, the experimenter requests the subject to replace the vowel /a/ by /i/ in 'BACH' (the word is a German word which means 'brook' in English). In this case, the answer is 'BICH' (a pseudoword) (Wimmer *et al.*, 1991).

The testing procedures used in tasks and materials vary in the different studies. Consequently, this variation in the tasks, procedures, and materials has resulted in different estimates of the level of phonological awareness. The difficulty of the tasks may vary considerably as a function of the different linguistic, analytic, and memory demands which are involved in the separate tasks (Tunmer & Rohl, 1991).

Wagner and Torgesen (1987) adopted a principal-component solution for

Lundberg *et al.*'s (1980) phonological awareness data and obtained two different components with eigenvalues greater than 1. The proportions of total variance accounted for these principal components were .53 and .14. After varimax rotation, the loadings of phonological measures on the first principal component were substantial (with value from 0.61 to 0.91) for all phonological awareness tasks except segmenting word into syllables with picture and rhyme. These two tests were the only significant loadings on the second principal component. The results implied that most of the variance in common measures of phonological awareness can be accounted for by a single latent ability. Factor analysis of ten phonological awareness tests by Yopp (1988) also showed that only two factors accounted for most of the variance. In Yopp's study, the tests of phonemic segmentation, sound isolation, and phoneme counting were found to have high loadings on factor 1 and low loadings on factor 2. In contrast, the tests requiring the deletion of phonological segments and tests of word matching on the single phonemes were found to have high loading on factor 2 and low loading on factor 1. Hence, Yopp concluded that factor 1 reflects a "simple phonemic awareness" whereas factor 2 reflects a "compound phonemic awareness". The result from a stepwise regression analysis of reading scores on phonological awareness revealed that both factors were good predictors of reading ability.

An overview of the measures of phonological awareness reveals that oddity tests were the easiest one to perform, whereas phoneme deletion tests were the most difficult (Stanovich *et al.*, 1984; Yopp, 1988). In this thesis, oddity tests and phoneme deletion tests were used throughout the three studies. There are four reasons for choosing these two tests: the first reason is that both tests were widely used in the area. Phoneme and rhyme awareness seem more important than syllabic awareness.

The second reason is that they vary widely in difficulty. The third reason is that these two measures are not a kind of teaching material of *Zhu-Yin-Fu-Hao* or a type of class test. That is, children have not practised oddity or phoneme deletion tests before in Taiwan (Studies One and Three) or in Hong Kong (Study Two). The last reason is that since each Chinese character is monosyllabic, it is impossible to employ a phonological test at the syllabic level.

3.2.3 Research on the relationship between phonological awareness and reading an alphabetic system

Alphabetic writing systems represent basically the phonemic structure of speech and the English script provides important clues for the recovery of phonological information. A child learning to read English needs to be aware of the phonemic units that occur in the spoken language. Therefore, the relationship between phonological awareness and reading ability is a subject which has been argued over for at least two decades.

Investigations into the relation between phonological awareness and reading have been prolific in recent years. A great amount of research has revealed that performance on phonological awareness tests is closely related to reading ability in the early school grades in English (Bryant & Bradley, 1985; Calfee *et al.*, 1973; Fox & Routh, 1975; Gleitmen & Rozin, 1977; Liberman *et al.*, 1977; Rosner & Simon, 1971; Treiman & Baron, 1981; Tunmer & Nesdale, 1985), as well as in other languages such as Italian (Cossu *et al.*, 1988), Danish (Lundberg *et al.*, 1980), and French (Bertelson, 1987). The correlation is significant even when IQ and socioeconomic status are controlled (Goldstein, 1976; Zifcak, 1977).

3.2.3.1 Three views of the relation between phonological awareness and reading in an alphabetic system

Although many studies have revealed an association between phonological awareness and success in learning to read an alphabetic orthography, the question is what the nature of the relationship between phonological awareness and reading acquisition is. There are many arguments about this relationship.

Bryant *et al.* (1990) proposed three different links between phonological awareness and reading an alphabetic system as models 1, 2, and 3 in Fig. 3-2.

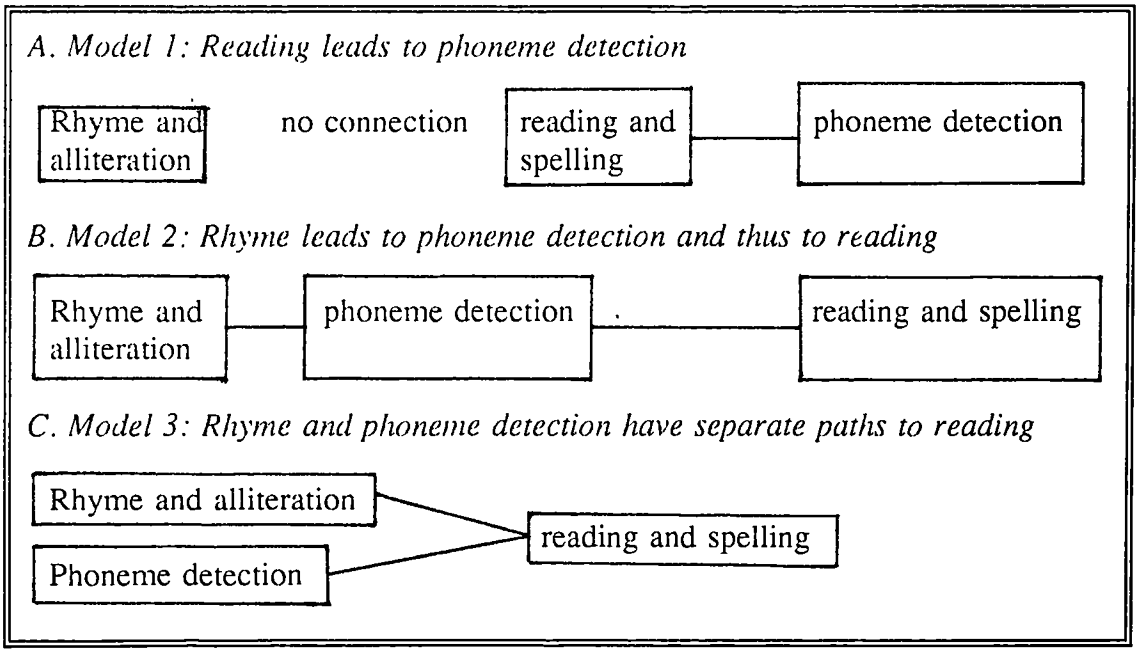


Fig. 3-2: Three different links between phonological awareness and reading (From: Bryant, Maclean, Bradley, Crossland, 1990, p.430).

Model 1 holds that the experience of being taught to read plays the main causal role. This model predicts that there should be no particular relation between the detection of rhyme and alliteration and the later ability to detect phonemes because these two skills are unconnected. It also predicts that children's ability to detect phonemes should be far more strongly related to success in reading than should their rhyming skills.

According to model 2, the sensitivity to rhyme eventually leads to an awareness of phonemes and then this new skill plays a part when the child learns to read and spell. Thus, the model predicts that children's early rhyme and alliteration scores are related to their success in reading, but only because of the intervening development in phoneme detection. The main prediction produced in Model 3 is that rhyme and phoneme detection have separate paths to progress in reading.

Indeed, model 1, 2, and 3 follow three authors' theories respectively. These researchers are Morais *et al.* (1986), Bryant and Bradley (1985), and Goswami (1986). The difference between model 2 and 3 is that model 2 predicts that controls for differences in phonemes-detecting ability will remove the relationship between rhyme sensitivity and reading ability, whereas model 3 predicts that the relationship will still be there after these controls.

Bryant *et al.* (1990) tested 64 children from the ages of 4 years 7 months to 6 years 7 months over a period of 2 years. The results from their longitudinal study produced strong support for a combination of model 2 and model 3, but none at all for model 1. Rhyme and alliteration scores were related to phoneme detection measures and were related to reading and spelling, but not to arithmetic. Rhyme and alliteration scores can predict reading ability even after differences in the ability to delete phonemes have been controlled.

However, there are two problems in their examination of the relationship between phonological awareness and reading ability. One is that Bryant *et al.* used sensitivity to rhyme and alliteration to stand for phonological awareness and treated the phoneme detection task as an intervening variable. According to the definition of phonological awareness (see Section 3.2.1), the ability to delete phonemes represents a form of phonological awareness. It is therefore inappropriate to regard it as an intervening variable. The other problem is that they ignored the possible reciprocal relation between phonological awareness and reading in their model.

In general, three different views of the relation between phonological awareness and reading have been debated: one is that phonological awareness is a prerequisite for learning to read (e.g., Bradley and Bryant, 1978; Juel *et al.* 1986; Tunmer *et al.* 1988; Tunmer & Nesdale, 1985; Yopp, 1985); the opposing view is that phonological awareness is a consequence of learning to read (e.g., Morais *et al.*, 1979; Read *et al.* 1986), and the third is that a reciprocal relationship exists between phonological awareness and learning to read. That is, phonological awareness is both a cause and a consequence of reading acquisition (e.g., Perfetti *et al.*, 1987).

The following is a brief review of selected studies of the three different relations between phonological awareness and reading.

1. Phonological awareness is a prerequisite of learning to read

There is a great deal of evidence showing that children who come to reading with good phonological awareness do better than those less conscious of their language, and that a deficiency in phonological awareness in a kindergartner may cause problems in beginning reading (Liberman *et al.*, 1974; Mann and Liberman, 1984).

One of the most significant studies was work by Liberman *et al.* (1974). Their results revealed that phonological awareness is associated with reading success. It was found that phonological awareness, as measured by a child's ability to count phonemes in a spoken utterance, can be used to predict reading success in the first grade. On the other hand, children who failed a phoneme counting test were likely to become poorer readers.

The work by Bradley and Bryant (1978) showed that poor readers had trouble picking the odd word out from a series of phonologically related words and also had difficulty in generating rhymes. The method which they used in their experiments to test phonological awareness was to read out four monosyllabic words to the subjects. Three of the four monosyllabic words had a sound in common which the fourth did not share. This experiment produced a startling difference in an oddity test between the backward reading group (aged 8 to 13) and the normal group (aged 5 to 8) whose reading ages matched the backward reading group. 91.66 % of the 60 backward readers made errors, and 85 % made more than one error. Only 53.33 % of 30 normal readers made errors and only 26.66 % made more than one. Hence, their results suggested that backward readers are held back by a particular difficulty with organising sounds and also concluded that one aspect of phonological awareness-sensitivity to rhyme and alliteration was a possible cause of reading difficulties.

These results suggest that phonological awareness can presage reading and that there is a striking relationship between children's phonological awareness and their success in learning to read.

2. Phonological awareness is the result of reading an alphabetic system

Some researchers (e.g., Morais *et al.* 1979; Read *et al.*. 1986) claimed that phonological awareness is not inborn and that learning to read an alphabetic system may accelerate phonological awareness. Thus, they found that people who have learned an alphabetic script have higher phonological awareness scores than people who have not. Morais *et al.* (1979) chose two groups of Portuguese in their study. One group were illiterate; the other were adults who had been illiterate but had learned to read in adult literacy programmes. Morais *et al.* found that the illiterate people made more mistakes in the phonological tests than the literate people did. The illiterate people did worse than the literate people in two "deletion" tests. In 1986, Morais *et al.* also conducted another similar investigation. The group of illiterate Portuguese people was compared to a group of literate people in their work. The illiterate group was found to perform much worse than the literate group in both the phoneme deletion test and the syllable deletion test. Furthermore, the illiterate group was found to have a greater disadvantage in the phoneme deletion test than in the syllable deletion test.

A similar study was conducted by Read *et al.* (1986). They chose two groups of subjects:

a. a non-alphabetic group, adults literate only in Chinese characters;

b. an alphabetic group who had learned both *Pinyin* and Chinese characters. Each subject was asked to add or delete a single consonant at the beginning of a spoken syllable (e.g., adding /p/ to /in/, the subject should pronounce /pin/). The result showed that Chinese adults literate only in Chinese characters could not add or delete individual consonants in spoken Chinese words very well; the adults literate in an alphabetic pronunciation system (*Pinyin*) as well as Chinese characters, could readily and accurately perform the same tests. The mean score varied significantly with alphabetic literacy. These findings implied that phonological skill (phoneme deletion and addition ability) does not develop with cognitive maturation or non-alphabetic literacy, and is not a spontaneously emerging ability. It seems to develop in the process of learning to read and write alphabetically.

A study was performed by Mann in 1986 to compare the difference between American and Japanese subjects. The results obtained from both a counting test and a deletion test showed that the Japanese first graders who had learned a logographic script and a syllabary but not an alphabetic system are often very poor at detecting or manipulating the constituent phonemes in a word compared with American first graders. However, the Japanese children were found to improve at phoneme-counting and phoneme deletion ability with increasing age and exposure to the alphabet.

According to these results, the development of phonological awareness seems to be obtained from the process of learning to read an alphabetic system.

3. There is a reciprocal relation between phonological awareness and reading.

Perfetti *et al.* (1987) examined the view that although some phonological awareness is important for beginning reading, the relationship between phonological awareness and learning to read may be reciprocal. The results of their longitudinal study of 82 first grade readers supported this claim. Subjects were tested at 4 points during the year on a phoneme-blending task and phoneme-deletion and tapping tasks. Analyses of the tasks emphasized the differing cognitive demands of phoneme synthesis (phoneme blending) and phoneme analytic tasks (deletion and tapping). The results of partial time-lag correlations showed that prereaders' existing phonological skills were greatly enhanced once they had received reading instruction, and this enhancement was related to further development of word recognition skills. That is, gains in reading enable gains in phonological awareness which allow further gains in reading.

4. Overview of the three views

The relationship between phonological awareness and reading may be dependent on the nature of the task adopted. Phonological awareness is not an "all-or-none" phenomenon and the phonological tests include many levels. Rhyming seems a skill acquired very early by young children, and research shows that the child who has this skill makes better progress in reading and spelling when s/he comes to school (Bradley, 1980). Morais (1991) also claimed that formal instruction is not a necessary requirement for the development of sensitivity to rhyme. On the other hand, children are unable to isolate single phonemes before they start learning to read (Liberman *et al.*, 1977). In that case, learning to read provides explicit knowledge of the phonological structure of language. So, the acquisition of reading skill might affect the subsequent development of phonological awareness. Therefore, some phonemic segmentation ability appears to be necessary for learning to read, and some skills are acquired or improved as a result of learning to read. This suggests that phonological awareness may be both a cause and a consequence of learning to read.

Yopp (1992) concluded that "youngsters must have a certain level of phonemic awareness. Reading instruction, then, heightens their awareness of language. Thus, phonemic awareness is both a prerequisite to and a consequence of learning to read" (p.697).

It is useful to classify relevant research procedurally, as involving:

1. simultaneous correlation; or

2. longitudinal correlation; or

3. training studies.

3.2.3.2 Simultaneous correlation research

This type of research means that children were given reading tests and phonological tests at nearly the same time. A study by Liberman *et al.* (1974) showed a significant relationship between young children's ability to segment phonemes and their reading ability as measured by a word-recognition task. In Zifcak's (1977) study, phonological awareness as measured by phoneme segmentation was again found to be related to successful reading performance for the early reader. Furthermore, their relation was not affected by IQ, age or sex. Tunmer and Nesdale (1985) also examined the relationship between children's success on a phoneme-tapping task and their reading score. Their results showed a strong relationship between the children's success in the non-digraph phoneme tapping test and their reading.

3.2.3.3 Longitudinal studies

The longitudinal studies considered here all focus on the importance of phonemic awareness in early reading. A number of investigators found that there was a substantial correlation between phonological awareness scores taken before school and later reading achievement, even when IQ was controlled.

A two-year study by Stuart and Coltheart (1988) showed that early phonological awareness and letter-sound knowledge are significant predictors of subsequent reading ability. Thirty-six 4-year-old children of nursery classes were selected as subjects in their study. Several different kinds of phonological tests were adopted by Stuart and Coltheart, including a rhyme production test, a rhyme detection supply-final-syllable test, a supply-final-phoneme test, an identify-initial-phoneme test, and a segment-initial-phoneme test. Once the children entered schools, their knowledge of letter-names and of letter-sounds was repeatedly tested. They also repeatedly tested children's ability to pronounce single printed words which had been exposed in school. After the children had started school, their reading age was tested four times. In addition, they took an IQ test. The children's scores on phonological tests given in the nursery, including letter-sound scores and IQ scores, were entered into multiple regression analyses as predictors of reading age. After 9 months of schooling, it was found that only the children's IQ scores were significant predictors of reading age; after 1 year and 7 months of schooling, both IQ and pre-school phonological scores were found to be significant predictors of reading age; after 2 years and 11 months of schooling, only the children's pre-school phonological scores were significant predictors of their reading age; after 3 years and 6 months of schooling, this pattern was even more apparent. Overall, then, they found that children's phonological state is an important factor in the subsequent development of reading.

Lundberg and his colleagues (1980) chose 200 six to seven year-old kindergarten children and wanted to examine the relationship between the kindergarten child's phonological awareness and his or her progress at school a year later in learning to read. Their results showed that the children who did well in the initial tests of phonological awareness were also the ones who made most progress in learning to read at school.

In the Lundberg *et al.*'s study, there are some experimental weaknesses. For example, Bradley and Bryant (1983) thought that it was not enough for the experiment to use only one kind of educational skills test. Therefore, they tested 403 children, aged four to five years, by using longitudinal and training methods. Before the children had started to read, they gave the children three or four three-letter words, all but one of which had the same initial, middle, or final sound. Children had to say which word was the "odd man out". For example, if the words were "*pin, win, sit, fin* ", then, "*sit*" was the odd one out in terms of the final sound. There were 30 items in the test of categorizing of sounds.

Bradley and Bryant's study went on for another four years until the children had reached eight or nine years old. At the end of the project, they gave the children standardized tests of reading and spelling. They also tested the children's IQ (WISC/R) to exclude the effects of intellectual differences. In addition, a standardized mathematical test was used in the research for checking that the results were specific to reading and not to educational achievement in general. Multiple regression showed that these relationships remained strong even when the influence of intellectual level was removed.

The results indicated that the children's scores on the initial rhyming tests did predict their progress in reading four years later on. However, the children's early rhyming scores did not seem to bear any relation to their success in mathematics. Therefore, this study provided that awareness of phonology has a powerful differential influence on their eventual success in learning to read.

Juel *et al.* (1986) tested a model of early literacy acquisition with longitudinal data from 129 first-grade children progressing to second grade. It was found that there was a substantial contribution of phonemic awareness (segmentation, blending, deletion of first and last phonemes, and substitution of first and last phonemes) to word recognition and word spelling. Their results showed a weaker contribution to reading comprehension and writing in a series of multiple regression analyses after IQ and listening comprehension were controlled.

A general problem connected with the studies of phonological awareness among preschool children is the lack of control for the possible influences of early reading ability or preschool reading instruction (Lundberg & Høien, 1991). Wagner and Torgesen (1987) argued that the observed relations between kindergarten phonological awareness and first-grade reading might originate from pre-existing differences in reading skill. They calculated partial correlation coefficients between kindergarten phonological awareness measures and first-grade reading from Lundberg *et al.*'s (1980) data, with the score on the kindergarten screening test of reading held constant. The partial correlations, with kindergarten reading held constant, ranged from -.07 (n.s.) to .21 ($p<.01$), with a median of .06 (n.s.). Only two of the nine partial correlation coefficients were significant at the .05 level. This result makes the causal implications of these data ambiguous. Therefore, it is important to test pupils' reading ability at the beginning of a longitudinal study. That procedure will be adopted in Study Three of this thesis.

3.2.3.4 Effects of phonological awareness training on reading

Mattingly (1972) contended that phonological awareness can be rapidly increased by appropriate training. Many pieces of research have shown that phonological awareness can be successfully trained (Ball & Blackman, 1991; Bradley & Bryant, 1983; Hohn & Ehri, 1983; Lundberg *et al.* 1988; Marsh & Mineo, 1977, Williams, 1980). Table 3-2 summarizes the main training studies.

Table 3-2: A summary of main training studies.

Researcher	publ. year	subjects	age	period	curriculum	results
Bradley & Bryant	1983	65 children in 4 gps.	6 yrs.	40 sessions in 2 yrs.	1. gp. 1: sound category. 2. gp. 2: sound category & alphabetic letter. 3. gp.3: conceptual category. 4. gp.4: no training.	1. gp. 1 & 2 much better than gp.3 & 4 in reading. 2. gp.2 better than gp.1 in reading & spelling. 3. the differences are smaller between groups in maths test.
Cunningham	1990	1. 42 first grade children in 3 gps. 2. 42 kindergartners in 3 gps.	1. 7.2 yrs. 2. 5.9 yrs.	three session (15-20 min)per week for 10 weeks	1. metalevel gp.: phonological training & explicit discussion. 2. skill & drill gp.: only phonological training. 3. ctrl. gp.: listening stories & answering question.	1. 2 exp. gps. better than ctrl gp. in the phonological tests & reading test in both grades. 2. metalevel gp. better than skill & drill gp. in reading for the 1st grade.
Goldstein	1976	23 in exp. & ctrl. gps.	4 yrs	13 weeks	1.Exp. gp.: were taught the sound correspondence in words. 2. Ctrl. gp.: were taught the names & the order of the letters in words.	Exp. gp. better than ctrl. gp. on reading.
Lundberg *et al.*	1988	1. exp. gp.: 235 2. ctrl. gp: 155 preschool children (Danish)	6 yrs.	daily training session for 8 months	1. Exp. gp.: listening games, rhyming exercises, break up sentences into words, syllable, or phonemes. 2. Ctrl. gp.: no special treatment.	1. Exp. gp better than ctrl. gp. in rhyme & phoneme detecting tests. 2. Exp. gp. better in subsequent reading.
Vellutino & Scanlon	1987	300 normal & poor readers	8-10 yrs	½hour per day for 5 or 6 days	1. phonemic segmentation training gp. (PST). 2. response acquisition gp. (RA). 3. PST & RA. 4. 2 Ctrl. gps.	a positive effect on the word-recognition skill for both training gps.
Wallach & Wallach	1976	1. Exp. gp. 2. Ctrl. gp.	7 years old	30 weeks (half an hour per day)	1. the sound of the alphabet 2. initial sounds in words 3. oral segmentation of words, etc.	1. the exp. gp. better than the ctrl gp. 2. no difference in maths test.
Williams	1980	learning disabled children	7-12 yrs	26 weeks(20 min. per day)	intensive training on the component sounds in words	the exp. gp. did better than the ctrl. gp. in reading task

The most striking study is by Bradley and Bryant (1983). 65 children, aged six, were divided into four groups. These children were drawn from those with lower scores on sound categorization, at least two standard deviations below the mean, and they could not read when the training began.

In group one, the subjects were taught about rhyme and alliteration with a series of pictures of familiar objects. The names of all but one picture in each series had a sound in common. In group two, the first year of the study was the same as group one. In the second year, experimenters showed the children plastic letters and taught them to identify the sound which the names of the pictures had in common with a particular letter. In group three, the subjects were taught to sort the same pictures into conceptual categories. The subjects from group four received no training at all. At the end of the project, Bradley and Bryant gave children standardized tests of reading, spelling, and a mathematics test. Their results can be summarized as follows:

1. The first two groups were better readers than the ones who were only taught to put words into conceptual categories. Group two (trained with alphabetic letter as well as on sound categorization) succeeded better in reading than group one (trained on sound categorization only).
2. The improvement was quite specific to reading and spelling. The difference between the first two groups and the rest was much smaller on the mathematics test.
3. Measures of children's sensitivity to rhyme and alliteration predict their progress in reading. Teaching them about rhyme and alliteration enhances that progress.

Training effects on reading in other languages rather than English, such as Danish or Hebrew, have also been investigated by researchers. Lundberg *et al.* (1988)

explored training effects on reading in Danish and showed that preliterate children could be successfully trained in phonological awareness skills during their kindergarten year and that this training transferred to early progress in reading. They showed that there were small but significant training effects of rhyming, word and syllable-manipulation tasks, and significant phoneme-segmentation when the children were assessed on their performance in reading and spelling in their first and second grades. That is, preschool training in phonological awareness has a facilitating effect on subsequent reading and spelling acquisition. The results of Lundberg *et al.* also suggest that "phonological awareness can be developed before reading ability and independently of it" (p.282). Similarly, in Israel, Bentin (1992) showed that training phonemic segmentation in kindergarten (aged five years) for 10 weeks with hour session per week is effective in inducing the metaphonological skills required for the acquisition of reading.

To summarize, this kind of training research suggests that phonological awareness training can help to raise subsequent reading and spelling levels when it is given in an informal kindergarten setting before reading instruction begins, or as part of a more formal reading programme. However, phonological awareness training in combination with letter-sound training seems more effective than phonological awareness training alone.

3.2.3.5 Effects of reading instruction methods on phonological awareness

The development of phonological awareness should presumably be dependent on the nature of the instructional method. Some researchers (e.g., Alegria *et al.*, 1982; Liberman & Liberman, 1980) have supported this viewpoint. Their results claimed that the development of phonological awareness depends on the way people are taught to read. That is, the method of the instruction may influence the development of phonological awareness.

In the research of Alegria *et al.* (1982), for instance, the results showed that the phonic group who were taught to learn reading by a phonic method performed significantly better than the whole-word group who were taught by a whole-word method in the "phoneme reverse" task which was to reverse the order of phonemes in the utterance (e.g., to say /os/ for /so/), but no difference appeared in the "syllable reverse" task which was to reproduce the dissyllabic word or non-word with the second syllable first and the first syllable at the end (e.g., to say *dira* for *radi*). Sixty-four first grade French-speaking Belgian children were also tested in this study on two tasks: a segmentation task and a memory task. During the four months of instruction, half of them were taught through a phonic method; the other half were taught through a whole-word method. It was found that children taught by a phonic method were better than children taught by a whole-word method at reversing the phonemes of a one-syllable, two phoneme word or nonword. In other words, the "phonics" group showed a greater awareness of phonemic structure than did the "whole-word" group (60 percent correct as opposed to a mere 16 percent correct). The two groups, however, were not very different in their awareness of syllable structure (72 percent correct as opposed to 63 percent correct). Thus, differential reading instruction at the first grade level apparently has a marked effect on phonemic awareness but not on syllabic awareness. This seems plausible because the phonic method may draw more attention to the sounds of language than whole-word methods. Therefore, Alegria *et al.* concluded that the method of instruction affected phonetic awareness. That is, phonological awareness depends on the way people are taught to read.

3.2.3.6 Summary of the section

It seems fairly clear from the research discussed above that phonological awareness is important in learning to read an alphabetic system. Goswami and Bryant (1990) claimed that there is a strong link between children's awareness of rhyme and alliteration and their progress in reading. In addition, rhyme is more important than phoneme because rhyme detection ability can presage later reading, and phonemic awareness develops later than rhyme awareness.

The evidences from training studies supported that phonological awareness training can help reading ability. As Stuart and Coltheart (1988) have pointed out, phonological awareness and reading acquisition have a reciprocal interactive causal relationship. Phonological skills can play a part in the very first stage of learning to read. Reading helps the pupil to acquire phonological skills and what the reader gains in phonological awareness helps the reader to read better. Success in reading and success in phonological awareness seem to go hand in hand.

3.2.4 Research on the relationship between phonological awareness and reading in Chinese

Phonological awareness has been confirmed to be a crucial factor in reading English or other alphabetic writing systems. However, it is unknown whether phonological awareness is also an important variable in reading Chinese. No studies on the topic of phonological awareness and learning to read in Chinese have been found when this thesis was designed.

3.3 REVIEW OF VISUAL SKILLS AND READING ABILITY

Many researchers suggest that there might be two main sources of reading difficulties: linguistic and visual problems (e.g., Boder, 1973). During the last few decades research in reading seems to downplay the role of visual skills and to emphasize the linguistic processes in reading acquisition. The following review will focus on the investigation of visual skills and English reading ability. The second section will review the studies that are concerned with visual skills and Chinese reading.

3.3.1 English reading and visual skills

Earlier investigations concerned with visual skills and English reading ability were involved in the training effect of visual perception. More recently, studies focused on the topic of the visual deficits in backward readers and normal readers. The evidence comes mainly from three major kinds of studies: (a) on the effects of visual perception training, (b) on the differences in visual skills between backward and normal readers, (c) on the visual deficits in reading disability. Research in these three areas will be introduced separately.

3.3.1.1 The effects of visual perception training

A number of investigations have revealed that training in visual perception skills does not improve word recognition and reading comprehension. Rosen (1966), for example, explored the effects of a visual perception training program upon achievement in reading toward the end of first grade. In the 29-day training program, 305 normal first-graders (aged 6 years) in experimental classes received 30 minutes per day of visual perception training after subjects had been at school for one month. The training program focused upon development of the five subtests of Marianne Frostig Developmental Test of Visual Perception (DTVP): (a) visual motor co-ordination, (b) figure ground, (c) perceptual constancy, (d) position in space, (e) spatial relation. Rosen found that there was a significant training effect on the post-test of DTVP. However, the training of visual perception for the first graders did not result in significant improvements in reading scores when compared with the control group.

Similarly, a visual perceptual training program was conducted by Cohen (1966) to examine the hypothesis that the visual perceptual training could produce significant gains in visual perception and reading progress in first grade children with visual perception retardation who received the low scores on Winterhaven Perceptual Forms Test. These 73 children received 20 minute daily training sessions in visual perception which was based on the Frostig Training Program for 10 weeks. There was no special activity for the 82 subjects in the control group who were matched for social economic level and the score of visual perception. After 10 weeks of training, the Winterhaven Perceptual Test and the Harsh-Soeberg Survey of Reading Development post-tests were administered. The experimental groups gained significantly more in visual skills than did the control group. Nevertheless, the reading score of the control group was higher than the experimental group. Cohen noted that subjects in the experimental group were trained in visual perception and lacked follow-up in their daily reading work, whereas the control group spent the same amount of time on reading work. Obviously, the weakness in the investigation was the failure to provide reading instruction as nearly alike for the experimental and control groups.

Buckland (1969) presented some evidence concerning the effect of visual perception training on reading achievement in first-grade children who scored below C or below on the Metropolitan Readiness Test and in the lower half of their class in 'reading readiness' and achievement as defined by teacher ranking. Subjects were randomly assigned by sex to control or experimental groups. The pre-test score differences of the Metropolitan Readiness Test and DTVP were non-significant between the two groups. The experimental group received the Frostig training program for 15 minutes per day for forty consecutive school days, while the control group listened to, and talked about, taped stories. At the end of the experimental period, the experimental group did not make any significant gains on a word recognition test compared with the control group.

An overview of the above investigations revealed that visual perception abilities may be improved by the visual perception training program, but no significant progress in reading abilities was found among the trained group.

3.3.1.2 The differences in visual skills between backward and normal readers

3.3.1.2.1 Recognizing visual patterns

Bradley (1980, 1983) investigated the detection of visual similarities and differences in the written words between the backward readers (aged 10 years and 4 months) and the younger normal readers (aged 6 years and 10 months) with similar reading age (7 years). Children were asked to select the odd one out of four words which were presented written on a card. In the test, three of the words had a letter in common which the fourth did not share. There was no significant difference between the backward and normal readers to detect visual similarities and differences in written words.

3.3.1.2.2 Remembering visual patterns

Bradley and Bryant (1981) tested the backward readers and normal readers in a visual memory task. There were three groups in their study: backward readers with 18 months or more behind the average reading ability for their age; younger normal children who were matched at the same level as the backward readers; normal children with the same age as the backward readers. The child was shown a word per trial that was printed on a card for 5 seconds, and was asked to reproduce it using letters that were printed on small cards. Their results revealed that even though the backward readers did not perform as efficiently as the younger normal readers did, the number of words constructed correctly by the backward readers and the younger normal readers did not differ. More importantly, the normal group with the same age as the backward readers made no errors at all and was significantly better than that of the backward readers.

It is worth noting that the visual memory task in their research involved real words and letters. In fact, the ability to perform the task might be influenced by the subject's linguistic skills, not pure visual skills. Therefore, it was not surprising to find a significant correlation between visual memory and Neale reading score in both backward readers and younger normal readers.

3.3.1.2.3 Visual motor ability

Malatesha (1986) investigated the visual motor ability in the normal readers and disabled readers. The subjects were matched by age (from 7 years 8 months to 9 years), sex and IQ. Children were given the Bender Visual-Motor Gestalt Test in which children should copy nine two-dimensional geometric designs. A significant difference between the disabled readers and normal readers on the Bender Visual-Motor Gestalt Test was found.

3.3.1.2.4 Visual perceptual memory

De Jong (1989) explored the differences in the visual and auditory perceptual short-term memory between dyslexics and normal readers. In this study, dyslexic was defined as the reading age two or more years below grade level with average intelligence. The results showed that disabled and normal readers did not differ significantly in any of the visual measures, except for the short-term memory condition of the visual letters test which of course contained an auditory, phonological recoding component.

3.3.1.2.5 Visual paired associates learning

Vellutino *et al.* (1975) revealed that retarded readers performed as well as normal children in the task of Visual paired association learning. Goyen and Lyle (1971) also examined the differences between poor and normal readers (aged 6 to 7 years) on visual paired associates learning in which the stimuli were pairs of geometrical shapes. Subjects were required to learn which two shapes went together. They found that there were no differences between two groups in the performance of visual paired associates learning.

From the review of the differences in visual skills between backward readers and normal readers, it is widely found that disabled and normal readers did not differ significantly in the majority of visual measures.

3.3.1.3 Visual deficits in reading disability

A number of studies claimed that visual problems are regarded as the cause of developmental dyslexia. The argument that visual problems cause reading retardation was firstly proposed by Hinshelwood in 1895 and Orton in 1937 (mentioned by Hulme, 1988). Frostig (1968) also suggests that a child who is deficient in visual abilities is likely to be handicapped in all academic subjects, but the difficulties will probably be most apparent in progress in reading. However, some researchers (e.g., Hulme, 1988; Vellutino, 1979) claimed that visual problems are not a cause of their reading problems for the majority of dyslexics.

Lovegrove *et al.* (1986) suggested that low-level impairments in the transient visual system may be a cause of reading retardation. According to Breitmeyer and Ganz's (1976) viewpoint, there are two complementary subsystems in the visual system: one is the *sustained* which is primarily involved in information extraction during fixations; the other is the *transient* which has a major role in guiding eye movements. Lovegrove *et al.* argued that some disabled readers have an insensitivity in the transient system although their sustained system appears to function normally. However, Hulme (1988) does not support the hypothesis of visual processing deficits among developmental dyslexics. He argued that cases of visual deficits causing reading problems are extremely rare and atypical, and that most retarded readers have difficulties in phonological awareness.

Goulandris and Snowling (1991) reported a case study in developmental dyslexic whose reading difficulties were accompanied by significant visual memory deficits although phonological processing was relatively good. In the Visual Recognition subtest of British Ability Scales, the subject was required to look at a geometric shape for 5 seconds and then to choose the same one from a selection of 6-8 alternatives. The subject only performed 4 out of 8 items correctly, with equivalence of the age of 7 years 9 months and 7 years 11 months. The performance was relatively low for her age (22 year-old). In addition, she was also extremely poor in other visual processing tests (e.g., Benton Visual Retention Test, British Ability Scales Test of Recall of Designs) which require visual memory and visual recognition. Thus, it is obvious that the subject's reading problems were accompanied by a severe deficit in visual memory.

In summary, the results from those investigations which tested the hypothesis that the visual deficit causes reading ability seems contradictory and inconsistent.

3.3.2 Chinese reading and visual skills

Little attention has been paid over the last two decades to the relationship between visual skills and reading acquisition in Chinese. There are two investigations that focused on the relationship between the visual perception and reading ability.

In the investigation by Woo and Hoosain (1984), 13 dyslexic Chinese boys (aged from 7 years 10 months to 9 years 11 months) were compared to a control group of age-matched boys of normal reading ability in the following tests: a Chinese character recognition test, a Chinese version of the Frostig Developmental Test of Visual Perception, the Auditory Association subtest of the Illinois Test of Psycholinguistic Abilities, and a digit span test. Dyslexic subjects made more visual-distractor errors (when targets were mixed with similar looking characters) in character recognition but no more phonological-distractor errors (when targets were mixed with similar sounding characters) than the controls. There was a significant difference in all of the five subtests of the Frostig Test between these two groups, but there was no significant difference in either of the two auditory tests. The results indicated the importance of visual processing in the reading of Chinese and suggested that it may be the primary factor in dyslexia among Chinese children. However, it should be noted that the Chinese recognition test is more like a verbal memory test. In their study, the stimulus list in the test was presented by a slide projector for five seconds and then subjects were required to circle those characters in the printed response list which had been appeared in the stimulus list.

Ho (1989) investigated visual ability among good and poor readers of Chinese. Forty second graders (aged 7 years and 11 months) were divided into high and low reading groups based on their scores in a word recognition test and a sentence comprehension test. The subjects were given two visual ability tests: the Abstract Design Comparison Test and the Abstract Design Recognition Test. The former was based on modification of the patterns in the Recall of Designs and Visual Recognition Subtests of the British Ability Scales. There were three abstract designs displayed in different orientations in each item, with two identical designs and one similar design which was different from the other two in terms of change in position of parts, addition or omission of lines, etc. The latter visual test in her study was also modified from some of the patterns in the Recall of Designs and Visual Recognition Subtests of the British Abilities Scales. The target designs were displayed by a overhead projector and subjects chose their answers from a booklet of designs in which each choice in every item was a design similar to the target but with the addition, omission or reversal of parts. The good readers and poor readers did not differ in tests of visual abilities.

These two studies have yielded conflicting results in visual skills and reading ability in Chinese. The phenomenon implies that the issue of the relation between visual skills and reading abilities seems still an open one and needs further exploration.

CHAPTER FOUR

TEST MATERIALS

This chapter describes the main test materials used in this thesis. Most of the tests were used in the U.K., Taiwan and Hong Kong, with only minor differences between the English and Chinese versions of tests and between these three different studies. Any differences will be mentioned in the appropriate place in subsequent chapters.

Five different kinds of test materials were utilised in this research. They are separately explained as follows (abbreviations are displayed in parentheses):

4.1 READING TESTS

There were two different types of reading test used in this thesis. One was the Schonell Reading Test, R1, which was used in Britain and Hong Kong; the other one was the Chinese Character Recognition Test, used in Hong Kong and Taiwan.

4.1.1 English Reading Test (ER): Schonell Graded Word Reading Test

The Schonell Graded Word Reading Test is one of the most popular reading tests in the U.K.. In addition, the testing procedure is easy and brief, with high reliability and validity. Although the test is quite old, it is still widely used by researchers (e.g., Bradley & Bryant, 1983; Bryant *et al.*, 1990; Hanley *et al.*, 1992; Kay & Lesser, 1985; Raz & Bryant, 1990).

4.1.1.1 Description

This is an attainment test of reading which entails the selection of a scientific sample of words of increasing difficulty, and which gives an accurate estimate of a pupil's word recognition ability, making it possible to calculate a reading age. The number of words used is one hundred, divided into ten age groups. That is ten words per group from ages five to thirteen and ten words for the two ages of fourteen and fifteen.

These words were selected from 300 words administered individually to approximately 60 children in each of ten age groups. The easiest word was read correctly by 55 per cent of the five-year-old children, the most difficult word by 45 per cent of the fourteen and fifteen year-old children (McCulloch, 1965).

The word recognition test allows the teacher, in a single test, to get a quick and reasonably accurate picture of a child's general reading ability in relation to that of other children. The Schonell Reading Test is shown in the Appendix A.

4.1.1.2 Administration

The test was carried out in a quiet, friendly and cooperative atmosphere. The printed form of the test was placed in front of the child and the examiner recorded the responses on a separate sheet.

Subjects were required to read out a series of words. The tester said:" I have a lot of words here and I want to see how many you can read. The first words are fairly easy and then they get a little harder. Now, let me see how many you can read. Please read across the page". If the subject was nervous and apprehensive, the procedure adopted was to talk to the pupil for a little while. The testing took about 5 to 6 minutes per subject.

According to the test manual, young subjects under 9 year-old should start the test from the beginning. Thus, in the research, the subjects who were eight years old were asked to start from the beginning of the test. Subjects were not hurried, and self-corrections were counted as correct.

The usual pronunciation of words was accepted and guessing was not discouraged. Testing was continued until 10 consecutive words were failed.

4.1.1.3 Scoring

The score is the total numbers of words correctly read. The maximum is 100 and the minimum is 0.

4.1.1.4 Norm and reliability

The norm of the test was established by Geoffrey Bookbinder, based on the testing of 10,000 children between six and three quarters and eleven and three quarters in Salford and then adjusted to the national norm. The revised norm of the Schonell Reading Test is 34 words read correctly for the reading age of 8.3 year-old children and the reliability coefficient on retest of groups of children was .96 (Schonell and Goodacre, 1974, p.211-215).

Norms are different from one nation to another in the test. Therefore, the raw score was used in this thesis.

4.1.2 Chinese Reading test (CR): Chinese Characters Recognition Test

The difficulty of the Schonell words in English is dissimilar to that of the words in Chinese. For example, 'grotesque' is one of the most difficult words in English. However, '奇怪的' ('grotesque' in Chinese) is an easy word for young children. It is impossible to find a word which is the same in degree of difficulty as 'grotesque' and has the same meaning. Furthermore, when a word in the Schonell reading test was translated into Chinese, it often contained two or three Chinese characters, not merely one character. At the beginning, when I translated the Schonell Reading test into Chinese and pretested ten 8-year-old Chinese pupils in Taiwan, the results showed that the score was too high, mean= 85.6 (out of 100). Accordingly, it is not very appropriate simply to translate the Schonell Reading Test into Chinese.

It seemed necessary to compile a new Chinese Character Recognition Test (as shown in the Appendix B). The following is the introduction of this test:

4.1.2.1 Description

The test was designed by the author. The principle of compilation was to follow the Schonell Reading Test as closely as possible in order to avoid huge differences between the English Reading and Chinese Reading tests. Therefore the number of words and the procedure of testing were kept as similar as possible.

One hundred Chinese words in the test were selected from a book called 'The High Frequency Words Used in Chinese Elementary School Reading Materials' which was edited by the National Institute for Compilation and Translation (1967) in the Republic of China. This book is comprehensive and is the official publication of word frequency. It has been used by many researchers (Chen & Juola, 1982; Hue *et al.* 1990) interested in Chinese reading. The National Institute for Compilation and Translation collected and counted the frequency of 753,940 words selected from six different kinds of reading material: newspapers, textbooks of elementary schools, children's reading, extra-course reading, radio scripts and reading materials for the public. This book included 4,864 frequent words which were arranged according to their frequency of appearance in general reading materials. We divided these 4,864 frequent words into ten degrees of difficulty and randomly chose ten words (randomly) from each degree. Hence, one hundred words in total were selected for the test. They were arranged with 10 words per line and in sequence depending on their difficulty.

4.1.2.2 Administration

The testing took place in a calm, quiet atmosphere. The material was placed squarely in front of the subject. Then, the examiner told the subject:" I have a lot of words here and I want to see how many you can read. Please read across the pages now and from the first line read out the words that you can recognise" (in Chinese). Self correction was counted as correct in this test. Credit was given if the word was clearly and correctly read out. Following the procedure of the English reading test, the testing was stopped when the subject got ten consecutive words wrong in the test process. It took 5 to 6 minutes for a subject to complete this test.

4.1.2.3 Scoring

The examiner privately recorded the responses on a separate sheet, by ticking the right side of a word read correctly and by putting a dot on the right side of a word read wrongly. The maximum possible score was 100 and the minimum was 0.

4.1.2.4 Reliability

The coefficient of stability was used to present the reliability of this test by the author. Those 45 children, aged between eight and nine from Ming-Sheng Primary School located in Chung-Hua city of Taiwan, were given the test. Subsequently, those same children were retested after 4 weeks. The coefficient of reliability is .94 ($p<.001$).

4.2 Visual skills tests

Two visual skills tests were used in this investigation. It is important to note that the materials were exactly the same when the tests were administered in the U.K., Hong Kong and Taiwan.

One major issue concerned the choice of visual skills tests. Originally, the "Visual Form Discrimination" and the "Visual Recognition Test" were selected for a pretest. The Visual Recognition Test is a subtest of British Ability Scales which was designed by Elliott *et al.* (1978). This test consists of 17 items and 2 trials. Subjects were shown trial 1 and asked to look at the picture for 5 seconds. They were asked then to find the same picture from several choices on the next page. Because a ceiling effect was found on the "Visual Recognition Test" in the pre-test, the "Visual Paired Associates" was chosen to replace the "Visual Recognition Test". The reason why I chose these two tests was that the tests were very reliable on the pre-test (see Chapter Five) and turned out to be of appropriate difficulty for children of the same age as those tested in this thesis.

4.2.1 Visual Form Discrimination (VFD)

4.2.1.1 Description

The test was designed by A.L. Benton *et al.* in 1983 as a brief, convenient procedure to assess the capacity for complex visual form discrimination. It comprises sixteen items covering a fairly broad range in terms of difficulty. One item of the test is shown in Fig. 4-1.

Each multiple-choice item includes four situations:

1. the correct foil.

2. the incorrect foil involving displacement or rotation of the peripheral figure which is a minor one in each item.

3. an incorrect foil involving rotation of a major figure.

4. an incorrect foil involving distortion of the other major figure.

4.2.1.2 Administration

Two demonstration items A and B were presented to subjects, with the multiple-choice card lying flat on the table and a stimulus figure positioned at about 45 degrees to facilitate inspection. In this test, the stimulus and the multiple-choice response array were presented simultaneously. The examiner pointed to the stimulus design and said:" See this design? Find it among these four designs. Which one is it? Show me." Subjects had to discriminate among the response choices in order to identify the same one as the stimulus design.

If the subject responded correctly, then the examiner proceeded to demonstration item "B". If s/he again succeeded, then the experimenter went on to the test; if the subject failed in the demonstration item, the examiner showed him/her the correct foil and pointed out the difference between it and the one s/he has chosen.

There was no time limit for the administration of the test. However, if no response was given after 30 seconds, the subject was encouraged to make his/her decision through hearing the question repeated.

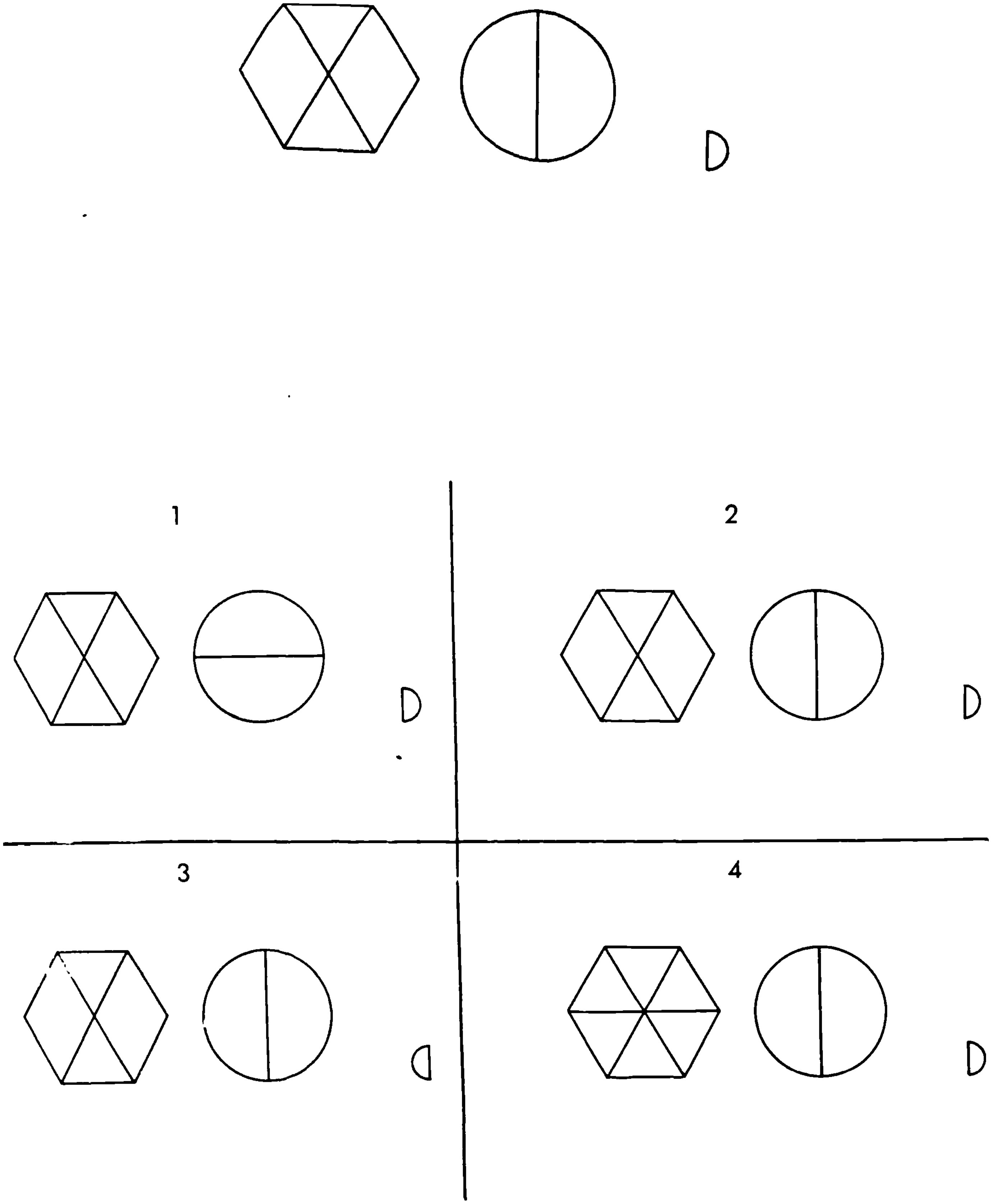


Fig. 4-1: An example of Visual Form Discrimination.

1= rotation of major figure; 2= correct foil; 3= rotation of peripheral figure; 4= distortion of other major figure.

4.2.1.3 Scoring

The scoring system consists of crediting each correct response with 2 points and each peripheral error response with 1 point. Major rotations, major distortions and the " no-response" error were given 0 credit (Benton *et al.*, 1983, P.57). Thus, the maximum possible score is 32 and a score of 12 would correspond to a chance level of performance.

4.2.1.4 Norm

In research by Benton *et al.* (1983), the mean for 85 normal subjects (ranging in age from 19 to 74 years) was 29.3-30.8 (out of 32). Therefore, a majority of subjects had perfect or near perfect scores. Scores of 26 or higher were achieved by 95% of the group. No normative data were available for children.

4.2.2 Visual Paired Associates (VPA)

4.2.2.1 Description

The Visual Paired Associates, which is a subtest of Wechsler Memory Scale-Revised (WMS-R), requires the subject to learn the colour associated with each of six abstract line drawings. The test materials include one stimulus booklet, which contains two demonstration items, six sets of materials, and colour folder A and B. The six sets of materials are the same, but only in a different order. In the design of Visual Paired Associates, using six sets of presentations ensures that nearly all non-impaired examinees learn the material to the criterion of one perfect repetition. Because there were no impaired examinees in this thesis and the manual suggests using the first three sets, the first 3 sets were used to test the subjects. Fig. 4-2 displays an example of the test.

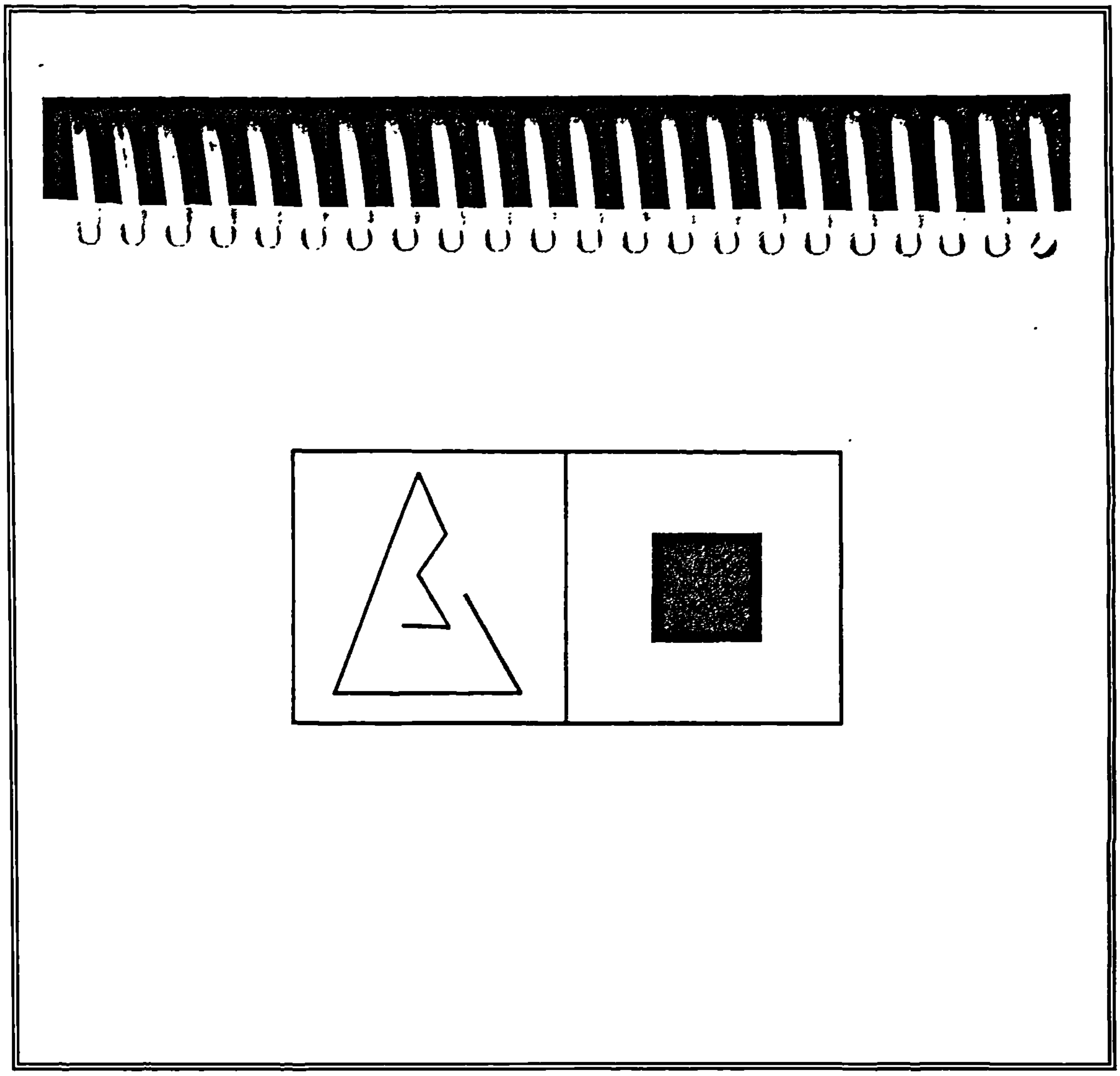


Fig. 4-2: An example of Visual Paired Associates.

4.2.2.2 Administration

At first, the examiner explained the two tasks:" I am going to show you some figures, each one paired with a different colour. As you look at the figures, try to remember the colour that goes with each figure. After I have shown you the figures with their colours, I will ask you to point to the right colour in the folder", and opened the spiral bound booklet in front of the subject to expose the first demonstration card. Then, the examiner said:" This figure here goes with this colour", and turned over the second demonstration card with the same introduction as that of the first demonstration. After that, the experimenter turned over the third card and said:" now, look at this figure: it has no colour square with it. Try to remember what colour goes with it.". Then, the examiner opened folder A and said "look at these colours and point to the one that goes with the figure....". In order to minimize the role of verbal mediation in memorizing and responding to the figure-colour pairs, the colour names were not used either in presenting the items or in responding to them.

The subject had 5 seconds to point. If the response was not given in 5 seconds, encouragement was provided. The fourth card was asked with the same procedure. During the demonstration and testing, the correct response was indicated to the subject.

After the demonstration, the experimenter replaced folder A with folder B and proceeded to the first set of six cards at the rate of one pair every 5 seconds. In general, the exposure time is 3 seconds. Since, however, the subjects in this study were young children not adults, the exposure time for them was adjusted to 5 seconds. There was also an interval of 5 seconds between exposures of the figures. After exposing the last figure in the first set, the experimenter told the subject:"Now, let us try once more. Here is the same figure paired with the same colours, only in a different order." The second and third sets were presented in the same manner as before.

4.2.2.3 Scoring

The examiner recorded the subject's responses in the appropriate spaces on the record forms and scored one point for each correct response. The total score was based on the first three sets. Accordingly, the maximum score is 18.

4.2.2.4 Norm and reliability

The sample for the WMS-R was designed to represent the normal population of the United States between the ages of 16 years 0 months and 74 years 11 months. Unfortunately, there are no norms for young children.

Table 4-1 shows the means and standard deviations of the standardization sample (Wechsler, 1987, p.52):

Table 4-1: Means and standard deviations of Visual Paired Associates.

Age	16-17	20-24	35-44	55-64	65-69	70-74
N	53	50	54	54	55	50
Mean	15.7	15.3	14.8	11.2	10.2	8.4
SD	2.7	3.0	3.7	4.3	4.2	4.3

In WMS-R test, test-retest (stability) coefficients were used as reliability estimates for five of the subtests which consist of Visual Paired Associates; internal consistency estimates were presented for the remaining seven subtests. The reliability data were obtained by administering the WMS-R twice to members of the standardization sample in 3 different age groups. The time period between the two administrations ranged from four to six weeks. The reliability is shown in Table 4-2 (Wechsler, 1987, pp. 59-61):

Table 4-2: Reliability of Visual Paired Associates.

Age	20-24	55-64	70-74
N	48	53	50
Stability coefficient	.52	.52	.68

4.3 IQ TEST (IQ)

Coloured Progressive Matrices is a non-verbal IQ test used in the U.K., Hong Kong, and Taiwan. Spearman and Jones (1950, p.70) regarded the Progressive Matrices as a non-verbal test of "g", "the best of all non-verbal tests of 'g'". Moreover, the test is widely used in the reading research literature as an indicator of non-verbal intelligence (Stanovich *et al.*, 1984; Gathercole *et al.*, 1991). Court (1991) also claims that the test was recognised as culture-fair. In fact, it is preferable to use a non-verbal test in a cross-cultural study because such a test is less strongly affected by social and cultural differences.

4.3.1 Description

The Coloured Progressive Matrices covers an age range of 5:6 to 11 years, and may be given individually or in groups. It is untimed and is a non-reading test. The Matrices provides a rough and ready guide to 'intelligence'. The manual suggests that it should be used in conjunction with a vocabulary test. The thirty-six problems are designed to assess, as accurately as possible, mental development up to intellectual maturity (Raven, 1956, p.3).

4.3.2 Administration

In this test, each problem is printed on a brightly-coloured background. The test can be presented in the form of boards and movable pieces, or as illustrations printed in a book. It has been found that for the majority of routine purposes, the book and board forms of the test give practically the same results. For the convenience of testing in the various countries, this study used the book form.

In the book form of the test, a stimulus and six choices are put on the same page. Fig. 4-3 shows an example of the test. During the test, the examiner opened the book to the first illustration (A1) and said:"Look at this, (pointing to the upper figure), it's a pattern with a piece cut out of it. Each of these pieces (pointing to each in turn) is the right shape to fit the space, but only one of them is the right pattern. Point to the piece which is exactly right." If a child did not point to the right piece, the examiner continued the explanation until the nature of the problem to be solved was clearly grasped. Then, the examiner proceeded the same way to ask another question. The child's attention was guided to the matrix to be completed. The subject was warned that only one of the pieces shown below was right and asked to look carefully at each piece.

4.3.3 Scoring

If a subject answered each item correctly, one point was given. The maximum score is thirty-six.

4.3.4 Norm and reliability

For children under 7 years of age, the test showed a retest reliability of .65, and a correlation of about .50 with both the Crichton Vocabulary Scale and with the Terman Merrill Scale Form L. By the age of 9, the re-test reliability of the test has been found to increase to .80. In Taiwan, the test-retest reliability is .95 when testing 50 children at 30 days interval. The split-half reliability is .92 (Liu, 1977). On this evidence, it can be safely said that the test has high reliability.

— A —

A 1

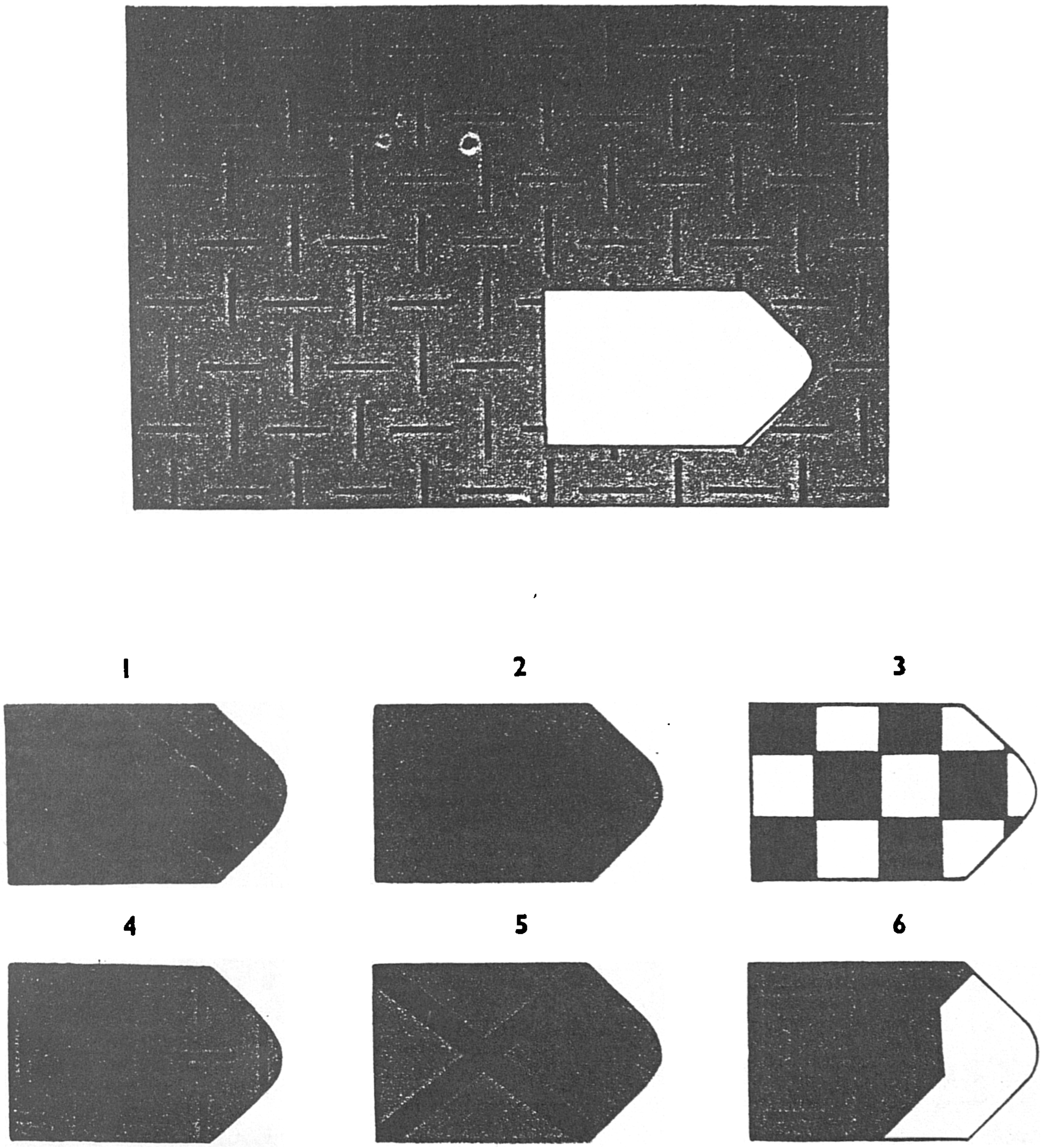


Fig. 4-3: An example of the Coloured Progressive Matrices.

In a study by Raven (1956), 608 Dumfries school children who were aged between 5 and 11:6 were tested. The mean score was 18 in the eight-year-old group; 20 in the group of children aged eight years and six months.

4.4 VOCABULARY TEST

British Picture Vocabulary Scale (BPVS, short form) was used as a vocabulary test. It was translated into Chinese when testing in Taiwan.

4.4.1 Description

BPVS, developed in Great Britain by Dunn, Dunn, and Whetton (1982), was designed as a measure of subjects' "g" intelligence-vocabulary which is an achievement test.

The BPVS is based on the Peabody Picture Vocabulary Test-Revised(PPVT-R) which is well established and generally accepted in the United States for educational, clinical and research purposes (Dunn *et al.*, 1982). The test was used in this research because it is a well known English vocabulary test and convenient to administer. In the test, children are asked to identify, by pointing, which of four pictures corresponds to the word spoken by the test administrator. The test is graded in difficulty.

4.4.2 Administration

The test was given in a quiet room away from other people. The examiner and the subject were seated at the corner of a desk or table from each other. The easel containing the series of plates was placed so that the subject could see only the plate being considered.

In this test, training plates, C, D, E, and F were used, the examiner introduced the test until the subject had responded correctly to three consecutive words without help. In the Fig. 4-4, for example, the experimenter said:" I have some pictures to show you. There are four pictures on this page. Each of them is numbered. I'll say a word, then you point to the picture which best shows the meaning of the word. Let's try one, put your finger on 'swing'." The subject was then required to point to the No.3 picture. If the subject chose the wrong illustration on any training plate, the examiner would give the correct choice and explain why it was correct.

To confront subjects with very hard or very easy items would be of little use and might well invalidate the results, therefore, only those items within, or close to, the subject's critical range are administered (Dunn *et al.*, 1982). Starting points for subjects thought to be of around average ability are given on the left of the item numbers on the individual test record. For eight-year-old children, the starting point is from the fifth item. The starting points were derived conservatively so that the majority of individuals would obtain a basal, which is six consecutive correct responses, without having to work backwards. That is, if 6 or more consecutive correct responses have been made, a basal has been established. However, when the subject has not made 6 consecutive correct responses before the first error, the subject will drop back to take the word below the starting point.

Sometimes, the starting points may be considered inappropriate and subjects may be started from an earlier item. The test is continued until the subject reaches a ceiling of 4 errors in six consecutive responses. The last item was presented as the ceiling item. Praise was given generously, even when an incorrect response was made. However, if a subject asked about the correctness of an answer, whether it was right or wrong, the experimenter gave an ambiguous, non-committal response.

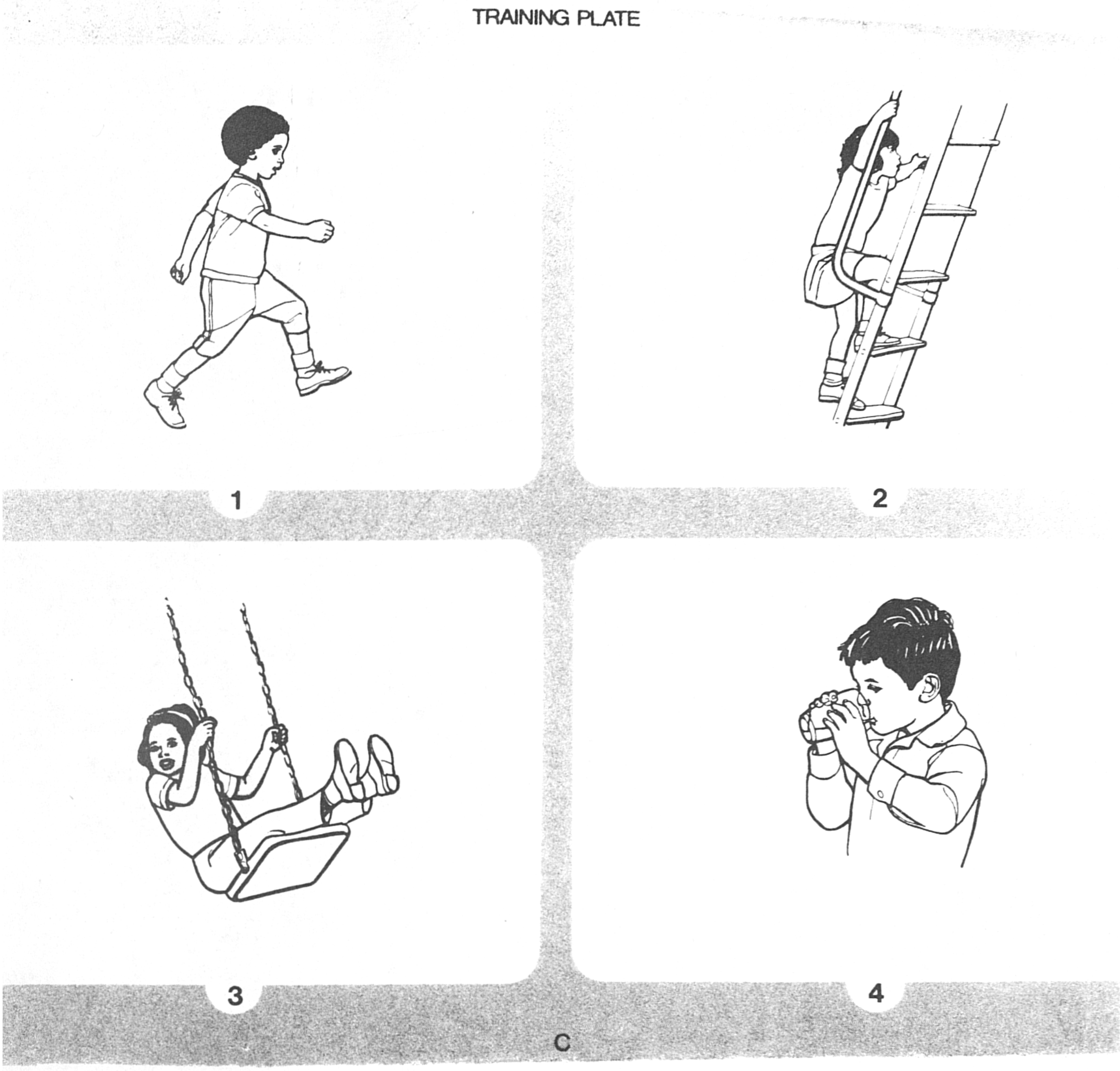


Fig. 4-4: An example of British Picture Vocabulary Scale.

The subject is asked to point which one is 'swing', Number 3 is the correct answer.

4.4.3 Scoring

The experimenter recorded the subject's response (1, 2, 3, 4, or NR-no response) for each item administered in the appropriate space on the individual test record form. When an error was made, the examiner drew an oblique line through the symbol at the end of the line. The total score is obtained by subtracting the number of errors over the critical range from the number of the ceiling item. Table 4-3 demonstrates an example of BPVS record form.

In this form, the testing began from item 5, and tested forward to establish a basal. Then, testing was continued until a ceiling was reached. The ceiling item is 22 and the total errors are 6 in this example. Therefore, the score is 16 (22-6=16). The raw scores were used in the analyses reported in this thesis.

Table 4-3: British Picture Vocabulary Scale record form.

	Plate No.	Word	Key	Response	Errors*	
2-6	1	bucket	(1)			
	2	ball	(4)			
	3	car	(2)			
	4	wooden	(2)			
7-9	5	camera	(4)	4		← starting point
	6	envelope	(2)	2		basal: 6 consecutive correct responses (items 5–10)
	7	circle	(4)	4		
	8	furniture	(3)	3		
	9	nostril	(1)	1		
10-13	10	dangerous	(2)	2		
	11	furious	(1)	3	/	← first error
	12	athlete	(3)	3		
	13	artist	(3)	2	/	
14-18	14	weary	(3)	3		
	15	socket	(1)	1		
	16	antler	(3)	3		
	17	pulley	(4)	3	/	ceiling: 4 errors in 6 consecutive responses (items 17–22)
	18	inflated	(3)	4	/	
	19	assisting	(1)	1		
	20	collision	(4)	4		
	21	floral	(1)	2	/	
	22	goblet	(3)	4	/	← last item administered
	23	utensil	(2)			
	24	talon	(3)			
	25	confiding	(3)			
	26	inoculation	(1)			
	27	consuming	(4)			
	28	gable	(4)			
	29	apparition	(2)			
	30	emission	(3)			
	31	ambulation	(2)			
	32	saltation	(4)			

Calculating Raw Score

Ceiling item	22
minus errors	6
Raw score	16

*To record errors, make oblique strokes through the ... figures. Every sixth figure ... to ease the determination of the basal or ceiling.

4.5 PHONOLOGICAL AWARENESS TESTS (See the Appendix C)

The phonological tests are designed to test children's rhyme and alliteration ability as well as phoneme deletion skill. They consisted of two main parts:

4.5.1 Odd Man Out tests

The Odd Man Out Tests assessed the ability to recognize rhyme and alliteration in spoken words. Rhyming is a skill acquired very early by young children, and much research has shown that English children who have this skill when they come to school make better progress in reading and spelling.

4.5.1.1 Description

Three versions of the test were used: English Word Odd Man Out test (**EOMO**), Chinese Word Odd Man Out test (**CWOMO**) and Chinese Non-word Odd Man Out test (**CNOMO**). Chinese Word and Non-word Odd Man Out Tests were created by the author for this thesis. In addition, Bryant and Bradley's oddity test (1985) was employed as an English Word Odd Man Out Test. All of the words in both of EOMO and CWOMO are real words and those words in CNOMO are non-words in Chinese Mandarin. It is worth noting that all of the Chinese words and non-words in CWOMO and CNOMO are in the first tone in order to avoid the confusion of different tones. As mentioned in Chapter Two, there are four different tones in Chinese Mandarin. If these tests had included different tones, subjects' responses might have been affected. Therefore, the tests used words in the first tone only.

Each test version includes three parts: one is **first** sound difference; one is **middle** sound difference; the other is **last** sound difference. Each of them contains two practice trials and ten experimental trials. In one section, the child hears four one-syllable words and has to indicate which is the odd word out in terms of its first sound. In the next section, the decision is similar but concerns the middle sound, and in the remaining section, the decision concerns the final sound. The position of the odd word varied systematically in all three series.

4.5.1.2 Administration

The experimenter said four words and asked the subject to detect which word was different from the other three words in the first (middle or last) sound. During testing, the examiner always inconspicuously screened his/her mouth from the child. Therefore, the shape of his/her mouth did not provide any extra cue for the subject. In addition, each word was pronounced with equal emphasis at about two second intervals. When the subject asked, the experimenter could repeat the four words but only if the child had not given an answer. Feedback was not provided during the experimental trials.

In the English version, for example, the examiner said four words: 'rot', 'rod', 'rock', 'box', then the subject was required to answer which one is different in the first sound. In this case, 'box' was the odd one. In the Chinese version, the tester also asked the child to find out which one of four words was the odd one out in the first (middle or last) sound. With the items 'ba', 'bo', 'fei', 'be', for example, 'fei' is the different one in terms of the first sound. Some examples are shown in Table 4-4 and full details are displayed in the Appendix C.

4.5.1.3 Scoring

To record the child's reply to each item, the examiner circled the word s/he gave as being the 'odd word out' on the record sheet. At the end of the test, the total number of correct responses was given in each condition. That is, the maximum score is 10 for each condition and the total score for each version is 30.

Table 4-4: Examples of Odd Man Out Tests

a. English Word Odd Man Out

First *sound difference*	***Last*** *sound difference*	***Middle*** *sound diff.*
rot rod rock box	fan cat hat mat	mop hop tap lop
bud bun bus rug	pin win sit fin	lot cot pot hat

b. Chinese Word Odd Man Out

First *sound difference*	***Last*** *sound difference*	***Middle*** *sound diff.*
ba bo bei pao	jia qia bian xia	liang guang jiang qiang
fu mei mai mo	xie jiang qiang liang	dian xuan juan quan

c. Chinese Non-word Odd Man Out

First *sound difference*	***Last*** *sound difference*	***Middle*** *sound diff.*
ra ro chei rai	rai de te le	fian buan puan muan
fao te to ten	be len pe me	düan muan tüan nüan

4.5.1.4 Norm and reliability

Bradley (1980) tested 368 eight-year-old children. The norms for the test are given in Table 4-5:

Table 4-5: Norms of English Odd Man Out Test.

Position	Mean No. correct	SD	Max.
First sound	8.79	1.63	10
Middle sound	8.68	1.73	10
Last sound	8.97	1.61	10

4.5.2 Phoneme deletion tests

4.5.2.1 Description

The test asks subjects to work out what particular words would sound like if they lost a specific phoneme. The English Phoneme Deletion test (**EPD**) and Chinese Phoneme Deletion test (**CPD**) consist of two sections. One section requires the child to delete the first phoneme of a word; the other is to delete the last phoneme. In the English Phoneme Deletion test, there are two different types: CCVC and CVCC (C stands for a consonant; V stands for a vowel), in both the first phoneme deletion and the last phoneme deletion. Each list has ten experimental items and two practice items. Thus, there are 40 items in the English Phoneme Deletion test and 20 items in the Chinese Phoneme Deletion. It is worth noting that all of these words are real words in both English and Chinese Phoneme Deletion tests. Table 4-6 presents some examples from the Phoneme Deletion Tests.

Table 4-6: Examples of Phoneme Deletion Test.

English Phoneme Deletion Test	
deletion:end sound	
CVC(C) TYPE	CCVC(C) TYPE
1.farm-----far	1.start-----star
2.tent-----ten	2.whom------who
deletion:first sound	
CVC(C) TYPE	CCVC(C) TYPE
1.bus------us	1.stop-------top
2.cat------at	2.spin-------pin
Chinese Phoneme Deletion Test	
deletion:end sound	*deletion:first sound*
1. xia [çia]----xi [çi]	1. fan [fan]----an [an]
2. ua [ua]-----u [u]	2. tang [taŋ]---ang [aŋ]

4.5.2.2 Administration

The experimenter said a word and then told the child the sound that had to be deleted, the child was required to remove the first sound (or the last sound) from the word. (e.g., 'stop' becomes 'top'). The examiner asked the subject :"Now, I will say some words. Tell me what word is left when you take away the first sound. For example, if I say 'pink', then you take away the first sound 'p', 'ink' is left".

4.5.2.3 Scoring

The score of each condition is the total number of correct responses. Hence, the maximum for each subtest is 10. The total score of English Phoneme Deletion is 40 and the maximum score of Chinese Phoneme Deletion is 20.

4.6 CHAPTER SUMMARY

In conclusion, the test materials used in Study One, Study Two, and Study Three are summarized in Table 4-7.

Table 4-7: A summary of the test materials.

Test materials	**Reading**	**Visual skills**	**IQ**	**Vocabulary**	**Phonological tests**
STUDY ONE					
U.K.	Schonell reading test	1.Visual Form Discrimination 2.Visual Paired Associates	Coloured Progressive Matrices	BPVS	1.Eng. Odd Man Out 2.Eng. Pho. Del. 3.Chi.Non-word Odd Man Out
Taiwan	Chinese reading test	(same as above)	(same as above)	(same as above)	1.Chi. Non-word Odd Man Out 2.Chi. Word Odd Man Out 3.Chi. Pho. Del.
Hong Kong	1.Schonell reading test 2.Chinese reading test	(same as above)	(same as above)	(same as above)	1.Eng. Odd Man Out 2.Eng. Pho. Del. 3.Chi. Non-word Odd Man Out 4.Chi. Word Odd Man Out 5.Chi. Pho. Del.
STUDY TWO					
Hong Kong **1.Pinyin group.** **2.Non-Pinyin group.**	1.Schonell reading test 2.Chinese reading test	(same as above)	(same as above)	(same as above)	1.Eng. Odd Man Out 2.Eng. Pho. Del. 3.Chi. Non-word Odd Man Out 4.Chi. Word Odd Man Out 5.Chi. Pho. Del.
STUDY THREE					
First phase-third phase (the beginning of Sep.1991-the beginning of July 1992)	Chinese reading test	Visual Paired Associates	(same as above)	(same as above, only in the third phase)	1.Chi. Non-word Odd Man Out 2.Chi. Word Odd Man Out 3.Chi. Pho. Del.

PART TWO

STUDY ONE:

A CROSS-CULTURAL STUDY

CHAPTER FIVE

THE U.K. STUDY

5.1 INTRODUCTION

As mentioned in Chapter Three, several researchers (e.g., Bradley & Bryant, 1983; Gathercole *et al.* 1991; Goswami & Bryant, 1990; Stuart & Coltheart, 1988; Wagner & Torgeson, 1987) have argued that phonological ability plays an important part in learning to read alphabetic writing systems such as English in which the written symbols basically represent the phonemic structure of speech. Stuart and Coltheart (1988) also suggested that there is a reciprocal interactive causal relationship between phonological awareness and reading ability. In other words, a child who learns to read an alphabetic script needs to be aware that speech consists of phonemic units. At the same time, learning to read in an alphabetic system affects awareness of phonemes. In a logographic writing system such as Chinese, however, it is not yet confirmed whether phonological awareness plays a role in the way that children learn to read.

Study One intends to investigate three main issues. The first is to examine whether phonological awareness associated with rhyme and phonemes play any role in the acquisition of reading skills in English children and (critically) in Chinese children. The second is to analyse the relationship between visual skills and reading in English and Chinese, and to investigate whether or not any of these factors can predict the children's success in reading English and Chinese. The third is to investigate possible differences between children's phonological awareness and visual skills in Britain, Hong Kong and Taiwan. The research is based on three primary schools in the UK, Taiwan and Hong Kong. Participants in Study One include 137 children who were all aged between eight and nine. First of all, the U.K. study will be described in this chapter. The Taiwan and Hong Kong studies will be reported in the following chapters.

A landmark study by Bryant and Bradley (1985) indicated that performance of rhyme and alliteration tasks is significantly correlated with reading age in young schoolchildren and also successfully predicts pre-schoolers' subsequent success or failure in learning to read. Consistent with this, Goswami and Bryant (1990) argued that a child at the earliest stages of learning to read an alphabetic script needs to be able to break a word down into its onset and rime segments. Other researchers (e.g., Yopp, 1988) have suggested that the ability to isolate and manipulate individual phonemic units is the critical factor that is associated with learning to read. Foorman and Liberman (1989) also found that good readers excelled in phonological recoding and application of grapheme-phoneme correspondence rules but were weaker in applying visual-orthographic knowledge. Poor readers, however, applied visual more than phonological coding and benefited from the visual-orthographic knowledge available in a clue word. In their research, they focused on phonological recoding skill and visual-orthographic knowledge, and did not examine basic visual skills. In general, the majority of researchers are interested in the relationship between *phonological awareness* and English reading. Only a few researchers have explored the relationship between visual skills and reading ability (e.g., Malatesha, 1986; Vellutino *et al.*, 1975). Gattuso *et al.* (1991) claimed that the performance of visual tasks did not usually relate to reading and spelling skill. The ability to attend selectively to phonemes seems to be "a 'special' skill --one which may require specific experiences with language" (p.139).

In the research, reported below, the U.K. study tries to investigate whether English children's phonological awareness and visual skills predict their reading ability and intends to analyse the relationship between phonological awareness, visual skills and reading. This chapter, therefore, has as its main purpose the presentation of detailed data on the results in the U.K.

5.2 METHOD

5.2.1 Description of subjects

The subjects comprised forty-five eight year old children (20 boys and 25 girls) from three classes at St. Michael-in-the-Hamlet School in Liverpool. None of them had ever learned Chinese and all were native speakers of English. Subjects for whom English was a second language and those experiencing learning difficulties, according to teachers, were not included in the study. The ages of the subjects ranged from 8.0 to 8.9 with a mean of 8.43 years at the time of testing.

5.2.2 Description of test materials

The following tests were given to the English children:

1. English Reading Test: Schonell Reading Test.
2. Visual Skill Tests:
    a. Visual Form Discrimination.
    b. Visual Paired Associates.
3. IQ Test: Coloured Progressive Matrices.
4. Vocabulary Test: British Picture Vocabulary Scale.

5. Phonological Tests:

a. Odd Man Out Tests: English Odd Man Out Test and Chinese Non-words Odd Man Out Test.

b. English Phoneme Deletion Test.

5.2.3 Procedure of testing

The test was administered individually to each child. At first, in order to pretest all of the test materials, 12 eight-year-old children had been chosen from Pleasant Street School and St. Nicholas School in Liverpool in March 1991. The results showed that the difficulty of the tests was suitable for an eight-year-old child. None of the tests showed floor or ceiling effects apart from the Visual Recognition Test, which had a ceiling effect in this pilot study. Accordingly, Visual Paired Associates replaced the Visual Recognition test as one of the tests of visual skills. In a continuation of the pilot study, those same subjects took the Visual Paired Associates to ensure that this test was appropriate.

After the pretesting, the testing was carried out in Liverpool in June 1991. The whole testing took approximately fifty minutes per child. To avoid boring or tiring the child, testing was divided into two sections: the first 30-minute section included IQ test (Coloured Progressive Matrices), Reading test, Visual Form Discrimination and Odd Man Out test (English version and Chinese non-word version); the other 20-minute section, which was carried out the following day, consisted of Visual Paired Associates, Phoneme Deletion, and BPVS. The arrangement of testing in the 2 sections was followed by balance of verbal type and non-verbal type.

One of the examiners was a native speaker of English in order to avert any language barrier. The examiner was a Liverpudlian student who is studying Psychology.

5.2.4 Statistical methods

The data were analysed by 4 statistical tests:

1. Pearson's Product-Moment Correlation.
2. t-test.
3. Stepwise multiple regression.
4. Analysis of variance (ANOVA) and analysis of covariance (ANCOVA).

All of these tests were performed using the Statistical Analysis System (SAS, 1988).

5.3 RESULTS

Descriptive statistics for reading, IQ, vocabulary test, visual skills and phonological tests will be presented first. Secondly, the results examining the relationship between phonological tests, visual skills, IQ, vocabulary and reading will be described. The results of multiple stepwise regression will be shown next. Finally, the analyses of variance on the Odd Man Out test and Phoneme Deletion test will be displayed, followed by results of a t-test performed to examine possible differences between the skilled readers and less skilled readers and between sex will be shown at the end of this section.

5.3.1 Descriptive statistics

The means and standard deviations for the U.K. subjects on the measures of general intelligence, vocabulary test, reading ability, phonological awareness, and visual skills are presented in Table 5-1. As can be seen, the mean score for the English reading test in this study was 34.84 which was very similar to the norms of Schonell's standardized sample (34 words for the reading age of 8.3 years).

Table 5-1: Means and standard deviations among the tests for the U.K. subjects (Standard deviations in parentheses)

Tests	Coloured Prog. Matrices	BPVS	Visual Paired Associates	Visual Form Discrimination
Mean	24.64 (4.44)	17.64 (2.95)	11.91 (4.16)	24.51 (3.89)
Max.	36	32	18	32

Tests	Schonell Reading	Chinese Nonword OMO	English OMO	English Phoneme Deletion
Mean	34.84 (13.31)	17.29 (4.19)	22.8 (3.42)	34.09 (6.86)
Max.	100	30	30	40

5.3.2 The relationship between phonological tests, visual skills, IQ, vocabulary score, and reading in English

5.3.2.1 The correlations between the reading test and other tests

The correlations between the English reading test, IQ test, vocabulary test, visual skills, and phonological tests are displayed in Table 5-2.

Table 5-2: The pattern of correlation among the reading test and other tests

a. The correlation of reading and each test

	IQ	BPVS	VisualPairedAssoci.	VisualFormDiscrimination	Eng.OMO	Chi. Non-word OMO	EngPho.Del.
Reading	.56***	.41**	.20	.43**	.37*	.41**	.59***

b. Partial correlation of reading and each test, IQ as a partial variable

	BPVS	VisualPairedAssoci.	VisualFormDiscrimination	Eng.OMO	Chi. Non-word OMO	Eng.Pho.Del.
Reading	.38*	.10	.23	.27	.34*	.50***

c. The correlation of reading and separate phonological subtests

	Eng.OMO(F)	(M)	(L)	CNOMO(F)	(M)	(L)	EPD,first(CVCC)	(CCVC)	End(CVCC)	(CCVC)
Reading	.18	.40**	.17	.09	.42**	.31*	.45**	.55***	.42**	.43**

d. Partial correlation of reading and separate phonological subtests, IQ as a partial variable

	Eng.OMO(F)	(M)	(L)	CNOMO(F)	(M)	(L)	EPD,first(CVCC)	(CCVC)	End(CVCC)	(CCVC)
Reading	.21	.22	.10	.07	.38*	.20	.30*	.42**	.49***	.40**

* $p<.05$ ** $p<.01$ *** $p<.001$

It is obvious that there was a high correlation between English reading and all three of the phonological tests (r=.37 to .59, p<.05; p<.001). The Phoneme Deletion Test, particularly, was highly related to English reading. A significant correlation also existed between reading and IQ, reading and BPVS, reading and the Visual Form Discrimination, but not between reading and the Visual Paired Associates.

When the effects of IQ were partialled out, the correlations between reading and the English Phoneme Deletion tests, reading and vocabulary test, reading and the Chinese Non-word Odd Man Out test were still significant. It is interesting to note that the correlation between reading and the Visual Form Discrimination dropped from .43 to .23 (n.s.), when IQ was a partial variable. This may indicate that the skills required for the Visual Form Discrimination overlapped with IQ.

If we look at the relationship between the separate phonological subtests and reading ability from the same Table, it is striking that the four subtests of Phoneme Deletion and the middle sound oddity in the English Odd Man Out test and the last, middle sound oddity in the Chinese Non-word Odd Man Out test were significantly correlated with reading ability. However, the first sound oddity in both the English Odd Man Out test and the Chinese Odd Man Out test was not significantly related to reading.

5.3.2.2 The intercorrelations of phonological subtests

From Table 5-3, it can be seen that the English Odd Man Out test and the Chinese Non-word Odd Man Out test were highly intercorrelated (r=.69, p<.001). Even with Coloured Progressive Matrices as a partial variable, the correlation between the Chinese non-word Odd Man Out and the English Odd Man Out was still significant (r=.66, p<.001). However, English Phoneme Deletion was not significantly correlated with the English Odd Man Out or the Chinese Non-word Odd Man Out.

Table 5-3: The intercorrelation of phonological tests

a. Correlation of phonological tests

	Chinese Nonword Odd Man Out	English Phoneme Deletion
English Odd Man Out	.69***	.23
Chinese Nonword Odd Man Out	-	.12

b. Partial correlation of phonological tests, IQ as a partial variable

	Chinese Nonword Odd Man Out	English Phoneme Deletion
English Odd Man Out	.66***	.14
Chinese Nonword Odd Man Out	-	.03

* p<.05 ** p<.01 *** p<.001

Because the phoneme deletion test and the odd man out test comprise a number of subtests, the intercorrelations of the subtests are shown in Table 5-4. From the intercorrelation coefficient, it is obvious that the intercorrelations of the subtests of English Phoneme Deletion test are significantly high, r=.34 to .77, p<.05 to p<.001. In contrast, there is not a significant correlation between the subtests of the Chinese Non-word Odd Man Out test and the English Phoneme Deletion.

It is worth noting that the only intercorrelation is between the middle sound oddity and last sound oddity both in the English Odd Man Out test and in the Chinese Non-word Odd Man Out test. However, there was no correlation between the first sound oddity and the middle sound oddity. As Table 5-4 shows, the majority of subtests of the English Odd Man Out test are significantly related to the subtests of the Chinese Non-word Odd Man Out test.

Table 5-4: the intercorrelations of phonological subtests

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
English Odd Man Out										
First(1)	.	.15	-.08	.34*	.34*	.22	.04	.09	.29	.04
Middle(2)		.	.43**	.29*	.35*	.50***	.25	.39**	.19	.37*
Last(3)			.	.13	.30*	.38*	-.09	.00	-.07	.06
Chinese Non-word Odd Man Out										
First(4)				.	.06	.15	-.09	.06	.11	.16
Middle(5)					.	.40**	-.07	.07	.20	.12
Last(6)						.	-.05	.24	-.02	.00
English Phoneme Deletion										
(First sound deletion)										
CVCC(7)							.	.59***	.54***	.70***
CCVC(8)								.	.34*	.39**
(End sound deletion)										
CVCC(9)									.	.77***
CCVC(10)										.

* p<.05 ** p<.01 *** p<.001

5.3.3 Which factor predicts English reading?

The issue of the minimum number of subjects required to run regression analyses has been investigated by statisticians. They suggested various rules of thumb. According to Tabachnick and Fidell (1989), " a minimum requirement is to have at least 5 times more cases than independent variables" (p.129). It is known that it is not reasonable to include a large number of predictor variables in a stepwise regression with only 45 subjects. Therefore, the stepwise regression focused on the predictive power of phonological tests combined together and on visual skills tests combined together, not on the individual tests. That means that the two odd man out tests and the phoneme deletion test were combined as a single phonological score. This was calculated by first converting each child's score on each test to a standard score and then using the sum of the mean of each child's standard scores from each phonological test. The Visual Form Discrimination and Visual Paired Associates were combined as a single visual score, which was calculated in the same way as the phonological score, to predict reading ability. IQ, vocabulary, phonological score, and visual score were entered into the multiple regression as predictors of reading ability. The results of the stepwise regression analysis are presented in Table 5-5, section A.

Table 5-5: Summary of multiple stepwise regression analysis

A. Combined phonological tests
IQ, vocabulary test(BPVS), phonological tests, and visual skills as predictor variables

variables	R^2 Changed	F	p
Phonological test	.44	33.34	.0001
IQ	.09	8.43	.0059
British Picture Vocabulary Scale	.05	4.95	.0316

Overall $F(3, 41)=18.98$, $p<.0001$; $R^2=.58$

B. Separate phonological tests
IQ, vocabulary test(BPVS), oddity test, phoneme deletion test, and visual skills as predictor variables

variables	R^2 Changed	F	p
Phoneme deletion	.35	23.05	.0001
IQ	.14	11.13	.0018
Oddity	.06	5.25	.0272
British Picture Vocabulary Scale	.05	4.46	.0410

Overall $F(4, 40)=14.36$, $p<.0001$; $R^2=.59$

When one looks at the regression results from Table 5-5, section A, these data indicate that the single set of phonological tests was the first and the most powerful predictor of English reading for these subjects ($F(1, 43)=33.34$, $p<.0001$). IQ was the second variable to predict English reading significantly ($F(2, 42)=8.43$, $p<.0059$), and vocabulary ability was the final variable entered in the multiple regression equation. Visual skill was not found to be a significant predictor of English reading ability in the stepwise regression analysis.

Some researchers have argued that the oddity task and phoneme deletion test may require different cognitive procedures (Yopp, 1992). Moreover, the results from Sec. 5.3.2.2 showed that both of Odd Man Out tests (English word and Chinese non-word) were not correlated with the phoneme deletion test, r=.23 (n.s.) and .12 (n.s.), respectively. Therefore, both of the Odd Man Out tests were combined as a single oddity score and entered separately from the phoneme deletion scores. The predictors contained IQ, BPVS, visual skill, oddity score and phoneme deletion test. The results were shown in Table 5-5 section B. It was striking that the phoneme deletion test more significantly predicted reading ability than the oddity test did.

In order to test how powerfully the phonological tests or visual skills tests predict reading ability when IQ and vocabulary have been partialled out, a 4-steps fixed-order multiple regressions was conducted. The results are reported in Table 5-6.

The dependent variable was 'reading score' and the first two steps entered in each analysis were IQ and vocabulary ability (BPVS). The third step was the score of the phonological tests, followed by visual skills; or the score of visual skills tests, followed by the score of phonological tests. It is evident that when the phonological test was entered into the equation in step 3, then the amount of variance in reading scores that is accounted for went up from 41% to 58%. However, when visual skills was entered in step 3, the amount of variance accounted for went up from 41% to 43%. Therefore, the contribution of phonological score is much greater than the contribution of visual skills. It can also be seen that when scores on the phonological tests were entered into the equation in step 4, then the amount of variance in reading scores that was accounted for went up from 43% to 59%. By contrast, when visual skills were entered in step 4, the amount of variance accounted for only went up from 58% to 59%.

Table 5-6: Summary of fixed-order multiple regression

Variables	R^2 changed	cumulative R^2
First step: IQ Second step: British Picture Vocabulary Scale	$.3100^{***}$ $.0981^{**}$	$.3100^{*}$ .4081
Third step: phonological tests	$.1733^{**}$	.5814
Fourth step: visual skills	.0081	.5895
or Third step: visual skills	.0256	.4337
Fourth step: phonological tests	$.1558^{**}$	.5895

* p<.05   ** p<.01   *** p<.001

(Note: The partial correlation between reading and phonological scores was .52, p<.001, when IQ, BPVS, Visual skills were partial out.)

5.3.4 Analyses of phonological tests

In this section, performance by the English children on the phonological tests is analyzed.

5.3.4.1 Odd Man Out Tests

English Odd Man Out Vs Chinese Non-word Odd Man Out

Table 5-7 reveals the mean scores on the English Odd Man Out test and Chinese Non-word Odd Man Out test in terms of first, middle or last sound. A two-way analysis of variance was conducted to examine performance on these two tests. The dependent variable for the analysis was the number of correct responses and the independent variables were the different versions (English/Chinese) and positions (first/middle/last). Because all subjects received all tasks, the study was an entirely within-subjects design.

Table 5-7: Mean number of English Odd Man Out test and Chinese Non-word Odd Man Out test

Version\Position	First	Middle	Last	Total
English OMO	7.47	8.16	7.18	22.81
Chinese Non-word OMO	5.73	5.69	5.87	17.29
Max.	10	10	10	30

Analysis of variance showed that the mean scores differed significantly by version, $F(1, 44)=142.09$ ($p<.0001$). The performance on the English Odd Man Out was significantly better than on the Chinese Non-word Odd Man Out. However, there was no significant effect of position, $F(2, 88)= 1.31$ ($p>.05$) and no significant interaction between version and position, $F(2, 88)=2.90$ ($p>.05$).

Analysis of covariance was also used in order to partial out the effects of IQ and vocabulary (BPVS). Similar results were obtained, which means that the significant difference between different version (English Odd Man Out Test and Chinese Odd Man Out Test) on ANOVA was confirmed by ANCOVA. ANOVA and ANCOVA summary tables can be found in the Appendix E. Table 5-7-1 and 5-7-2.

5.3.4.2 Phoneme Deletion Test

Table 5-8 shows the performance by the U.K. subjects on the English Phoneme Deletion test.

Table 5-8: Mean number of English Phoneme Deletion

Position	First sound deletion		End sound deletion		Total
	CVC(C)	CCVC	CVC(C)	CCVC	
Score	9.09	6.64	9.40	8.96	34.09
Max.	10	10	10	10	40

A 2 x 2 (phoneme position (first x end) x syllable type (CVCC x CCVC)) analysis of variance was performed, with repeated measures on phoneme position, and syllable type, using the number correct as the dependent variable.

The analysis showed a significant main effect of position, $F(1, 44)=21.80$ ($p<.001$); and syllable type, $F(1, 44)=50.62$ ($p<.001$). There was also a significant 2 way interaction between phoneme position and syllable type, $F(1, 44)=21.64$, $p<.001$.

Newman-Keuls tests showed that the performance on first sound deletion of CCVC words was significantly lower than on first sound deletion of CVC(C) words, and than on end sound deletion of both CVC(C) and CCVC words, $p<.0001$. None of the other differences was significant. This shows that the first sound deletion of CVC(C) words is much easier than the first sound deletion of CCVC words for English children. For example, to delete /b/ from "bus" is much easier than to delete /s/ from "stop". As one would expect, there was no corresponding difference between CVC(C) and CCVC words in end sound deletion.

Using an analysis of covariance, with IQ (Coloured Progressive Matrices) and vocabulary ability (BPVS) as covariates, the results again revealed significant main effects of position, $F(1, 42)=10.17$, $p<.01$; and type, $F(1, 42)=9.94$, $p<.01$, as well as a significant 2 way interaction, $F(1, 42)=7.38$, $p<.05$ (also see the Appendix E. Table 5-8-1 and Table 5-8-1).

5.3.5 The differences between the skilled readers and less skilled readers

Previous researchers have argued that skilled readers are superior to less skilled readers on phonological tests. Thus, the subjects were split into a group of 24 less skilled readers whose reading scores are below average (Mean < 34.84) and a group of 21 skilled readers whose reading scores are above average (Mean >= 34.84). The results of the t-test on the two groups is shown on Table 5-9.

Table 5-9: T-test of the skilled and the less skilled subjects on the all tests

Tests	Means		diff.	t (d.f.=43)
	skilled N=21	less skilled N=24		
Coloured Prog. Matrices	27.57	22.08	5.49	5.23***
BPVS	18.33	17.04	1.29	1.49
Visual Paired Associates	12.19	11.67	.52	.42
Visual Form Discrimination	25.67	23.50	2.17	1.92
Chinese Nonword Odd Man Out	18.86	15.92	2.94	2.48*
English Odd Man Out	24.43	21.38	3.05	3.31**
English Phoneme Deletion	38.10	30.58	7.52	4.35***

* p<.05 ** p<.01 *** p<.001

It is apparent that all of the phonological tests displayed significant differences between the two groups. On the other hand, there was no statistical difference between the skilled readers and less skilled readers on the Visual Form Discrimination and Visual Paired Associates.

The data concerning the 't' ratios for all tests on the sex differences are summarized in the Appendix E. Table 5-10. The analyses indicated that there was no significant difference between boys and girls on either phonological tests, visual skills tests or reading ability (p>.05). The only two tests on which the difference between means was significant were the IQ test (Coloured Progressive Matrices) and the vocabulary test (BPVS). It was apparent that the boys' IQ and vocabulary ability were significantly higher than the girls', $t(43)=3.20$, $p<.0026$; $t(43)=2.24$, $p<.03$, respectively. The other six tests had no significant sex differences. This means that there is no significant difference between boys and girls on the visual skills tests, phonological tests and reading ability in this study.

5.4 DISCUSSION AND CONCLUSIONS

In view of the evidence gathered in this study, the first question we must try to answer is what the relation is between phonological awareness, visual skills and reading ability for English children. The results support the hypothesis that there is a high correlation between the English reading and phonological awareness score. However, the relation between the visual skills score and reading was not significant when the effects of IQ were partialled out. This finding might be influenced by the characteristics of English orthography. English orthography is often described as a code that pairs sounds and individual letters or graphemes. Therefore, if someone can manipulate phonemes or other phonological units such as rime segments, s/he also succeeds in learning to read, whereas visual skills are not of primary importance.

The results of the correlations between the three phonological tests and reading match those found by Stanovich *et al.* (1984) who also showed high correlations between oddity tasks, phoneme deletion tasks and reading. In their research, the correlation between the 'strip initial consonant' (phoneme deletion test, first sound) and the score on the reading test one year later was .42 ($p<.05$). In this current study, both the CVCC and the CCVC type of first sound deletion task were highly related to reading ($r=.45$, $p<.01$; $r=.55$, $p<.001$). These results were also similar to those observed by Bryant *et al.* (1990), who demonstrated that the first sound and end sound of Phoneme Deletion were strongly related to reading measures, r=.67 and .58, respectively. Stanovich *et al.* (1984) also revealed that the 'initial consonant difference' (Odd Man Out, first sound difference) or 'final consonant difference' (Odd Man Out, last sound difference) was related to reading score, r=.60 ,.45 (p<.01), respectively. However, in this current study, the first sound oddity and last sound oddity in the English Odd Man Out test were not significantly related with reading. Only middle sound detecting was correlated with English reading.

Fox and Routh (1975) claimed that there was a significant correlation between the children's scores in a standardised test of reading and their performance on a phoneme deletion test. The evidence in the present study also supported the view that Phoneme Deletion task was more strongly related to reading of 8 years old children than the Odd Man Out test.

Work by Bryant *et al.* (1990) showed that the rhyme and alliteration measures are strongly related to the phoneme deletion measures. They tested children's rhyme and alliteration oddity at 4 years 7 months and tested phoneme deletion test at 5 years 11 months. The results in this study did not reveal a significant correlation between the Odd Man Out tests and the phoneme deletion test. It seems likely that the different results are due to the age of subjects, because the subjects in Bryant *et al.* research were 2 years and 6 months younger than the subjects in this study.

A further interesting finding is the significant effect of the different languages on the Odd Man Out test. It was shown that the performance on the English Odd Man Out test was significantly better than on the Chinese Non-word Odd Man Out test. This may be caused by the different language stimuli. According to some English children's responses during testing, the items in the Chinese Non-words task sounded strange for them. Even though those stimuli are non-words, they are still in the structure of a foreign language for English children. That may be the reason why the subjects got a lower score on the Chinese Non-word Odd Man Out Test.

Research by Bradley and Bryant (1983) showed that both 5-year-old and 4-year-old children received the highest score in the middle sound difference of the English Odd Man Out test, 6.89 out of 10 (each item includes 4 words) and 7.53 out of 10 (each item includes 3 words), respectively. The data in my research were consistent with their results: the score on the middle sound oddity was higher than the first sound and the last sound in English Odd Man Out test. However, the difference was not significant.

Treiman (1985) argued that children always group the phonemes in a syllable into the onset and the rime and that initial consonant clusters are treated as units. A study by Stuart and Coltheart (1988) also suggested that their subjects treated initial consonant clusters as units. They explained that, as 4-and 5-year-olds, they considered that 'bread' began with /br/ and not with /b/; that 'grapes' began with 'gr' and not with 'g'; and that 'plum' began with /pl/ and not with /p/; as 8-year-olds, they tended to delete the entire cluster when asked to delete. These facts suggest that children often only parse letter strings phonologically into single consonant and single vowel units. Therefore, CCVC, CVCC, and CCVCC words would all be parsed as simple CVC strings.

This current research supports the assumption that initial consonant clusters are treated as a single phonological unit, so it is more difficult to delete the first phoneme from the consonant clusters. As mentioned in the previous section, there was a significant main effect of different syllable types in the English Phoneme Deletion

Test. Subjects performed better on the CVCC type than on the CCVC type.

A number of writers have commented on the differences between boys and girls in reading ability. For example, Johnston and Thompson (1989) found that girls performed more accurately than boys on a lexical decision task. Reading problems of all degrees may occur more frequently among boys than among girls, and that girls also tend to be better writers and spellers. In this study, no significant difference was found between the sexes on tests of reading, phonological tests and visual skills.

There were also large differences between skilled readers and less skilled readers on the phonological tests. These findings suggest that less skilled readers are poor at detecting odd man out and deleting phonemes. The evidence from the study of Bryant and Bradley (1985) supports the conclusion that there was a tendency that the sharper the child's awareness of sounds, the better s/he is at reading. Bradley and Bryant (1978) compared the auditory organisation of backward readers and normal readers and found that the backward readers were at a particular disadvantage relative to the normal readers in the first-sound different part. Foorman and Liberman (1989) also claimed that good readers are better at phonological recoding.

This investigation has shown that English children's phonological awareness is the most significant predictor of reading in English, when compared with visual skills, IQ and vocabulary test.

In conclusion, the following conclusions can be drawn from the U.K. study:

1. All three of the Phonological tests were highly related to reading. Conversely, the relation between the Visual Paired Associates and reading was relatively low. There was no significant effect of visual skills when the effects of IQ had been partialled out.

2. The score on the phonological tests was a more powerful predictor of reading ability than visual skills.

3. The score on the English Odd Man Out test was higher than the score on the Chinese Non-word Odd Man Out test. Nevertheless, there is no significant main effect of the different positions.

4. The subjects were superior at deleting the first sound of CVCC syllable type word to CCVC syllable type word.

5. All the phonological tests displayed a significant difference between the skilled readers and less skilled readers, but there was no difference between skilled and less skilled readers on the visual skills tests.

6. There was no significant effect of sex on the phonological tests, visual skill and reading ability.

On the whole, the evidence obtained in the present study suggests that English reading is more dependent on phonological skill than on visual skills. Thus, the conclusion that phonological skill is a significant determiner of English reading ability is supported by the results of this study.

CHAPTER SIX

THE TAIWAN STUDY

6.1 INTRODUCTION

The research presented in this chapter was intended to investigate the relation between visual skills, phonological ability and reading Chinese in Taiwan and examine which of these factors best predicts the children's success in reading Chinese. More particularly, the hypothesis was tested that the Chinese children's reading should depend more on visual skills than on phonological awareness.

Before I proceed to describe the study, it is first necessary to give an overview of the Taiwan primary education system.

6.2 BACKGROUND INFORMATION ON TAIWAN PRIMARY EDUCATION

Generally speaking, the prevailing school system in Taiwan is divided into four levels, namely: preschool education, primary education, secondary education, and higher education. In 1968, compulsory education was extended from 6 years to 9 years. Therefore, children must attend primary school from the age of six. Primary education is the first stage of universal free education and admits children who are 6-12 years old. This is followed by the three years of junior high school and three year of senior high school. There are also some three year vocational schools at secondary level. Higher education consists of four years of college or university, followed by postgraduate study in universities or colleges. The current school system in Taiwan is shown in Fig. 6-1.

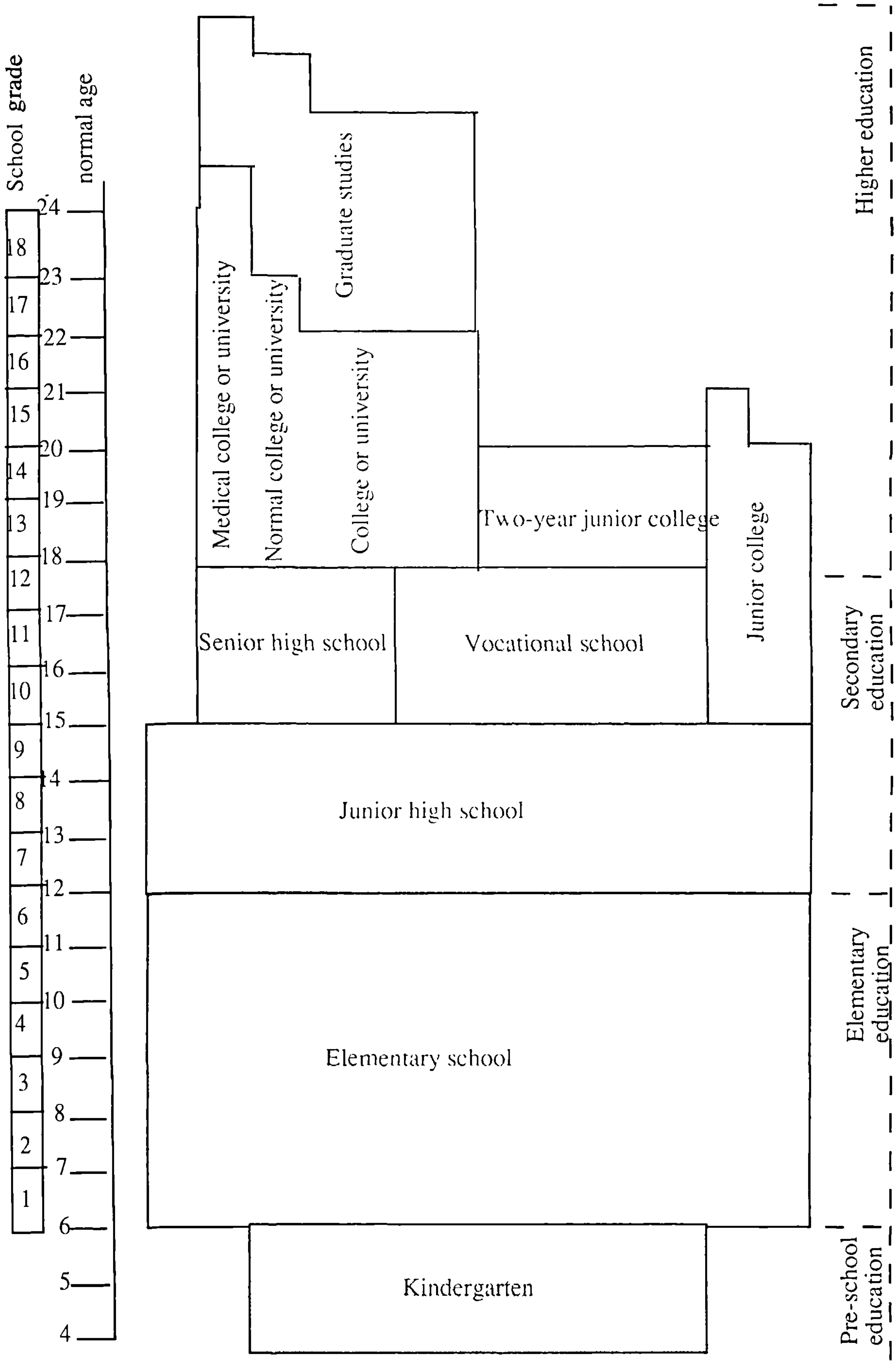


Fig. 6-1: The current school system in Taiwan.

Zhu-Yin-Fu-Hao is taught to the first graders in primary schools for the first ten weeks before the children begin to learn to read Chinese characters. *Zhu-Yin-Fu-Hao* is a phonetic representation for the Chinese characters in *Putonghua* (Mandarin) that is the official spoken language. An example of *Zhu-Yin-Fu-Hao* accompanied with Chinese character is presented in Fig. 6-2. It always appears on the right side of Chinese characters in the textbooks of primary school (as shown in Fig. 6-2) from the first grade to the third grade. These signs help children to pronounce new characters without other people's assistance. *Zhu-Yin-Fu-Hao* is used mainly in primary school, but not in ordinary communication. Chinese (in *Putonghua*) is the language of instruction at all levels in schools.

---

a. An example of *Zhu-Yin-Fu-Hao* accompanied with Chinese Characters

人 ㄖㄣˊ (people)

b. An example of the textbook of Chinese language in primary schools (a page from the Chinese textbook for first graders in Taiwan).

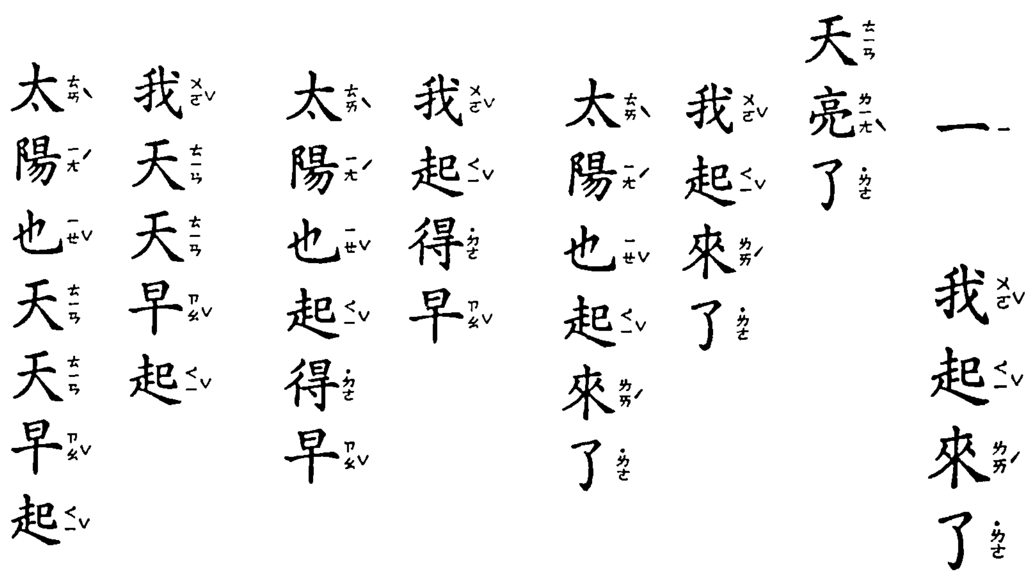


Fig. 6-2: Examples of Zhu-Yin-Fu-Hao and Chinese characters

6.3 METHOD

6.3.1 Description of subjects

Fifty children (25 boys, 25 girls) in Ming-Sheng Primary School located in Chang-Hua City, Taiwan, participated in this research. Ages range from 8.3 year-old to 9.3 year-old with a mean of 8.89 year-old. All of them are native Chinese and speak Putonghua (Mandarin) as well as Taiwanese which is a dialect in Taiwan. They have learned *Zhu-Yin-Fu-Hao* during the first ten weeks of the first grade. The samples excluded children who were suspected of mental retardation and those with sensory handicap, according to the judgement of class teachers.

In order to distinguish the Chinese subjects in Hong Kong in the ensuing chapter, the children in Taiwan were referred to "Taiwanese subjects".

6.3.2 Description of test materials

The following tests were given to the Taiwanese subjects (the details of test materials refer to those in Chapter Four):

1. Chinese Reading Test: Chinese Characters Recognition Test.
2. Visual Skill Tests:
    a. Visual Form Discrimination.
    b. Visual Paired Associates.
3. IQ Test: Coloured Progressive Matrices.
4. Vocabulary Test: British Picture Vocabulary Scale (Chinese Edition).
5. Phonological Tests:
    a. Odd Man Out Tests: Chinese Odd Man Out Test and Chinese Non-words Odd Man Out Test.

b. Chinese Phoneme Deletion Test.

6.3.3 Procedure of testing

The tests were administered individually in a quiet room. At the beginning of testing, the English Phoneme Deletion test was administered to a few subjects. These subjects were unable to respond when asked what particular words would sound like if the first (or end) phoneme had been taken away. Accordingly, the English Phoneme Deletion test was not used in the testing of Taiwanese children.

Each child was tested in all tests which were distributed over two separate sessions, the first including the IQ test, reading test, the Visual Form Discrimination, and the Odd Man Out test (Chinese word and Chinese non-word); the other consisting of the Visual Paired Associates, Phoneme Deletion, and BPVS. It took about 45 minutes for each subject to complete the test materials.

6.3.4 Statistical methods

The data were analysed by 4 statistical tests. First, Pearson's product-moment correlation was employed. Second, stepwise multiple regression was used to examine the predictive power of phonological and visual skills tests on reading ability. Thirdly, analysis of variance (ANOVA) and analysis of covariance (ANCOVA) were used to investigate performance on the Chinese Word Odd Man Out and Non-word Odd Man Out tests. Finally, t-tests were performed on the differences between skilled readers and less skilled readers and between boys and girls.

All of these tests were performed using the Statistical Analysis System (SAS, 1988).

6.4 RESULTS

Descriptive statistics for reading, IQ, vocabulary test, visual skills and phonological tests will be presented first. Secondly, the results examining the relationship between phonological tests, visual skills, IQ, vocabulary and reading will be described. The results of multiple stepwise regression will be shown next. Finally, the analyses of variance on the Odd Man Out test and Phoneme Deletion test will be displayed, and the differences between the skilled readers and less skilled readers and between the sexes will be shown at the end of this section.

6.4.1 Descriptive Statistics

The means and standard deviations for the Taiwanese subjects on the measures of general intelligence, vocabulary test, reading ability, phonological awareness, and visual skills are presented in Table 6-1.

Table 6-1: Means and standard deviations among the tests for the Taiwanese subjects (Standard deviations in parentheses)

Tests	Coloured Prog. Matrices	BPVS	Visual Paired Associates	Visual Form Discri.	Chinese Reading	Chinese Nonword Odd Man	Chinese Odd Man Out	Chinese Phoneme Deletion
Mean (SD)	32.30 (2.79)	27.58 (2.19)	11.98 (3.61)	27.54 (3.61)	60.94 (8.74)	19.72 (4.36)	20.98 (4.36)	16.84 (2.67)
Max.	36	32	18	32	100	30	30	20

6.4.2 The Relationship Between Phonological Tests, Visual Skills, IQ, Vocabulary score, and Reading in Chinese

6.4.2.1 The correlations between the reading test and other tests

The correlations between the Chinese reading test, IQ test, vocabulary test, visual skills, and phonological tests are displayed in Table 6-2.

Table 6-2: The pattern of correlation among the tests and Chinese Reading.

a. The correlation of reading and each test

	IQ	BPVS	VisualPairedAssoci.	VisualFormDiscrimination	Chi.OMO	Chi.Non.OMO	Chi.Pho.Del.
Reading	.39**	.50***	.76***	.36**	.40**	.26	.55***

b. The partial correlation of reading and each test, IQ as a partial variable

	BPVS	VisualPairedAssoci.	VisualFormDiscrimination	Chi.OMO	Chi. Non.OMO	Chi.Pho.Del.
Reading	.51***	.79***	.27	.27	.14	.51***

c. The correlation of reading and separate phonological subtests

	Chi.OMO(F)	(M)	(L)	Chi. Non.OMO(F)	(M)	(L)	Chi.Pho.Del.,first	end
Reading	.42**	.30*	.24	.28*	.17	.18	.54***	.42**

d. The partial correlation of reading and separate phonological subtests

	Chi.OMO(F)	(M)	(L)	Chi. Non.OMO(F)	(M)	(L)	Chi.Pho.Del.,first	end
Reading	.30*	.20	.12	.17	.07	.09	.52***	.36*

* $p<.05$ ** $p<.01$ *** $p<.001$

It was apparent that there was a high correlation between Chinese reading and Visual Paired Associates test (r=.76, p<.001). The vocabulary test, particularly, was also highly related to Chinese reading (r=.50, p<.001). A significant correlation also exists between Chinese reading and IQ, Visual Form Discrimination, Chinese Odd Man Out, Chinese Phoneme Deletion, but not between reading and Chinese Non-word Odd Man Out. When IQ was partialled out, the correlations between reading and Visual Paired Associates, vocabulary test, Chinese Phoneme Deletion were still significant. However, no significant correlation was observed between reading and Chinese Non-word Odd Man Out, and reading and Chinese Odd Man Out. If we look at the relationship between the separate phonological sub-tests and reading ability from the same Table, it is striking that all the subtests of Phoneme Deletion, the first and middle sound oddity in the Chinese Odd Man Out test and the first sound oddity in Chinese Non-word Odd Man Out test were significantly related to reading ability. Nevertheless, the last sound oddity in both the Chinese Odd Man Out test and the Chinese Non-word Odd Man Out test was not significantly related to reading.

6.4.2.2 The intercorrelations of phonological subtests

From Table 6-3, it can be seen that the Chinese Word Odd Man Out test and Chinese Non-word Odd Man Out test were highly intercorrelated (r=.76, p<.001). Even with the Coloured Progressive Matrices as a partial variable, the correlation between the Chinese Non-word Odd Man Out and the Chinese Word Odd Man Out was still significant (r=.72, p<.001). Moreover, Chinese Phoneme Deletion was also significantly correlated with Chinese Word Odd Man Out and Chinese Non-word Odd Man Out, r=.44 and .39, p<.01, respectively.

Table 6-3: The intercorrelation of phonological tests.

	Chinese Nonword Odd Man Out	Chinese Phoneme Deletion
Chinese Odd Man Out	.76***	.44**
Chinese Non-word Odd Man Out	-	.39**
Partial correlation of phonological subtests, IQ as a partial variable		
	Chinese Nonword Odd Man Out	Chinese Phoneme Deletion
Chinese Odd Man Out	.72***	.38**
Chinese Non-word Odd Man Out	-	.33*

* p<.05 ** p<.01 *** P<.001

Because both the phoneme deletion test and the odd man out test consist of several subtests, the intercorrelations of the subtests are shown in Table 6-4.

Table 6-4: the intercorrelations of phonological subtests.

	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Chinese Odd Man Out							
First (1)	.53***	.51***	.61***	.43**	.56***	.29*	.48***
Middle (2)	.	.39**	.42**	.37**	.58***	.37**	.33*
Last (3)		.	.63***	.45**	.45**	.22	.16
Chinese Non-word Odd Man Out							
First (4)			.	.40***	.51***	.22	.22
Middle (5)				.	.54**	.26	.33*
Last (6)					.	.31*	.29*
Chinese Phoneme Deletion							
First Sound Deletion (7)						.	.50***
End Sound Deletion (8)							.

* p<.05 ** p<.01 *** p<.001

From the intercorrelation coefficient, it is obvious that the intercorrelations of subtests of Chinese Odd Man Out and Chinese Non-word Odd Man Out are significant, r=.39 to .54, p<.01 to p<.001. There was a highly significant correlation between the first sound deletion and the last sound deletion in the Chinese Phoneme

Deletion, r=.50, p<.001.

As Table 6-4 shows, the majority of subtests of the Chinese Odd Man Out test are related to the subtests of the Chinese Non-word Odd Man Out test, r=.37 to .63, p<.01 to .001.

6.4.3 Which factor predicts Chinese reading?

This research is interested in the predictive power of the phonological tests and that of the visual skills scores. Therefore, a stepwise regression focused on the predictive power of the phonological tests combined together, and visual skills tests combined together, not on the individual tests. In other words, the two odd man out tests and the phoneme deletion test were combined as a phonological score, and the Visual Form Discrimination and Visual Paired Associates were combined as a visual score to predict reading ability (see Chapter Five). Table 6-5 shows the results of the stepwise regression analysis.

Table 6-5: Summary of multiple stepwise regression analysis.

IQ, vocabulary test, phonological tests, and visual skills as predictor variables			
variables	R^2 changed	F	p
Visual Skills	.45	39.84	.0001
IQ	.06	5.63	.0218
BPVS	.05	4.73	.0348
Overall F(3, 46)=19.32, p<.0001; Multiple correlation=.56			

A closer look at the regression results from Table 6-5 indicates that the set of visual skills was the first and the most powerful predictor of Chinese reading for these subjects ($F(1, 48)=39.84$, $p<.0001$). IQ was the second variable of significance in predicting Chinese reading ($F(2, 47)=5.63$, $p<.0218$), and BPVS was the final variable in this multiple regression equation ($p<.05$). Phonological ability was not found to be a significant predictor of reading in the stepwise regression analysis. When the two Odd Man Out tests were combined as a single score and entered separately from the Phoneme Deletion test, the results were the same as above.

The results of 4-steps fixed-order multiple regressions is reported in Table 6-6. The dependent variable was 'reading test score' and the first two steps entered in each analysis were IQ and vocabulary ability. The third step was the score of the phonological tests, followed by visual skills; or the score of visual skills tests, followed by the score of phonological tests. This analysis was performed to test how powerfully phonological tests or visual skills tests predict reading ability when IQ and vocabulary have been partialled out.

Table 6-6: Summary of fixed-order multiple regression.

Variables	R^2 changed	cumulative R^2
First step: IQ Second step: vocabulary test	$.1555^{**}$ $.2179^{***}$	.1555 .3734
Third step: phonological tests	.0473	.4207
Fourth step: visual skills	$.1478^{**}$	.5685
or Third step: visual skills	$.1841^{**}$	.5575
Fourth step: Phonological tests	.0110	.5685

** $p<.01$ *** $p<.001$

From Table 6-6, it can be found that the variance in Chinese reading (55.75%) accounted for was significantly higher when the visual skills entered in the third step than that (42.07 %) when the phonological tests entered in the third step. The results showed that visual skills predicted reading more significantly than the phonological tests.

6.4.4 Analyses of phonological tests

In this section, performance by the Taiwan children on the phonological tests is analyzed.

6.4.4.1 Odd Man Out Tests

Chinese Odd Man Out Versus Chinese Nonword Odd Man Out

Table 6-7 reveals the mean scores on the Chinese Odd Man Out and Non-word Odd Man Out tests in terms of first, middle and last sounds. A two-way analysis of variance (repeated measure) was conducted to examine the performance of this test. The dependent variable for the analysis was number of correct responses, and the independent variables were the version (word\ non-word) and various positions (first\ middle\ last). Analysis of variance showed that there was no significant effect of position, $F(2,98)=.04$, $p>.05$. However, the main effect of version was significant, $F(1,49)=8.81$, $p<.01$, with the mean of Chinese Odd Man Out being significantly higher than the score of Chinese Non-word Odd Man Out. There was no significant interaction between version and position, $F(2, 98)=2.26$, $p>.05$.

Table 6-7: Mean number of Chinese Odd Man Out and Non-word Odd Man Out tests.

Language\Position	First	Middle	Last	Total
Chinese OMO	6.94	7.20	6.84	20.98
Chinese Non-word OMO	6.68	6.32	6.72	19.72
Max.	10	10	10	30

Analysis of covariance was also used in order to partial out the effects of IQ and vocabulary (BPVS). The results showed that the significant difference between various versions on ANOVA was disappeared in ANCOVA. That is, there were no differences between two Odd Man Out tests. The ANOVA and ANCOVA summary tables can be found in the Appendix Table 6-7-1 and Table 6-7-2.

6.4.4.2 Phoneme Deletion Test

The performance by the Taiwan subjects on the Chinese Phoneme Deletion test is displayed in Table 6-8. As can be seen, the means were exactly the same in the two parts of the phoneme deletion test. Thus, there was no difference between the first sound and end sound deletion ($F(1, 49)=.00$, $p>.05$).

Table 6-8: Mean number of the Chinese Phoneme Deletion test.

Position	First sound deletion	End sound deletion	Total
Score	8.42	8.42	16.84
Max	10	10	20

6.4.5 The differences between skilled readers and less skilled readers

The results from Chapter Five has shown that skilled readers are superior to less skilled readers on phonological tests for English children. It is in light of this, this study also examines whether there are any differences between skilled readers and less skilled readers in phonological and visual skills. Subjects whose reading scores were equal to or greater than 60.94 (Mean score of reading) were categorized as skilled readers and those with scores less than 60.94 were categorized as less skilled readers. The results of the t-test on the two groups are shown in Table 6-9.

It is evident that all of the visual skills tests, Chinese Odd Man Out and Phoneme Deletion displayed significant differences between the two groups. In other words, skilled readers scored significantly higher than less skilled readers on the Visual Paired Associates and Visual Form Discrimination, t(48)=4.99 and 2.45, p<.0001 and p<.0181, respectively. The most striking point in Table 6-9 is that there are no significant differences between skilled readers and less skilled readers on Chinese Non-word Odd Man Out test and IQ.

Table 6-9: T-test of the skilled and less skilled subjects on the all tests.

Tests	Means		diff.	t (d.f.=48)	p
	skilled	less skilled			
Coloured Prog. Matrices	32.93	31.43	1.50	1.93	.0591
BPVS	28.45	26.38	2.07	3.70	.0005
Visual Paired Associates	13.76	9.52	4.24	4.99	.00001
Visual Form Discrimination	28.55	26.14	2.41	2.45	.0180
Chinese Nonword Odd Man Out	20.41	18.76	1.65	1.33	.1891
Chinese Odd Man Out	22.07	19.48	2.59	2.15	.0365
Chinese Phoneme Deletion	17.93	15.33	2.60	3.85	.0004

The results of the t-test for all tests on sex differences can be found in the Appendix E. Table 6-10. The analyses indicated that there was no significant difference between boys and girls on any test (p>.05). This means that there is no significant difference between boys and girls on the visual skills tests, phonological tests, reading ability, IQ, and vocabulary in this study.

6.5 DISCUSSION AND CONCLUSIONS

This investigation focused on the relationship between phonological ability, visual skills and Chinese reading in Taiwanese subjects. The results support the hypothesis that there is a high correlation between Chinese reading and visual skills score; nevertheless, the relation between reading and the Chinese Odd Man Out or Phoneme Deletion was also significant. This current study showed significant correlations between reading and Chinese Word Odd Man Out Test ($r=.40$, $p<.01$) and Chinese Phoneme Deletion Test ($r=.55$, $p<.001$). These have three possible explanations. First of all is that performance on the phonological tests reflects general intelligence. If so, then the correlation between reading and Chinese odd man out or phoneme deletion tests should drop when IQ was a partial variable. However, since the relationship between reading and phoneme deletion remained significant when IQ was partialled out, this does not seem to be the appropriate explanation.

The other possibility is that because students in Taiwan learn Chinese characters via *Zhu-Yin-Fu-Hao*, this might cause the significant correlation between reading and phoneme deletion test. This possibility will be tested in Chapter Seven. Chen and Yuen (1991) investigated the effects of learning *Pinyin* on Chinese, Taiwanese and Hong Kong children. Their results suggested that *Pinyin* training helps readers pronounce unfamiliar words by facilitating the extension of phonological information for pronunciation.

The last possibility is that Chinese reading may also be related to phonological awareness to a certain extent. It is well known that phonology and orthography are closely related in English. It may be true that they are not completely unrelated in Chinese.

The results of the stepwise regression indicate that the single set of visual skills, IQ, and vocabulary were the significant variables in predicting Chinese reading ability. Only the phonological score was not a significant predictor. If one looks back at the correlations of phonological tests and reading, it can be seen that Chinese Word Odd Man Out and Chinese Phoneme Deletion are correlated with Chinese reading. The correlation between the phoneme deletion test and reading score remains significant after the effects of differences in IQ had been controlled. One may ask why the phonological score has not entered into the stepwise regression significantly. The answer is that the significant relationship between the phoneme deletion test and reading may be caused by vocabulary ability. The evidence to support the possibility is that vocabulary test correlated well with the phoneme deletion test ($r=.33$, $p<.05$, correlations between vocabulary and phonological tests were shown in the Appendix E. Table 6-2-1) and reading score ($r=.51$, $p<.001$, see Table 6-2) when the differences of IQ were removed. This implies that the phoneme deletion ability may be related to vocabulary ability, which in turn relates to reading. Therefore, the relationship between reading and phoneme deletion was strikingly reduced when the controls were made for differences in the children's vocabulary ability.

As for the differences between boys and girls in reading ability, no significant difference was found between the sexes on tests of reading, phonological tests and visual skills in this study. Stevenson *et al.* (1982) tested children's reading ability in the United States, Japan and Taiwan, and revealed that very few significant sex differences were found in their research.

There were great differences between skilled readers of Chinese and less skilled readers of Chinese on visual skills, Chinese odd man out, the phoneme deletion test and the vocabulary test. These findings suggest that less skilled readers are poor at visual skills, detecting the odd word out and deleting phonemes.

At the end of this chapter, the following conclusions can be drawn from the Taiwan study:

1. Performance of the Visual Paired Associates was highly related to Chinese reading, even when IQ had been partialled out.

2. The set of Visual skills tests was the most powerful predictor of reading scores.

3. The Chinese Odd Man Out and Chinese Phoneme Deletion tests were significantly correlated with reading ability. The correlation between reading and Chinese Phoneme Deletion remained significant even when the effects of IQ had been controlled. However, when the differences in vocabulary and IQ were partialled out in the stepwise regression, score of phonological awareness did not significantly predict Chinese reading.

4. The three Chinese phonological tests showed no significant effect of position.

5. There were significant differences between skilled and less skilled readers on the visual skills tests, Chinese Odd Man Out test, phoneme deletion, and the vocabulary test.

6. There was no significant effect of gender on the phonological tests, visual skill and reading ability.

In summary, the results of the present study demonstrate that visual skills have been found to be more important in reading Chinese than phonological ability and that they may contribute significantly to Chinese reading ability.

CHAPTER SEVEN

THE HONG KONG STUDY

7.1 INTRODUCTION

From the results in Chapter Six, it was found that the correlation between visual skills and Chinese reading was significant. However, reading ability was also related to the Chinese Phoneme Deletion test even after the effects of IQ were partialled out. As discussed in last chapter, this may be caused by two factors: one is that learning Chinese depends on phonological skills, the other possibility is that learning Chinese characters via a phonetic system produces a significant relationship between Chinese reading and phoneme deleting ability. Therefore, it is worth investigating whether reading ability still strongly relates to some aspects of phonological awareness if children learn Chinese characters without the assistance of *Zhu-Yin-Fu-Hao* or *Pinyin.*

As described in Chapter Two, the teaching of Chinese reading introduces a phonetic system to young children when they start schooling in China and Taiwan. That is, all 6 year-old children in the People's Republic of China are taught to read alphabetically before beginning to learn the Chinese characters. Similarly, pupils in Taiwan learn *Zhu-Yin-Fu-Hao* during the first ten weeks of the first grade. Nowadays, Hong Kong is the one place where the majority of children learn Chinese as their first language and are not taught *Pinyin* or *Zhu-Yin-Fu-Hao* first. Moreover, children in Hong Kong learn the same standard Chinese script as Taiwan pupils while people in mainland China use a simplified script. If the Hong Kong children also show a significant correlation between Chinese reading and phonological skills, then the relationship can not be explained in terms of learning to read Chinese via *Zhu-Yin-Fu-Hao*.

Hong Kong is an international trading centre where, according to an official government publication (Hong Kong Government, 1990), "the ability to use language well is a key ingredient of success". The official languages of Hong Kong are English and Chinese. Both languages are used with equal status in all communication between the government and the public. Major government reports and publications of public interest are available in both languages. English and Chinese are also used as the media of instruction for most subjects. Virtually, all kindergartens use Chinese as the language of instruction and may teach a rudimentary form of English. In the primary schools, Chinese is used as the medium of instruction in the majority of schools, with English taught as a second language. The document 'The Hong Kong Education System' produced by the Hong Kong Government in 1981 states that 'the written form of Chinese is the standard traditional script, the dialect used by virtually all schools is Cantonese, the principal dialect of the people of Hong Kong and of the adjacent Guangdong Province' (p.16). Generally speaking, Cantonese is commonly spoken by the majority of the local Chinese population in Hong Kong. Cantonese and *Putonghua* are linked linguistically, as all the dialects in China are uninflected, monosyllabic and tonal with the spoken tone of a monosyllable playing an important role in conveying its meaning (as introduced in Sec. 2.1.2).

One of the purposes of the Hong Kong study is to focus on the relation between phonological awareness, visual skills and Chinese reading ability when children learn Chinese characters without recourse to *Zhu-Yin-Fu-Hao* or *Pinyin*. Another purpose is to investigate the correlation between phonological, visual skills and English reading among the native Chinese children. Before the relationship between phonological awareness, visual skills and reading in Hong Kong is described, some background information about the education system in Hong Kong will be introduced.

7.2 BACKGROUND INFORMATION ON HONG KONG PRIMARY EDUCATION

This section provides an overall review of the Hong Kong primary education system.

Since 1979, the Hong Kong Government has implemented nine years of free, compulsory and universal education for the vast majority of the 6-15 age-groups. The school system encompasses 2 or 3 years (normally 2 years) of kindergarten education, for children aged from 3 to 6 or 4 to 6. It is followed by six years of primary education (Primary 1-6; ages 6-12). In September 1991, 515,938 children were enrolled in 662 primary schools (Hong Kong Government, 1992). There follow 3 years of junior secondary education(Forms 1-3; ages 12 -15), two years of senior secondary education (Forms 4-5; ages 15-17) and one or two years of sixth form education (Forms lower 6 - Upper 6; ages 17-19, or Form middle 6, age 18) are offered to those students who have completed junior secondary school. Last comes higher education in universities or colleges. The education system in Hong Kong is presented in Fig. 7-1.

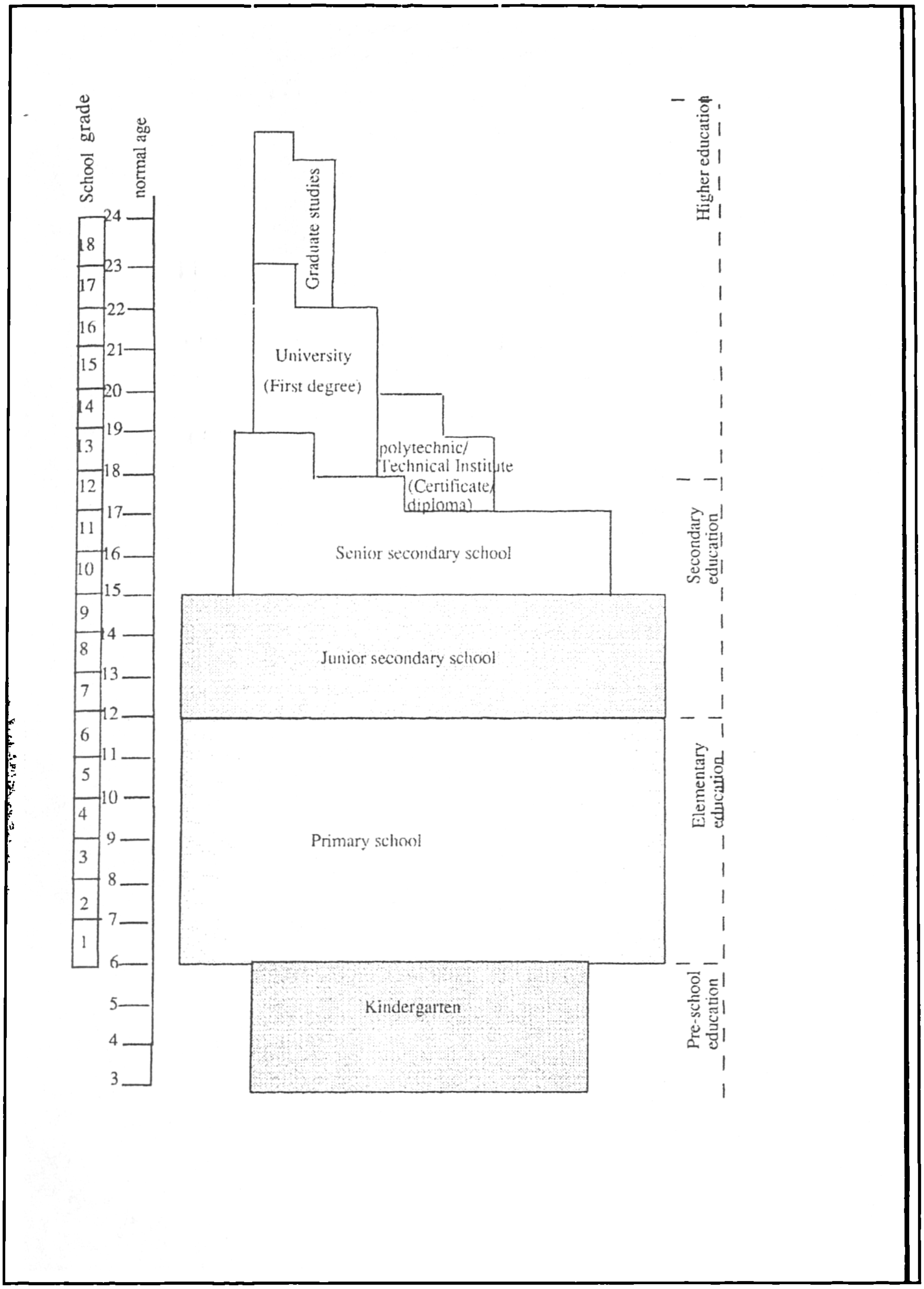


Fig. 7-1: The education system in Hong Kong

7.2.1 The age in the primary schools

Primary education is six years for the pupils aged from 6 to 12 years old. In 1980, a Green Paper entitled "Primary Education and Pre-primary Services" suggested that the age of entry to primary education should remain compulsory at six years of age on 1 September but become voluntary down to five years and 8 months of age. Parents are encouraged to enter their children at the lower age (Hong Kong Government, 1981, P.165). Therefore, the pupils' ages in any given class are fairly uniform.

Most primary schools operate on a bisessional basis, with children attending for a period of about four and a half hours either in the morning or in the afternoon, in order to meet the demand from an increasing school population in a situation of severe space constraints. There were no differences between the morning session and afternoon session in what is taught.

7.2.2 The curriculum in the primary schools

The primary curriculum aims to provide a broad, balanced and general education. The core curriculum in Hong Kong primary schools consists of nine subjects as in Table 7-1, which also shows the minimum number of teaching periods per week in each subject recommended by the Education Department. A syllabus for each core subject is prepared by the Curriculum Development Council. The total number of teaching periods is 38 per week in a bisessional school.

Primary schools are not differentiated by curriculum. Their treatment of the curriculum, however, varies considerably. Textbooks are submitted for review by publishers or may be obtained by the committee as a result of their being included in textbook lists submitted for Departmental approval. After evaluation, the titles of books which are considered fully suitable for use in schools are placed on the Recommended List, which is regularly reported and issued to all schools.

Table 7-1: Subjects of the primary school curriculum.

Group	Subjects \periods*\Grades	P1	P2	P3	P4	P5	P6
BASIC	Chinese language	11	10	9	8	8	8
	English language	5	6	7	8	8	8
	Mathematics	5	5	5	5	5	5
GENERAL	Health Education	1	1	1	1	1	1
	Primary Science	2	2	2	2	2	2
	Social studies	2	2	2	2	2	2
CULTURAL	Music	2	2	2	2	2	2
	Physical Education	2	2	2	2	2	2
	Art and craft	3	3	3	3	3	3
OTHERS: Religious, Ethics, Putonghua, etc.		5	5	5	5	5	5
Total		38	38	38	38	38	38

**Periods stand for total periods for each subject per week, most schools adopt a 35-minute or 40-minute period.*

7.3 METHOD

7.3.1 Description of subjects

42 eight-year-old children (21 boys, 21 girls), who have not learned *Pinyin* or *Zhu-Yin-Fu-Hao* and cannot speak *Putonghua*, from the Dr.Catherine F. Woo Memorial School participated in the study. Their average age was 8.88 years. Children whose first language was not Chinese (Cantonese) and those with mental retardation were excluded.

7.3.2 Description of test materials

The following tests were given to Hong Kong children:

1. Reading tests:

   a. Chinese reading test: Chinese Characters Recognition Test.

   b. English reading test: Schonell Reading Test.

2. Visual skill tests:

   a. Visual Paired Associates.

   b. Visual Form Discrimination.

3. IQ test: Coloured Progressive Matrices

4. Vocabulary test: British Picture Vocabulary Scale

5. Phonological tests:

   a. Odd Man Out Tests: English Odd Man Out Test, Chinese Odd Man Out Test, and Chinese Non-words Odd Man Out Test.

   b. Phoneme Deletion Test: Chinese phoneme deletion and English phoneme deletion tests.

These various test materials are explained more fully in Chapter Four.

7.3.3 Procedures of testing

Pupils were withdrawn from classes one by one and individually tested by examiners trained in the administration of the test. In order to avoid the language barrier, one of the examiners could speak the native Cantonese with subjects. The whole testing took approximately seventy minutes per child. Testing was divided into two sections according the balance of verbal and nonverbal types: the first section included the IQ test, Chinese reading test, Visual Form Discrimination, and Odd Man

Out test (English version, Chinese word version and Chinese non-word version); the other section consisted of English Reading, Visual Paired Associates, and Phoneme Deletion. All of the materials were explained to subjects in Cantonese and asked to response in Cantonese in the majority of tests except the phonological tests. The stimuli of vocabulary in the British Picture Vocabulary Scale were read out in English by one of examiners. The testing was carried out in April and May 1991 in Hong Kong.

7.3.4 Statistical methods

The data were analysed by 4 statistical tests:

1. Pearson's product-moment correlation.
2. t-test.
3. Multiple regression.
4. Analysis of variance (ANOVA) and analysis of covariance (ANCOVA).

All of these tests were performed using the Statistical Analysis System (SAS, 1988).

7.4 RESULTS

7.4.1 Descriptive statistics

The means and standard deviations on the measures of general intelligence, vocabulary ability, reading ability, phonological awareness, and visual skills are shown in Table 7-2. It can be seen that the mean score of Coloured Progressive Matrices (33.19) was very close to the score of the Taiwan subjects (32.30) and near the ceiling.

Table 7-2: Means and standard deviations among the tests for the Hong Kong subjects (N=42)
(Standard deviations in parentheses).

Tests	Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.	Schonell Reading	Chinese Reading
Mean	33.19 (1.97)	5.02 (2.09)	12.26 (3.98)	27.31 (3.03)	16.98 (3.54)	52.55 (5.42)
Max.	36	32	18	32	100	100

Tests	Chinese Nonword OMO	Chinese Word OMO	English Odd Man Out	Chinese Phoneme Deletion	English Phoneme Deletion
Mean	17.24 (5.33)	16.57 (4.72)	20.83 (4.18)	5.36 (2.59)	32.40 (3.53)
Max.	30	30	30	20	40

7.4.2 The relationship between phonological test, visual skills and reading in Chinese and English

7.4.2.1 The correlation between Chinese reading test and other tests

The correlations between the Chinese reading test, visual skills, and phonological tests are shown in Table 7-3.

It is obvious that there was a high correlation between Chinese reading and Visual Paired Associates ($r=.70$, $p<.001$) and significant correlations between Chinese reading and both Chinese Phoneme Deletion and English Phoneme Deletion, $r=.41$, $p<.01$; $r=.32$, $p<.05$, respectively. In contrast, a negative correlation was found between Chinese Non-word Odd Man Out test and Chinese reading ($r=-.37$, $p<.05$).

Table 7-3: The pattern of correlation among the Chinese reading test and other tests

a. The correlation of Chinese reading score and each test

Tests	Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.	English OMO
Chinese reading	.05	.00	.70***	-.19	-.00

Tests	Chinese Non-word OMO	Chinese OMO	English Phoneme Deletion	Chinese Phoneme Deletion
Chinese reading	-.37*	-.07	.32*	.41**

b. Partial correlation of Chinese reading score and each test, Coloured Progressive Matrices as a partial variable

Tests	BPVS	Visual Paired Associ.	Visual Form Discri.	Eng. OMO	Chi. Non-word OMO	Chi. OMO	Eng. Pho.Del.	Chi. Pho. Del.
Chinese reading	-.01	.70***	-.21	-.01	-.37*	-.09	.32*	.41**

* p<.05   ** p<.01   *** p<.001

7.4.2.2 The correlation between English reading test and other tests

There was a significant correlation between Visual Paired Associates and reading ($r=.36$, $p<.05$). No significant correlation existed between the English reading and the subtests of the phonological test except Chinese Phoneme Deletion ($r=.59$, $p<.001$).

When the effects of IQ are partialled out, the correlations between reading and other tests were similar to the above results.

Table 7-4: The pattern of correlation among the English reading test and other tests

a. The correlation of English reading and each test

Tests	Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.	English OMO
English reading	.13	.18	.36*	-.14	.01

Tests	Chinese Non-word OMO	Chinese OMO	English Phoneme Deletion	Chinese Phoneme Deletion
English reading	-.23	.01	.29	.59***

b. Partial correlation of English reading and each test, Coloured Progressive Matrices as a partial variable

Tests	BPVS	Visual Paired Associ.	Visual Form Discri.	Eng. OMO	Chi. Non-word OMO	Chi. OMO	Eng. Pho. Del.	Chi.Pho. Del.
English reading	.15	.36*	-.17	-.02	-.29	-.03	.26	.59***

* $p<.05$ ** $p<.01$ *** $p<.001$

7.4.2.3. The intercorrelation of phonological subtests

From Table 7-5, it can be seen that the three Odd Man Out tests were highly intercorrelated, ranged from .33 to .71 ($p<.05$ to $p<.001$).

It is worth noting that the correlation between Chinese word and Chinese non-word versions of the Odd Man Out test was high. This implies that these two tests are similar. The Phoneme Deletion tests (English and Chinese versions) were not significantly correlated with the Odd Man Out tests.

Table 7-5: The intercorrelation of phonological tests

a. Correlation of phonological tests

Coefficient	CNOMO	EOMO	CPD	EPD
COMO	.71***	.33*	.18	.16
CNOMO	-	.42**	-.00	-.05
EOMO	-	-	.06	.04
CPD	-	-	-	.28
EPD	-	-	-	-

b. Partial correlation of phonological tests, Coloured Progressive Matrices as a partial variable

Coefficient	CNOMO	EOMO	CPD	EPD
COMO	.68***	.29	.18	.07
CNOMO	-	.38*	-.02	-.17
EOMO	-	-	.05	-.04
CPD	-	-	-	.28
EPD	-	-	-	-

* $p<.05$ ** $p<.01$ *** $p<.001$

7.4.3 Which factor predicts Chinese and English reading?

In attempting to assess the power of the tests in predicting reading in Chinese and English, two stepwise regression analyses were performed. In these, Chinese reading ability and English reading ability were the dependent variables. IQ, English vocabulary ability, a single phonological score, a single visual score tests were predictor variables to predict English reading ability. IQ, a single phonological score, a single visual score tests were predictor variables to predict Chinese reading ability. All of the scores of the phonological tests were standardized, and combined into a single phonological score. Additionally, both visual skills tests were also standardized and combined into a single visual score.

7.4.3.1 Chinese reading

The visual skills score was the only significant predictor in the regression to predict Chinese reading ($F(1, 40)=11.16$, $p<.01$, $R^2=.2182$) when IQ, the set of phonological tests (Odd Man Out tests and Phoneme Deletion tests), and the scores of visual skills set were the predictors. Table 7-6 presents the results of stepwise regression. If the Odd Man Out tests and the Phoneme Deletion test were entered separately, the visual skills score was still the most significant predictor, and the score of phoneme deletion tests was marginally significant, $F(2, 39)=3.79$, $p=.0589$, $R^2=.29$.

Table 7-6: Summary of multiple stepwise regression analysis on predicting Chinese reading.

A. Combined phonological tests
IQ, phonological tests, and visual skills as predictor variables

variables	R^2 Changed	F	p
Visual Skills	.22	11.16	.0018

Overall $F(1, 40)=11.16$, $p<.0018$; $R^2=.22$

B. Separate phonological tests
IQ, oddity test, phoneme deletion test, and visual skills as predictor variables

variables	R^2 Changed	F	p
Visual skills	.22	11.16	.0018
Phoneme deletion	.07	3.79	.0589

Overall $F(2, 39)=7.86$, $p<.0014$; $R^2=.29$

Table 7-7 shows the results of the fixed order regression to predict Chinese reading. The regression is to test how powerfully phonological tests or visual skills tests predict reading ability when the differences in IQ have been partialled out. The dependent variable was 'Chinese reading score' and the first step entered in the analysis was IQ (Coloured Progressive Matrices). The second step was the score of the set of phonological tests, followed by the score of visual skills set; or the score of the visual skills set, followed by the score of the single phonological tests.

Table 7-7: Summary of fixed-order multiple regression on predicting Chinese reading

Variables	R^2 changed	cumulative R^2
First step: Coloured Progressive Matrices	.0022	.0022
Second step: phonological tests	.0235	.0257
Third step: visual skills	.2156***	.2413
or Second step: visual skills	.2173***	.2195
Third step: phonological tests	.0218	.2413

*** p<.001

When we examined the fixed-order regression, it is striking that the amount of variance in Chinese reading scores went up from 0.22% to 21.95% (p<.001) when the visual score was entered into the equation in step 2. Nevertheless, when the phonological score was entered in step 2, the amount of variance only went up from 0.22% to 2.57% (n.s.). The contribution of the phonological score was much less than that of visual score. When the phonological score was entered as the third step after visual score, the amount just went up from 21.95% to 24.13% (n.s.). However, if the visual skill was entered into the regression after the phonological score as the third step, the multiple correlation jumped from 2.57% to 24.13% (p<.001).

7.4.3.2 English reading

When the Odd Man Out tests and the Phoneme Deletion tests were combined together, no variable entered the stepwise equation (p=.05) to predict English reading. However, if phoneme deletion tests entered separately from the score of the Odd Man Out tests, with IQ, vocabulary, Visual skills as predictors, the score of the phoneme deletion tests was the only significant predictor in the stepwise regression, $F(1, 40)=14.45$, $p<.001$, $R^2=.27$.

The results of 4-steps fixed-order multiple regressions are reported in Table 7-8. It is evident that when the visual score was entered into the equation in step 3, the amount of variance in English reading scores went up from 4.14% to 8.24%. However, when the phonological score was entered in step 3, the amount of variance went up from 4.14% to 4.89%.

Table 7-8: Summary of fixed-order multiple regression on predicting English reading

Variables	R^2 changed	cumulative R^2
First step: Coloured Progressive Matrices Second step: British Picture Vocabulary Scale	.0179 .0241	.0179 .0414
Third step: phonological tests	.0075	.0489
Fourth step: visual skills	.0485	.0899
or Third step: visual skills	.0410	.0824
Fourth step: phonological tests	.0075	.0899

7.4.4 Analyses of phonological tests

In this section, performance by Hong Kong children on the phonological tests is analysed.

7.4.4.1. Analyses of Odd Man Out Tests

English Vs Chinese Word Vs Chinese non-word Odd Man Out Tests

A two factors 3 x 3 repeated measures ANOVA (version (English, Chinese word, and Chinese non-word) x position (first, middle and last)) revealed that there were significant main effects on version, $F(2, 82)=19.29$, $p<.0001$; position, $F(2, 82)=14.13$, $p<.0001$. Furthermore, there was a significant two-way interaction between version and position, $F(4, 164)=6.29$ ($p<.0001$). The mean of three versions of the Odd Man Out tests is presented in Table 7-9.

Table 7-9: Mean number of three versions of Odd Man Out tests

Versions	First sound	Middle sound	Last sound	Total	Max.
English word	7.12	5.40	8.31	20.83	30
Chinese word	5.69	4.86	6.02	16.57	30
Chinese non-word	5.60	5.50	6.14	17.24	30
Total	18.41	15.76	20.47		-

Newman-Keuls post tests shows that the score for detecting the last sound was higher ($p<.05$) than the first sound difference which was also much higher ($p<.01$) than the middle sound difference. The results implied that the middle sound difference was the most difficult one for these subjects. On the various versions of Odd Man Out tests, the English version was significantly higher ($p<.0001$) than Chinese word version and Chinese non-word version. It is interesting to note that the mean score on the Chinese Non-word Odd Man Out was slightly higher than that on the Chinese Word Odd Man Out, although the difference did not reach the level of significance ($p=0.05$). Post test also showed that the last sound and the first sound detection in English Odd Man Out were significantly higher than the other subtests in Chinese Word Odd Man Out and Chinese Non-word Odd Man Out tests.

The above results were reanalysed using an analysis of covariance, with Coloured Progressive Matrices and vocabulary ability as covariates. The analysis showed a nonsignificant main effect of version, position, $F(2, 78)=1.23$, $p>.05$; $F(2, 78)=0.89$, $p>.05$, respectively. There was a significant 2 way interaction between various version and different positions, $F(4, 156)=2.51$, $p<.05$. These two analyses are summarized in the Appendix E. Tables 7-9-1 and 7-9-2.

7.4.4.2 Phoneme Deletion tests

7.4.4.2.1 English Phoneme Deletion test

Table 7-10 shows the performance on the English Phoneme Deletion test . A 2 x 2 (phoneme position (first x end) x syllable type (CVCC x CCVC)) analysis of variance was produced, with repeated measures on phoneme position, and syllable type, using the number correct as the dependent variable. The analysis showed significant main effect of position, $F(1, 41)=123.75$ ($p<.0001$); and syllable type, $F(1, 41)=77.24$ ($p<.0001$). There was also a significant 2 way interaction between phoneme position and syllable type, $F(1, 41)=99.23$, $p<.0001$. The summary of analysis of variance is demonstrated in the Appendix E. Table 7-10-1.

Table 7-10: Mean number of English Phoneme Deletion test

Position	First sound deletion		End sound deletion		Total	Max.
	CVCC	CCVC	CVCC	CCVC		
Mean	4.58	8.62	9.60	9.60	32.40	40
Total	13.21		19.20		.	.

Post test of the means showed that end sound deletion was much easier than first sound deletion ($p<.05$). Additionally, the CCVC type is significantly easier than CVCC type. The significant 2 way interaction was also investigated by post-tests. The CVCC first sound deletion was significantly lower than the other subtests in the English Phoneme Deletion test. Additionally, the performance on CVCC and CCVC of end sound deletion was better than the CCVC of first sound deletion.

Using an analysis of covariance, with Coloured Progressive Matrices and vocabulary ability as covariates, the results again revealed significant main effect of position, $F(1, 39)=7.39$, $p<.01$. There were no significant effects of type ($F(1, 39)=0.67$), $p>.05$), as well as 2 way interaction between version and syllable type, $F(1, 39)=1.61$, $p>.05$ (see the Appendix E. Table 7-10-2).

7.4.4.2.2 Chinese Phoneme Deletion Test

A one-way analysis of variance was also performed on the Chinese Phoneme Deletion test with the position (the first sound, and the end sound deletion) as independent variable. The analysis of variance showed a non-significant main effect of position, $F(1, 41)=2.80$ ($p>.05$). Table 7-11 shows the mean of the Chinese Phoneme Deletion test. The summary of analysis can be seen in the Appendix E. Table 7-11-1.

Table 7-11: Mean number of Chinese Phoneme Deletion test

Position	First	End	Total	Max.
Mean	2.41	2.95	5.36	20

7.4.5 The differences between the skilled readers and the less skilled readers

This section will investigate the differences between skilled readers and less skilled readers in Chinese and English.

7.4.5.1 The skilled readers of Chinese

These subjects were divided into skilled Chinese readers (Mean>= 52.55) and less skilled Chinese readers (mean < 52.55) in accordance with their Chinese reading scores. Table 7-12 shows the results of the t-test of the skilled and the less skilled Chinese readers.

The t-test results revealed that skilled Chinese readers performed better than less skilled Chinese readers on the Visual Paired Associates and the English reading test. However, the less skilled Chinese readers performed better than skilled readers on the Chinese Non-word Odd Man Out test.

Table 7-12: The t-test results of the skilled and the less skilled Chinese readers on all the tests

Tests	Means		diff.	t (d.f.=40)	p
	skilled (N=22)	less skilled (N=20)			
Coloured Progressive Matrices	33.09	33.30	-.21	-.34	n.s.
BPVS	4.91	5.15	-.16	-.37	n.s.
Visual Paired Associates	14.45	9.85	4.60	4.56	<.0001
Visual Form Discrimination	26.82	27.85	-1.03	-1.10	n.s.
Schonell Reading	18.18	15.65	2.53	2.45	<.05
Chinese Odd Man Out	15.50	17.75	-2.25	-1.57	n.s.
Chinese Nonword Odd Man Out	14.68	20.05	-5.37	3.74	<.001
English Odd Man Out	19.86	21.90	-2.04	-1.61	n.s.
Chinese Phoneme Deletion	6.05	4.60	1.45	1.86	n.s.
English Phoneme Deletion	33.00	31.75	1.25	1.15	n.s.

7.4.5.2 The skilled readers of English

The subjects were split into a group of 20 less skilled readers whose English reading scores were below the group average (Mean < 16.98) and a group of 22 skilled readers whose reading scores were above the group average (Mean >= 16.98). The results of the t-test on the two groups are shown in Table 7-13.

It is apparent that the Chinese Phoneme Deletion and the Chinese reading test displayed significant differences between the skilled readers of English and less skilled readers of English.

Table 7-13: The t-test results of the skilled and the less skilled English readers on all the tests

Tests	Means		diff. (skilled-less skilled)	t (d.f.=40)	p
	skilled	less skilled			
Coloured Progressive Matrices	33.14	33.25	-.11	-.14	n.s.
BPVS	5.14	4.90	0.24	0.36	n.s.
Visual Paired Associates	13.00	11.45	1.55	1.27	n.s.
Visual Form Discrimination	27.05	27.60	-0.56	-.59	n.s.
Chinese Reading	54.41	50.50	3.91	2.48	<.05
Chinese Odd Man Out	16.00	17.20	-1.20	-.82	n.s.
Chinese Nonword Odd Man Out	16.18	18.40	-1.22	-1.36	n.s.
English Odd Man Out	20.64	21.05	-.41	-.32	n.s.
Chinese Phoneme Deletion	6.32	4.30	2.02	2.71	<.01
English Phoneme Deletion	32.36	32.45	-.09	-.08	n.s.

The data concerning 't' ratios for all the tests on sex differences are summarized in the Appendix E. Table 7-14.

The analyses indicated that there was no significant difference between boys and girls on any of the phonological tests, visual skills tests or reading ability ($p>.05$). The only test on which the difference between means was slightly significant was the Coloured Progressive Matrices. This means that there is no significant difference between boys and girls on the visual skills tests, Odd Man Out tests and reading ability in this study.

7.5 DISCUSSION AND CONCLUSIONS

One of the aims in this investigation was to study the relation between phonological awareness, visual skills and learning to read Chinese among pupils who do not learn Chinese reading via *Zhu-Yin-Fu-Hao* or *Pinyin*. The results support the hypothesis that there is a high correlation between visual skills and Chinese Reading. There is also some evidence for the view that Chinese reading is highly related to phoneme deletion tests (English and Chinese) among these Hong Kong children, even after differences in IQ were controlled. Therefore, the results of this current study coincide with those of the Taiwan study: learning Chinese reading requires some aspects of phonological awareness, whether via a phonetic system or not.

The study was also intended to examine the relation between phonological awareness, visual skills and learning English for a native Chinese child. The findings from this research are that the Visual Paired Associates and Chinese Phoneme Deletion test were strongly related to English reading. This implies that native Chinese pupils may learn English differently from native English children.

It is worth noting that subjects found that the middle sound detection was the most difficult task in the three Odd Man Out tests, especially for the English Odd Man Out test. The phenomenon may be explained by two facts. One is that only three phonemes can be at the middle position in Chinese syllables, which may cause problems in detecting the middle sound of English odd man out task. The other is that all the words but one in the first sound detection task share the onset and part of rime (e.g., rot rod rock box) and that all the words but one in the last sound detection task rhyme (e.g., fan cat hat mat). It can be seen that all of words used in each task share the same vowel. However, the words in the middle sound detection task include one which differs from that rest in the vowel that forms the nucleus of the syllable (e.g., mop hop tap lop). It seems that the Hong Kong subjects found it harder to discriminate among vowels than among consonants.

The subjects performed better on the English Odd Man Out test than on the Chinese Word Odd Man Out test and the Chinese Non-word Odd Man Out test. It was surprising that the mean score in the Chinese Non-word Odd Man Out test was higher than that on the Chinese Word Odd Man Out test, although the difference did not reach significance. This may indicate that the words and non-words are not different for a child whose native language is Cantonese not *Putonghua*.

The reason why the subjects received high scores on the CCVC type of the first sound deletion test but low scores on the CVCC type of the first sound deletion test may be because there are not any blending consonants in Chinese syllables. Accordingly, the consonant clusters were always treated as two separate Chinese characters. Therefore, it is easy to parse two blending consonants. In contrast, the Chinese language is monosyllabic, and every character consists of one consonant and one or two vowels. Sometimes they just contain one vowel. Consequently, children always deal with one consonant and one vowel as a single unit in a Chinese character. The implication is that it is more difficult to parse the CVC(C) type of the first sound deletion for the Hong Kong subjects.

It was found that the Hong Kong subjects received low mean scores on the British Picture Vocabulary Scale (5.02 out of 32) and the Chinese Phoneme Deletion test (5.36 out of 20). This might have been expected because the BPVS was tested in English and the phoneme deletion may require the knowledge of Mandarin phoneme. The reason why BPVS was tested only in English not in Cantonese was time limitation in Hong Kong. There was not enough time to translate the test into Cantonese.

In summary, the following conclusions can be drawn from this investigation:

1. The visual skills score is the most significant predictor for Chinese reading.
2. The Visual Paired Associates is highly correlated with Chinese reading and English reading. However, the phoneme deletion tests are significantly related to Chinese reading even when the effects of IQ are partialled out.
3. The middle sound detection task is the most difficult part in the three versions of Odd Man Out test for the Hong Kong subjects.
4. End sound deletion is easier than the first sound deletion either in the English Phoneme Deletion or in the Chinese Phoneme Deletion. Particularly, achievement with the CCVC in the first sound deletion is superior to that with the CVCC of the first sound deletion.

On the whole, the evidence obtained in the present study suggests that learning Chinese reading requires visual skills, as well as some phonological knowledge (e.g., phoneme deletion) and native Chinese children may learn English in a dissimilar way from the English subjects.

CHAPTER EIGHT

COMPARISONS AND CONCLUSIONS

8.1 COMPARISONS OF THE U.K., TAIWAN AND HONG KONG STUDIES

This chapter focuses on the comparison of children's reading, visual, and phonological skills in the U.K., Taiwan and Hong Kong. It was intended to investigate the difference in children's phonological awareness and visual skills and to compare the relationship between phonological awareness, visual skills and reading in these three areas. This section gives us the opportunity to consider all three investigation.

The means and standard deviations for the U.K., Taiwan and Hong Kong subjects on the measures of reading ability, phonological awareness, and visual skills are displayed in Table 8-1. It is interesting to note that there was a great difference between Hong Kong and English subjects in the English reading. The difference is reasonable because English is not the mother tongue of the Hong Kong subjects even though they learn English from the first grade.

It can be seen that the Chinese subjects performed better than the English subjects on the Coloured Progressive Matrices. In addition, the Hong Kong subjects are slightly higher than the Taiwan subjects. Actually, it is a common finding that the average Chinese scores are typically higher than those found for American or British populations, for all ages investigated (Chan & Vernon, 1988; Court, 1991). The differences between the three groups on the Coloured Progressive Matrices will be partialled out by using analyses of covariance when the performance on visual skills and phonological tests is analyzed. The comparison of the phonological tests and visual skills between the three groups will be presented in the later sections.

Table 8-1: Means and standard deviations among the tests for the U.K., Taiwan and Hong Kong subjects (Standard deviations in parentheses)

Groups\tests	English reading	Chinese reading	Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.
U.K.	34.84 (13.31)	-	24.64 (4.44)	17.64 (2.95)	11.91 (4.16)	24.51 (3.89)
Taiwan	-	60.94 (8.74)	32.30 (2.79)	27.58 (2.19)	11.98 (3.61)	27.54 (3.61)
Hong Kong	16.98 (3.54)	52.55 (5.42)	33.19 (1.97)	5.02 (2.09)	12.26 (3.98)	27.31 (3.03)
Max.	100	100	36	32	18	32

Groups\tests	English OMO	Chinese Non-word OMO	Chinese OMO	English Phoneme Deletion	Chinese Phoneme Deletion
U.K.	22.8 (3.42)	17.29 (4.19)	-	34.09 (6.86)	-
Taiwan	-	19.72 (4.36)	20.98 (4.36)	-	16.84 (2.67)
Hong Kong	20.83 (4.18)	17.24 (5.33)	16.57 (4.72)	32.40 (3.53)	5.36 (2.59)
Max.	30	30	30	40	20

8.1.1 Comparison of the relationship between the reading ability and visual or phonological skills

The correlations between the Chinese reading test, English reading test, visual skills, and phonological tests are shown in Table 8-2. It is obvious that there are high correlations between Chinese reading and Visual Paired Associates in the Hong Kong subjects (r=.70, p<.001) and in the Taiwan subjects (r=.76, p<.001). In the Taiwan group, the vocabulary test, particularly, was also highly related to Chinese reading (r=.50, p<.001). In addition, significant correlations also exist between IQ, Visual Form Discrimination, Chinese Odd Man Out, Chinese Phoneme Deletion and Chinese Reading, but not between Chinese Non-word Odd Man Out and Chinese reading in the Taiwan group.

Table 8-2: The pattern of correlation between the reading test and other tests

a. The correlation of the Chinese reading and each test

Groups		Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.
Chinese reading	Taiwan (N=50)	.39**	.50***	.76***	.36**
	Hong Kong (N=42)	.05	-	.70***	-.19
	Significance levels (d.f.=90)	1.67*	-	0.60	2.63*

Groups		English OMO	Chinese Non-word OMO	Chinese Word OMO	English Phoneme Deletion	Chinese Phoneme Deletion
Chinese reading	Taiwan (N=50)	_	.26	.40**	-	.55***
	Hong Kong (N=42)	-.00	-.37*	-.07	.32*	.41**
	Significance levels (d.f.=90)	-	3.02**	2.28*	-	.84

b. The correlation of the English reading and each test

Groups		Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.
Schonell reading	U.K. (N=45)	.56***	.41**	.20	.43**
	Hong Kong (N=42)	.13	.18	.36*	-.14
	Significance levels (d.f.=85)	2.27*	1.14	.79	2.72**

Groups		English OMO	Chinese Non-word OMO	Chinese Word OMO	English Phoneme Deletion	Chinese Phoneme Deletion
Schonell reading	U.K. (N=45)	.37*	.41**	-	.59***	-
	Hong Kong (N=42)	.01	-.23	.01	.29	.59***
	Significance levels (d.f.=85)	1.72*	3.5***	-	1.72*	-

* p<.05 ** p<.01 *** p<.001

On English reading, all phonological tests were highly correlated with English reading score in the UK subjects, ranging from .37 to .59 ($p<.05$; $p<.001$). The Phoneme Deletion Test, particularly, was highly related to English reading in the U.K. group. A significant correlation also existed between reading and BPVS, but not between reading and Visual Paired Associates in the U.K. group. For the Hong Kong subjects, no significant correlation existed between English reading and any of the phonological tests except the Chinese Phoneme Deletion. However, there was a significant correlation between Visual Paired Associates and English reading. When Coloured Progressive Matrices had been partialled out, the correlation between reading and other tests (as shown in the Appendix E Table 8-2-1) was similar to Table 8-2.

If one look at the comparative results in Table 8-2, it can be seen that the correlations between Chinese reading and the Visual Form Discrimination test, the Chinese Non-word Odd Man Out test and the Chinese Word Odd Man Out test for Taiwan group were significantly higher than those for Hong Kong group. Similarly, for the U.K. subjects, the relations between English reading and the Visual Form Discrimination test as well as three phonological tests (EOMO, CNOMO, EPD) were also stronger than those for the Hong Kong subjects.

8.1.2 Comparison of the regression results

The IQ, vocabulary, phonological score, and visual score were entered into multiple regression as predictors of reading ability.

8.1.2.1 Predicting English reading

The results of the stepwise regression analysis are presented in Table 8-3. These data indicates that a single score of phonological tests was the most powerful predictor of English reading for English children. Vocabulary and IQ were also significant factors in predicting English reading in the U.K. group. Visual skill was not found to be a significant predictor of English reading ability. Nevertheless, no variable entered in the stepwise regression in the Hong Kong group to predict English reading when phonological tests were combined as a single set. If the score of Odd Man Out tests and the score of the phoneme deletion tests were entered separately, the score of phoneme deletion tests was the most powerful predictor of English reading in both of English and Hong Kong groups.

Table 8-3: Summary of stepwise regression analysis for two groups in predicting English reading.

A. Combined phonological tests

IQ, vocabulary test(BPVS), phonological tests, and visual skills as predictor variables

variables	R^2 Changed	F	p
U.K. subjects			
Phonological test	.44	33.34	.0001
IQ	.09	8.43	.0059
BPVS	.05	4.95	.0316
Overall $F(3, 41)=18.98$, $p<.0001$; $R^2=.58$			
Hong Kong subjects			
No variable entered the regression			

B. Separate phonological tests

IQ, vocabulary test (BPVS), oddity test, phoneme deletion test, and visual skills as predictor variables

variables	R^2 Changed	F	p
U.K. subjects			
Phoneme deletion	.35	23.05	.0001
IQ	.14	11.13	.0018
Oddity	.06	5.25	.0272
British Picture Vocabulary Scale	.05	4.46	.0410
Overall $F(4, 40)=14.36$, $p<.0001$; $R^2=.59$			
Hong Kong subjects			
Phoneme deletion	.27	14.45	.0005
Overall $F(1, 40)=14.45$, $p<.001$, $R^2=.27$			

8.1.2.2 Predicting Chinese reading

Table 8-4 shows the results of the stepwise regression to predict Chinese reading.

Table 8-4: Summary of Multiple Stepwise Regression Analysis for two groups in predicting Chinese reading.

A. Combined phonological tests

IQ, vocabulary test, phonological tests, and visual skills as predictor variables

variables	R^2 changed	F	p
Taiwan subjects			
Visual Skills	.45	39.84	.0001
IQ	.06	5.63	.0218
BPVS	.05	4.73	.0348

Overall $F(3, 46)=19.32$, $p<.0001$; $R^2=.56$

Hong Kong subjects

IQ, phonological tests, and visual skills as predictor variables

variables	R^2 Changed	F	p
Visual Skills	.22	11.16	.0018

Overall $F(1, 40)=11.16$, $p<.0018$; $R^2=.22$

B. Separate phonological tests

Taiwan subjects

IQ, vocabulary test, oddity test, phoneme deletion test, and visual skills as predictor variables

same as the results in section A.

Hong Kong subjects

IQ, oddity test, phoneme deletion test, and visual skills as predictor variables

variables	R^2 Changed	F	p
Visual skills	.22	11.16	.0018
Phoneme deletion	.07	3.79	.0589

Overall $F(2, 39)=7.86$, $p<.0014$; $R^2=.29$

On predicting Chinese reading, for the Hong Kong and Taiwan subjects, visual skills provided the best variable to predict Chinese reading ability ($F(1, 40)=11.16$, p<.01, for the Hong Kong group, and F(1, 48)=39.84, p<.0001 for the Taiwan group). IQ was the second variable to significantly predict Chinese reading (F(2, 47)=5.63, p<.0218), and BPVS was the final variable in this multiple regression equation (p<.05) for the Taiwan group. Phonological ability was not found to be a significant predictor of reading in the Taiwan group, even though the score of Odd Man Out tests and the score of the phoneme deletion tests separately entered the multiple regression. In the Hong Kong group, the score of phoneme deletion tests was also entered into the stepwise regression (p=.0589) when oddity tests and phoneme deletion tests entered separately.

8.1.3 Comparison of phonological awareness

In this section, performance by the English, Hong Kong and Taiwan children on the phonological tests is analyzed.

8.1.3.1 Odd Man Out Tests

8.1.3.1.1 English Odd Man Out

A two-way analysis of variance was conducted to examine the difference between the UK group and the Hong Kong group on the English Odd Man Out Test. Groups were manipulated between subjects, and positions of oddity words were manipulated within subjects. The mean of the English Odd Man Out is presented in Table 8-5 and shown graphically in Figure 8-1.

Table 8-5: Mean number of the English Odd Man Out

Group \ position	First	Middle	Last	Total	Max.
Hong Kong	7.12	5.40	8.31	20.83	30
UK	7.47	8.16	7.18	22.81	30
Total	14.59	13.56	15.49	.	

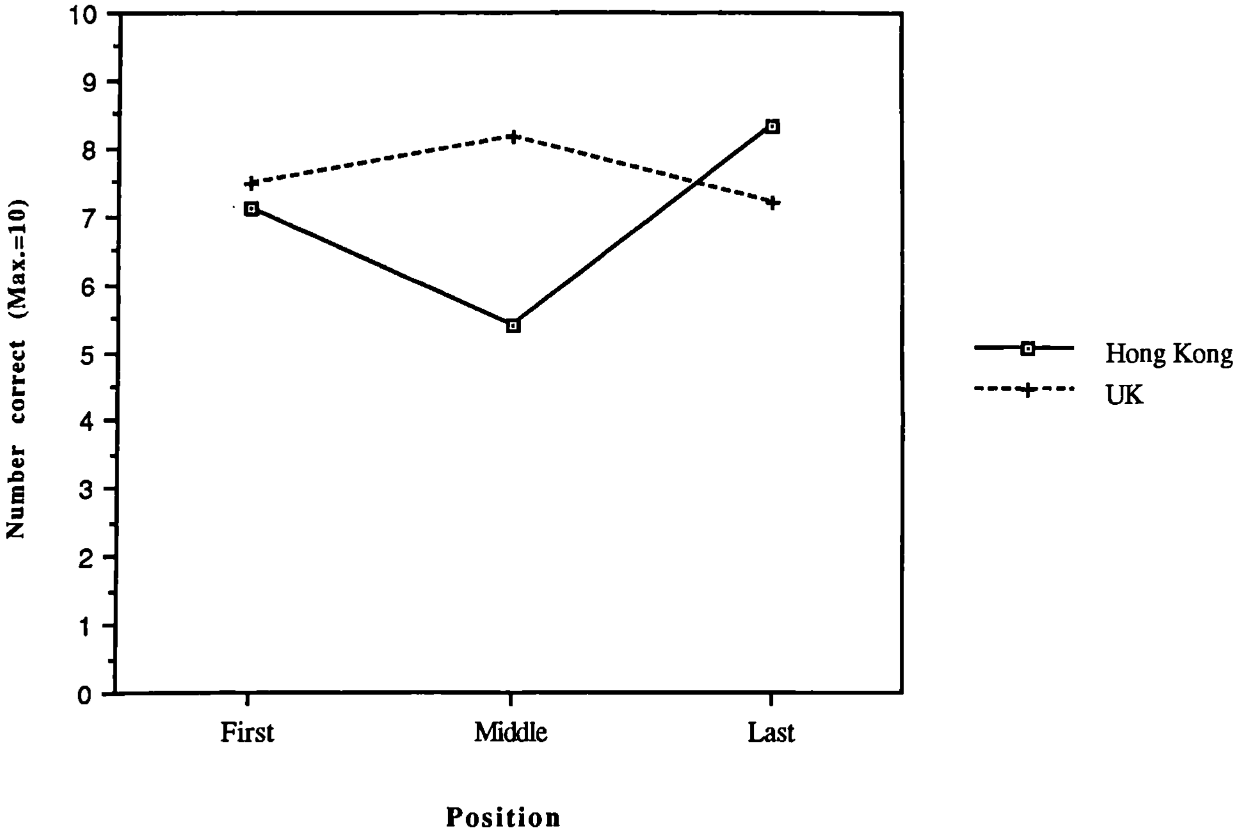


Fig. 8-1: Average level of English Odd Man Out scores in the U.K. and Hong Kong groups.

Analysis of variance showed that mean score differed significantly by group, $F(1, 85)=5.80$ ($p<.05$) and by position, $F(2, 170)=7.08$ ($p<.01$). Furthermore, there was a significant interaction between group and position, $F(2, 170)=29.25$ ($p<.0001$).

Post tests (Newman-Keuls test) showed that the middle sound difference was the most difficult task for the Hong Kong subjects ($p<.001$). Contrariwise, English subjects achieved higher scores on the middle sound task than the first sound and the last sound tasks ($p<.05$). Most important, the English children were significantly superior ($p<.001$) to the Hong Kong children on the middle sound different part of the test.

Analysis of covariance was used in order to partial out the effects of IQ (Coloured Progressive Matrices), and English reading in each group. The difference between ANOVA and ANCOVA was that there was no significant main effect of group, $F(1, 83)=1.55$, $p>.05$. That means that the significant differences between the U.K. group and Hong Kong group were clearly related to IQ, and English reading. However, the effect of position and the 2 way (group x position) interaction remained significant. The English subjects were still superior to Hong Kong subjects in middle sound detecting after the influence of the two covariates was partialled out. The summary of analyses is presented in the Appendix E. Table 8-5-2.

8.1.3.1.2 Chinese Word Odd Man Out

A two-factor ANOVA (group (Hong Kong, Taiwan) x position (first, middle and last)) revealed that there was a significant main effect on group, $F(1, 90)=21.66$, $p<.0001$, and a two-way interaction between group and position, $F(2, 180)=5.13$ ($p<.01$); but there was no significant effect on position, $F(2, 180)=1.43$, $p>.05$. The mean of two groups of the Chinese Word Odd Man Out tests is presented in Table 8-6 and Fig. 8-2. Newman-keuls post tests show that the Hong Kong subjects performed significantly worse than the Taiwan groups on all of the three subtests ($p<.05$).

Table 8-6: Mean number of Chinese Word Odd Man Out

Group \ position	First	Middle	Last	Total	Max.
Hong Kong	5.69	4.86	6.02	16.57	30
Taiwan	6.94	7.20	6.84	20.98	30
Total	12.63	12.06	12.86	.	

The results of the ANCOVA, IQ, and Chinese reading as covariates, was similar to the above results. The summary of these analyses can be seen in the Appendix E. Table 8-6-1 and Table 8-6-2.

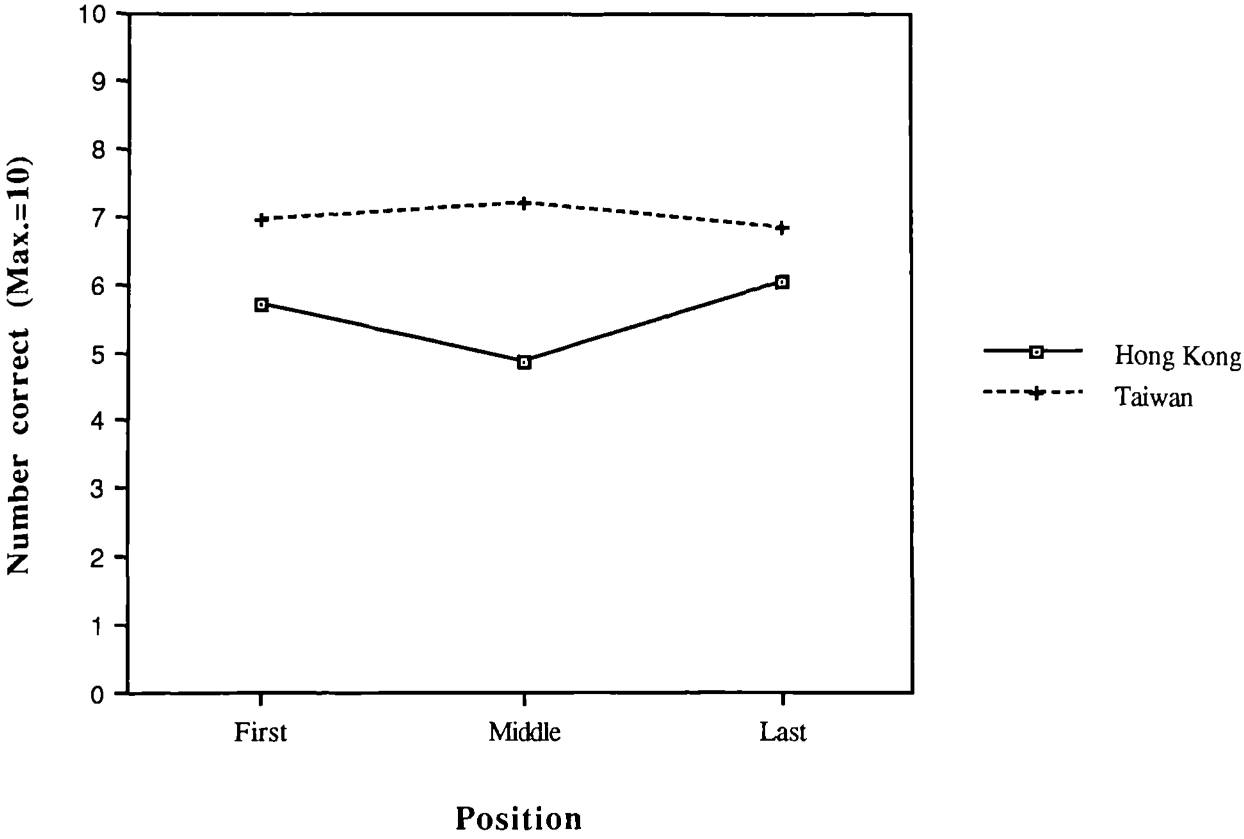


Fig. 8-2: Average level of Chinese Odd Man Out scores in the Taiwan and Hong Kong groups.

8.1.3.1.3 Chinese Non-word Odd Man Out

A 3 x 3 mixed design analysis of variance was also performed on Chinese Non-word Odd Man Out. Group (UK, Taiwan and Hong Kong) was a between-subjects variable, while position (the first sound, the middle and the last sound difference) was a within-subjects variable. The analysis of variance showed a significant main effect of group, F(2, 134)=4.47, (p<.05), but no significant effect of position, F(2, 134)=2.12 (p>.05) and no significant interaction between group and position were found, F(4, 268)=.43 (p>.05). Post hoc tests showed that the Taiwan groups performed significantly higher than the Hong Kong group and the U.K. group. There was no significant difference between the English group and the Hong Kong group. Table 8-7 and Fig. 8-3 show the mean of the Chinese Non-word Odd Man Out.

Table 8-7: Mean number of the Chinese Non-word Odd Man Out

Group \ position	First	Middle	Last	Total	Max.
Hong Kong	5.60	5.50	6.14	17.24	30
UK	5.73	5.69	5.87	17.29	30
Taiwan	6.68	6.32	6.72	19.72	30
Total	18.01	17.51	18.73	.	

The results were reanalysed using an analysis of covariance, with Coloured Progressive Matrices as covariate. The analysis showed main effect of group, F(2, 133)=5.32, p<.01. There was no effect of position, F(2, 133)=0.12, p>.05, and no effect of interaction, F(4, 266)=0.26 (p>.05). These two analyses are summarized in the Appendix E. Table 8-7-1 and Table 8-7-2.

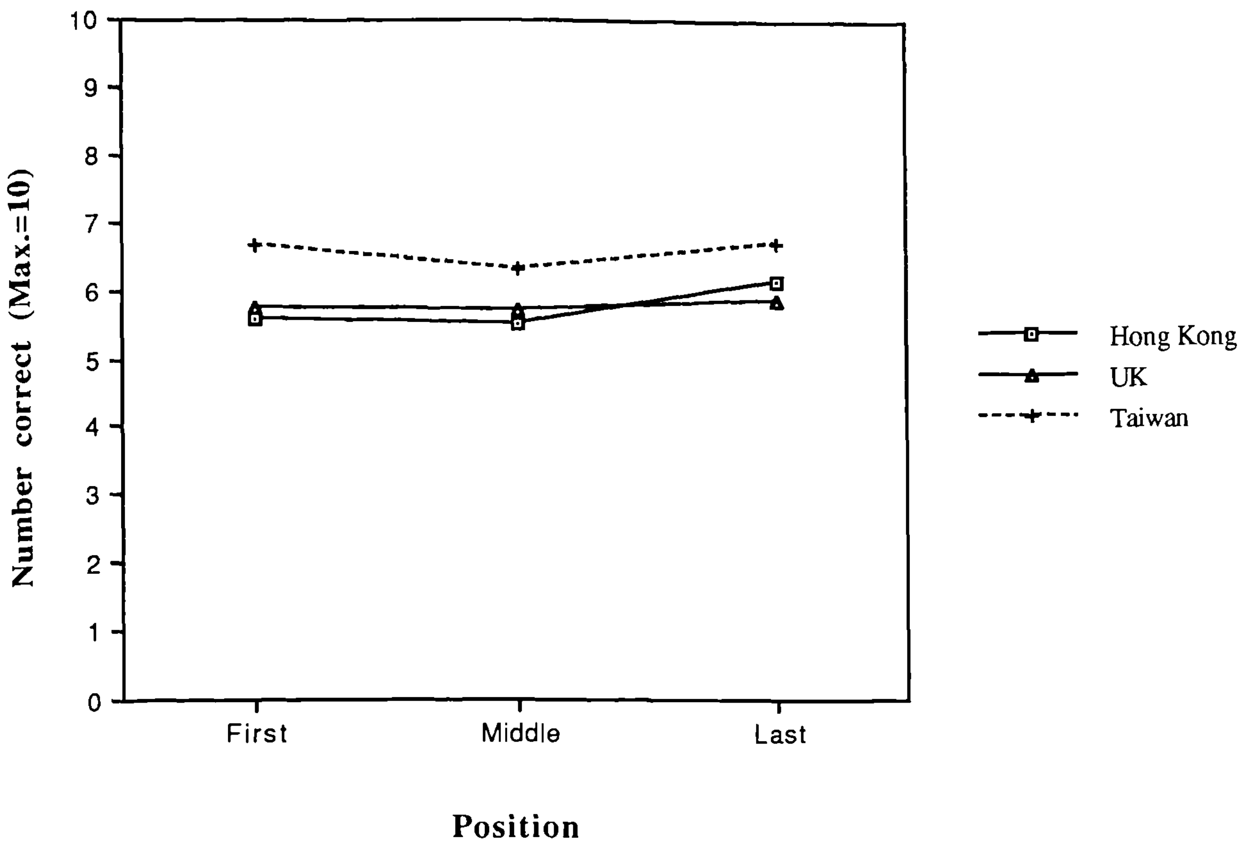


Fig. 8-3: Average level of Chinese Non-word Odd Man Out scores in the three groups.

8.1.3.2 Phoneme Deletion Tests

8.1.3.2.1 English Phoneme Deletion test

Table 8-8 and Figure 8-4 show the performance by the two groups (U.K. and Hong Kong) on the English Phoneme Deletion. A 2 x 2 x 2 (group x phoneme position (first/end) x syllable type (CVCC/CCVC)) analysis of variance was produced, with repeated measures on phoneme position, and syllable type, using the number correct as the dependent variable. The analysis showed a main effect of position, $F(1, 85)=121.72$ ($p<.0001$) and a significant 3 way interaction between group, phoneme position and syllable type, $F(1, 85)=103.57$, $p<.0001$. There were significant 2-way interactions between group and position, group and type, and position and type. However, a main effect of group and a main effect of syllable type were not significant, $F(1, 85)=2.03$ ($p>.05$) and $F(1, 85)=3.46$ ($p>.05$), respectively. The summary of analysis of variance is shown in the Appendix E. Table 8-8-1.

Table 8-8: Mean number of the English Phoneme Deletion

Group\position	First sound deletion		End sound deletion		Total	Max.
	CVCC	CCVC	CVCC	CCVC		
Hong Kong	4.59	8.62	9.60	9.60	32.41	40
UK	9.09	6.64	9.40	8.96	34.09	40
Total	13.68	15.26	19.00	18.56	.	.

Post-tests of the means showed that the end sound deletion was much easier than the first sound deletion ($p<.05$). The significant 3 way interaction was also investigated by post-tests. The UK children were significantly better than the Hong Kong children only on the CVCC first sound deletion ($p<.0001$).

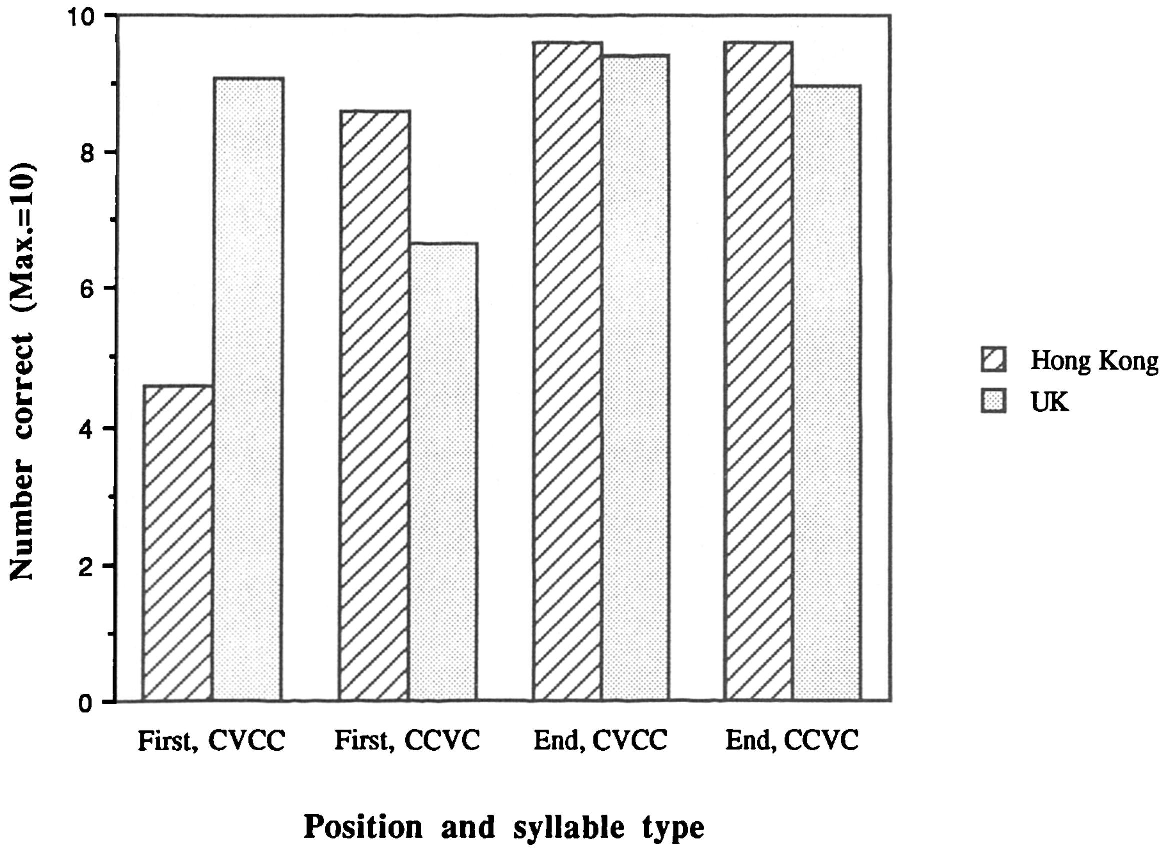


Fig. 8-4: Average level of the English Phoneme Deletion Test scores in the U.K. and Hong Kong groups.

On the other hand, the Hong Kong students were significantly better than the English children on the CCVC first sound deletion. That means that the CVCC type of first sound deletion is much more difficult than CCVC type of first sound deletion for Chinese subjects, but not for English children. For example, to delete /s/ from "stop" is much easier than to delete /b/ from "bus" for the Hong Kong group. In contrast, English children found the CCVC type of first sound deletion to be more difficult than the CVCC.

Using an analysis of covariance, with Coloured Progressive Matrices, and English reading as covariates, the results again presented significant main effect of position, $F(1, 83)=23.30$, $p<.0001$, as well as 3 way interactions, $F(1, 83)=21.54$, $p<.0001$. The pattern was similar to the results of ANOVA (see the Appendix E. Table 8-7-2). Post test of the means still showed that the U.K. subjects achieve the superiority than the Hong Kong group ($p<.0001$) on the CVCC of the first sound deletion task, and the inferiority on the CCVC of the first sound deletion.

8.1.3.2.2 Chinese Phoneme Deletion Test

A two-way (2 x 2) analysis of variance was also performed on Chinese phoneme deletion tests with group (the Hong Kong and Taiwan groups) and position (the first sound, the end sound deletion) as independent variables. The repeated measure was position. Table 8-9 and Fig. 8-5 show the means of the Chinese Phoneme Deletion tests.

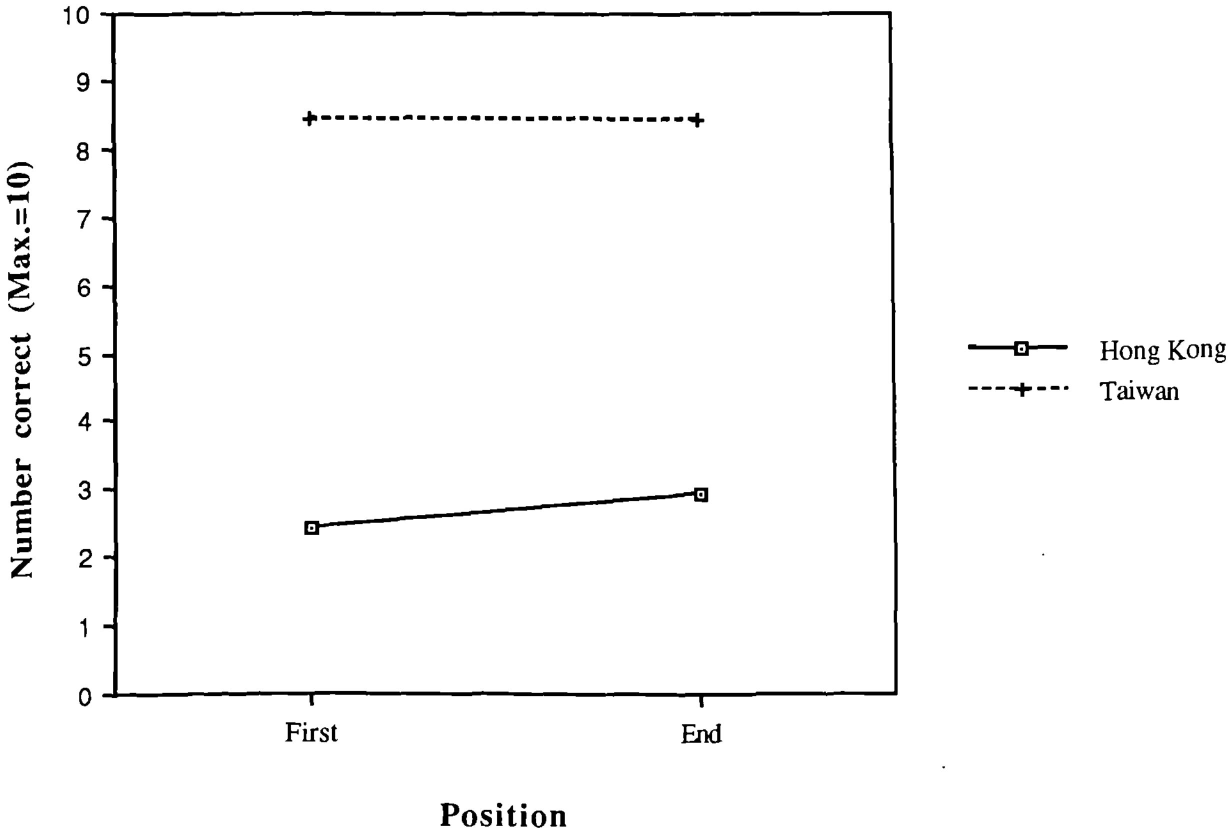


Fig. 8-5: Average level of the Chinese Phoneme Deletion Test scores in the Taiwan and Hong Kong groups.

Table 8-9: Mean number of Chinese Phoneme Deletion test

Groups \ Position	First	End	Total	Max.
Hong Kong	2.40	2.95	5.35	20
Taiwan	8.42	8.42	16.84	20
Total	10.82	11.37	-	

The analysis of variance showed a significant main effect of group, F(1, 90)=433.85 (p<.0001), but no significant effects on position, F(1, 90)=2.05 (p>.05) and no interaction between group and position, F(1, 90)=2.05 (p>.05). The results were reanalysed using an analysis of covariance, with Coloured Progressive Matrices, and Chinese reading as covariates. The analysis also only showed a significant main effect of group, F(1, 88)=296.28, p<.0001. These two analyses are summarized in the Appendix E. Tables 8-9-1 and 8-9-2.

8.1.4 Comparisons of visual skills between three groups

The mean scores of visual skills tests are shown in Table 8-10.

Table 8-10: Mean number of visual skills tests in three groups

Tests	Groups	Scores	Max.
Visual Form Discrimination	U.K.	24.51	32
	Hong Kong	27.31	
	Taiwan	27.54	
Visual Paired Associates	U.K.	11.91	18
	Hong Kong	12.26	
	Taiwan	11.98	

On the Visual Form Discrimination, the UK group showed the lowest mean score, and the difference between groups was significant, $F(2, 134)=10.36$, $p<.0001$. However, there was no significant difference between the two Chinese subgroups. It is worth noting that the difference between groups was non-significant, $F(2, 133)=0.41$, $p>.05$, when the effect of IQ was partialled out. The summary of these analyses can be found in the Appendix E Table 8-10-1 and 8-10-2.

On the Visual Paired Associates, the Hong Kong subjects received the highest mean score in the three groups, but the differences between groups were not statistically significant, $F(2, 134)=0.10$, $p>.05$. These summary tables are presented in the Appendix E Table 8-10-3.

8.2 DISCUSSION

The study compared the relation between phonological awareness, visual skills and reading in Britain, Taiwan and Hong Kong. The results support the hypothesis that there is a high correlation between visual skills and Chinese reading in the Hong Kong group and Taiwan group. This might be because Chinese is more pictographic. In addition, the ability to read Chinese requires discrimination of large numbers of different visual forms. Mann (1986) found that good and poor Japanese readers differed in memory for abstract designs and that their memory for *kanji* was significantly related to memory for the designs. In contrast, English orthography is often described as a code that pairs sounds and individual letters. Hoosain (1986) review the relation between language and cognitive processes and argue that Chinese language facilitates visual form manipulation.

In this cross-cultural study, English reading is related to all of the phonological tests for English subjects, but English reading was related only to the Chinese Phoneme Deletion test for the Hong Kong group. Furthermore, the relation between the Visual Paired Associates score and English reading was not significant in the UK group. If this was influenced only by the characteristics of the English orthography, the Hong Kong subjects should show a high correlation between phonological tests and English reading. However, only the Visual Paired Associates test and the Chinese Phoneme Deletion test were correlated with English reading in the Hong Kong study. Therefore, the relationship may be affected not only by the characteristics of orthography, but also by the different teaching methods and various learning styles.

This investigation has shown that English children's phonological awareness was a significant predictor of reading in English. For Chinese reading, the visual skill was the most significant predictor variable in the Hong Kong and Taiwan groups. The result was taken to suggest that the factor which can predict the children's success in reading is significantly different by the writing orthographies.

Hong Kong children felt that the middle sound detection was the most difficult task in all the three Odd Man Out tests. On the other hand, like Bradley and Bryant (1983), this study showed that young English children get the highest score in the middle sound difference in the English Odd Man Out test. This may be because the two languages are different in phonemic composition. As mentioned in Sec. 7.5, the fact that only three different phonemes can occupy the middle position in Chinese syllables may cause problems in detecting the middle sound odd man out.

The data presented in the current study support the view that the phonic structure of language produces differences in phonological awareness. The most apparent evident was from the significant three-way interaction between different groups, phoneme positions, and syllable types in the English Phoneme Deletion Test. English subjects were superior to Chinese children on the CVCC type of the first sound deletion, but Chinese children were significantly better than English subjects on the CCVC type of the first sound deletion.

As mentioned in Chapter Five, children group the phonemes in a syllable into the onset and the rime (Treiman, 1985; Stuart & Coltheart, 1988). That is, initial consonant clusters are treated as units. This research supports the finding that English subjects treat an initial consonant cluster as a single phonological unit. That is why it is hard for them to delete the first phoneme from the consonant clusters. Morais *et al.* (1984) showed that French-speaking normal children in the first and second grades have less trouble deleting initial consonant of CVC type than that of CCVC type. Perfetti *et al.* (1987) also showed that children performed better when the consonant was an onset (e.g., deleting /s/ from *s̲it*) rather than when it was part of an onset (e.g., deleting /s/ from *s̲tar*). Therefore, Bruck and Treiman (1990) concluded that consonant in cluster onsets of CCV are more difficult to delete than the single consonant of CVC. Interestingly, a recent cross-linguistic study by Caravolas and Bruck (1993) observed that Czech children (aged 6 years) had no difficulty deleting a target phoneme when it was embedded in a cluster onset (CCV) either in the native language condition (Czech) or in the foreign language condition (English). The reason proposed by the authors was that Czech and English differ at the level of syllable structure, for instance, Czech has a higher frequency and variety of complex onsets than English.

On the other hand, there are no consonant blends in Chinese syllables (see Sec. 2.1.3.1). As Wang (1973) has noted: "One striking feature of Chinese words in comparison with most European words is the lack of clusters of consonants before and after the nuclear vowel. When European words with consonant clusters are presented in Chinese, they are typically broken up so that each consonant has its own syllable" (p.57). The name Marx, for example, in rendered with three characters representing three syllables:ma-ke-si. Thus, it is easy for Chinese children to parse two blending consonants. That is why the Chinese subjects received a higher score in the CCVC type of the first sound deletion test. From the comparison, it implies that the nature of language seems to play an important part in the performance of the phoneme deletion test.

As can be seen, the end sound deletion is significantly better than the first sound deletion both in the English Phoneme Deletion for English and Chinese subjects. That is, to delete an end sound (e.g. start-star) is easier than to delete the first sound (e.g., stop-top).

Chen and Juola (1982) examined the effects of phonemic, graphemic, and semantic information on lexical coding and memory for Chinese logographs and English words. The results showed that Chinese speaking subjects responded most rapidly and accurately in the graphemic recognition task, whereas performance was generally equivalent in all three tasks for the English speaking subjects. Chen, Yung and Ng (1988) also pointed out that, in Chinese, graphemic and semantic information is more important in word recognition. This would suggest that, if a graphemic code is the most important factor in learning to read Chinese, the correlation between visual skills and reading should be higher than the correlation between phonological ability and reading. The present research has confirmed the hypothesis. This may be influenced by the fact that Chinese characters require significantly more visual information for accurate recognition.

It was surprising to find the significant correlation between Chinese reading and Chinese Phoneme Deletion in both Chinese groups. As explained in Chapter Six, Chinese reading may be related to phonological awareness to a certain extent.

One hypothesis was that there are differences between Chinese subjects and English subjects on the visual skills test. This hypothesis was partially supported by the results of this study. The Chinese subjects performed significantly better than English children on Visual Form Discrimination, but not on Visual Paired Associates. It seems that the Chinese subjects have higher visual skill than the English subjects. However, the significant difference was disappeared after IQ was as a covariate. Therefore, it seems that the difference between English subjects and Chinese subjects on the Visual Form Discrimination test are due to the effects of IQ.

8.3 CONCLUSIONS

These results support the view that Chinese reading is more dependent on visual skill and English reading more related to phonological skill. In conclusion, the following finding can be drawn from this cross-cultural study:

1. There was a high correlation between Chinese reading and the Visual Paired Associates test in the Hong Kong and Taiwan groups. The Chinese Phoneme Deletion test related to Chinese reading in both Chinese groups.

2. English reading correlated with all phonological tests in English subjects. This was not true of Chinese children in the Hong Kong group. The only two correlations were between the Visual Paired Associates, the Chinese Phoneme Deletion and English reading for the Hong Kong subjects.

3. English children were superior on the middle sound of English Odd Man Out Test, nevertheless, Hong Kong children were better on the last sound detection of three Oddity tests.

4. On the phoneme deletion test, English subjects were superior to Chinese children on the CVCC type of the first sound deletion, but Chinese children were better than the British subjects on the CCVC type of the first sound deletion.

5. English subjects received a lower score on Visual Form Discrimination and there were no significant differences of visual skills between two Chinese groups.

Thus, it seems likely that visual skill is an more important factor in reading Chinese and phonological skill is a more significant element in reading English for English children.

PART THREE

STUDY TWO:

A COMPARATIVE STUDY

CHAPTER NINE

THE COMPARATIVE STUDY ON PINYIN AND NON-PINYIN GROUPS IN HONG KONG

9.1 INTRODUCTION

Some researchers (Morais *et al.*, 1979, 1986; Read *et al.*, 1986) have claimed that phonemic segmentation ability (such as phoneme deletion) is not acquired naturally in the absence of an alphabetic writing system. Morais and his colleagues (1979) chose two groups in Portugal. One was called the illiterate group, most of them having never received any reading instruction. The other one was referred to as the literate group of those who had learned to read after the age of 15 years. The subjects were asked to delete the first sound of a word or to add a phoneme at the beginning of a word. The results showed that the illiterate adults performed worse than literate subjects with similar environmental and childhood experience. They concluded that phonological awareness is not attained spontaneously and may require specific training which is probably provided by learning to read in an alphabetic system.

Read *et al.* (1986) showed that Chinese adults from the People's Republic of China who went through school before the introduction of the *Pinyin* (alphabetic) script in the teaching of reading were much worse at adding or deleting phonemes in spoken words than those who had been taught the *Pinyin* script at school. However, there were two problems with their research. One was that subjects in the *Pinyin* group had been at school longer than subjects in the non-*Pinyin* groups; the other was that the age of the subjects in the two groups was different (the *Pinyin* group was 16 years younger than the non-*Pinyin* group).

The results from Study One (Chapter Eight) showed that the Hong Kong children got lower scores in the Odd Man Out tests and phoneme deletion test than did the Taiwan subjects. In another study by Chen and Yuen (1991), they examined the effect of learning *Pinyin* by comparing children in mainland China, Taiwan and Hong Kong. They found that the subjects in mainland China and in Taiwan performed better than the Hong Kong children in the naming of Chinese pseudohomophones when the children were asked to pronounce unfamiliar printed stimuli. Their results indicate that the Hong Kong children who had not learned *Pinyin* were less able to extract phonological information for pronunciation than the Chinese and Taiwanese children who had learned *Pinyin* or *Zhu-Yin-Fu-Hao*. However, it must be noted that the curriculum, the mother tongue, and the environment are dissimilar in Taiwan, in China and in Hong Kong. This may cause some or perhaps most of the differences in phonological awareness. Therefore, the present study in which groups of children in Hong Kong are compared, provides the opportunity to study phonological skills in two groups of children of similar age and background who differed only in terms of their familiarity with the *Pinyin* system in Hong Kong.

Since 1981, the Education Department of Hong Kong has launched a pilot scheme on the teaching of *Putonghua* (Mandarin) in some primary schools. This is because the teaching of *Putonghua* in Hong Kong and its use as the medium of instruction are very restricted, and Hong Kong will become a Special Administrative Region (SAR) of the People's Republic of China on the first of July, 1997. There are about 8% of primary and secondary schools which teach *Putonghua* as a subject, and some schools which include *Putonghua* as an extra-curricular activity (Education Commission, 1984, p.47). The Hong Kong Government also claimed that the time is right to encourage the teaching of *Putonghua*, in order to put Hong Kong in the mainstream of Chinese cultural and economic development (Hong Kong Government, 1990).

Compared with the teaching of Chinese reading elsewhere in the world, Hong Kong is the only place where the way in which *Putonghua* is taught depends on decisions made by individual schools. As described in Chapter Two, *Pinyin* is a phonetic system which is used to pronounce Chinese characters in *Putonghua* and is employed in the instruction of *Putonghua* in mainland China. Some schools in Hong Kong teach *Pinyin* when *Putonghua* is a subject in those schools. However, the majority of schools in Hong Kong do not teach children to learn *Putonghua* via *Pinyin*. This means that, with regard to phonology, there may be some differences between children who learn *Pinyin* and children who do not learn *Pinyin*.

The purpose of this comparative study is to explore possible differences between the *Pinyin* children and non-*Pinyin* children. In particular, an attempt was made to compare phonological awareness in the two groups. Moreover, the present study was designed to investigate possible differences between phonological ability, visual skills and reading in Chinese and in English in the two groups and to examine whether the factor that best predicts reading differs between the *Pinyin* and the non-*Pinyin* groups.

In addition to examining Chinese reading, this study also looked at reading of English. As stated in Chapter Seven, there are two official languages in Hong Kong, namely, Chinese and English. Children learn English from the first grade in primary school. It was considered important to investigate whether the same factors that influence Chinese reading in the *Pinyin* and non-*Pinyin* group affect their reading of English in the same way.

The two main hypotheses that were put forward were as follows:

1. There would be a significant difference of performance on the phonological tests between the *Pinyin* group and the non-*Pinyin* group. The *Pinyin* group would be superior to the non-*Pinyin* group.

2. There would be a stronger relationship between visual skills and Chinese reading in the non-*Pinyin* children than that in the *Pinyin* group. We also predicted that there would be a stronger relationship between phonological skills and Chinese reading in the *Pinyin* than that in the non-*Pinyin* group. We would expect that visual skills would be a strong predictor variable on predicting reading in the non-*Pinyin* group and the phonological test scores would be a powerful variable to predict reading in the *Pinyin* group.

9.2 METHOD

9.2.1 Description of subjects

The native language of these selected subjects in this study is Cantonese and the instruction language is Cantonese in both schools. The primary schools adopted the English Language as a basic subject for 7 hours per week, and the Chinese Language (in Cantonese) for 9 hours per week for the third graders (as seen in Chapter Seven Table 7-1).

9.2.1.1 The *Pinyin* group

Forty-five eight-year-old children (23 boys, 22 girls) from two classes who have learned *Pinyin* for about one year in RosaryHill School took part in the study. These children are referred to as 'the *Pinyin* group'. As stated in the previous section, a few schools teach *Putonghua* and *Pinyin* as a subject. Most schools of this type start the *Putonghua* instruction from grade 4, only a few schools begin the instruction earlier. RosaryHill school introduces *Putonghua* for one or two periods (of 40 minutes each) per week from grade 3. Although they learn *Putonghua* in the classroom, the majority of students and teachers speak Cantonese as their main language. Their average age was 8.76 years.

9.2.1.2 The non-*Pinyin* group

The forty-two Hong Kong subjects from Study One were compared with the *Pinyin* group and are henceforth referred to as 'the non-*Pinyin* group'. The students backgrounds and their parents' socio-economic status were similar to those of the children attending the RosaryHill school. Their average age was 8.88 years and there was no significant difference between the ages of the two groups, $t(85) = 1.77$, $p>.05$.

9.2.2 Description of test materials

The materials were the same as those in the Hong Kong study section of Study One.

9.2.3 Procedures of testing

The tests were administered independently in two schools in 1991. The procedures were exactly the same as those employed in the Hong Kong study (Sec.

7.3.3).

9.2.4 Statistical methods

The data analyses were the same as in Sec. 7.3.4.

9.3 RESULTS

9.3.1 Descriptive Statistics

The mean and standard deviations of correct response in all tests for each group of subjects (the *Pinyin* and the non-*Pinyin* groups) are presented in Table 9-1.

In order to compare the differences on all tests between the two groups, t-tests were used. The results of the t-tests are also shown in the same Table. In IQ, BPVS, Chinese reading (responding in Cantonese), English reading, and the Chinese Phoneme Deletion, there were significant differences between the two groups. The *Pinyin* group performed better than the non-*Pinyin* group on BPVS, English reading, and the Chinese Phoneme Deletion test, $t(85)=2.11$, $p<.05$; $t(85)=6.91$, $p<.001$; $t(85)=2.63$, $p<.05$, respectively. Conversely, the scores on Coloured Progressive Matrices, and Chinese reading of the non-*Pinyin* group were higher than those of the *Pinyin* group, $t(85)=4.14$, $p<.001$; $t(85)=4.99$, $p<.001$, respectively.

Accordingly, the children's scores should be matched on several variables before their performance on the critical tests was compared. Thirty subjects were therefore selected from all the subjects in each group in order to achieve homogeneity between the two groups.

Table 9-1: Means and standard deviations among the tests for **all subjects** in the two groups (Standard deviations in parentheses).

Tests		Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.	Schonell Reading	Chinese Reading	Chinese Nonword OMO	Chinese Word OMO	English Odd Man Out	Chinese Phoneme Deletion	English Phoneme Deletion
Mean	*Pinyin* group	30.24 (4.20)	6.58 (4.33)	11.76 (3.75)	26.24 (2.87)	21.91 (3.12)	44.29 (9.36)	19.02 (5.55)	18.62 (5.01)	21.02 (4.18)	7.36 (4.23)	33.11 (3.87)
	non-*Pinyin* group	33.19 (1.97)	5.02 (2.09)	12.26 (3.98)	27.31 (3.03)	16.98 (3.54)	52.55 (5.42)	17.24 (5.33)	16.57 (4.72)	20.83 (4.18)	5.36 (2.59)	32.40 (3.52)
t-test (d.f. = 85)		-4.14***	2.11*	-.61	-1.68	6.91***	-4.99***	1.53	1.96	.21	2.63*	.89
Max.		36	32	18	32	100	100	30	30	30	20	40

Table 9-2: Means and standard deviations among the tests for **thirty subjects** in the two groups (Standard deviations in parentheses).

Tests		Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.	Schonell Reading	Chinese Reading	Chinese Nonword OMO	Chinese Word OMO	English Odd Man Out	Chinese Phoneme Deletion	English Phoneme Deletion
Mean	*Pinyin* group	32.17 (2.34)	6.60 (5.16)	12.67 (3.44)	26.83 (2.28)	22.77 (2.99)	48.47 (87)	20.87 (5.04)	20.27 (4.25)	21.93 (3.94)	8.03 (3.92)	33.80 (3.59)
	non-*Pinyin* group	32.47 (1.63)	4.50 (2.11)	11.80 (4.23)	26.97 (2.80)	16.13 (2.58)	51.00 (5.01)	17.17 (5.12)	16.10 (4.74)	20.37 (4.72)	5.17 (2.35)	31.63 (3.40)
t-test (d.f. = 58)		-0.58	2.06*	.87	-.20	9.17***	-1.63	2.82**	3.58***	1.40	3.44*	2.40*
Max.		36	32	18	32	100	100	30	30	30	20	40

* p<.05 ** p<.01 *** p<.001

They were matched closely in age (8.76 years for the *Pinyin* group; 8.87 for the non-*Pinyin* group), sex (15:15 and 14:16 for the ratio of boys:girls in the *Pinyin* and the non-*Pinyin* groups), IQ, and Chinese reading. The procedure ensured that any difference between the *Pinyin* group and the non-*Pinyin* group would not be explained by differences in children's age, sex, IQ, or Chinese reading ability. It was not possible to match BPVS and English reading in the *Pinyin* subjects and the non-*Pinyin* subjects, so there were still differences between groups, $t(58)=2.06$ ($p<.05$), and 3.58 ($p<.001$) on BPVS and English reading respectively. However, statistical methods were utilized to partial out these differences. The data reported in the present study were based on these 30 subjects in each group. Table 9-2 shows the means, standard deviations and t-test on all tests for these thirty subjects in each group.

When one looks at the difference between these two groups on the visual skills tests, one finds that there were no significant differences between the *Pinyin* group and the non-*Pinyin* group. The performance on the phonological subtests will be analyzed in the following section.

9.3.2 The relationship between phonological tests, visual skills and reading in English and Chinese

9.3.2.1 The correlation between Chinese reading and other tests

Table 9-3 shows the correlation between the Chinese reading test, visual skills, and the phonological tests for both groups.

For the *Pinyin* group, Chinese reading was significantly related to the Chinese non-word Odd Man Out test ($r=.46$, $p<.05$), the Chinese Odd Man Out test ($r=.59$, $p<.001$). However, there was no significant correlation between the Chinese reading and visual skills scores. For the non-*Pinyin* group, the correlation between the Chinese reading and the Visual Paired Associates (r=.71, p<.001), and the Chinese Phoneme Deletion (r=.41, p<.05) were significant. It is surprising to find a negative relation between the Chinese Non-word Odd Man Out Test and Chinese reading (r=-.48, p<.01) in the non-*Pinyin* group. It was interesting to note that English reading and Chinese reading had a high correlation in the *Pinyin* group, r=.43 (p<.05), but no significant relation in the non-*Pinyin* group, r=.27. If IQ was taken out, the pattern of partial correlations was similar to the above results.

Table 9-3: The pattern of correlation among Chinese reading and other tests

a. The correlation of Chinese reading and each test

Groups		Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.	English OMO
Chinese reading	*Pinyin*	.23	.25	.30	.14	.32
	non-*Pinyin*	.22	-.25	.71***	-.32	-.09

Groups		English reading	Chinese Non-word OMO	Chinese OMO	English Phoneme Deletion	Chinese Phoneme Deletion
Chinese reading	*Pinyin*	.43*	.46*	.59***	.18	.34
	non-*Pinyin*	.27	-.48**	-.29	.14	.41*

b. Partial correlation of the Chinese reading and each test, Coloured Progressive Matrices as a partial variable

Groups		BPVS	Visual Paired Associ	Visual Form Discri.	Eng. OMO	Chi. Non-word OMO	Chi. OMO	Eng. Pho. Del.	Chi. Pho. Del.
Chinese reading	*Pinyin*	.19	.23	.13	.25	.41*	.58**	.11	.28
	non-*Pinyin*	-.24	.71***	-.27	-.07	-.44*	-.24	.20	.44*

* p<.05   ** p<.01   *** p<.001

9.3.2.2 The correlation between English reading and other tests

As can be seen from Table 9-4, most of the phonological tests were highly correlated with the English reading score in the *Pinyin* group, ranging from .36 (marginally significant at p=.05) to .55(p<.01). Visual Form Discrimination and BPVS were also related to English reading, r=.49; .48, p<.01, respectively. For the non-*Pinyin* group, however, only Chinese Phoneme Deletion was correlated with English reading (r=.52, p<.01).

Table 9-4: The pattern of correlation among English reading and other tests

a. The correlation of English reading and each test

Groups		Coloured Prog. Matrices	BPVS	Visual Paired Associ.	Visual Form Discri.	English OMO
Schonell reading	*Pinyin*	.27	.48**	.25	.49**	.47*
	non-*Pinyin*	-.26	.01	.14	-.15	-.17

Groups		Chinese Non-word OMO	Chinese OMO	English Phoneme Deletion	Chinese Phoneme Deletion
Schonell reading	*Pinyin*	.43*	.54**	.36	.55**
	non-*Pinyin*	-.15	-.22	-.04	.52**

b. Partial correlation of English reading and each test, Coloured Progressive Matrices as a partial variable

Groups		BPVS	Visual Paired Associ	Visual Form Discri.	Eng. OMO	Chi. Non-word OMO	Chi. OMO	Eng. Pho. Del.	Chi. Pho. Del.
Schonell reading	*Pinyin*	.43*	.16	.49**	.38	.35	.49**	.29	.50*
	non-*Pinyin*	.02	.12	-.08	-.15	-.06	-.16	.02	.56*

* p<.05 ** p<.01

If the effects of IQ were partialled out, the correlation between the English Odd Man Out, the Chinese Non-word Odd Man Out and English reading were non-significant in the *Pinyin* group. The other correlations were similar to the above results. The relationships between the separate phonological subtests and reading ability are shown in the Appendix E. Table 9-4-1.

9.3.2.3 The intercorrelation of phonological tests

Table 9-5 shows the intercorrelation between all the phonological tests.

Table 9-5: The intercorrelation of phonological tests
(The coefficients at the right hand upper corner are for the Pinyin group, the underlined coefficients are for the non-Pinyin group)

a. Correlation of phonological tests

Coefficient	COMO	CNOMO	EOMO	CPD	EPD
COMO	-	$.77^{***}$	$.68^{***}$	$.45^{*}$	$.62^{***}$
CNOMO	$.73^{***}$	-	$.62^{***}$	.08	$.37^{*}$
EOMO	.35	$.46^{**}$	-	.36	.19
CPD	.09	.08	.03	-	$.37^{*}$
EPD	-.04	-.08	-.03	.04	-

b. Partial correlation of phonological tests, Coloured Progressive Matrices as a partial variable

Coefficient	COMO	CNOMO	EOMO	CPD	EPD
COMO	-	$.67^{***}$	$.58^{***}$	.29	$.55^{**}$
CNOMO	$.70^{***}$	-	$.46^{*}$	.06	.23
EOMO	.33	$.46^{**}$	-	.22	.04
CPD	.08	.06	.02	-	.26
EPD	-.11	-.18	-.05	.03	-

* $p<.05$ ** $p<.01$ *** $p<.001$

The three Odd Man Out tests were intercorrelated, and the correlation between the English and Chinese Phoneme Deletion tests was significant in the *Pinyin* group. Even with IQ as a partial variable, the correlation between Chinese Odd Man Out (word and non-word) and English Odd Man Out was still significant, and ranged from .46 to .67 ($p<.05$ to $p<.001$). In the non-*Pinyin* group, the intercorrelations between three Odd Man Out Tests were not as strong as those in the *Pinyin* group.

In both groups, the correlation between Chinese Word and Non-word Odd Man Out was strongly significant. Moreover, the Phoneme Deletion (English and Chinese versions) was not significantly correlated with the English Odd Man Out scores.

When IQ was statistically controlled, the significant correlations between the Chinese and the English Phoneme Deletion tests, between the Chinese Phoneme Deletion and the Chinese Odd Man Out test, and between the English Phoneme Deletion and the Chinese Non-word Odd Man Out were faded. The other results were the same as the above correlations.

9.3.3 Which factor predicts Chinese and English reading

In this section, the difference of the predictive power on the Chinese reading and English reading between both groups will be presented.

9.3.3.1 Predicting Chinese reading

The predictor variables were IQ, a single phonological score combined from standardized scores of the five subtests (English Odd Man Out, Chinese Odd Man Out, Chinese Non-word Odd Man Out, English Phoneme Deletion, and Chinese Phoneme Deletion), and a single visual skills score combined from standardized scores of the

Visual Paired Associates and Visual Form Discrimination. The criterion variable was the Chinese reading.

For the *Pinyin* group, the phonological score was the only significant predictor in the regression to predict Chinese reading ($F(1, 28)=9.76$, $p<.0041$, $R^2=.2584$). For the non-*Pinyin* group, on the other hand, only visual skills entered into the regression equation ($F(1, 28)=6.66$, $p<.0154$, $R^2=.1922$).

In order to clarify the predictive power from phonological tests, the score of Odd Man Out tests and phoneme deletion tests were entered separately with other predictor variables. The results revealed that the score of the Odd Man Out tests was the only significant variable on predicting Chinese reading, $F(1, 28)=10.10$, $p<.0036$, $R^2=.2652$ for the *Pinyin* group. Once again, the score of visual skill was still an significant predictor of Chinese reading for the non-*Pinyin* group, $F(1, 28)=6.66$, $p<.0154$, $R^2=.1922$.

Fixed-order regression was used to examine the predictive power after the effects of IQ (Coloured Progressive Matrices) were partialled out. Therefore, the first step was IQ. Then, the second step was a single phonological score, followed by a visual skills; or a single visual skills score first, followed by a single phonological score. The results of the fixed-order regression are shown in Table 9-6.

In the *Pinyin* group, it is obvious that when the phonological score was entered in the regression as step 2, the amount of variance went up from 5.16% to 26.94% (R^2 changed 21.78%, $p<.01$). However, when the score of visual skills was entered as step 2, the R^2 only changed 5.52% (n.s.), which was much less than that from phonological score.

Table 9-6: Summary of fixed-order multiple regression on predicting Chinese reading

the Pinyin group

Variables	R^2 changed	cumulative R^2
First step: Coloured Progressive Matrices	.0516	.0516
Second step: phonological tests	.2178**	.2694
Third step: visual skills	.0020	.2714
or Second step: visual skills	.0552	.0680
Third step: phonological tests	.1646*	.2714

the non-Pinyin group

Variables	R^2 changed	cumulative R^2
First step: Coloured Progressive Matrices	.0498	.0498
Second step: phonological tests	.0230	.0728
Third step: visual skills	.2137**	.2865
or Second step: visual skills	.2127**	.2625
Third step: phonological tests	.0240	.2865

* p<.05 ** p<.01

In the non-*Pinyin* group, the contribution of visual skills (21.27 %, p<.01) was much greater than that of phonological tests (2.30 %, n.s.) when the variables were entered into the regression as the second step separately.

9.3.3.2 Predicting English reading

The multiple stepwise regression was also utilized to predict English reading in both groups. The predictor variables were the same as described in Sec. 9.3.3.1. For the *Pinyin* group, after the phonological test score was entered into the regression equation, no other variable made a significant contribution (p<.05), F(1, 28) 16.23,

$p<.0004$, $R^2=.37$, to predict English reading variance. When the scores of Odd Man Out tests and phoneme deletion tests were entered separately with other predictors, the phoneme deletion test score was a significant variable in predicting English reading for the *Pinyin* group, $F(1, 28)=12.25$, $p<.0016$, $R^2=.3044$. For the non-*Pinyin* group, no variable entered the stepwise equation whether or not the phonological tests were combined or separate.

Table 9-7 shows the results of 4-steps fixed-order multiple regressions in predicting English reading.

Table 9-7: Summary of fixed-order multiple regression on predicting English reading

the Pinyin group

Variables	R^2 changed	cumulative R^2
First step: Coloured Progressive Matrices Second step: British Picture Vocabulary Scale	.0715 .1717*	.0715 .2432
Third step: phonological tests	.1944*	.4376
Fourth step: visual skills	.0119	.4495
or Third step: visual skills	.0653	.3085
Fourth step: Phonological tests	.1410*	.4495

the non-Pinyin group

Variables	R^2 changed	cumulative R^2
First step: Coloured Progressive Matrices Second step: British Picture Vocabulary Scale	.0678 .0003	.0678 .0681
Third step: phonological tests	.0006	.0687
Fourth step: visual skills	.0040	.0727
or Third step: visual skills	.0041	.0722
Fourth step: Phonological tests	.0005	.0727

* $p<.05$

It can be seen that, for the *Pinyin* group, the contribution from the phonological score (R^2 changed 19.44%, $p<.05$) was much greater than that from visual skills (R^2 changed 6.53%, n.s.) when both were in the step 3. In contrast, the contribution of visual skills was greater (R^2 changed 0.44%, n.s.) than that of phonological score (R^2 changed 0.06%, n.s.) in the non-*Pinyin* group.

9.3.4 The differences between the two groups on phonological tests

9.3.4.1 Analysis of Odd Man Out Tests

English Vs Chinese Word Vs Chinese Non-word Odd Man Out Tests

Table 9-8 presents the mean of three versions of the Odd Man Out tests in both groups.

Table 9-8: Mean number of three versions of Odd Man Out tests

Versions	Groups	First sound	Middle sound	Last sound	Total	Max.
English	*Pinyin* group	7.40	5.67	8.87	22.94	30
	non-*Pinyin* group	7.07	5.27	8.03	20.37	30
Chinese word	*Pinyin* group	7.27	6.30	6.70	20.27	30
	non-*Pinyin* group	5.63	4.90	5.57	16.10	30
Chinese non-word	*Pinyin* group	7.13	7.30	6.43	20.86	30
	non-*Pinyin* group	5.53	5.63	6.00	17.16	30
Total	*Pinyin* group	21.80	19.27	22.00	-	
	non-*Pinyin* group	18.23	15.80	19.60		-

A three-way analysis of variance (group (*Pinyin* and non-*Pinyin*) x version (English, Chinese word, and Chinese non-word) x position (first, middle and last), with repeated measures on the version and position was applied to the data. The results showed that the *Pinyin* group performed significantly better than the non-*Pinyin* group on the Odd Man Out tests, $F(1, 58)=9.42$, $p<.01$. There were also significant differences in performance between different versions, $F(2, 116)=15.85$, $p<.0001$; and various positions, $F(2, 116)=12.98$, $p<.0001$. Furthermore, there was a significant two-way interaction between version and position, $F(4, 232)=18.05$ ($p<.0001$), and group and version, $F(2, 116)=3.25$, $p<.05$. However, there was no significant two way interaction between group and position, $F(2, 116)=.47$, $p>.05$. In addition, a three way interaction, $F(4, 232)=1.46$, $p>.05$, was not significant.

Fig. 9-1 and Fig. 9-2 show the 2-way interactions between version and position, and between group and version, respectively. The interaction was further investigated by Newman-Keuls tests. They showed that the last and the first sound in the English Odd Man Out were higher than the last and first subtests in the Chinese Word and Non-word Odd Man Out tests ($p<.05$ to $p<.001$). The subjects achieved their worst score in the middle sound detection of the English Odd Man Out which was significantly worse than the other subtests in the three Odd Man Out tests except the middle sound and the last sound detection of the Chinese Odd Man Out test.

As mentioned above, the two groups were not identical in vocabulary ability and English reading, the results were thus reanalysed using an analysis of covariance, with English reading, vocabulary ability and Coloured Progressive Matrices as Covariates. The results of the ANCOVA revealed the main effect of group, $F(1,55)=6.23$, $p<.02$. The other effects were non-significant. The summaries of the two analyses can be seen from the Appendix E. Tables 9-8-1 and 9-8-2.

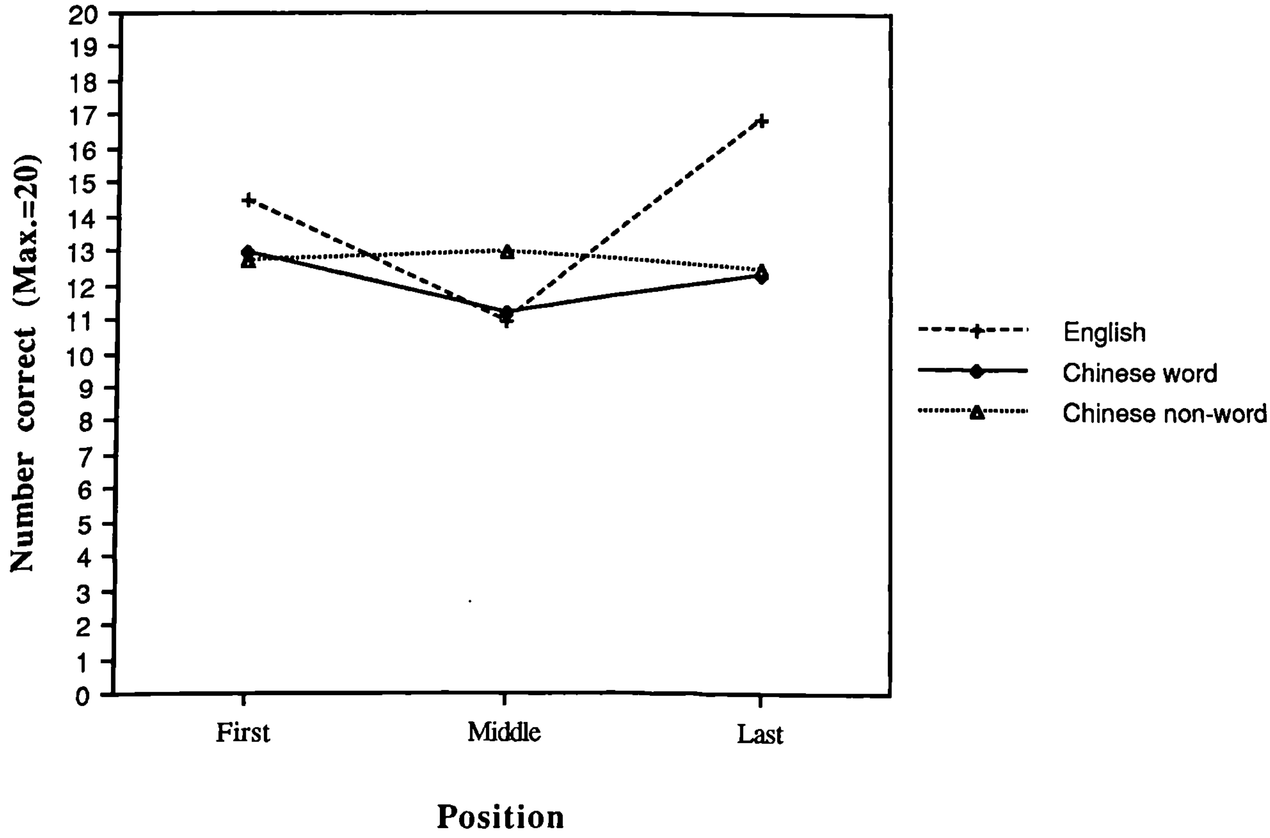


Fig. 9-1: The mean scores of three versions of Odd Man Out tests.

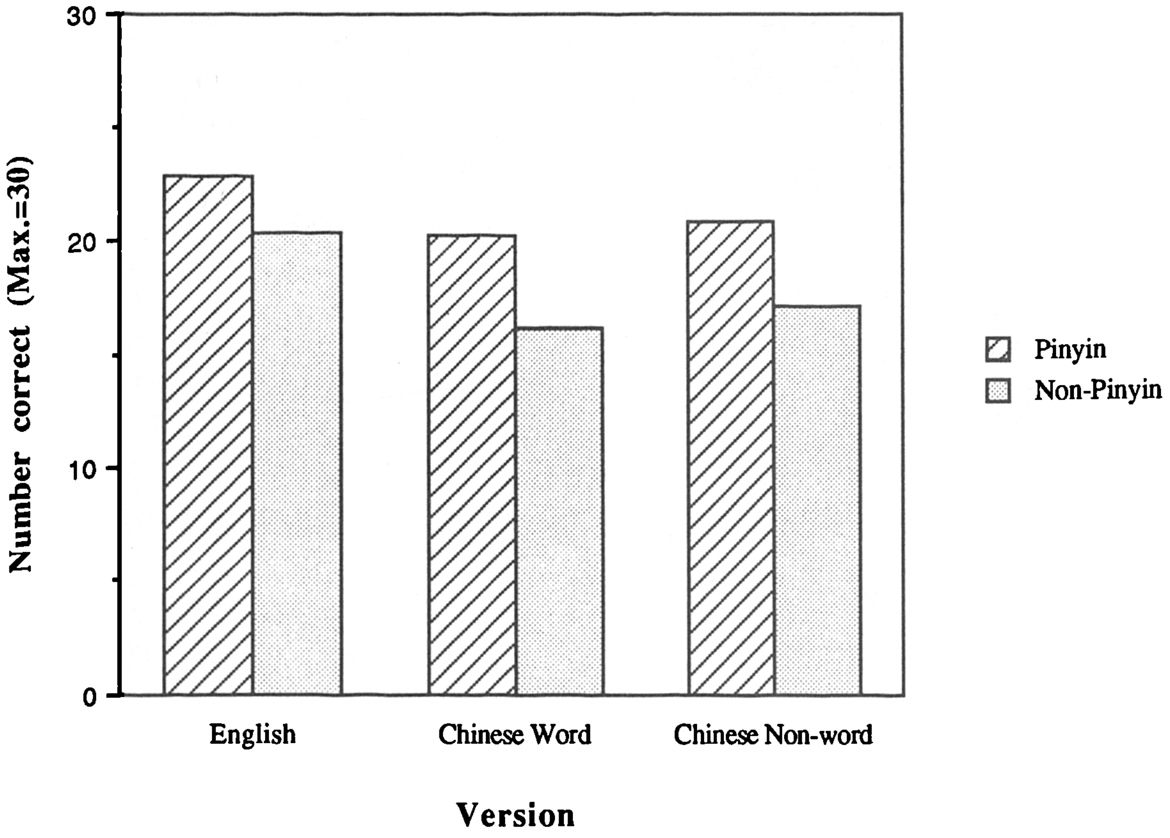


Fig.: 9-2 The mean scores of three version of Odd Man Out tests for two groups.

9.3.4.2 Analyses of Phoneme Deletion tests

9.3.4.2.1 English Phoneme Deletion test

The study had phoneme position (first/end) and syllable type (CVCC/CCVC) as within-subject variables and group (*Pinyin*/non-*Pinyin*) as a between-subjects variable. The performance on the English Phoneme Deletion test is shown in Table 9-9. A 3-factor analysis of variance revealed a significant main effect of groups, $F(1, 58)=5.77$ ($p<.05$); of position, $F(1, 58)=197.16$ ($p<.0001$); and of syllable type, $F(1, 58)=97.52$ ($p<.0001$). There were two significant 2-way interactions between group and position, $F(1, 58)=8.27$, $p<.01$; position and syllable type, $F(1, 58)=101.78$, $p<.0001$ and a significant 3-way interaction (as shown in Fig. 9-3) between group, phoneme position and syllable type, $F(1, 58)=11.54$, $p<.01$.

Table 9-9: Mean number of the English Phoneme Deletion test

Group\Position	First sound deletion		End sound deletion		Total	Max.
	CVCC	CCVC	CVCC	CCVC		
Pinyin group	6.10	8.57	9.40	9.73	33.80	40
Non-*Pinyin* group	4.10	8.33	9.63	9.57	31.63	40
Total	10.20	16.90	19.03	19.30	.	.

Post hoc tests revealed that the *Pinyin* children performed better than the non-*Pinyin* children only on the CVCC first sound deletion. In addition, both groups were superior on the end sound deletion to the first sound deletion in both the CVCC and the CCVC syllable types.

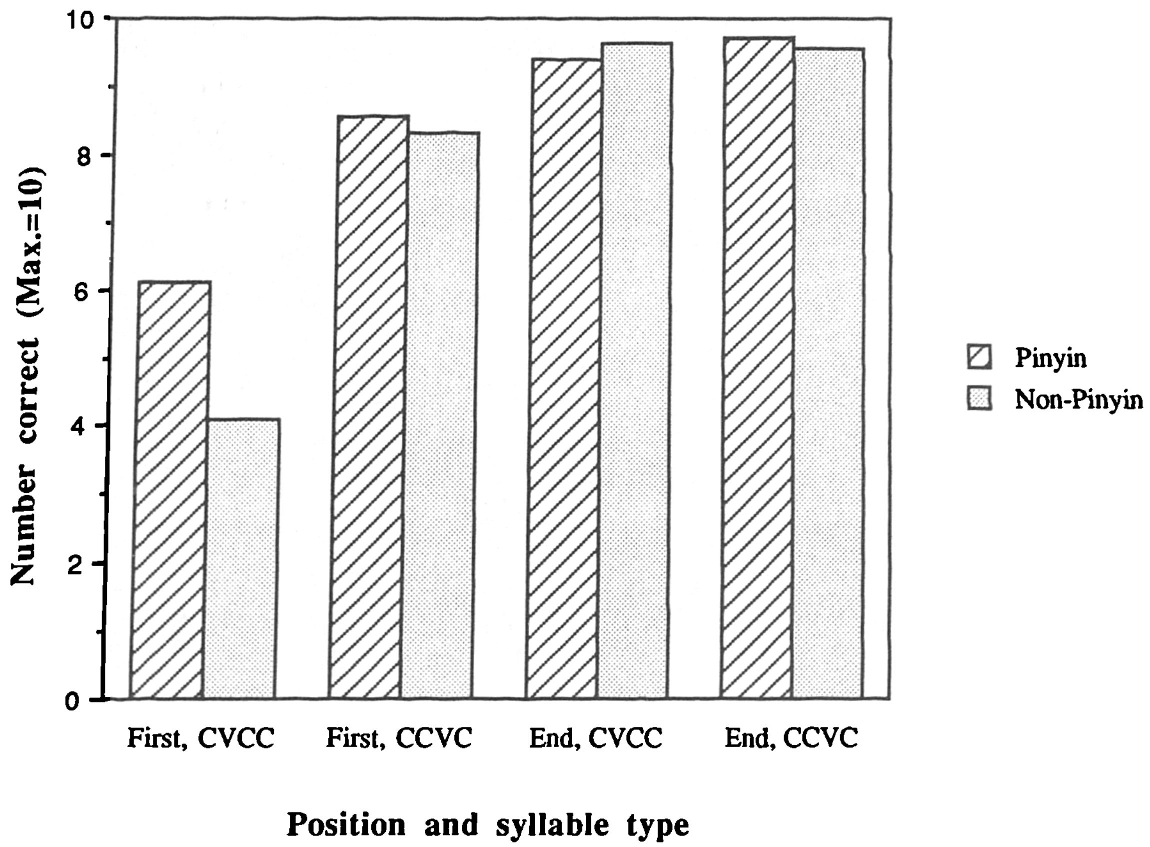


Fig. 9-3: The mean scores of the English Phoneme Deletion test.

The results from an analysis of covariance, with Coloured Progressive Matrices, vocabulary ability and English reading as covariates, showed that there was no longer a significant main effect of group, $F(1, 55)=0.63$, $p>.05$ and no significant 3-way interaction between group, position and syllable type, $F(1,55)=3.08$, $p>.05$. That means that there was no significant difference between the *Pinyin* group and non-*Pinyin* group after the influence of IQ, Vocabulary, and English reading was partialled out.

What is the effect of the three covariates? If only IQ and vocabulary were used as covariates in the analysis of covariance, the results still showed a main effect of group, $F(1, 56)=4.97$, $p<.0298$ and 3-way interaction between variables, $F(1, 56)=8.98$, $p<.0040$. Compared with the results of ANCOVA with IQ, vocabulary, English reading as covariates, it can be seen that English reading test scores played an important role in the performance on the English Phoneme Deletion test. The summaries of the three analyses are displayed in the Appendix E. Table 9-9-1, 9-9-2 and 9-9-3.

9.3.4.2.2 Chinese Phoneme Deletion Test

Table 9-10 shows the mean of the Chinese Phoneme Deletion test by the *Pinyin* and the non-*Pinyin* groups.

Table 9-10: Mean number of the Chinese Phoneme Deletion test

Groups \ Position	First	End	Total	Max.
Pinyin group	3.23	4.80	8.03	20
Non-*Pinyin* group	2.26	2.90	5.16	20
Total	5.49	7.70		

A two-way (2 x 2) analysis of variance showed a significant main effect of group, $F(1, 58)=11.81$ ($p<.01$), and a significant effect of position, $F(1, 58)=11.95$ ($p<.01$). However, no significant 2-way interaction between group and position was found, $F(1, 58)=2.15$ ($p>.05$). Results showed that the *Pinyin* group performed significantly higher than the non-*Pinyin* group, and the end sound was better than the first sound deletion.

The results were reanalysed using an analysis of covariance, with English reading, vocabulary ability and Coloured Progressive Matrices as covariates. The analysis showed a non-significant main effect of group, $F(1, 55)=.72$ ($p>.05$), no effect of position, $F(1, 55)=1.07$, $p>.05$ and no significant interaction, $F(1, 55)=.64$ ($p>.05$). The results from the ANCOVA revealed that no difference between two groups on Chinese Phoneme Deletion when the effects of English reading, vocabulary and IQ were taken away. Once again, if covariates were reduced to only IQ and vocabulary, the results of analysis of covariance revealed a main effect of group, $F(1, 56)=10.17$, $p<.0023$. The three analyses are summarized in the Appendix E. Tables 9-10-1, 9-10-2 and 9-10-3.

9.4 DISCUSSION AND CONCLUSIONS

The aims of this investigation were to study the effects of different educational treatments on phonological awareness, and to examine the relation between phonological awareness, visual skills and learning to read in pupils attending two different kinds of school.

One of the hypotheses in the comparative study was that there would be differences between the two groups on phonological tests. The results supported the hypothesis in that the *Pinyin* group performed much better than the non-*Pinyin* group on all the phonological tests. The significant difference between groups still existed on the Odd Man Out tests after the effects of IQ, vocabulary and English reading were partialled out. The difference on the three versions of Odd Man Out tests may be caused by learning the *Pinyin* script. The finding is similar to the research by Read *et al.* (1986), and is consistent with the view that reading a phonetic system has a facilitating effect on phonological awareness (Bradley and Bryant, 1983; Lundberg *et al.*, 1988).

It is important to note that the differences between the *Pinyin* and the non-*Pinyin* groups on the English and the Chinese Phoneme Deletion tests disappeared after the differences in English reading, vocabulary and IQ were taken into account. However, if the effect of English reading was ignored, the results of the ANCOVA, with IQ and vocabulary as covariates, still showed a significant difference between the *Pinyin* and the non-*Pinyin* group on the English Phoneme Deletion test and on the Chinese Phoneme Deletion test. This implies that English reading ability played an influential role in the phoneme deletion task.

Another important finding was that the subjects in both groups received higher scores on the end sound deletion task both in the English Phoneme Deletion and in the Chinese Phoneme Deletion tests. The results from Study One also showed the superior effect of the end sound deletion in the English Phoneme Deletion test for both English and Hong Kong subjects. Rosner and Simon (1971) revealed that the children in the 5-6 year-old group performed much better on the last phoneme deletion task (e.g., "belt"-"bel") than on the first sound deletion task (e.g., "lend"-"end"). Similarly, in Content *et al.*'s investigation (1986), children did the end sound deletion with fewer mistakes. Why is the performance on end sound deletion task better than that on the first sound deletion task? One of possible reasons is that children may have learned that they had to produce an incomplete word which meant stopping before the end. It cannot be sure that children exactly know how to manipulate the phonemes.

It is interesting to note that both the *Pinyin* subjects and the non-*Pinyin* subjects performed worse on the middle sound detection of the Chinese Odd Man Out and the English Odd Man Out tests. Furthermore, no difference between the first sound oddity and the last sound oddity was existed. The subjects in both groups found that the CCVC of the first sound deletion was easier than the CVCC of the first sound deletion. The result from Study One also presented the similar findings. The possible reasons have been discussed in Chapter Seven.

The other hypothesis was that there would be a higher correlation between visual skills and reading in the non-*Pinyin* group than that in the *Pinyin* group. This was supported by the current results. The Visual Paired Associates scores were highly related to Chinese reading in the non-*Pinyin* group. On the contrary, for the *Pinyin* group, Chinese reading was related to Chinese Non-word and Chinese Word Odd Man Out tests, and there was no significant relationship between visual skill and Chinese reading. Moreover, phonological tests were more strongly related to English reading in the *Pinyin* group than that in the non-*Pinyin* group. It is plausible that, for the *Pinyin* subjects, relationships between phonological tests and English reading were higher than those for the non-*Pinyin* children. The reason is that the *Pinyin* subjects received more phonetic training which in turn strengthen the relations. However, the question why the similar pattern also occurred on Chinese reading is raised. There are two possible reasons to answer the question. One is that learning *Pinyin* also facilitates the relations between phonological tests and Chinese reading. Another possibility is that vocabulary ability in Cantonese affect the relation between phonological tests and Chinese reading. As discussed in Chapter Six, for Taiwanese subjects, the strong correlation between Chinese reading and the phoneme deletion test was overlapped with the correlation between Chinese vocabulary ability and phoneme deletion test. Therefore, when IQ and vocabulary entered the stepwise regression, the effect of the phoneme deletion test disappeared. Such a relationship may also exist in this study without being detected. It remains to be tested in further investigations in which Chinese vocabulary tests are given.

Above all, it is important to emphasize the significant relationship between Chinese Non-word Odd Man Out, Chinese Phoneme Deletion and Chinese reading in the non-*Pinyin* group. A recent study conducted by So and Siegel (unpublished) also focuses on the relationship between phonological skills and reading Chinese. They tested 196 grade 1 to grade 4 Chinese children who had not learned Chinese characters via *Pinyin* in Hong Kong and revealed that Chinese (in Cantonese) tone and rhyming discrimination tasks were highly correlated with Chinese word recognition. The tone discrimination task was to assess children's ability to recognize the tone differences or similarities. That is, the task asked children to detect which 2 characters have the same tone (out of 4 characters in each item) in Cantonese. In the rhyming discrimination task, subjects were asked to determine which 2 characters rhymed with each other (out of 4 characters in each item) in Cantonese. Their results confirmed that phonological skills play a role in Chinese characters recognition even though children do not learn Chinese via *Pinyin*. One reason for the result is that the majority of Chinese characters contained a phonetic part (as described in Sec. 2.1.1). Unfortunately, their results can be questioned on that the failure to provide subjects' IQ and vocabulary makes the significant correlation between phonological tests and Chinese reading ambiguous. The correlation may be caused by IQ or vocabulary ability.

On predicting Chinese reading, the phonological test was an important predictor variable for the *Pinyin* children, whereas visual skill was the most significant predictor variable in the non-*Pinyin* group. The result was taken as indicating that the factors that predict the children's success in reading Chinese are significantly different in the *Pinyin* and the non-*Pinyin* children. One possible interpretation of the results is that learning *Pinyin* stimulates children's phonological awareness. Previous research has also suggested that learning *Pinyin* affects children's ability to manipulate phonological information (Chen & Yuen, 1991; Read *et al.*, 1986).

Study Two was intended to investigate the effects of learning *Pinyin* by comparing children in the *Pinyin* group and the non-*Pinyin* group and try to avoid possible differences in age and education level that were showed in Read *et al.*'s investigation. When this study was designed, I had not recognised that children in Hong Kong learn English from primary school onwards. It was therefore disappointing to find that the non-*Pinyin* group had also learnt another kind of alphabetic script (English). As Liberman *et al.* (1977) claimed, it is hard to carry out a pure test to compare phonological difference between an alphabetic group and a non-alphabetic group who have never learnt a phonetic script before.

In brief, a summary of the main results from the comparative study is as follows:

1. The *Pinyin* group performed better than the non-*Pinyin* group on all the phonological tests, although there were no significant differences on the visual skills tests between two groups.

2. The correlations between phonological tests and both English reading and Chinese reading in the *Pinyin* group are higher than those in the non-*Pinyin* group.

3. The phonological score was the most powerful variable in predicting English reading and Chinese reading in the *Pinyin* group. However, the visual skills score was the most significant predictor of Chinese reading in the non-*Pinyin* group.

4. For both *Pinyin* and the non-*Pinyin* groups, the middle sound of the Odd Man Out task was the most difficult part of the English and Chinese Word Odd Man Out tests.

5. Subjects in both groups were superior on the CCVC of the first sound deletion to the CVCC of the first sound deletion.

The results obtained have therefore provided strong evidence that the *Pinyin* group performed better than the non-*Pinyin* group on all the phonological tests. The current result concerning the effect of *Pinyin* in relation to phonological skill is in accordance with results reported from other studies in this field.

PART FOUR

STUDY THREE:

A LONGITUDINAL STUDY

CHAPTER TEN

PHONOLOGICAL AWARENESS, VISUAL SKILLS AND CHINESE READING ACQUISITION IN FIRST GRADERS: A LONGITUDINAL STUDY IN TAIWAN

10.1 INTRODUCTION

10.1.1 Background

A great deal of research has employed the use of a longitudinal study to investigate learning to read (e.g., Bradley & Bryant, 1983; Bryant & Bradley, 1985; Ellis & Large, 1987; Lundberg *et al.* 1980; Maclean *et al.* 1987; Mann, 1984; Mann & Liberman, 1984; Stanovich *et al.*,1984; Stuart and Coltheart, 1988; Wimmer *et al.*, 1991). The majority of these investigations are concerned with the relationship between phonological awareness and English orthography. They showed that there is a striking relation between children's early phonological awareness and their subsequent reading success in an alphabetic writing system.

For example, Stuart and Coltheart (1988) tested children's phonological awareness before they began to learn to read and measured their reading ability on four different occasions from 9 months of schooling until they reached the fourth grade. The results from their research showed that children's phonological score at the time before they start learning to read is a determining factor in their consequent reading development. Their multiple regression analyses showed that IQ was a significant predictor of reading age after 9 months of schooling. Then, IQ and pre-school phonological scores were significant predictors of reading after 1 year and 7 months of schooling. However, after 2 years and 11 months of schooling, only the pre-school phonological scores were a significant predictor of their reading ability.

Wimmer *et al.* (1991) examined the relationship of phonemic awareness to German reading acquisition among Austrian children. The results also showed that children with high phonemic awareness at the beginning of the first grade produced high reading and spelling scores at the end of the first year.

However, it should be pointed that the majority of the studies mentioned, except Lundberg *et al.* (1980) and Wimmer *et al.* (1991), failed to test the children's reading ability before they received any formal instruction. This is clearly inappropriate. For example, Bryant and Bradley (1985) only mentioned that none of 4 and 5 year-old children could read in their study and then they tested subjects' reading ability after 4 years when children had reached the age of eight or nine years. In Lundberg *et al.*'s study, although they measured the reading ability (screening test) before reading instruction, the effect of early reading ability was not partialled out when they looked at the relationship between early phonological awareness and later reading ability. Spodek (1982) has revealed that kindergartens in the United States introduce basic reading skills before children start school. Similarly, it is known that some introduction to reading begins in the nursery class at the age of 4 years in Britain. Wagner and Torgesen (1987) recalculated the data of Lundberg *et al.* (1980) and controlled for the preschooler's reading scores. Then, most of the significant prediction from the phonological tests to subsequent reading ability dropped to near zero. In the study by Stuart and Coltheart (1988) and in research by Bryant *et al.* (1989), the reading testing was given after 9 months or longer of schooling. Therefore, it is important to measure children's reading ability at the beginning testing point of a longitudinal study.

It is possible that the longitudinal development of reading may differ from one orthography to another. Wimmer and Frith (1992) found that English children in the beginning phase rely on direct word recognition while German children rely heavily on systematic phonemic mediation in the beginning phase. Hence, they concluded that learning to read a more regular alphabetic orthography such as German differed from learning to read English. They also claim that the "English" model of reading acquisition cannot be considered as an universal model of learning to read.

Here, the question is whether early phonological skills play an essential role in later success in Chinese reading. As we have seen already, although English and Chinese writing systems do obviously differ in some ways, alphabetic English has an inherent morphological component, and morphemic Chinese also requires some degree of phonetic recoding. The results from Study One (cross-cultural study) showed that visual skills were an important variable in predicting Chinese reading for the third graders in Taiwan and Hong Kong. On the other hand, Study One also showed that some of the phonological tests were related to Chinese reading, even for the Hong Kong children who did not learn Chinese characters via *Pinyin* or *Zhu-Yin-Fu-Hao*. Thus, the findings from Study One implied that learning to read Chinese characters not only strongly relates to visual skills, but may also require some phonological skills. But are phonological skills a precondition or a consequence of learning Chinese?

In an alphabetic writing system, this topic has been disputed by many researchers. Ehri (1979) and Morais *et al.* (1979) supported the view that phonemic awareness is a consequence of learning to read. In contrast, the findings from Juel *et* *al.* (1986) and Tunmer *et al.* (1988) supported the opposite view that phonemic awareness is a prerequisite of learning to read. Other psychologists have proposed that the relation between reading and phonological skills is reciprocal (e.g., Perfetti *et al.*, 1987; Stuart & Coltheart, 1988). Yopp (1992) suggested that the relationship should depend on the nature of phonological skills.

The key question is whether Chinese reading stimulates phonological skills, or phonological skills facilitate Chinese reading. As far as I know, no previous research has used a longitudinal study to investigate the relationship between early phonological awareness, visual skills and later success on Chinese reading acquisition. Therefore, this longitudinal study was the first attempt to examine empirically the relationship between phonological awareness, visual skills before children received formal instruction, and subsequent reading ability in the first school year.

10.1.2 Goals of the study

As described in Chapter Two, all children learn *Zhu-Yin-Fu-Hao* during the first 10 weeks of the first grade in Taiwan. Then, they learn Chinese characters via *Zhu-Yin-Fu-Hao*. It is worth noting again that *Zhu-Yin-Fu-Hao* is a phonetic system and Chinese characters are written in a logographic writing system. As children learn the different systems (phonetic system and logographic writing system), the relationship between phonological awareness, visual skills and reading ability may be different.

There were three main aims in this current study. First, the purpose of the study was to investigate the relationship between early phonological awareness, visual skills and subsequent reading ability of Chinese logographs. Secondly, the longitudinal study was also interested in the possible relationships between phonological awareness, visual skills and reading ability at the three different occasions: (1) before pupils learn *Zhu-Yin-Fu-Hao* and Chinese characters. (2) after pupils have learnt *Zhu-Yin-Fu-Hao* for 10 weeks, and before they learn Chinese characters. (3) after children have learnt *Zhu-Yin-Fu-Hao* and Chinese characters for one school year. Thirdly, a further aim of the present study was to uncover the developmental patterns of phonological awareness and visual skills on different occasions during the first year of schooling.

10.1.3 Hypotheses of the study

According to the aims of the study, the hypotheses were as follows:

1. The main hypothesis was that there would be a significant correlation between early visual skills and perhaps also phonological skills when assessed before children received formal instruction and subsequent Chinese reading development.

2. There would be a higher correlation between phonological awareness and reading after children had learnt the phonetic system (at the second testing session) than before they had learnt the phonetic system (at the first testing session). It was also predicted that there would be a higher correlation between visual skill and reading ability after pupils had learnt Chinese characters for one school year (at the third testing session).

3. Phonological awareness and visual skills would be different at the various testing sessions. If learning a phonetic system facilitates children's phonological awareness as suggested in Study One and Study Two, then children should also show significantly higher phonological skills after 10 weeks of instruction in *Zhu-Yin-Fu-Hao*. Phonological skills, accordingly, might be increased after *Zhu-Yin-Fu-Hao* had

been learnt, and visual skill might be enhanced after pupils had learnt Chinese characters.

4. The predictive power of phonological awareness would be stronger than that of visual skills on reading ability at the second testing session (after 10 weeks of instruction in *Zhu-Yin-Fu-Hau*). However, the situation might be reversed at the third testing session.

10.2 METHOD

10.2.1 Description of subjects

Subjects in this study were 44 (22 males, 22 females) first graders from Hsin-Chuang Primary School in a rural medium-sized town of Chang-Hua, which primarily serves a lower middle class population. All subjects lived in the same village and their parental literacy and socio-economic status (SES) were similar. The language spoken at home for all the subjects was Taiwanese, though they can understand some *Putonghua* (Mandarin).

In the education system of the Republic of China (as seen in Sec. 6.2), children start their schooling from six years old. When these subjects participated in the study, they had just started their schooling. Some of them had attended nursery schools or kindergarten before they entered primary school. In the judgement of class teachers, none of the children has had sensory, hearing, or neurological problems, and none were mentally retarded.

There were 4 subjects whose data were not completely collected at the three testing points. Two pupils left the school half way through the year. Two of them were absent on the testing days. Consequently, the research was based on the remaining 40 subjects (18 males, 22 females). Their average age was 6.48 years at the first testing session.

10.2.2 Description of test materials

The details of the test materials were described more fully in Chapter Four.

1. Reading test: Chinese Character Recognition Test.
2. Visual skill test: Visual Paired Associates.
3. IQ test: Coloured Progressive Matrices.
4. Phonological awareness tests:

These phonological awareness tests were the same as Study One for Taiwan subjects (Chapter Six).

a. Odd Man Out Tests: Chinese Odd Man Out Test and Chinese Non-words Odd Man Out Test.

b. Chinese Phoneme Deletion Test.

5. Vocabulary test: British Picture Vocabulary Scale (Chinese edition).

This test was only administered at the third testing session.

10.2.3 Procedure of testing

Testing took place in the 3 different phases during the year: first, the subjects were given phonological tests, the visual skill test, IQ and reading tests before any phonetic instruction was introduced. At that time, no reading instruction had taken place. In general, class teachers focus on introducing the school environment and assisting pupils to accommodate to the order and school schedule in the first two weeks which are called a "preparing period". Hence, the experimenter could carry out the first testing during the first few weeks before the children were taught any subjects.

Ten weeks later, after finishing the instruction of *Zhu-Yin-Fu-Hao*, the experimenter retested their phonological awareness, visual skills, IQ, and reading ability. Then, when they had studied in school for one school year, they were given the phonological tests, visual skill test, IQ, and the reading test on a third occasion. In addition, the British Picture Vocabulary Scale was also tested at this time. Table 10-1 displays the testing timetable of this study.

Table 10-1: The testing timetable of Study Three

Date	Test materials
the beginning of September 1991	IQ, visual skill, phonological tests, reading.
the end of November 1991	IQ, visual skill, phonological tests, reading.
from the end of June to July, 1992	IQ, vocabulary, visual skill, phonological tests, reading.

At each of the 3 different testing points, children were tested individually in a quiet classroom in the school by the same experimenter who is an experienced primary school teacher. The testing was divided into two parts: the first part comprised the IQ test, reading test, the Visual Paired Associates test. The order of presentation in the second part was the Odd Man Out test (Chinese word and Chinese non-word), the Chinese Phoneme Deletion test and BPVS (only in the third testing session). Total testing time was about 35 minutes per subject in the first and the second testing sessions, and about 40 minutes in the third session.

10.2.4 Statistical methods

Analyses were conducted using the Statistical Analysis System (SAS, 1988). Pearson's product-moment correlation was used to determine the strength of the relationship between phonological awareness, visual skills and reading and to calculate the correlation among the tests at the three testing sessions. The multiple regression was employed to investigate how well phonological awareness and visual skills predicts reading ability. Analysis of variance (ANOVA) and analyses of covariance were also utilised in this study. Finally, t-tests were performed on the differences between boys and girls.

10.3 RESULTS

10.3.1 A comparison of performance on the three testing sessions on each task

Table 10-2 presents an overview of the results. The means, standard deviations and significant differences are given for each measure at the three testing sessions.

It can be seen that there was a tendency for performance on each test to improve in successive testing sessions. In particular, the increases in IQ and visual skill were more steady than those of the Chinese reading and phonological tests. In order to test the differences in performance between the three testing sessions, analyses of variance were used for each test. The results revealed that there were significant differences ($p<.05$ to $p<.0001$) on all tests between various testing sessions (see Table 10-2). The summary of analyses of variance is shown in the Appendix E. Table 10-2-1 to 10-2-6.

To provide a clear description, the comparative results will be reported for one test at a time. The comparisons of 3 testing performances on each measure were as follows:

Table 10-2: Means, standard deviations and significant differences among the tests for the first grader subjects (N=40) at the three testing sessions (standard deviations in parentheses)

Testing session	Tests	Chinese reading	Coloured Prog. Matrices	BPVS
1	Mean (SD)	6.88 (9.38) A*	18.25 (5.96) A	-
2	Mean (SD)	7.78 (9.21) B	20.73 (7.31) B	-
3	Mean (SD)	17.85 (9.47) C	21.63 (6.57) B	22.35 (8.51)
F(2, 78)		145.32	6.39	-
p		.0001	.0027	-
Max.		100	36	32

Testing session	Tests	Visual Paired Associates	Odd Man Out	Chinese Phoneme Deletion
1	Mean (SD)	8.33 (4.07) A	19.50 (7.18) A	7.13 (5.23) A
2	Mean (SD)	9.35 (5.04) A B	24.63 (12.04) B	12.15 (5.13) B
3	Mean (SD)	10.25 (4.31) B	28.73 (9.70) C	12.30 (4.72) B
F(2, 78)		4.13	18.96	31.14
p		.0198	.0001	.0001
Max.		18	60	20

Notes: * cells which do not contain the same letter differed significantly on post hoc tests.

10.3.1.1 Comparison of performance on reading test

First of all, the children's performance on the reading test at the 3 different testing sessions will be compared here.

The reading ability difference during the three testing sessions:

The performance on reading ability differed significantly between the three sessions, $F(2, 78)=145.32$, $p<.0001$. The score on Chinese reading after learning

Chinese characters for 8 months jumped up from 7.78 to 17.85. Post hoc tests showed that the performance at the third testing session was significantly better than that at the first and the second testing ($p<.0001$). There was also a smaller but significant difference on reading performance between the first testing and the second testing sessions ($p<.05$).

Reading ability before phonetic instruction:

The mean of the Chinese reading at the first testing session was 6.88, because some of children had been taught to recognize Chinese characters in an informal way (e.g., word game) at kindergarten or at home.

Only one child could read no words at the first testing session. All the remaining children could recognise 1 or more than 1 character. 80% of the subjects could read between 1 and 7 characters correctly. 17.5% of them read more than 7 characters.

Reading ability after 10 weeks phonetic instruction:

It is not permitted to teach any Chinese characters during the 10 weeks of phonetic instruction. The only teaching material is a textbook of Chinese language (the first volume) concerned with *Zhu-Yin-Fu-Hao*. The performance on the Chinese reading test was only slightly higher than that at the first testing session perhaps because it is unavoidable to glance at and recognise some Chinese characters in a learning environment. The mean score was 7.78 at the second testing.

Reading ability after 8 months of Chinese characters instruction:

The reading score was significantly improved after 8 months instruction with a mean of 17.85. 82.5% of subjects scored above 10.

10.3.1.2 Comparison of performance on the visual skills test

The difference on the Visual Paired Associates between the three sessions was significant, $F(2, 78)=4.13$, $p<.05$. The results showed that there was no difference between the first session and the second session, and between the second session and the third session. However, the third session score was better than the first session score ($p<.01$).

10.3.1.3 Comparison of performance on the phonological tests

Because the phonological tests consisted of several subtests, the analyses of the phonological tests will be presented in detail.

10.3.1.3.1 Odd Man Out tests

The mean numbers of correct responses on the Chinese Odd Man Out and the Chinese Non-word Odd Man Out tests are presented in Table 10-3.

The results from a 3-factor (3 x 2 x 3) repeated measure analysis of variance (session x version (word/non-word) x position (first/middle/last)) revealed that there was a main effect of testing session, $F(2, 78)=18.96$, $p<.0001$. The performance on the Odd Man Out tests at the first testing was significantly worse than that at the second and the third testing ($p<.0001$). The difference on the Odd Man Out tests between the second time and the third testing was also significant ($p<.001$). There was a significant two-way interaction between version and position, $F(2, 78)=7.08$, $p<.01$. The first sound difference of the Chinese Word Odd Man Out test was higher than that of the Chinese Non-word Odd Man Out test ($p<.05$). In contrast, the last sound difference of the Chinese Word Odd Man Out test was inferior to that of the

Chinese Non-word Odd Man Out test ($p<.05$). However, no significant main effects were obtained for version (word/non-word), $F(1, 39)=2.04$, $p>.05$, or for position, $F(2, 78)=.52$, $p>.05$. Because there was no significant difference between the Chinese Word Odd Man Out test and the Chinese Non-word Odd Man Out test, both tests were combined together as a single Odd Man Out score in the following results.

Table 10-3: Mean number of Odd Man Out tests at the different sessions.

Session	version\position	First sound	Middle sound	Last sound	Subtotal	Total	Max.
1	word	3.75	2.95	3.58	10.28	19.50	60
	non-word	3.15	2.90	3.18	9.23		
2	word	4.05	4.33	3.63	12.01	24.63	60
	non-word	3.68	4.15	4.80	12.63		
3	word	5.35	4.85	4.58	14.78	28.73	60
	non-word	4.60	4.50	4.85	13.95		
Total		24.58	25.68	24.62	-	-	-

Analysis of covariance was used to control the effects of IQ and reading ability at the first testing. The analysis yielded a significant effect of session, whereas an interaction between version and position was non-significant. The other effects remained the same as above results. The summary of these two analyses can be found in the Appendix E. Table 10-3-1 and Table 10-3-2.

It is clear from these results that there is an increase in oddity scores after pupils have learnt the phonetic system (*Zhu-Yin-Fu-Hao*) for ten weeks. Since there were four choices for each question of the odd man out test, chance level in this task would be 15 out of 60 for the Odd Man Out test. The mean score in the first session was 19.50 in the Odd Man Out test. 22.5% of subjects received a score of 15 or less in the Odd Man Out test.

10.3.1.3.2 Chinese Phoneme Deletion Test

The scores on the Chinese Phoneme Deletion test in the individual sessions are shown in Table 10-4. A two-factor (3 x 2) repeated measure analysis of various (session x position (first/end)) yielded a significant main effect of session, $F(2, 78)=31.74$, $p<.0001$. ANOVA also showed a significant effect of the different positions, $F(1, 39)=37.47$, with the first sound deletion was easier than the end sound deletion, $p<.0001$. Moreover, there was an interaction between session and position, $F(2, 78)=6.59$, $p<.01$.

Post tests showed that the first testing session produced scores that were significantly worse than the second and the third testing sessions ($p<.0001$). The difference between the second testing and the third testing was not significant ($p>.05$). That is, the overall performance on the Chinese Phoneme Deletion test did not significantly increase after pupils had learnt Chinese characters for about eight months. The significant interaction suggests that first and end sound deletion may develop at different rates.

Table 10-4: Mean number of the Chinese Phoneme Deletion test at different sessions (the maximum score was shown in parentheses).

Session\Position	First sound deletion	End sound deletion	Total
1	4.33 (10)	2.80 (10)	7.13 (20)
2	7.15 (10)	5.00 (10)	12.15 (20)
3	6.48 (10)	5.83 (10)	12.31 (20)
Total	17.96	13.63	-

ANCOVA was used to confirm the results from ANOVA once again, with IQ and reading ability (at the first session) as covariates. The results still yielded a significant effect of session. The summary was presented at the Appendix E. Table 10-4-1 and Table 10-4-2.

10.3.2 Correlation between reading and each test

10.3.2.1 The correlations between phonological tests, visual skills and reading at each session

The Pearson correlation between the reading test, phonological tasks, visual skill, IQ, and vocabulary test for the three testing sessions are shown in Table 10-5.

Table 10-5: The pattern of correlation among the tests and Chinese reading.

a. The correlation of reading with each test

First testing (before learning *Zhu-Yin-Fu-Hao* and Chinese characters)

	age	IQ	VisualPairedAssoci.	OddManOut	Chi.Pho.Del.
Reading	.34*	.41**	.25	.64***	.70***

Second testing (after learning *Zhu-Yin-Fu-Hao*, before learning Chinese characters)

	age	IQ	VisualPairedAssoci.	OddManOut	Chi.Pho.Del.
Reading	.28	.33*	.33*	.74***	.49**

Third testing (after learning *Zhu-Yin-Fu-Hao* and Chinese characters for 1 school year)

	age	IQ	VisualPairedAssoci.	OddManOut	Chi.Pho.Del.	BPVS
Reading	.17	.44**	.39*	.43**	.58***	.32*

b. The partial correlation of reading with each test, IQ as a partial variable

First testing (before learning *Zhu-Yin-Fu-Hao* and Chinese characters)

	age	VisualPairedAssoci.	OddManOut	ChinesePhonemeDeletion
Reading	.20	.18	.56***	.63***

Second testing (after learning *Zhu-Yin-Fu-Hao*, before learning Chinese characters)

	age	VisualPairedAssoci.	OddManOut	ChinesePhonemeDeletion
Reading	.21	.18	.70***	.39*

Third testing (after learning *Zhu-Yin-Fu-Hao* and Chinese characters for 1 school year)

	age	VisualPairedAssoci.	OddManOut	Chi.Pho.Del.	BPVS
Reading	.05	.16	.27	.45**	.08

* $p<.05$ ** $p<.01$ *** $p<.001$

The correlations at the first testing session:

Before children learnt *Zhu-Yin-Fu-Hao* and Chinese characters, the strongest association at the first testing was between the Chinese Phoneme Deletion test and Chinese reading ($r=.70$, $p<.001$). A significant correlation also existed between age and Chinese reading ability ($r=.34$, $p<.05$), IQ and Chinese reading ($r=.41$, $p<.01$), and performance on the Odd Man Out test and Chinese reading ($r=.64$, $p<.001$). It should be noted that the relationship between visual skills and reading was not significant at the first testing session.

The correlations at the second testing session:

After phonetic instruction for 10 weeks, the Odd Man Out and Phoneme Deletion tests were significantly related to reading ability ($r=.74$, $p<.001$ and .49, $p<.01$, respectively). Visual skills and IQ were correlated with reading score too. It is interesting to find the relation between age and reading dropped and was non-significant ($r=.28$, $p>.05$) at the second session. The Odd Man Out test was the test most strongly related to reading at the second testing session.

The correlations at the third testing session:

Most of the tests were significantly related to reading. The only non-significant correlation was between age and reading ability. At the third testing session, the Chinese Phoneme Deletion test had the highest correlation with reading ($r=.58$, $p<.001$).

Most important, the relation between the Chinese Phoneme Deletion test and reading ability remained significant when IQ differences between children were partialled out. The partial correlation with the Odd Man Out score came close to significance ($r\approx.27$, $p<.09$).

A comparison of correlations at the three testing sessions:

The results showed that phonological scores were highly correlated with Chinese reading at the three testing sessions during the first year of schooling. Even when the effects of IQ had been controlled, the relation between the phonological tests and reading were still significant at the first and the second testing sessions and were significant for the phoneme deletion test at session 3. It is worth noting that the correlation pattern of the Odd Man Out test differed from that of the Phoneme Deletion test. The correlations between reading and the odd man out score showed a marked rise after the teaching in *Zhu-Yin-Fu-Hao* and a trend towards decline after children have learnt Chinese characters for about 8 months. On the contrary, the correlation between reading ability and the Phoneme Deletion test decreased after 10 weeks of phonetic instruction and then increased after 8 months Chinese characters learning. Moreover, the Phoneme Deletion Test was the only significant variable to correlate with reading ($r=.45$, $p<.01$) at the end of the first year after the effects of IQ were statistically removed.

The correlations between Chinese reading and the Visual Paired Associates test increased from the first session, and the correlations at the second and the third sessions were significant ($r=.33$ and $.39$, $p<.05$, respectively). However, the correlations between reading and visual skills at the second and third testing were reduced when IQ was a partial variable.

The results also showed that subjects' age was correlated with reading ability at the beginning of the first year. Nevertheless, the correlation was reduced later in the first year of schooling.

10.3.2.2 The relationship between early phonological tests and later reading ability

The phonological tests assessed before formal instruction were highly related to reading ability at the end of the first year. The correlation between early Chinese Phoneme Deletion test and later reading ability was the highest one, r=.61, p<.0001. The coefficient between the early Odd Man Out and later reading ability was also significant, r=.50, p<.001. The coefficient between early IQ and later reading ability was .34, p<.05. Nevertheless, when the difference in IQ was held constant, the partial correlations were still significant, .54 (p<.001) for the Phoneme Deletion test, and .40 (p<.01) for the Odd Man Out score.

10.3.2.3 The relationship between early visual skill and later reading ability

Early visual skill (at the first session) was not significantly related to later reading ability (at the third session), r=.29, p>.07. If IQ was used as a partial variable, the correlation was .22 (p>.17).

10.3.3 Prediction of Chinese reading

10.3.3.1 The prediction of the early phonological and visual skills for later reading ability

This section explored the predictive power of early phonological awareness or visual skills on later reading success. The fixed-order multiple regression aim to find out how much of variation in one set of scores can be counted for by other variables after the effects of differences in IQ before children learn any subjects in primary schools and in vocabulary ability had been controlled. As described by Tabachnick and Fidell (1989), the independent variables are given priorities by the researcher before their contribution toward prediction of the dependent variable is assessed. In general, the effects of lower-priority independent variables are assessed and removed before the effects of higher-priority independent variables are measured. In this research, the dependent variable was the reading score at the end of the first year and the independent variables entered in 4 successive steps in a fixed-order multiple regression. The first 2 steps entered the extraneous factors whose effects one wanted to control, and the final 2 steps were of greater interest. The order of 4 steps was as follows:

1. IQ at the first testing.
2. vocabulary ability.
3. phonological score at the first testing.
4. visual skills at the first testing.

or

3. visual skills at the first testing.
4. phonological score at the first testing.

The criterion variable was reading score in session 3. Table 10-6 shows the summary of fixed-order multiple regression analyses.

It can be seen that the early phonological score was better than the early visual skill score at predicting reading ability nearly 10 months later after the effects of IQ and BPVS had been removed. When the early phonological score was entered as the third step, the variance in reading (21.14%, $p<.001$) accounted for was much greater than that (2.86%, n.s.) as the visual score entered in the third step.

Table 10-6: Longitudinal prediction of reading ability at the end of the first year after IQ, vocabulary were controlled.

Variables	R^2 changed	cumulative R^2
First step: IQ(1st)	.1209*	.1209
Second step: vocabulary	.0606	.1815
Third step: phonological skills (1st)	.2114***	.3929
Fourth step: visual skills (1st)	.0351	.4280
or third step: visual skills (1st)	.0286	.2101
Fourth step: phonological skills (1st)	.2179***	.4280

* $p<.05$ ** $p<.01$ *** $p<.001$

10.3.3.2 Early phonological and visual skills as predictors of later reading ability after IQ, BPVS and early reading were controlled

From the above results, it can be seen that early phonological score was a strong predictor of later reading for the first graders in Taiwan. It might, however, have been influenced by the effects of reading ability before pupils entered school.

The aim of this regression in this session was to examine the effect of early phonological and visual skills on predicting later reading ability after the influences of extraneous factors, IQ, reading ability at the first testing session and vocabulary ability, have been partialled out. Therefore, the above mentioned three extraneous factors were entered in the first 3 steps, and then the last 2 steps were early phonological score and visual skill test. The results of the 5-steps fixed order regression are presented in Table 10-7.

Table 10-7: Longitudinal prediction of reading ability at the end of the first year after IQ, vocabulary, and early reading were controlled.

Variables	R^2 changed	cumulative R^2
First step: IQ (1st)	.1209*	.1209
Second step: vocabulary	.0606	.1815
Third step: reading before schooling	.5107***	.6922
Fourth step: phonological skills (1st)	.0006	.6928
Fifth step: visual skills (1st)	.0040	.6968
or Fourth step: visual skills (1st)	.0045	.6967
Fifth step: phonological skills (1st)	.0001	.6968

* $p<.05$ *** $p<.001$

The results were surprising and revealed that reading ability before pupils received any formal instruction in primary school had a notable effect on later reading ability. The amount counted for 51.07% ($p<.001$) of the variance in the later reading ability. Performance on the phonological tests played a trivial role in later reading ability after the differences on the early reading scores were controlled. The effects of both phonological awareness and visual skill tests were minimal.

10.3.3.3 Prediction of Chinese reading in each testing session

Table 10-8 presents the results of the stepwise regression analyses at each testing session. This regression focused on examining which variable could significantly predict reading ability at the various testing points during the first year of schooling. The scores of each task have been standardized. The three phonological tests were standardized first and then combined together as a single phonological score. In the stepwise regression analyses, the phonological score, visual skill and IQ were predictors at the first and the second testing. BPVS was also one of predictors at the third testing. Reading ability at each testing session was the criterion variable.

Table 10-8: Summary of multiple stepwise regression analysis.

A. Combined phonological tests
IQ, phonological tests, and visual skill (vocabulary at the 3rd session) as predictor variables, reading ability as criterion variable

variables	R^2 changed	F	p
the first testing session			
phonological test	.56	48.10	.0001
Overall F(1, 38) =48.10, p<.0001; R^2=.56			
the second testing session			
phonological test	.52	41.99	.0001
Overall F(1, 38)=41.99, p<.0001; R^2=.52			
the third testing session			
phonological test	.27	13.97	.0006
Overall F(1, 38)=13.97, p<.0006; R^2=.27			

B. Separate phonological tests
IQ, oddity score, Chinese Phoneme Deletion, and visual skill (vocabulary at the 3rd session) as predictor variables, reading ability as criterion variable

variables	R^2 changed	F	p
the first testing session			
Chinese Phoneme Deletion	.48	35.65	.0001
oddity	.09	7.74	.0084
Overall F(2, 37)=24.86, p<.0001; R^2=.57			
the second testing session			
oddity score	.54	45.30	.0001
Overall F(1, 38)=45.30, p<.0001; R^2=.54			
the third testing session			
Chinese Phoneme Deletion	.34	19.40	.0001
Overall F(1, 38)=19.40, p<.0001; R^2=.34			

At the first testing, 56% of the variance in the reading score was accounted for by the single phonological test score. The phonological test score was the only significant predictor of Chinese reading, even though the variance accounted for decreased at the second and the third sessions. No other variables entered the stepwise regression other than the phonological score (p=.05).

If one intended to look at the predictive power from the Odd Man Out tests and phoneme deletion test, then both of Odd Man Out tests were combined as a single oddity score and entered separately from the phoneme deletion scores. The predictor variables contained IQ, visual skill, oddity score and phoneme deletion test at the first and the second sessions. BPVS was entered as a predictor at the third session. The results were shown in Table 10-8 section B.

In this stepwise regression, 57% of the variance in reading was accounted for by the 2 predictors: phoneme deletion test and oddity score at the first testing. At the second session, the oddity score was the most powerful predictor of reading ability. After 8 months of instruction in Chinese characters, the Phoneme Deletion Test appeared to exert the most powerful influence, R^2=.34, p<.0001.

10.3.4 The correlations between phonological subtests and reading in each session

The correlations between reading and the separate phonological subtests are demonstrated in Table 10-9. If we look at the relation between the phonological subtests and reading, it can be found that the correlation between reading and the end sound deletion was stronger than that between reading and the first sound deletion in the Chinese Phoneme Deletion test. In the Odd Man Out test, the first sound detection was more significantly related to reading than the other two tasks (middle and last sound detection) in the first and the third testing sessions, but not in the second testing session. The trend in the correlations was similar to the above results when the effect of IQ was partialled out.

Table 10-9: The pattern of correlation among phonological subtests and Chinese reading.

a. The correlation of reading with separate phonological subtests								
First testing (**before learning *Zhu-Yin-Fu-Hao* and Chinese characters**)								
	Chi.OMO(F)	(M)	(L)	Chi. Non.OMO(F)	(M)	(L)	Chi.Pho.Del.,first	end
Reading	$.46^{**}$	$.38^{*}$	$.40^{*}$	$.65^{***}$	$.33^{*}$	$.39^{*}$	$.57^{***}$	$.72^{***}$
Second testing (**after learning *Zhu-Yin-Fu-Hao*, before learning Chinese characters**)								
	Chi.OMO(F)	(M)	(L)	Chi. Non.OMO(F)	(M)	(L)	Chi.Pho.Del.,first	end
Reading	$.54^{***}$	$.60^{***}$	$.63^{***}$	$.62^{***}$	$.67^{***}$	$.55^{***}$	$.42^{**}$	$.47^{**}$
Third testing (**after learning *Zhu-Yin-Fu-Hao* and Chinese characters for 1 school year**)								
	Chi.OMO(F)	(M)	(L)	Chi. Non.OMO(F)	(M)	(L)	Chi.Pho.Del.,first	end
Reading	$.56^{***}$	.15	.25	$.39^{*}$	$.36^{*}$	.27	$.49^{**}$	$.61^{***}$
b. The partial correlation of reading with separate phonological subtests								
First testing (**before learning *Zhu-Yin-Fu-Hao* and Chinese characters**)								
	Chi.OMO(F)	(M)	(L)	Chi. Non.OMO(F)	(M)	(L)	Chi.Pho.Del.,first	end
Reading	$.35^{*}$	.29	$.34^{*}$	$.61^{***}$	.30	.24	$.50^{**}$	$.66^{***}$
Second testing (**after learning *Zhu-Yin-Fu-Hao*, before learning Chinese characters**)								
	Chi.OMO(F)	(M)	(L)	Chi. Non.OMO(F)	(M)	(L)	Chi.Pho.Del.,first	end
Reading	$.46^{**}$	$.56^{***}$	$.58^{***}$	$.57^{***}$	$.62^{***}$	$.49^{**}$	.32	$.37^{*}$
Third testing (**after learning *Zhu-Yin-Fu-Hao* and Chinese characters for 1 school year**)								
	Chi.OMO(F)	(M)	(L)	Chi. Non.OMO(F)	(M)	(L)	Chi.Pho.Del.,first	end
Reading	$.44^{**}$	.02	.16	.26	.16	.15	$.35^{*}$	$.48^{**}$

* $p<.05$ ** $p<.01$ *** $p<.001$

10.3.5 The correlation between the three testing sessions on each test

Table 10-10 shows the correlation between the three sessions of reading ability, phonological and visual skill. There was a tendency for each task to display a high correlation at the three testing sessions.

Table 10-10: The developmental pattern of correlation between the three testing sessions on each test.

reading ability			visual skill		
	2nd	3rd		2nd	3rd
1st	$.97^{***}$	$.83^{***}$	1st	$.65^{***}$	$.46^{**}$
2nd	-	$.86^{***}$	2nd	-	$.57^{**}$

phonological tests

Chinese Odd Man Out			*Chinese Non-word OMO*			*Chinese Pho. Del.*		
	2nd	3rd		2nd	3rd		2nd	3rd
1st	$.54^{***}$	$.51^{***}$	1st	$.47^{**}$	$.34^{*}$	1st	$.56^{***}$	$.44^{**}$
2nd	-	$.44^{**}$	2nd	-	$.59^{***}$	2nd	-	$.69^{***}$

* p<.05 ** p<.01 *** p<.001

The developmental pattern of reading ability:

High correlations on reading between the first, the second and the third testing sessions were found. This implies that the performance on reading was stable. It is not surprising to find a high correlation between the first session and the second session on reading ability, r=.97, p<.001, as there is no instruction in characters during the ten weeks. The significant correlation between the first testing and the third testing indicated that if anyone achieves high score in a reading test at the beginning, then it is predicable that s/he will perform well later.

The developmental pattern of visual skills:

The correlation between the first visual skills testing and the second testing was higher than the other correlations, although the correlations between each testing session were significant (p<.01 to p<.001). That is, the performance at the first testing was similar to the second testing.

The developmental pattern of phonological skills

The developmental patterns among the three phonological tests were varied. It appears that the highest correlations on the phoneme deletion task and the non-word oddity test occurred between the second testing and the third testing, even though the interval was nearly 8 months. Conversely, the highest correlation on the Chinese Word Odd Man Out test was between the first testing and the second testing.

Overview of the developmental pattern:

It is interesting to note that the correlation between the first testing and the third testing was the least significant in each task except the Chinese Word Odd Man Out test. The reason may be the testing interval of 10 months. Nevertheless, the most significant correlation on the Chinese Non-word Odd Man Out and Phoneme Deletion tests were not found at the shortest testing interval (i.e., between the first and the second testing). For both tests, the most significant correlations existed between the second and the third testing sessions.

10.3.6 The intercorrelation between phonological tests

Table 10-11 presents the intercorrelation between phonological tests at each testing session.

The three phonological tests were highly correlated with each other at the three testing sessions, ranging from .49 to .82 ($p<.01$ to $p<.001$). The relations between the three phonological tests held when IQ was controlled ($r=.37$ to .78, $p<.05$ to $p<.001$). In addition, the correlation between Chinese Word Odd Man Out and Non-word Odd Man Out were very significant at the three testing sessions.

Table 10-11: The intercorrelation of phonological tests.

Correlation of phonological subtests

session	Chinese Nonword Odd Man Out *1st*	*2nd*	*3rd*	Chinese Phoneme Deletion *1st*	*2nd*	*3rd*
Chinese Odd Man Out	.66***	.82***	.75***	.49**	.56***	.59***
Chinese Non-word Odd Man Out	-			.54***	.60***	.67***

Partial correlation of phonological subtests, IQ as a partial variable

session	Chinese Nonword Odd Man Out *1st*	*2nd*	*3rd*	Chinese Phoneme Deletion *1st*	*2nd*	*3rd*
Chinese Odd Man Out	.59***	.78***	.68***	.37*	.43**	.46***
Chinese Non-word Odd Man Out	-			.45**	.46**	.54***

* p<.05 ** p<.01 *** P<.001

10.3.7 Sex differences

The performances of boys and girls on all tasks at the three testing sessions are shown in the Appendix E. Table 10-12. At the three testing sessions, the only steady difference between boys and girls existed in Chinese reading. The results showed that the girls performed better than the boys on the Chinese Odd Man Out test at the second testing and on the Chinese Phoneme Deletion test at the third testing. There were no significant differences between the sexes on other tasks.

10.4 DISCUSSION AND CONCLUSIONS

This was a one-year longitudinal study to investigate phonological awareness and visual skills differences during reading acquisition in the first year of schooling.

The results obtained in the present research were that early phonological performance before pupils received any formal instruction was significantly related to children's reading ability at the end of the first year. In contrast, early visual skills were not related to later reading ability. This suggested that the early phonological skills play an essential role in learning to read in the first year, and that skills required for recognising Chinese characters may be somewhat related to phonological awareness. The results were in accord with these of research concerned with an alphabetic writing system (Bryant & Bradley, 1985; Ellis & Large, 1987; Mann & Liberman, 1984; Stanovich *et al.*,1984; Tunmer, 1990; Wimmer *et al.*, 1991). However, the question is how such similar results could have occurred with such different writing systems.

There are three possibilities: first, pupils learn a phonetic system in addition to Chinese characters in the first year. Teachers continue to employ *Zhu-Yin-Fu-Hao* in the class after the 10 weeks of phonetic instruction. Moreover, pupils use Chinese characters and *Zhu-Yin-Fu-Hao* together as they practice characters or write a diary (a typical kind of homework in primary schools). In general, children always write the characters which they have learnt and use *Zhu-Yin-Fu-Hao* to express the characters or words they have not been taught. According to the teachers' guide book for the Chinese language, children should learn to write and recognise 350 Chinese characters plus another 123 Chinese characters which they should be able to recognize. The total number for a first grader to recognise is 473 characters. With the limited characters that children have learned, they are allowed to use the phonetic system through the year, and this may lead to phonological performance being strongly related to reading ability at the 3 testing sessions even after the effects of IQ have been controlled.

Another possibility is that the phonetic compounds characters account for over 80 % of the Chinese characters (Leong, 1986; Taylor & Taylor, 1983) which implies a possible role for phonetic recoding in reading Chinese. The Chinese characters can be divided into six categories: pictographs, ideographs, compound ideographs, phonetic compounds, loan characters and analogous (see Sec. 2.1.1). Phonetic compounds have two parts, a phonetic, and a radical. The phonetic is like a rhyming cue and the radical gives a clue as to the meaning of the characters. The ability to read words may be highly correlated with the children's ability to use the phonetic parts to pronounce individual characters. The results of the current study were similar to the studies of So and Siegel (unpublished) in which significant relationships were found among phonological skills and Chinese reading for Hong Kong children (refer to Sec. 9.4). Another investigation by Ho (1989) also showed that Chinese reading scores (both word recognition and comprehension) were significantly correlated with scores of two phonological tests (Rime Detection Test and Character-string Memory Test) when the effect of IQ was partialled out.

The last possibility is the "third variable" problem. That is, the significant correlation may derive from their relations to an unmeasured third variable. Longitudinal studies would not exclude the possibility that the predictor variables and criterion variables are determined by some unknown factors. In this research, attempts have been made to control the parents SES and pupils' age, IQ and vocabulary ability. However, one can not be sure about other extraneous variables. For instance, the fact that BPVS was only tested at the end of the first year may be inappropriate. The results from Chapter Six implied that the significant relationship between the phoneme deletion test and Chinese reading may be caused by vocabulary ability. That is, the phoneme deletion ability is related to vocabulary ability, which in turn relates to reading. Therefore, the relationship between reading and phoneme deletion was strikingly reduced when the controls were made for differences in the children's vocabulary ability. Accordingly, it would be more appropriate to give subjects a vocabulary test at the beginning of a longitudinal study.

Why was visual skill not a significant predictor variable of Chinese reading for the first year students? This was surprising since Study One showed that reading ability in the third grade Taiwanese children was significantly correlated with visual skills. There may have been two reasons for this. Perhaps, visual skill may not be important for the beginning readers, but it becomes critical in the second or third year. Alternatively, reading a logographic writing system may increase visual skill. As Hoosain (1986) claimed, learning to read the Chinese language may facilitate visual form manipulation. Consequently, children who are better readers may develop superior visual skills.

The results from the correlation coefficient and from stepwise regression showed an impressive connection between phonological test scores and reading ability. However, the surprising results from the fixed-order regression which showed that the early phonological score only accounted for .06% of the variance in later reading score after the effects of IQ, vocabulary (BPVS) and early reading score were partialled out must be discussed here. This indicates that the significant correlation between early phonological score and later reading ability may be influenced by the children's early reading score before they entered school. The surprising finding coincided with the results from Wagner and Torgesen (1987). The possible causal role of learning to read in the development of phonological skills can not be neglected. As mentioned in the introduction of this chapter (Sec. 10.1), both of the investigations by Stuart and Coltheart (1988) and by Bryant *et al.* (1989) tested children's reading ability after 8 months or longer of schooling. Therefore, the significant correlation between early phonological awareness and later success on reading in their research might be affected by the preexisting difference in reading ability.

Nowadays, it seems difficult to find subjects who enter school without recognizing any Chinese characters in Taiwan. This is due to the educational value of Chinese parents in recent years. People emphasize the effects of early learning. Parents or teachers in Kindergarten may play word games to encourage children to recognize characters before they enter primary school. In particular, when children come from urban districts or from a family with high SES, the tendency is more significant. That is why the subjects were chosen from a rural town. It was probably unavoidable to find that the subjects recognised some characters before they entered school. The results from the longitudinal study therefore can not answer the question of whether early phonological skills facilitate later success on Chinese reading. Of course, it is perhaps not surprising that such a complicated question can not be answered by a single study. Thus, some further investigation remains to be done. It seems necessary to explore the relationship between phonological awareness and reading development among even younger children.

Goswami and Bryant (1990) argued that children's awareness of rhyme may well influence their progress in reading. Here, the result revealed evidence that phoneme deletion skills may play a more important role in the subsequent success at Chinese reading. The reason was that the early Phoneme Deletion test score was more strongly related to later reading success ($r=.61$, $p<.0001$). Even when the effects of IQ were partialled out, the correlation was still significant.

It was interesting to find that the scores of phonological tests increased after 10 weeks instruction of *Zhu-Yin-Fu-Hao*. It is evident that children's performance on the phonological tests improved enormously from the first testing session to the second testing session. The findings implied that learning a phonetic system increases phonological skills. This is consistent with the finding from Read *et al.* (1986) which revealed that people who have not learnt *Pinyin* had difficulty in adding or deleting individual consonants in spoken Chinese words. The mean score for word targets among the non-alphabetic group was 3.7 out of 10 in their results. Similarly, the score of the phoneme deletion test before any formal instruction in this study was 7.15 (out of 20) which is strikingly similar to Read *et al.*'s mean score. Moreover, the performance on odd man out tests before children learned *Zhu-Yin-Fu-Hao* was slightly higher than the chance level. However, after 10 weeks of instruction in a phonetic system, the scores on the Odd Man Out test increased from 19.50 to 24.63. The increase in the phoneme deletion test was the most striking one, from 7.13 to 12.15. It should be emphasized here that the instruction of *Zhu-Yin-Fu-Hao* does not specifically teach these kinds of task. As pointed out by Read *et al.* (1986), "there is not a classroom exercise like the deletion task" (p.42). After 8 months' instruction in Chinese characters, there was no significant difference on the performance of the Chinese Phoneme Deletion test. Conversely, the score of the Odd Man Out test at the third testing was still higher than that of the second testing. This may be caused by the learning effect that gains in reading facilitated the oddity detecting ability.

One of the purposes of the present study was to explore the relationship between phonological awareness, visual skills and reading ability during the first year of schooling. When the correlations at the three testing sessions were investigated, it could be ascertained that the relationship also varied with the content of instruction. After subjects had learnt a phonetic system, the correlations between odd man out tests and reading ability were significantly raised. Nevertheless, the above relation declined after children had learnt Chinese characters for nearly eight months. The relationship between the phoneme deletion score and reading showed the reverse pattern. Although the relation decreased after the phonetic instruction, the phoneme deletion score was the only significant variable to correlate with reading ability after the difference in IQ was controlled at the end of the first year. Research by Perfetti *et al.* (1987) discovered that the deletion tasks (to delete the initial, e.g.,"cat"-"at" or the final sound) were the most strongly related to the reading performance one year later when compared with the blending test (constructing a word from phonemes) and tapping task. It should be noted that the relationships between phonological tests and reading were still stronger than that between visual skills and reading at the end of the first year. The reason may be that when teachers introduce Chinese characters, they also show *Zhu-Yin-Fu-Hao* in the meantime during the first year instruction.

Another important finding of the present research was that the correlations between reading scores at the three sessions were highly significant. Even after about 10 months interval of retest, the correlation was still very significant ($p<.0001$). Williams and Silva (1985) conducted a longitudinal study of factors associated with reading ability in 748 children. Reading was assessed when subjects were aged 7 and 9 years using the Burt Word Reading Test, 1974 Revision. Their research also found that the correlation between reading at age 7 and reading at age 9 years was very high (0.87).

The difference between sexes was that girls performed better than boys on reading ability through the first year of schooling. The finding corresponded with the results by Martin and Hoover (1987). They examined the relationship between gender and achievement, and the change in this relationship over time using 4,875 females and 4,497 males who were tested with the Iowa Tests of Basic Skills each year from

Grade 3 to Grade 8. Their results also showed that females had higher levels of achievement on spelling and Reading Comprehension tests.

The longitudinal study yielded valuable information about the relations between phonological awareness, visual skills and Chinese reading in the first year. In summary, the crucial findings from the longitudinal study are as followings:

1. An increase of phonological skills was found after subjects had learnt a phonetic system.

2. The relationship between reading and oddity skills increased after the instruction of a phonetic system. The relation between visual skills and reading increased with the time that children had been learned Chinese characters. However, the correlation coefficient was less strong than that between phonological tests and reading.

3. Early phonological skills were significantly correlated with later reading ability. In contrast, the early visual skill showed a non-significant correlation with the later reading ability.

4. Although phonological score was a significant factor in predicting reading at the three testing sessions, it was not a powerful variable in predicting later reading ability when the effects of early reading score were controlled.

5. The performance of phoneme deletion task at the first testing was significantly worse than that at the second and the third testing. There was no difference between the second and the third testing sessions.

6. There was a significant correlation between the three testing sessions on each task.

7. Girls performed better than boys on Chinese reading at the three testing sessions in the first year of schooling.

PART FIVE

Chapter Eleven 264

CHAPTER ELEVEN

GENERAL DISCUSSION AND CONCLUSIONS

The present chapter is divided into three sections. The first section gives a brief summary of the major findings from three studies. The second part is a general discussion of all three studies. The final section offers suggestions for further research.

11.1 SUMMARY OF MAIN FINDINGS

This thesis examines the role of phonological awareness and visual skill in recognizing Chinese and English. It includes three main studies: one, a cross-cultural study; another, a comparative study; and the third, a longitudinal study. The main findings can be summarized in four parts. The first two parts are mainly concerned with the relationship between phonological awareness, visual skills and reading in English and Chinese. The third part concentrates on a comparison of phonological awareness tests in the three studies. The last part deals with performance in the visual skills tests in all three studies. Then, a brief conclusion will be given.

11.1.1 The relationship between phonological awareness, visual skills and reading in Chinese

11.1.1.1 Visual skills and reading in Chinese

One of the most important findings of this thesis is the result from the cross-cultural study (Study One) that Chinese reading was highly related to the Visual Paired Associates test for Taiwan and Hong Kong. In Study Two, the visual skills score was the most significant predictor for Chinese reading in the non-*Pinyin* group. However, there was no significant relationship between visual skills and Chinese reading ability for the *Pinyin* children in Hong Kong. A similar pattern of results emerged from Study Three. There was no significant relationship between visual skills and Chinese reading ability before children received any formal instruction in primary schools in Taiwan. Therefore, the correlation increased with time spent at school. After children had studied *Zhu-Yin-Fu-Hao* for ten weeks and Chinese characters for nearly 8 months, visual skill was significantly related to Chinese reading ability.

11.1.1.2 Phonological tasks and Chinese reading

The relation between phonological awareness and Chinese reading were not the same throughout the three studies. For Study One, the Chinese Phoneme Deletion test was found to have a significant relationship with Chinese reading ability for the subjects in Taiwan and Hong Kong. All the phonological awareness tests had a strong relationship with Chinese reading ability for the *Pinyin* group of Hong Kong in Study Two and for the first graders in three different testing sessions in Study Three. Furthermore, early phonological skill was significantly correlated with later reading ability.

11.1.1.3 The powerful predictor of Chinese reading

The results from Taiwan, Hong Kong (Study One) and non-*Pinyin* group in Hong Kong (Study Two) showed that visual skills were the most powerful predictor of Chinese reading. In comparison, the *Pinyin* group (Study Two) and the longitudinal study (Study Three) revealed that phonological awareness was the only significant predictor variable for Chinese reading. The early phonological score was not, however, a powerful variable for predicting later reading ability when the effects of early reading score were controlled.

11.1.2 The relationship between phonological awareness, visual skills and reading in English

11.1.2.1 Visual skills and reading in English

For the Hong Kong subjects in Study One, a significant relationship was found between the Visual Paired Associates test and the English reading test. This, however, was not found either for the U.K. subjects in Study One or for the *Pinyin* group of Hong Kong subjects in Study Two.

11.1.2.2 Phonological awareness and reading in English

For the English subjects, all phonological awareness tests closely correlated with the English reading test. This was not found for the Hong Kong group in Study One. The only correlation for the Hong Kong subjects was that between the Chinese Phoneme Deletion test and English reading test. For the *Pinyin* group in Study Two, the correlations between phonological awareness tests and the English reading ability are higher than those for the non-*Pinyin* group.

The English Phoneme Deletion test was significantly related to the English reading ability for the English children. For the children in Hong Kong (including *Pinyin* and non-*Pinyin* group), the English reading was closely related to Chinese Phoneme Deletion test but not to the English Phoneme Deletion test.

The Odd Man Out tests had a very significant correlation with English reading ability for English subjects. For the *Pinyin* and non-*Pinyin* groups, however, there is no significant correlation between Chinese Non-word Odd Man Out test and English reading ability.

11.1.2.3 The powerful prediction of English reading

When the predictive power for English reading was compared, it was found that phonological awareness was the most powerful predictor of English reading for the *Pinyin* group and the English subjects, but not for the non-*Pinyin* group.

11.1.3 The comparisons of performance on phonological awareness tests

On the correlation between phonological tests, it was evident that Chinese Odd Man Out, English Odd Man Out and Chinese Non-word Odd Man Out had high correlations. The odd man out tests were not related to the phoneme deletion test for English subjects and the non-*Pinyin* group, but not for Taiwan subjects (the first and the third graders) and the *Pinyin* group in Hong Kong.

11.1.3.1 The comparison of Phoneme deletion tests

On the English Phoneme Deletion test, English subjects were superior on the CVCC type of the first sound deletion to Chinese children (Study One), but Chinese children were better than the British subjects on the CCVC type of the first sound deletion.

For the first graders, the performance of Chinese Phoneme Deletion task at the first testing was significantly worse than that at the second and the third testings.

There was no difference between the second and the third testing sessions. There was no difference between the first sound and the end sound deletion of Chinese Phoneme Deletion test for Taiwan subjects.

11.1.3.2 The comparison of Odd Man Out tests

It was found that the *Pinyin* group and non-*Pinyin* group in Hong Kong performed worse in the middle sound detection tests of English Odd Man Out and Chinese Odd Man Out than in the first and last sound detection tests. On the other hand, English children performed better in the middle sound detection tests of English Odd Man Out than in the first and last sound detection tests. These effects of superiority or the inferiority in Odd Man Out tests were not, however, found in the Taiwan group (either the 8 year-old group in Study One or the 6 year-old group in Study Three).

11.1.4 Comparisons of the performance on visual skills tests

In Study One, English children performed worse on the Visual Form Discrimination test than the children in Taiwan and Hong Kong ($p<.05$). Neither Taiwan nor Hong Kong children differed significantly on the Visual Form Discrimination test. In Study Two, neither of the groups (*Pinyin* and non-*Pinyin*) in Hong Kong showed any significant difference on the Visual Form Discrimination and Visual Paired Associates tests. The results of these comparison suggest that children's visual skills may be relatively unaffected by the variety of languages they learn.

A comparison of the performance on Visual Paired Associates across the three studies indicated that the scores of Visual Paired Associates increased with time at school: the Visual Paired Associates scores were 8.33, 10.25 and 11.98 for the children without formal school instruction (six year-old children, Study Three), the children at the end of the first grade (Study Three), and the children at the end of the third grade (in Study One), respectively.

11.2 GENERAL DISCUSSION AND CONCLUSIONS

Most of the main findings reviewed here have been separately discussed in each Study. There remain, however, three important questions that merit discussion here.

1. Why was visual skill found to be the most powerful predictor of Chinese reading for the third graders in Taiwan (Study One), whereas the phonological awareness score was the most significant predictor for the first graders (Study Three)?

This is a particularly interesting question given that the subjects from Taiwan in Study One and in Study Three have the same native language, study the same set of textbooks, and live in a similar environment. The main difference between the two groups is the subjects' age. As I claimed in Sec. 3.1.4, in mainland China and in Taiwan, the Chinese child's reading development may go through three stages: the first stage is a "phonetic phase", followed by a "mixed phase", then a "visual phase".

At the first stage, children learn a phonetic system (*Pinyin* or *Zhu-Yin-Fu-Hao*) before they are taught Chinese characters and the phonetic system is the dominant teaching material in the first year. They thus tend to become aware of the phonemic structure of speech. This may account for the significant correlations between Chinese reading and phonological tests and the powerful prediction from the score of phonological tests for the first graders. With increasing familiarity with Chinese characters, the visual strategy may become more important for children. Meanwhile, teachers have ceased to give so much emphasis to the phonetic system. These two facts may determine which factors are significant predictors of Chinese reading for the different age groups.

This may be why the correlation coefficient between the Visual Paired Associates test and Chinese reading increased from 0.25 (n.s.) for the pre-readers to 0.39 ($p<.05$) for the children at the end of the first year (in Study Three). More evidently, the correlation was 0.76 ($p<.001$) for the children at the end of the third year (in Study One) for Taiwan children. This seems to imply that the period at school is important for the relationship between visual skills and Chinese reading.

Alternatively it may be that reading a logographic writing system for a long term might increase visual skill. Consequently, children who are better readers may develop superior visual skills. This would explain why the relation between reading and visual skills takes time to develop.

2. Why were phonological tests related to Chinese reading among three studies?

All three studies showed that phonological awareness is not unrelated to Chinese reading. The relation varies with different phonological tasks, and with subjects' age and learning experience.

a. Different phonological tasks:

For the relationship between Chinese reading ability and phonological awareness, the most evident result was that the Chinese Phoneme Deletion test was significantly related to Chinese reading ability in all three studies, except for the

Pinyin group in Hong Kong (see Tables 8-2, 9-3, and 10-5), even when the effect of IQ has been removed.

In oddity tests, the correlations between Chinese reading and Chinese Word Odd Man Out were more significant than those between Chinese Non-word Odd Man Out test for the most subjects (see Tables 8-2, 9-3, and 10-5).

b. Subject's age:

The relation between phonological awareness and Chinese reading differed in both groups of eight year-old (Study One) and six year-old children (Study Three). This relationship was much more significant (see Table 10-5) for beginners than for the third graders (see Table 6-2).

c. Learning experience:

If one compares those children who have learnt *Pinyin* in Hong Kong and children who have learnt *Zhu-Yin-Fu-Hao* in Taiwan with those children who have not learnt *Pinyin* in Hong Kong, it can be seen that the children in the last group showed a lower relationship between phonological awareness and Chinese reading. The relationship was clearly affected by previous learning experience.

The significant relation between phonological awareness and English reading for English subjects has been confirmed by many studies (e.g., Bryant & Bradley, 1985; Tunmer & Nesdale, 1986). In studies conducted in this thesis, the relation has also been found for Chinese subjects to some extent. So and Seigel (unpublished) showed that Chinese word recognition was related to rhyming discrimination (see Sec. 9.4 for detailed interpretation). The question arises of why recognizing Chinese characters requires some aspects of phonological awareness in the three studies. There are three factors which might explain the correlations. One (discussed in Sec. 10.4) is that 80% of the Chinese characters contain a phonetic part (see Sec. 2.1.1). The second possible reason is that learning a phonetic system (Taiwan groups in Study One and Study Three, *Pinyin* group in Study Two) or learning English (non-*Pinyin* group in Study Two) facilitates the correlation between phonological awareness and Chinese reading. That is, learning *Pinyin* or English experience encourages readers to take notice of phonological information. Last, the significant relationships between phonological awareness tests and Chinese reading may be caused by the significant correlation between phonological awareness tests and vocabulary ability. In Study One, it has been found that the score of phonological tests did not significantly predict Chinese reading after the effects of IQ and vocabulary were partialled out.

3. Is the ability to delete a phoneme the result of learning a phonetic system for Chinese children?

When one compares the performance on the Chinese Phoneme Deletion test across the three studies, it can be seen that Hong Kong children who had **never** learnt *Pinyin* or *Zhu-Yin-Fu-Hao* received the lowest score 5.17 out of 20 (see Table 9-2, in Study Two). In contrast, the first graders who had learnt *Zhu-Yin-Fu-Hao* for ten weeks obtained 12.15 out of 20 (see Table 10-2, Study Three). More important, scores for the third graders in Taiwan were 16.84 (see Table 6-1, in Study One).

The comparison through three studies apparently displayed that the Hong Kong children had not learnt *Pinyin* or *Zhu-Yin-Fu-Hao* performed very badly on the Chinese Phoneme Deletion test even though they achieved high scores on the Odd Man Out test and high scores on the Chinese reading test. The results suggested that their ability to manipulate phonemes is a consequence of learning *Pinyin* or *Zhu-Yin-*

Fu-Hao, but is not a consequence of learning a logography. Nevertheless, this is not true for the oddity tests. That may be why the English subjects in Study One could perform Chinese Non-word Odd Man Out tasks quite well even though they had not learnt Chinese before. The subjects in Taiwan, however, could not cope with the English Phoneme Deletion test at all. The results of the current study agree with the argument from Yopp (1992) that children may have a certain level of phonemic awareness and the relationship between phonological awareness and reading ability should depend on the nature of phonological skills.

In conclusion, the evidence from three studies revealed that phonological awareness plays an important part in learning to read in English. By contrary, visual skill was not consequential in English reading for a native English learner. With regard to Chinese reading, visual skill seems a determinant factor for the older children. For the beginning readers, phonological awareness is more important than visual skill. From the developmental viewpoint, the results implied that there is a developmental change in the strategies used in reading Chinese. That is, the reading development in Chinese involves different skills in different phases.

11.3 RECOMMENDATIONS FOR FURTHER INVESTIGATION

These three main studies have yielded valuable results, but some work remains to be done. Recommendations for further studies will be briefly offered below.

1. Suggestions for a cross-cultural study

It would be interesting to pursue further research on the following issues:

a. To include a memory test.

It may be important to include a memory test because the items in the oddity tests may require a memory load. That is, working memory may play an important role in oddity tests. For instance, when a child try to respond to the items in oddity tests, s/he has to compare four words per item, and speak out which one of four words is the different word in the first (middle or last) sound. The process may need memory load to some extent.

b. To choose another different IQ test.

In order to avoid the culture difference in IQ tests, Raven's Coloured Progressive Matrices test was chosen as a non-verbal IQ test. It should be noted that this test is culture-fair, but not language-fair because children in Hong Kong, Taiwan, and mainland China who have learnt logographic writing system performed better than did American or British children (Court, 1991). Therefore, it is suggested to choose another kind of IQ test.

c. To give more educational tests.

It is worth giving more educational tests, such as Mathematics tests, in order to look at the particular effect on different educational tests.

2. Suggestions for a comparative study

Concerning further research on the comparative study in the *Pinyin* group and non-*Pinyin* group, it would be worth examining the effects of the time spent in learning *Pinyin*, that is, to include subjects who have learnt *Pinyin* for a longer period. For example, the *Pinyin* subjects in the current study had been learning *Pinyin* script for nearly one year. If one investigates children who have learned *Pinyin* for a longer time, the effect of *Pinyin* may be different. According to the Hong Kong government, there is only one primary school in which pupils learn *Pinyin* from the first grade until they leave, but, when the author contacted the school, the principal of the school would not agree to participate in the research.

In the present study, the fact that there were differences on the English reading and vocabulary tests between the *Pinyin* group and the non-*Pinyin* group may have created some ambiguity (as summarised in Sec. 11.1). The *Pinyin* group performed better than the non-*Pinyin* group on all tests of phonological awareness. The results may be affected by learning *Pinyin* or by differences in English reading ability between two groups. The exact explanation for this result requires further study. Therefore, reading ability in English should be matched in further research.

3. Suggestions for a longitudinal study

It would be of interest to investigate the following further research on the aspects of the longitudinal study in Chinese reading.

a. To begin from an earlier age.

In the present longitudinal study, the subjects participated at six years old when they started schooling. At that time, however, some of them had already learnt Chinese characters and *Zhu-Yin-Fu-Hao* at home or at kindergarten before they entered primary school. An investigation of younger children (e.g. from 3 or 4 years of age) would help to establish the developmental pattern of Chinese reading ability.

Liberman *et al.* (1974) showed important phonological awareness development in English between the ages of four and six. It would be worthwhile to investigate the emergence and development of those analytical skills in children between the age of three or four and six years.

b. To test vocabulary ability earlier.

The results from Study One suggested that vocabulary ability may be an important factor in the relationship between phonological awareness test and Chinese reading. Accordingly, it would be more appropriate to give subjects a vocabulary test at the beginning of a longitudinal study.

c. To continue the longitudinal study.

It would be interesting to continue the longitudinal study described in Study Three to ascertain the longer-term effects of phonological awareness and visual skills. It would be interesting to know whether visual skills becomes more strongly correlated with reading over time.

The present study considered the subjects only at the start of their schooling and at the end of their first year. More prolonged and continuous studies could supply much valuable information about the development and interaction of young learners' language-skills.

Extending a longitudinal survey to pre-school-age children and to children in their second and subsequent years at school would enrich our knowledge of the relations between phonological awareness, visual skills, and reading ability, and might make a useful contribution to the design and revision of reading syllabuses and to the supply of appropriate textbooks, reading-texts, and other learning materials.

REFERENCES

Adams, M. J. (1990). *Beginning to Read: Thinking and Learning about Print.* Cambridge, Massachusetts: The MIT Press.

Alegria, J., Pignot, E., and Morais, J. (1982). Phonetic analysis of speech and memory codes in beginning readers. *Memory and Cognition*, **10**, 5, 451-456.

Ball, E., & Blackman, B. (1991). Does phoneme segmentation training in kindergarten make a difference in early word recognition and developmental spelling? *Reading Research Quarterly*, **26**, 49-86.

Baron, J. (1979). Orthographic and word specific mechanisms in children's reading of words. *Child Development*, **50**, 60-72.

Bentin, S. (1992). Phonological awareness, reading, and reading acquisition: A survey and appraisal of current knowledge. In R. Frost & L. Katz (Eds.) *Orthography, Phonology, Morphology, and Meaning* (pp. 193-210). Amsterdam: Elsevier Science Publishers B.V..

Benton, A. L.; Hamsher, K.; Varney, N. R.; Spreen, O. (1983). *Contributions to Neuropsychological Assessment.* New York: Oxford University Press.

Bertelson, P. (1987). *The Onset of Literacy: Cognitive Processes in Reading Acquisition.* Cambridge, Mass: MIT Press.

Boder, E. M. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. *Developmental Medicine and Child Neurology*, **15**, 663-687.

Bradley, L. (1980). *Assessing Reading Difficulties: A diagnostic and remedial approach.* London: Macmillan Education Limited.

Bradley, L. (1983). The organisation of visual, phonological and motor strategies in reading and spelling. In U. Kirk (Ed.), *Neuropsychology of Language, Reading and Spelling*. New York: Academic Press.

Bradley, L., & Bryant, P. E. (1978). Difficulties in auditory organization as a possible cause of reading backwardness. *Nature*, **271**, 746-747.

Bradley, L., & Bryant, P. E. (1981). Visual memory and phonological skills in reading and spelling backwardness. *Psychological Research*, **43**, 193-199.

Bradley, L., & Bryant, P. E. (1983). Categorizing sounds and learning to read-- a causal connection. *Nature*, **301**, 419-421.

Bradley, L., & Bryant, P. E. (1985). Rhyme and reason in reading and spelling. I.A.R.L.D. Monography No.1. Ann Arbor: University of Michigan Press.

Breitmeyer, B. G., & Ganz, L. (1976). Implications of sustained and transient channels for theories of visual pattern masking, saccadic suppression, and information processing. *Psychological Review*, **83**, 1-36.

Bruce, D. J. (1964). The analysis of word sounds by young children. *British Journal of Educational Psychology*, **34**, 158-170.

Bruck, M., & Treiman, R. (1990). Phonological awareness and spelling in normal children and dyslexics: The case of initial consonant clusters. *Journal of Experimental Child Psychology*, **50**, 156-178.

Bryant, P. E., & Bradley, L.(1985). *Children's Reading Problems--Psychology and Education*. Oxford: Blackwell's.

Bryant, P. E., Bradley, L. L., Maclean, M., & Crossland, J. (1989). Nursery rhymes, phonological skills and reading. *Journal of Child Language*, **16**, 407-428.

Bryant, P. E., Maclean, M.; Bradley, L. L., & Crossland, J. (1990). Rhyme and alliteration, phoneme deletion and learning to read. *Developmental Psychology*. **26**, 3, 429-438.

Buckland, P. (1969). The Effect of Visual Perception Training on Reading Achievement of Low Readiness First Grade Pupils. Doctoral dissertation. University of Minnesota. *Dissertation Abstracts International*. **31**, 4, p.1613A.

Calfee, R. C., Lindamood, P., & Lindamood, C. (1973). Acoustic-phonetic skills and reading: Kindergarten through twelfth grade. *Journal of Educational Psychology*, **64**, 293-298.

Caravolas, M., & Bruck, M. (1993). The effect of oral and written language input on children's phonological awareness: A cross-linguistic study. *Journal of Experimental Child Psychology*, **55**, 1-30.

Chan, J. W. C., & Vernon, P. E. (1988). Individual differences among the peoples of China. Chapter 13. In S. H. Irvine & J. W. Berry (Eds.) *Human abilities in cultural context*. Cambridge: Cambridge University Press.

Chang, H. W. (1992). The acquisition of Chinese syntax. In H. C. Chen & O. J. L. Tzeng (Eds.), *Language Processing in Chinese* (pp.277-311). Amsterdam: Elsevier Science Publishers B.V..

Chang, R. (1978). *Speaking of Chinese*. New York: W. W. Norton & Company, Inc..

Chen, M. J. (1981). Direction scanning of visual displays: a study with Chinese subjects. *Journal of Cross-cultural Psychology*, **12**, 252-271.

Chen, C. H., & Shan, X. L. (1989). *Modern Chinese*. Hong Kong: Joint Publishing Co., Ltd.

Chen, H. C., & Juola, J. F. (1982). Dimensions of lexical coding in Chinese and

English. *Memory & Cognition*, **10**, 3, 216-224.

Chen, L. K., & Carr, H. A. (1926). The ability of Chinese students to read in vertical and horizontal directions. *Journal of Experimental Psychology*, **9**, 110-117.

Chen, M. J., & Yuen, J. C. (1991). Effects of Pinyin and script type on verbal processing: Comparisons of China, Taiwan, and Hong Kong experience. *International Journal of Behavioral Development*, **14**, 4, 429-448.

Chen, M. J., Yung, Y. F., & Ng, T. W. (1988) The effect of context on perception of Chinese characters. In I. M. Liu *et al.* (Eds), *Cognitive aspects of the Chinese language* (Vol. **1**, 27-39). Asian Research Service.

Cheng, C. M. (1982). Analysis of present-day Mandarin. *Journal of Chinese Linguistics,* 10, 282-357.

Cheng, C. M. (1992). Lexical access in Chinese: Evidence from automatic activation of phonological information. In H. C. Chen & O. J. L. Tzeng (Eds.), *Language Processing in Chinese* (pp.67-91). Amsterdam: Elsevier Science Publishers B.V..

Cohen, R. R. (1966). Remedial training of first grade children with visual perception retardation. *Education Horizons*. **45**, 60-63.

Coltheart, M. (1978). Lexical access in simple reading tasks. In G. Underwood (Ed.), *Strategies of Information Processing*. London: Academic Press.

Coltheart, M. (1980). Reading, phonological coding and deep dyslexia. In M. Coltheart, K. E. Patterson, & J. C. Marshall (Eds.). *Deep Dyslexia*. (pp.197-226). London: Routledge.

Coltheart, M. (1985). Cognitive Neuropsychology and the study of reading. In M. I. Posner, & O. S. M. Martin (eds.). *Attention and Performance XI*. Hillsdale, NJ:

Lawrence Erlbaum Associates, Inc., Publishers.

Content, A., Kolinsky, R., Morais, J., & Bertelson, P. (1986). Phonetic segmentation in pre-readers: Effects of corrective information. *Journal of Experimental Child Psychology*. **42**, 49-72.

Cossu, G., Rossini, F., & Marshall, J. C. (1993). When reading is acquired but phonemic awareness is not: A study of literacy in Down's syndrome. *Cognition*, **46**, 129-138.

Cossu, G., Shankweiler, D, Liberman, I. Y., Katz, L, et al. (1988). Awareness of phonological segments and reading ability in Italian children. *Applied Psycholinguistics*, **9**, 1, 1-16.

Coulmas, F. (1984). Arbitrariness and double articulation in writing. In L. Henderson (ed.) *Orthographies and Reading: Perspectives from Cognitive Psychology, Neuropsychology, and Linguistics*, 57-66. London: Lawrence Erlbaum Associates, Inc., Publishers.

Court, J.H. (1991). Asian applications of Raven's Progressive Matrices. *Psychologia*, **34**, 2, 75-85.

Cunningham, A. E. (1990). Explicit versus implicit instruction in phonemic awareness. *Journal of Experimental Child Psychology*, **50**, 429-444.

DeFrancis, J. (1989). *Visible Speech: The diverse oneness of writing systems.* Honolulu: University of Hawaii Press.

De Jong, C. (1989). Visual and auditory perceptual short-term memory processing of dyslexia and normal readers. University of California, Santa Barbara, *Dissertation Abstracts International*, **51**, 6, p.1967A.

DES, (1975). *Bullock Report. A Language for Life*. London: HMSO.

Dunn, L. M., Dunn, L. M., & Whetton, C. (1982). *British Picture Vocabulary Scale: Manual for Long and Short Forms*. Berks., England: NFER-NELSON.

Education Commission, (1984). *Education Commission Report. No. 1*. Hong Kong: Hong Kong Government Press.

Ehri, L. C. (1979). Linguistic insight: Threshold of reading acquisition. In T. Waller & G. Mackinnon (Eds.), *Reading Research: Advances in Theory and Practice* (pp.63-114). New York: Academic Press.

Ehri, L. C., Wilce, L. S., & Taylor, B. B. (1987). Children's categorization of short vowels in words and the influence of spellings. *Merrill Palmer Quarterly*, **33**, 393-421.

Elliott, C. D., Murray, D. J., & Pearson, L. S. (1978). *British Ability Scales*. Windson: NFER publishing Company Ltd..

Ellis, A. W. (1984). *Reading, Writing and Dyslexia:A Cognitive Analysis*. London: Lawrence Erlbaum Associates, Inc., Publishers.

Ellis, N. C., & Large, B. (1987). The development of reading: As you seek so shall you find. *British Journal of Developmental Psychology*, **78**, 1-28.

Erbaugh, M. S. (1992). The acquisition of Mandarin. In D. I. Slobin (ed.), *From the Crosslinguistic Study of Language Acquisition*, pp.373-455. New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Flores d'Arcais, G. B. (1992). Graphemic, phonological, and semantic activation processes during the recognition of Chinese characters. In H. C. Chen & O. J. L. Tzeng (Eds.), *Language Processing in Chinese* (pp.37-66). Amsterdam: Elsevier Science Publishers B.V..

Foorman, B. R., & Liberman, D. (1989). Visual and phonological processing of words:

A comparison of good and poor readers. *Journal of Learning Disabilities*. **22**, 6, 349-355.

Forrest, R. A. D. (1965). *The Chinese Language*. London: Faber and Faber Ltd.

Fox, B., & Routh, D. K. (1975). Analyzing spoken language into words, syllables and phonemes: A developmental study. *Journal of Psycholinguistic Research*, **4**, 331-342.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. Patterson, M. Coltheart and J. Marshall (Eds.), *Surface Dyslexia*. London: Lawrence Erlbaum Associates, Inc., Publishers.

Frith, U. (1988). Beneath the surface of developmental dyslexia. In K. Patterson, J. C. Marshall, & M. Coltheart (Eds.), *Surface Dyslexia*, Chapter 13. London: Lawrence Erlbaum Associates, Inc., Publishers.

Frostig, M. (1968). Sensory-motor development. *Journal of Special Education*, **57**, 2, 18-20.

Funnell, E. (1983). Phonological processes in reading: New evidence from acquired dyslexia. *British Journal of Psychology*, **74**, 159-180.

Gathercole, S. E., Wills, C. and Baddeley, A. D. (1991). Differentiating phonological memory and awareness of rhyme: Reading and vocabulary development in children. *British Journal of Psychology*. **82**, 387-406.

Gatherer, W.A. (1980). *A study of English: Learning and Teaching the language*. London: Heinemann Educational Books Ltd.

Gattuso, B., Smith, L. B., & Treiman, R. (1991). Classifying by Dimensions and reading: A comparison of the auditory and visual modalities. *Journal of Experimental Child Psychology*. **51**, 139-169.

Gelb, I. J. (1963). *A Study of Writing*. Chicago: University of Chicago Press.

Geschwind, H. (1972). Language and the brain. *Scientific American*, **226**, 76-83.

Gleitman, L. R., & Rozin, P. (1977). The structure and acquisition of reading I: relations between orthographies and the structure of language. In A. S. Reber & D. L. Scarborough (eds.), *Toward a Psychology of Reading*. New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Glushko, R. J. (1979). The organization and activation of orthographic knowledge in reading aloud. *Journal of Experimental Psychology: Human Perception and Performance*, **5**, 674-691.

Glushko, R. J. (1981). Principles for pronouncing print: The psychology of phonography. In A. M. Lesgold and C. A. Perfetti (eds.). *Interactive Processes in Reading*. Hillsdale, NJ: Erlbaum.

Goldstein, D. M. (1976). Cognitive-linguistic functioning and learning to read in preschool. *Journal of Educational Psychology*, **68**, 680-688.

Goodacre, (1979). What is reading: which model? In M. S. J. Roggett, C. Tutt, P. Raggett, *Assessment and Testing of Reading: Problems and Practices*, Chapter 2. London: Ward Lock Educational.

Goswami, U. (1986). Children's use of analogy in learning to read: A developmental study. *Journal of Experimental Child Psychology*, 42, 73-83.

Goswami, U. (1988). orthographic analogies and reading development. *Quarterly Journal of Experimental Psychology*, **40A**, 239-268.

Goswami, U. (1990). Phonological priming and orthographic analogies in reading. *Journal of Experimental Child Psychology*, **49**, 323-340.

Goswami, U. (1991). Learning about spelling sequences: The role of onset and rimes in analogies in reading. *Child Development*, **62**, 1110-1123.

Goswami, U., & Bryant, P. (1990). *Phonological Skills and Learning to Read*. East Sussex: Lawrence Erlbaum Associates, Inc., Publishers.

Goswami, U., & Mead, F. (1992). Onset and rime awareness and analogies in reading. *Reading Research Quarterly*, **27**, 2, 152-162.

Gough, P. B. (1972). One second of reading. In J. P. Kavanagh & I. G. Mattingly (Eds.), *Language by Ear and by Eye*. Cambridge, Mass.: MIT Press.

Gough, P. B. (1984). Word recognition. In P. D. Pearson (ed.), *Handbook of Reading Research*, Vol.1 , pp.225-253. New York: Longman.

Goulandris, N. K., & Snowling, M. (1991). Visual memory deficits: A plausible cause of developmental dyslexia? Evidence from a single case study. *Cognitive Neuropsychology*, **8**, 2, 127-154.

Goyen, J. D., & Lyle, J. G. (1971). Effect of incentives upon retarded and normal readers on a Visual-Associate learning task. *Journal of Experimental Child Psychology*, **11**, 274-280.

Haas, W. (1970). *Phono-graphic Translation*. Manchester: Manchester University Press.

Halliday, M. A. K. (1959), *The Language of the Chinese 'Secret History of the Mongols'*, Oxford: Basil Blackwell.

Hanley, J. R., Hastie, K., & Kay, J. (1992). Developmental surface dyslexia and dysgraphia: An orthographic processing impairment. *The Quarterly Journal of Experimental Psychology*, **44A**, 2, 285-319.

Harris, A. J. and Sipay, E. R. (1980). *How to Increase Reading Ability: A Guide to Developmental and Remedial Methods* (7th ed.). N.Y.: Longman.

Harris, M. and Coltheart, M. (1986). *Language Processing in Children and Adults: An Introduction*. London: Routledge.

Hatta, T. (1977). Recognition of Japanese *kanji* in the left and the right visual fields. *Neuropsychologia*, **15**, 685-688.

Henderson, L. (1982). *Orthography and Word Recognition in Reading*. London: Academic Press.

Ho, C. S. H. (1989). *The Relevance of Visual and Phonological Abilities for Chinese Beginning Readers*. M. A. thesis. University of Hong Kong.

Hohn, W., & Ehri, L. (1983). Do alphabet letters help pre-readers acquire phonemic segmentation skill? *Journal of Educational Psychology*, **75**, 752-762.

Hong Kong Government. (1981). *The Hong Kong Education System*. Hong Kong: Hong Kong Government Press.

Hong Kong Government. (1990). *Hong Kong 1990*. Hong Kong: Hong Kong Government Press.

Hong Kong Government. (1992). *Hong Kong 1992*. Hong Kong: Hong Kong Government Press.

Høien, T., & Lundberg, I. (1988). Stages of word recognition in early reading development. *Scandinavian Journal of Educational Research*, **32**, 4, 163-182.

Hoosain, R. (1986). Language, orthography and cognitive processes: Chinese perspectives for the Sapir-Whorf hypothesis. *International Journal of Behavioral Development*, **9**, 507-525.

Hue, C. W. (1992). Recognition processes in character naming. In H. C. Chen & O. J. L. Tzeng (Eds.), *Language Processing in Chinese* (pp.93-107). Amsterdam: Elsevier Science Publishers B.V..

Hue, C. W., Fang, D., & Hsu, K. Y. (1990). Immediate serial recall of Chinese Characters: A study of input modality effect. *Acta Psychologica*, **75**, 213-223.

Hulme, (1988). The implausibility of low-level visual deficits as a cause of children's reading difficulties. *Cognitive Neuropsychology*, **5**, 3, 369-374.

Hung, D. L., & Tzeng, O. J. L. (1981). Orthographic variations and visual information processing. *Psychological Bulletin.* **90**, 377-414. Amsterdam: Elsevier Science Publishers B.V..

Johnston, R. S., & Thompson, G. B. (1989). Is dependence on phonological information in children's reading a product of instructional approach? *Journal of Experimental Child Psychology.* **48**, 131-145.

Jorm. A. F. and Share, D. L. (1983). Phonological recording and reading acquisition. *Applied Psycholinguistics,* 4, 103-147.

Juel, C., Griffith, P. L., & Gough, P. B. (1986). Acquisition of literacy: A longitudinal study of children in first and second grade. *Journal of Educational Psychology*, **78**, 4, 243-255.

Karlgren, B. (1923). *Sound and Symbol in Chinese.* London: Oxford University Press.

Kay, J., & Lesser, R. (1985). The nature of phonological processing in oral reading: evidence from surface dyslexia. *The Quarterly Journal of Experimental Psychology*, **37A**, 39-81.

Kay, J., & Marcel, A. J. (1981). One process, not two, in reading aloud: Lexical analogies do the work of non-lexical rules. *The Quarterly Journal of Experimental Psychology*, **33A**, 397-413.

Kimura, Y., & Bryant, P. (1983). Reading and writing in English and Japanese: A cross-cultural study of young children. *British Journal of Developmental*

Psychology, **1**, 143-154.

Leong, C. K. (1973). Hong Kong. In J. Downing (Ed.). *Comparative Reading*, Chapter 18. New York: The MacMillan Company.

Leong, C. K. (1986). What does accessing a morphemic script tell us about reading and reading disorders in an alphabetic script? *Annals of Dyslexia*, **36**, 82-102.

Leong, C. K. (1991). From phonemic awareness to phonological processing to language access in children developing reading proficiency. In D. J. Sawyer & B. Fox (Eds.), *Phonological Awareness in Reading: The Evolution of Current Perspectives* (Chapter 8, pp.217-254). New York: Springer-Verlag.

Lewkowicz, N. K. (1980). Phonemic awareness training: what to teach and how to teach it. *Journal of Educational Psychology,* **72**, 686-700.

Liberman, I. & Liberman, A. M. (1980). Orthography and the beginning reader. In J. F. Kavanagh, & R. L. Venezky, *Orthography, Reading, and Dyslexia.* Baltimore: University Park Press.

Liberman, I., Shankweiler, D., Fisher, F. W., and Carter, B. (1974). Reading and awareness of linguistic segments. *Journal of Experimental Child Psychology,* **18**, 201-212.

Liberman, I., Shankweiler, D., Liberman, A. M., Fowler, C., & Fisher, W. (1977). Phonetic segmentation and recoding in the beginning reader. In A. S. Reber & D. Scarbrough (Eds.), *Towards a Psychology of Reading.* Hillsdale, NJ: Lawrence Erlbaum Associates, Inc., Publishers.

Liu, L. (1977). The research of Raven's Colour Progressive Matrices. *The Journal of Taipei Normal College.* **6**, 93-110.

Lovegrove, W., Martin, F., & Slaghuis, W. (1986). A theoretical and experimental case for a visual deficit in specific reading disability. *Cognitive Neuropsychology*, **3**, 225-267.

Lundberg, I., Olofsson, A., & Wall, S. (1980). Reading and spelling skills in the first school years predicted from phonemic awareness skills in kindergarten. *Scandinavian Journal of Psychology*, **21**, 159-173.

Lundberg, I., Frost, J., & Petersen, O. P. (1988). Effects of an extensive program for stimulating phonological awareness in preschool children. *Reading Research Quarterly*, **23**, 263-284.

Lundberg, I., & Høien, T. (1991). Initial enabling knowledge and skills in reading acquisition: Print awareness and phonological segmentation. In D. J. Sawyer & B. Fox (Eds.), *Phonological Awareness in Reading: The Evolution of Current Perspectives* (Chapter 3, pp.73-95). New York: Springer-Verlag.

Maclean, M.; Bryant, P.; & Bradley, L. (1987). Rhymes, nursery rhymes, and reading in early childhood. *Merrill Palmer Quarterly*, **33**, 3, 255-281.

Malatesha, R. N. (1986). Visual motor ability in normal and disabled readers. *Perceptual and Motor Skills*, **62**, 627-630.

Mann, V. A. (1984). Longitudinal prediction and prevention of early reading difficulty. *Annals of Dyslexia*, **34**, 117-136.

Mann, V. A. (1986). Phonological awareness: the role of reading experience. *Cognition*, **24**, 65-92.

Mann, V. A., and Liberman, F. Y. (1984). Phonological awareness and verbal short-term memory. *Journal of Learning Disabilities*. **17**, 10, 592-599.

Marsh, G., Desberg, P., & Copper, J. (1977). Developmental strategies in reading. *Journal of Reading Behaviour*, **9,** 391-394.

Marsh, G., Friedman, M. P., Desberg, P., & Saterdahl, K. (1981). Comparison of reading and spelling strategies in normal and reading disabled children. In M. P. Friedman, J. P. Das and N. O'Connor (Eds.), *Intelligence and Learning*, pp.363-367. New York: Plenum.

Marsh, G., & Mineo, R. (1977). Training preschool children to recognize phonemes in words. *Journal of Educational Psychology*, **69**, 748-753.

Martin, D. J., & Hoover, H. D. (1987). Sex differences in educational achievement: A longitudinal study. *Journal of Early Adolescence*, **7**, 1, 65-83.

Mattingly, I. G. (1972). Reading, the linguistic process and linguistic awareness. In J. Kavanagh & I. G. Mattingly (Eds.), *Language by Ear and by Eye* (pp.133-147). Cambridge, MA: MIT Press.

McCulloch, R. W. (1965). Review of Schonell Tests. in O.K. Buros (ed.), *The Sixth Mental Measurements Yearbook*, New Jersey: Gryphon Press.

Miao, X., & Zhu, M. (1992). language development in Chinese children. In H. C. Chen & O. J. L. Tzeng (Eds.), *Language Processing in Chinese* (pp.237-276). Amsterdam: Elsevier Science Publishers B.V..

Morais, J. (1991). Phonological awareness: A bridge between language and literacy. In D.J. Sawyer & B. Fox (Eds.), *Phonological Awareness in Reading: The Evolution of Current Perspectives* (Chapter 2, pp.31-71). New York: Springer-Verlag.

Morais, J., Alegria, J., & Content, A. (1987). The relationship between segmental analysis and alphabetic literacy: an interactive view. *Cahiers de Psychologie Cognitive*, **27**, 415-438.

Morais, J., Bertelson, P., Cary, L., & Alegria, J. (1986). Literacy training and speech segmentation. *Cognition*, **24**, 45-64.

Morais, J., Cary, L., Alegria, J., & Bertelson, P. (1979). Does awareness of speech as a sequence of phones arise spontaneously? *Cognition*, **7**, 323-331.

Morais, J., Cluytens, M, Alegria, J. (1984). Segmentation abilities of dyslexics and normal readers. *Perceptual and Motor Skills*, **58**, 221-222.

Morton, J., & Patterson, K. (1980). A new attempt at an interpretation, or an attempt at a new interpretation. In M. Coltheart, K. Patterson, and J. C. Marshall (Eds.), *Deep Dyslexia*. London: Routledge & Kegan Paul.

Morton, J., & Sasanuma, S. (1984). Lexical access in Japanese. In L. Henderson (Ed.), *Orthographies and Reading: Perspectives from Cognitive Psychology, Neuropsychology, and Linguistics*. London: Lawrence Erlbaum Associates, Inc., Publishers.

National Institute for compilation and Translation (1967). *A Study on the High Frequency Words Used in Chinese Elementary School Reading Materials*. Taipei: Chung Hwa Ltd.

Parkin, A. G. (1984). Levels of processing, context, and the facilitation of pronunciation. *Acta Psychologica*, **55**, 19-29.

Patterson, K. (1982). The relation between reading and phonological coding: Further neuropsychological observation. In A. W. Ellis (Ed.), *Normality and Pathology in Cognitive Functions* (pp.77-112). London: Academic Press.

Patterson, K. (1992). Phonology in reading. *The Psychologist*, **5**, 7, p.314.

Patterson, K., & Morton, J. (1985). From orthography to phonology: An attempt at an old interpretation. In K. Patterson, J. C. Marshall, & M. Coltheart (Eds.), *Surface Dyslexia*, Chapter 14. London: Lawrence Erlbaum Associates, Inc., Publishers.

Perfetti, C. A. (1992). Reading in English and Chinese: Evidence for a "universal" phonological principle. In R. Frost & L. Katz (Eds.), *Orthography, Phonology, Morphology, and Meaning* (pp. 227-248). Amsterdam: Elsevier Science Publishers B.V..

Perfetti, C. A., Beck, I., Bell, L. C., & Hughes, C. (1987). Phonemic knowledge and learning to read are reciprocal: A longitudinal study of first grade children. Special Issue: Children's reading and the development of phonological awareness. *Merrill Palmer Quarterly*, **33**, 3, 283-319.

Perfetti, C. A., & Zhang, S. (1991). Phonological processes in reading Chinese characters. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. **17**, 4, 633-643.

Ramsey, S. R. (1987). *The Language of China*. New Jersey: Princeton University Press.

Raz, I. S., & Bryant, P. (1990). Social background, phonological awareness and children's reading. *British Journal of Developmental Psychology*, **8**, 209-225.

Raven, J. C. (1956). *Guide to Using the Coloured Progressive Matrices*. (Reprinted ed.) Dumfries, The Crichton Royal.

Raven, J. C. (1977). *Raven's Coloured Progressive Matrices*. London: H. K. Lewis.

Read, C., Zhang, Y., Nie, H., & Ding, B. (1986). The ability to manipulate speech sounds depends on knowing alphabetic writing. *Cognition*. **24**, (1-2), 31-45.

Roach, P. (1991). *English Phonetics and Phonology: A practical course* (2nd Ed.). Cambridge: Cambridge University Press.

Rosen, C. (1966). An experimental study of visual perceptual training and reading achievement in first grade. *Perceptual and Motor Skills*, **22**, 979.

Rosner, J., & Simon, D. P. (1971). The auditory analysis test: An initial report. *Journal of Learning Disabilities*, **4**, 384-392.

Rozin, P., Poritsky, S., & Sotsky, R. (1971). American children with reading problems can easily learn to read English represented by Chinese characters. *Science*, **171**, 1264-1267.

Rubenstein, H., Lewis, S. S., & Rubenstein, M. A. (1971). Evidence for phonemic recoding in visual word recognition. *Journal of Verbal Learning and Verbal Behaviour*, **10**, 645-657.

SAS Institute Inc., (1988). *SAS/STAT User's Guide*. Cary: SAS Institute Inc.

Sasanuma, S. (1971). Selective impairment of phonetic and non-phonetic transcription of words in Japanese aphasic patients: kana vs kanji in visual recognition and writing. *Contex*, **7**, 1-18.

Sasanuma, S. (1974). Impairment of written language in Japanese aphasics: Kana versus kanji processing. *Journal of Chinese Linguistics*, **2**, 141-158.

Sasanuma, S., Itoh, M., Mori, K., & Kobayashi, Y. (1977). Tachistoscopic recognition of kana and kanji words. *Neuropsychologia*. **15**, 547-553.

Schonell, F. J., & Goodacre, E. J. (1974). *The Psychology and Teaching of Reading*. (5th ed.), Edinburgh: Oliver & Boyd.

Seidenberg, M. S. (1985). The time course of phonological code activation in two writing systems. *Cognition*, **19**, 1-30.

Seymour, P. H. K., & MacGregor, C. J. (1984). Developmental dyslexia: a cognitive experimental analysis of phonological, morphemic and visual impairments. *Cognitive Neuropsychology*, **1**, 43-82.

Smith, F. (1971) *Understanding Reading. A Psycholinguistic Analysis of Learning to Read.* New York, Holt, Rinehart and Winston.

Smith, F. (1985). *Reading* (2nd ed.). Cambridge: Cambridge University Press.

So, D., & Siegel, L. S. (unpublished transcript). Learning to read Chinese: Semantic, syntactic, phonological and short-term memory skills in normally achieving and poor Chinese readers.

Spearman, C, & Jones, L.W. (1950). *Human Ability: A continuation of 'the abilities of man'*. London: MacMillan.

Spodek, B. (1982). The kindergarten: A restrospective and contemporary view. In L. G. Katz (Ed.), *Current Topics in Early Childhood Education*, pp.173-192. Norwood, NJ: Ablex,.

Stanovich, K. E. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading Research Quarterly*, **16**, 32-71.

Stanovich, K. E. (1986). Mathew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly*, **21**, 360-407.

Stanovich, K. E., Cunningham, A. B., & Cramer, B. B. (1984), Assessing phonological awareness in kindergarten children: Issues of task comparability. *Journal of Experimental Child Psychology*, **38**, 175-190.

Stevenson, H. W., Stigler, J.W., Lucker, G. W. and Lee, S-Y (1982). Reading disabilities: The case of Chinese, Japanese, and English. *Child Development*, **53**, 1164-1181.

Stones, E. (1979). *Psychopedagogy: psychological theory and the practice of teaching.*

London, Methuen.

Stuart, M., & Coltheart, M. (1988). Does reading develop in a sequence of stages? *Cognition*, **30**, 139-181.

Tabachnick, B. G., & Fidell, L. S. (1989). *Using Multivariate Statistics* (2nd Ed.). New york: Harper & Row Publisher, Inc.

Taylor, I., & Taylor, M. M. (1983), *The Psychology of Reading*. London: Academic Press, Inc.

Treiman, R. (1985). Onsets and rimes as units of spoken syllables: evidence from children. *Journal of Experimental Child Psychology*. **39**, 161-181.

Treiman, R. (1991). Phonological awareness and its roles in learning to read and spell. In D.J. Sawyer & B. Fox (Eds.), *Phonological Awareness in Reading: The Evolution of Current Perspectives* (Chapter 6, pp.159-189). New York: Springer-Verlag.

Treiman, R., & Baron, J. (1981). Segmental analysis ability: Development and relation to reading ability. In G. E.Mackinnon & T. G. Waller (Eds.), *Reading Research: Advances in Theory and Practice* (Vol.3, pp.159-198). New York: Academic Press.

Treiman, R., & Baron, J., & Luk, K. (1981). Speech recoding in silent reading: A comparison of Chinese and English. *Journal of Chinese Linguistics*, **9**, 116-125.

Tsien, T. H. (1962). *Written on Bamboo and Silk: Beginnings of Chinese Books and Inscriptions*. Chicago: University of Chicago Press.

Tunmer, W. E. (1990). The role of language prediction skills in beginning reading. *New Zealand Journal of Educational Studies*, **25**, 2, 95-114.

Tunmer, W. E., Herriman, M. L., & Nesdale, A. R. (1988). Metalinguistic abilities and beginning reading. *Reading Research Quarterly*, **23**, 134-158.

Tunmer, W. E., & Nesdale, A. R. (1985). Phonemic segmentation skill and beginning reading. *Journal of Educational Psychology*. **77**, 417-527.

Tunmer, W. E., & Rohl, M. (1991). Phonological awareness and reading acquisition. In D. J. Sawyer & B. Fox (Eds.), *Phonological Awareness in Reading: The Evolution of Current Perspectives* (Chapter 1, pp.1-30). New York: Springer-Verlag.

Turnage, T. W., & McGinnies, E. (1973). A cross-cultural comparison of the effects of presentation mode and meaningfulness on short-term recall. *American Journal of Psychology*, **86**, 2, 369-381.

Tzeng, O. J. L., Hung, D. L., & Wang, W. S-Y. (1977). Speech recoding in reading Chinese characters. *Journal of Experimental Psychology: Human Learning and Memory*, **3**, 621-630.

Tzeng, O. J. L., Hung, D. L., Cotton, B., & Wang, W. S. Y. (1979). Visual lateralization effect in reading Chinese characters. *Nature*, **282,** 499-501.

Tzeng, O. J. L., & Hung, D. L. (1980). Reading in a non-alphabetic writing system: Some experimental study. In J.F. Kavanagh & R.L. Venezky (Eds.), *Orthography, Reading, and Dyslexia*. Baltimore: University Park Press.

Tzeng, O. J. L., & Wang, W. S-Y., (1983). The effect two R's. *American Scientist*. **71**, 238-243.

Unger, J. (1977). Introduction: Primary school reading texts and teaching methods in the wake of the cultural revolution. *Chinese Education*. **10**, 4-29.

Van, Y. Y., & Zian, C. T. (1962), Beginning readers learn and remember characters. *Acta Psychological Sinica*. **3**, 219-230.

Van Orden, G. (1987). A ROWS is a ROSE: spelling, sound, and reading. *Memory & Cognition,* **15**, 181-198.

Van Orden, G., Johnston, J., Hale, B. (1988). Word identification in reading proceeds from spelling to sound to meaning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **14**, 371-386.

Vellutino, F. R. (1979). *Dyslexia: Theory and Research.* Cambridge, Mass.: M.I.T. Press.

Vellutino, F. R., Harding, C. J., Phillips, F., & Steger, J. A. (1975). Differential transfer in poor and normal readers. *Journal of Genetic Psychology*, **126**, 3-18.

Vellutino, F. R., & Scanlon, D. M. (1987). Phonological coding, phonological awareness, and reading ability: Evidence from a longitudinal and experimental study. Special Issue: Children's reading and the development of phonological awareness. *Merrill Palmer Quarterly*, **33**, 3, 321-363.

Venezky, R. L. (1970). *The Structure of English Orthography.* Hague: Mouton.

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin*, **101**, 192-212.

Wallach, M. A., & Wallach, L. (1976). *Teaching All Children to Read.* Chicago: University of Chicago Press.

Wang, W. S.-Y. (1973). The Chinese language. *Scientific American*, **228**, 50-63.

Wechsler, D. (1987). *Manual of Wechsler Memory Scale--revised.* N.Y.: The Psychological Corporation Harcourt Brace Jovanovich Inc.

Williams, J. (1980). Teaching decoding with an emphasis on phoneme analysis and phoneme blending. *Journal of Educational Psychology*, **72**, 1-15.

Williams, S. M., & Silva, P.A. (1985) Some factors associated with reading ability:

A longitudinal study. *Educational Research*, **27**, 3, 159-168.

Wimmer, H., Landerl, K., Linortner, R., & Hummer, P. (1991). The relationship of phonemic awareness to reading acquisition: More consequence than precondition but still important, *Cognition*, **40**, 219-249.

Wimmer, H., & Frith, U. (1992). Orthographies and learning to read: An English - German comparison. Paper presented at the 25th International Congress of Psychology. 19-24 July, 1992, Brussels.

Woo, E. Y. G., & Hoosain, R. (1984). Visual and auditory functions of Chinese dyslexics. *Psychologia*, **27**, 164-170.

Wydell, T., Humphreys, G., & Patterson, K. (1992). Phonological processing of Japanese kanji: Is a ROWS still a ROSE? Paper presented to the Experimental Psychology Society, London, January.

Yin, B., & Felley, M. (1990). *Chinese Romanization: Pronunciation and Orthography.* Beijing: Sinolingua.

Yin, W. (1991). *On Reading Chinese Characters--an experimental and neuropsychological study.* Unpublished Ph.D. thesis. University of London.

Yin, W., & Butterworth, B. (1992). Deep and surface dyslexia in Chinese. In H. C. Chen & O. J. L. Tzeng (Eds.), *Language Processing in Chinese* (pp.349-368). Amsterdam: Elsevier Science Publishers B.V..

Yopp, H. K. (1985). Phoneme segmentation ability: A prerequisite for phonics and sight word achievement in beginning reading? In J. Niles & R. Lalik (Eds.), *Issues in Literacy: A Research Perspective* (pp.330-336). Rochester, NY: National Reading Conference.

Yopp, H. K. (1988). The validity and reliability of phonemic awareness tests. *Reading Research Quarterly*, **23**, 159-177.

Yopp, H. K. (1992). Developing phonemic awareness in young children. *The Reading Teacher*. **45**, 9, 696-703.

Zhou, Y. G. (1978). To what degree are the "phonetics" of present-day Chinese characters still phonetic? *Zhongguo Yuwen*, **146**, 172-177.

Zifcak, M. (1977). *Phonological Awareness and reading Acquisition in First grade*

Children. Ph.D. thesis. University of Connecticut.

A. Schonell Reading Test

tree	little	milk	egg	book
school	sit	frog	playing	bun
flower	road	clock	train	light
picture	think	summer	people	something
dream	downstairs	biscuit	shepherd	thirsty
crowd	sandwich	beginning	postage	island
saucer	angel	ceiling	appeared	gnome
canary	attractive	imagine	nephew	gradually
smoulder	applaud	disposal	nourished	diseased
university	orchestra	knowledge	audience	situated
physics	campaign	choir	intercede	fascinate
forfeit	siege	recent	plausible	prophecy
colonel	soloist	systematic	slovenly	classification
genuine	institution	pivot	conscience	heroic
pneumonia	preliminary	antique	susceptible	enigma
oblivion	scintillate	satirical	sabre	beguile
terrestrial	belligerent	adamant	sepulchre	statistics
miscellaneous	procrastinate	tyrannical	evangelical	grotesque
ineradicable	judicature	preferential	homonym	fictitious
rescind	metamorphosis	somnambulist	bibliography	idiosyncrasy

認　字　測　驗

的 人 到 會 可 很 西 明 問 車

定 寫 省 聲 條 親 帶 參 讀 容

南 江 科 傳 轉 附 推 羣 雄 營

灣 治 港 際 航 另 似 嚴 雷 彩

憲 換 泰 陵 洛 勒 覆 諾 賢 攝

羅 域 轄 准 卿 劑 腹 謂 蠟 渠

叟 滇 藺 鷀 濾 肪 嘩 棕 刺 簣

嚼 魁 帖 皿 糙 瓏 柚 誨 釉 冀

掖 楕 憔 謁 膩 罠 琊 魅 肱 疽

椿 彝 坏 綰 懍 麾 璩 摑 鏨 杳

C. Phonological Tests

1. Odd Man Out Tests

a. English Word Odd Man Out

Condition 1	Condition 2	Condition 3
First sound difference	**Last sound difference**	**Middle sound diff.**
rot rod rock box	fan cat hat mat	mop hop tap lop
lick lid miss lip	leg peg hen beg	pat bat fit cat
bud bun bus rug	pin win sit fin	lot cot pot hat
pip pin hill pig	doll hop top pop	fun pin bun gun
ham tap had hat	bun hut gun sun	hug dig pig wig
peg pen well pet	map cap gap pal	red fed lid bed
kid kick kiss fill	men red bed fed	wag rag bag leg
lot mop lock log	wig fig pin dig	fell doll well bell
leap mean meal meat	weed peel need deed	man bin pin tin
crack crab crag trap	pack lack sad back	fog dog mug log
slim flip slick slip	sand hand land bank	feed need wood seed
roof room food root	sink mint pink wink	fish dish wish mash
score__________	**score**__________	**score**__________

b. Chinese Word Odd Man Out

Condition 1	Condition 2	Condition3
First sound difference	**Last sound difference**	**Middle sound diff.**
ba bo bei pao	jia qia bian xia	liang guang jiang qiang
tong tui nuo tun	dai la tai kai	bin xin qin jun
pan pang mi peng	kuang suan huang shuang	que die bie pie
fu mei mai mo	lun song chong zhong	dian xuan juan quan
du ti deng dang	xun qiong xiong jiong	zuan jüan duan shuan
ka ge gu gang	xie jiang qiang liang	qian jian zhuan xian
fan feng fen dao	juan xuan lun quan	dun zun pin chun
bie pin bian biao	ba pa ma tao	qiong ping xing jing
gui long lun luo	hei nei gei de	tong bing cong dong
que quan qiong xun	shou mo po bo	ling ding ting jiong
song cun suo sui	zhan san dang fan	hong gong xiong kong
die dian tuo diu	chen feng shen zhen	jia qia xia zhua
score________	**score**__________	**score**__________

c. Chinese Non-word Odd Man Out

Condition 1 **First sound difference**	Condition 2 **Last sound difference**	Condition 3 **Middle sound diff.**
fai fao fe qu	ten do no lo	pia mia fia bua
bia din biu biang	dia tia nia gie	due gue hie kue
ra ro chei rai	chei rei fai sei	fian buan puan muan
fao te to ten	be len pe me	düan muan tüan nüan
pui nua nuai nuang	gi fi tei hi	lüan gian kian hian
gia giao miang ging	uan üan ian fao	fin din bun tin
hian hin hing fiao	rai de te le	dün nün tün gin
tia kie kiu kiang	buai nun muai puai	pun rün nun mun
luang dua luai lui	ging king piu hing	diang tiang buang miang
zua zuai zuang nui	fian kiang giang hiang	mong ging king hing
pia piu tin piang	dua tua nua bui	miong bong diong tiong
diang kian dia din	düan kün tüan lüan	biong piong niong fing
score________	**score**__________	**score**__________

2. Phoneme Deletion Test

a.English Phoneme Deletion Test

DELETION:END SOUND

CVC(C) TYPE	CCVC(C) TYPE
seat-------sea	skin--------ski
beef-------bee	
1.farm-----far	1.start-----star
2.tent-----ten	2.whom------who
3.card-----car	3.chart-----char
4.wind-----win	4.cramp-----cram
5.tint-----tin	5.crowd-----crow
6.warm-----war	6.plant-----plan
7.band-----ban	7.plump-----plum
8.bark-----bar	8.scant-----scan
9.bend-----ben	9.scarf-----scar
10.bust----bus	10.spurt-----spur
score________	**score**__________

DELETION:FIRST SOUND

CVC(C) TYPE	CCVC(C) TYPE
pink-------ink	score--------core
beat-------eat	blight-------light
1.bus------us	1.stop-------top
2.cat------at	2.spin-------pin
3.hit------it	3.slack------lack
4.man------an	4.snail------nail
5.win------in	5.slight-----light
6.hand-----and	6.blast------last
7.cold-----old	7.play-------lay
8.hill-----ill	8.block------lock
9.bend-----end	9.brace------race
10.task---ask	10.glove------love
score________	**score**____________

---

d. Chinese Phoneme Deletion test

DELETION:END SOUND	DELETION:FIRST SOUND
zou----z	ba-----a
xia----xi	qiang--iang
sai----s	fan----an
ua-----u	tang---ang
iu-----i	ji-----i
cao----c	ku-----u
re-----r	zhen---en
qiao---qi	hun----un
guang--gu	shuan--uan
chui---chu	min----in
die----di	suo----uo
lue----lu	pian---ian
score________	**score**___________

D: A list of abbreviation

EPD= English Phoneme Deletion test.

CPD= Chinese Phoneme Deletion test.

EOMO= English Word Odd Man Out test.

CWOMO= Chinese Word Odd Man Out test.

CNOMO= Chinese Non-word Odd Man Out test.

BPVS= British Picture Vocabulary Scale.

IQ= Coloured Progressive Matrices.

VPA= Visual Paired Associate.

VFD= Visual Form Discrimination.

E. Statistical Table

Table 5-7-1: Summary of 2-way ANOVA on the odd man out tests (English version Vs Chinese version)

Source	d.f.	SS	MS	F	p
Version	1	227.79	227.79	142.09	.0001
Error (version)	44	70.54	1.60	-	-
Position	2	8.10	4.05	1.31	.2758
Error (position)	88	272.57	3.10	-	-
Version x position	2	15.39	7.69	2.90	.0602
Error (version x type)	88	233.28	2.65	-	-

Table 5-7-2: Summary of 2-way ANCOVA on the odd man out tests (English version Vs Chinese version), IQ and BPVS as covariates.

Source	d.f.	SS	MS	F	p
IQ	1	26.57	26.57	3.42	.0716
BPVS	1	2.06	2.06	0.27	.6091
Error	42	326.56	7.78	-	-
Version	1	10.58	10.58	6.56	.0141
Error (version)	42	67.76	1.61	-	-
Position	2	3.40	1.70	0.57	.5658
Error (position)	84	249.28	2.97	-	-
Version x position	2	3.95	1.97	0.75	.4773
Error (version x position)	84	222.08	2.64	-	-

Table 5-8-1: Summary of ANOVA on English Phoneme Deletion

Source	d.f.	SS	MS	F	p
Position	1	77.36	77.36	21.80	.0001
Error (position)	44	156.14	3.55	-	-
Type	1	93.89	93.89	50.62	.0001
Error (type)	44	81.61	1.85	-	-
Position x type	1	45.00	45.00	21.64	.0001
Error (position x type)	44	91.50	2.08	-	-

Table 5-8-2: Summary of ANCOVA on English Phoneme Deletion, IQ and BPVS as covariates.

Source	d.f.	SS	MS	F	p
IQ	1	51.94	51.94	5.08	.0295
BPVS	1	20.84	20.84	2.04	.1609
Error	42	429.84	10.23	-	-
Position	1	30.87	30.87	10.17	.0027
Error (position)	42	127.48	3.04	-	-
Type	1	16.98	16.98	9.94	.0030
Error (type)	42	71.70	1.71	-	-
Position x type	1	15.57	15.57	7.38	.0148
Error (position x type)	42	88.72	2.11	-	-

Table 5-10: t-test of sex difference on the all tests

Tests	Means		diff. (boys - girls)	t (d.f.=43)	p
	boys	girls			
Coloured Prog. Matrices	26.80	22.92	3.88	3.20	.0026
BPVS	18.70	16.80	1.90	2.24	.03
Visual Paired Associates	11.30	12.40	-1.10	-.88	n.s.
Visual Form Discrimination	25.45	23.76	1.69	1.47	n.s.
Schonell Reading	37.3	32.88	4.42	1.11	n.s.
Chinese Nonword Odd Man Out	17.85	16.84	1.01	.80	n.s.
English Odd Man Out	22.75	22.84	-.09	-.09	n.s.
English Phoneme Deletion	33.70	34.40	-.70	-.34	n.s.

Table 6-2-1: Correlations between vocabulary test and phonological tests for Taiwan subjects

1. Correlation			
Variables	CNOMO	CWOMO	CPD
Vocabulary	.10	.17	.33*
2. Partial correlation (IQ as a partial variable)			
Variables	CNOMO	CWOMO	CPD
Vocabulary	.08	.15	.33*

* $p<.05$

Table 6-7-1: Summary of 2-way ANOVA on the odd man out test (Chinese word Vs Chinese nonword versions)

Source	d.f.	SS	MS	F	p
Version	1	13.23	13.23	8.81	.0046
Error (version)	49	73.60	1.50	-	-
Position	2	0.13	0.06	0.04	.9602
Error (position)	98	152.87	1.56	-	-
Version x position	2	8.18	4.09	2.26	.1099
Error (version x position)	98	177.49	1.81	-	-

Table 6-7-2: Summary of 2-way ANCOVA on the Odd Man Out test (Chinese word Vs Chinese nonword versions, IQ and BPVS as covariates.)

Source	d.f.	SS	MS	F	p
IQ	1	93.98	93.98	10.00	.0027
BPVS	1	6.97	6.97	0.74	.3936
Error	47	441.83	9.40	-	-
Version	1	1.49	1.49	0.98	.3275
Error (version)	47	71.37	1.52	-	-
Position	2	2.02	1.01	0.63	.5355
Error (position)	94	150.75	1.60	-	-
Version x position	2	1.24	.62	0.33	.7171
Error (version x position)	94	175.18	1.86	-	-

Table 6-10: T-test of sex difference on the all tests

Tests	Means		diff. (boys - girls)	t (d.f.=48)	p
	boys	girls			
Coloured Prog. Matrices	32.16	32.44	-0.28	-0.35	.73
BPVS	27.64	27.52	0.12	0.19	.85
Visual Paired Associates	11.40	12.56	-1.16	-1.14	.26
Visual Form Discrimination	26.88	28.20	-1.32	-1.30	.20
Chinese Reading	60.48	61.40	-0.92	-0.37	.71
Chinese Nonword Odd Man Out	19.08	20.36	-1.28	-1.04	.30
Chinese Odd Man Out	20.12	21.84	-1.72	-1.41	.17
Chinese Phoneme Deletion	16.40	17.28	-.88	-1.17	.25

Table 7-9-1: Summary of 2-way ANOVA on the odd man out tests (English, Chinese word and Chinese non-word versions)

Source	d.f.	SS	MS	F	p
Version	2	147.16	73.58	19.29	.0001
Error (version)	82	312.84	3.82	-	-
Position	2	156.33	78.17	14.13	.0001
Error (position)	82	453.67	5.53	-	-
Version x position	4	63.22	15.81	6.29	.0001
Error (version x position)	164	412.11	2.51	-	-

Table 7-9-2: Summary of 2-way ANCOVA on the odd man out tests (English, Chinese word and Chinese non-word versions), IQ and BPVS as covariates.

Source	d.f.	SS	MS	F	p
IQ	1	91.08	91.08	6.78	.0130
BPVS	1	17.69	17.69	1.32	.2583
Error	39	524.23	13.44	-	-
Version	2	9.50	4.75	1.23	.2965
Error (version)	78	299.89	3.84	-	-
Position	2	9.96	4.98	0.89	.4131
Error (position)	78	434.38	5.57	-	-
Version x position	4	24.03	6.01	2.51	.0444
Error (version x position)	156	374.05	2.40	-	-

Table 7-10-1: Summary of 2-way ANOVA on the English Phoneme Deletion tests

Source	d.f.	SS	MS	F	p
Position	1	375.01	375.01	123.75	.0001
Error (position)	41	124.24	3.03	-	-
Syllable type	1	170.01	170.01	77.24	.0001
Error (syllable type)	41	90.24	2.20	-	-
Position x syllable type	1	170.01	170.01	99.23	.0001
Error (position x syllable type)	41	70.24	1.71	-	-

Table 7-10-2: Summary of 2-way ANCOVA on the English Phoneme Deletion tests, IQ and BPVS as covariates.

Source	d.f.	SS	MS	F	p
IQ	1	11.23	11.23	3.84	.0571
BPVS	1	.25	.25	.09	.7700
Error	39	113.99	2.92	-	-
Position	1	20.50	20.50	7.39	.0097
Error (position)	39	108.10	2.77	-	-
syllable type	1	1.50	1.50	0.67	.4195
Error (syllable type)	39	87.83	2.25	-	-
Position x syllable type	1	1.61	1.61	0.90	.3484
Error (position x syllable type)	39	69.56	1.78	-	-

Table 7-11-1: Summary of ANOVA on the Chinese Phoneme Deletion

Source	d.f.	SS	MS	F	p
Position	1	6.30	6.30	2.80	.1019
Error	41	92.20	2.25	-	-

Table 7-14: The t-test results of sex difference on all the tests

Test	Means		diff. (boys-girls)	t	p
	boys	girls			
Coloured Progressive Matrices	33.81	32.57	1.23	2.13	<.05
BPVS	5.14	4.90	0.24	0.37	n.s.
Visual Paired Associates	12.48	12.05	.43	.35	n.s.
Visual Form Discrimination	27.62	27.00	0.62	.66	n.s.
Schonell Reading	16.57	17.38	-0.81	-.74	n.s.
Chinese Reading	52.29	52.81	-.52	-.31	n.s.
Chinese Odd Man Out	16.43	16.71	-.28	-.19	n.s.
Chinese Nonword Odd Man Out	17.43	17.05	.38	.23	n.s.
English Odd Man Out	21.05	20.62	.37	.33	n.s.
Chinese Phoneme Deletion	5.14	5.57	-.43	-.53	n.s.
English Phoneme Deletion	32.90	31.90	1.00	.92	n.s.

Table 8-2-1: Partial correlation of reading and each test

1. Partial correlation of the English reading and each test, Coloured Progressive Matrices as a partial variable

Groups		BPVS	Visual Paired Associ.	Visual Form Discri.	English OMO	Chinese Non-word OMO	Chinese OMO	English Phoneme Deletion	Chinese Phoneme Deletion
Schonell reading	U.K.	.38*	.10	.23	.27	.34*	-	.50***	-
	Hong Kong	.15	.36*	-.17	-.02	-.29	-.03	.26	.59***

2. Partial correlation of the Chinese reading and each test, Coloured Progressive Matrices as a partial variable

Groups		BPVS	Visual Paired Associ.	Visual Form Discri.	English OMO	Chinese Non-word OMO	Chinese OMO	English Phoneme Deletion	Chinese Phoneme Deletion
Chinese reading	Taiwan	.51***	.79***	.27	-	.14	.27	-	.51***
	Hong Kong	-.01	.70***	-.21	-.01	-.37*	-.09	.32*	.41*

Table 8-5-1: Summary of ANOVA on English Odd Man Out

Source	d.f.	SS	MS	F	p
Group	1	28.01	28.01	5.80	.0182
Error	85	410.34	4.83	-	-
Position	2	40.40	20.20	7.08	.0011
Group x position	2	166.83	83.41	29.25	.0001
Error (position)	170	484.84	2.85	-	-

Table 8-5-2: Summary of ANCOVA on English Odd Man Out

Source	d.f.	SS	MS	F	p
IQ	1	7.57	7.57	1.65	.2020
English reading	1	7.30	7.30	1.59	.2103
Group	1	7.09	7.09	1.55	.2168
Error	83	380.05	4.58	-	-
Position	2	22.28	11.14	3.95	.0453
Group x position	2	40.93	20.46	7.26	.0010
Error (position)	166	468.09	2.82	-	-

Table 8-6-1: Summary of ANOVA on Chinese Word Odd Man Out

Source	d.f.	SS	MS	F	p
Group	1	147.88	147.88	21.66	.0001
Error	90	614.42	6.83	-	-
Position	2	7.87	3.93	1.43	.2428
Group x position	2	28.26	14.13	5.13	.0068
Error (position)	180	496.21	2.76	-	-

Table 8-6-2: Summary of ANCOVA on Chinese Word Odd Man Out

Source	d.f.	SS	MS	F	p
IQ	1	66.59	66.59	11.31	.0011
Chinese reading	1	7.46	7.46	1.27	.2635
Group	1	100.02	100.02	16.98	.0001
Error	88	518.26	5.89	-	-
Position	2	3.27	1.63	.59	.5574
Group x position	2	17.75	8.87	3.18	.0438
Error (position)	176	490.54	2.79	-	-

Table 8-7-1: Summary of ANOVA on Chinese Non-word Odd Man Out

Source	d.f.	SS	MS	F	p
Group	2	63.84	31.92	4.47	.0132
Error	134	956.31	7.14	-	-
Position	2	11.41	5.70	2.12	.1220
Group x position	4	4.64	1.16	.43	.7864
Error (position)	268	720.93	2.69	-	-

Table 8-7-2: Summary of ANCOVA on Chinese Non-word Odd Man Out

Source	d.f.	SS	MS	F	p
IQ	1	73.20	73.20	11.02	.0012
Group	2	70.64	35.32	5.32	.0060
Error	133	883.11	6.64	-	-
Position	2	0.63	0.32	0.12	.8880
Group x position	4	2.86	.72	0.26	.8936
Error (position)	266	719.62	2.71	-	-

Table 8-8-1: Summary of ANOVA on English Phoneme Deletion

Source	d.f.	SS	MS	F	p
Group	1	15.40	15.40	2.03	.1579
Error	85	644.94	7.59	-	-
Position	1	401.53	401.53	121.72	.0001
Group x position	1	61.09	61.09	18.52	.0001
Error (position)	85	280.39	3.30	-	-
Type	1	7.00	7.00	3.46	.0663
Group x type	1	259.52	259.52	128.36	.0001
Error (type)	85	171.86	2.02	-	-
Position x type	1	22.24	22.24	11.69	.0010
Group x position x type	1	197.07	197.07	103.57	.0001
Error (position x type)	85	161.74	1.90	-	-

Table 8-8-2: Summary of ANCOVA on English Phoneme Deletion

Source	d.f.	SS	MS	F	p
IQ	1	4.92	4.92	0.91	.3431
English reading	1	115.90	115.90	21.42	.0001
Group	1	3.20	3.20	0.59	.4438
Error	83	449.05	5.41	-	-
Position	1	67.18	67.18	23.30	.0001
Group x position	1	32.75	32.75	11.36	.0011
Error (position)	83	239.34	2.88	-	-
Type	1	2.53	2.53	1.31	.2556
Group x type	1	50.99	50.99	26.38	.0001
Error (type)	83	160.46	1.93	-	-
Position x type	1	0.21	0.21	0.11	.7434
Group x position x type	1	41.67	41.67	21.54	.0001
Error (position x type)	83	160.55	1.93	-	-

Table 8-9-1: Summary of ANOVA on Chinese Phoneme Deletion

Source	d.f.	SS	MS	F	p
Group	1	1504.88	1504.88	433.85	.0001
Error	90	312.18	3.47	-	-
Position	1	3.42	3.42	2.05	.1556
Group x position	1	3.42	3.42	2.05	.1556
Error (position)	90	150.20	1.67	-	-

Table 8-9-2: Summary of ANCOVA on Chinese Phoneme Deletion

Source	d.f.	SS	MS	F	p
IQ	1	0.42	0.42	0.16	.6936
CR	1	66.20	66.20	24.74	.0001
Group	1	792.71	792.71	296.28	.0001
Error	88	235.45	2.68	-	-
Position	1	0.03	0.03	0.02	.8932
Group x position	1	0.51	0.51	0.30	.5827
Error (position)	88	148.11	1.68	-	-

Table 8-10-1: Summary of ANOVA on Visual Form Discrimination

Source	d.f.	SS	MS	F	p
Group	2	259.52	129.76	10.36	.0001
Error	134	1678.64	12.53	-	-
Total	136	1938.16	-	-	-

Table 8-10-2: Summary of ANCOVA on Visual Form Discrimination (IQ as a covariate)

Source	d.f.	SS	MS	F	p
IQ	1	482.77	482.77	44.39	.0001
Group	2	8.92	4.46	.41	n.s.
Error	133	1446.47	10.88	-	-
Total	136	1938.16	-	-	-

Table 8-10-3: Summary of ANOVA on Visual Paired Association

Source	d.f.	SS	MS	F	p
Group	2	2.99	1.50	0.10	n.s.
Error	134	2050.74	15.30	-	-
Total	136	2053.74	-	-	-

Table 9-4-1: The pattern of correlation among the reading tests and phonological subtests

a. The correlation of the English reading and separate phonological subtests

		EOMO,F	EOMO,M	EOMO,L	CNOMO,F	CNOMO,M	CNOMO,L	COMO,F	COMO,M	COMO,L	EPD,F,CVCC	EPD,F,CCVC	EPD,E,CVCC	EPD,E,CCVC	CPD,F	CPD,E
Schonell reading	*Pinyin*	.46*	.38*	.14	.33	.30	.36*	.31	.36	.48*	.42*	.19	.07	.02	.45*	.48*
	non-Pinyin	.07	.25	-.15	.15	-.12	-.40*	-.15	.12	-.21	.11	.13	-.37*	.05	.31	.43*

b. The correlation of the Chinese reading and separate phonological subtests

		EOMO,F	EOMO,M	EOMO,L	CNOMO,F	CNOMO,M	CNOMO,L	COMO,F	COMO,M	COMO,L	EPD,F,CVCC	EPD,F,CCVC	EPD,E,CVCC	EPD,E,CCVC	CPD,F	CPD,E
Chinese Reading	*Pinyin*	.24	.34	.11	.40*	.29	.36*	.27	.44*	.55**	.13	.31	-.19	.10	.10	.53**
	non-*Pinyin*	.0	-.11	-.07	-.18	-.49**	-.39*	-.03	-.26	-.31	.21	.07	-.33	.09	.34	.23

c. Partial correlation of the English reading and separate phonological subtests, Coloured Progressive Matrices as a partial variable

		EOMO,F	EOMO,M	EOMO,L	CNOMO,F	CNOMO,M	CNOMO,L	COMO,F	COMO,M	COMO,L	EPD,F,CVCC	EPD,F,CCVC	EPD,E,CVCC	EPD,E,CCVC	CPD,F	CPD,E
Schonell reading	*Pinyin*	.41*	.32	.03	.23	.25	.28	.25	.29	.42*	.38*	.14	.03	-.03	.39*	.14
	non-*Pinyin*	.03	-.23	-.09	.31	.11	-.35	-.04	-.09	-.21	-.06	.20	-.38	.03	.34	.45*

d. Partial correlation of the Chinese reading and separate phonological subtests, Coloured Progressive Matrices as a partial variable

		EOMO,F	EOMO,M	EOMO,L	CNOMO,F	CNOMO,M	CNOMO,L	COMO,F	COMO,M	COMO,L	EPD,F,CVCC	EPD,F,CCVC	EPD,E,CVCC	EPD,E,CCVC	CPD,F	CPD,E
Chinese reading	*Pinyin*	.19	.29	.02	.34	.25	.30	.22	.39	.52**	.07	.28	-.25	.06	.00	.50**
	non-*Pinyin*	-.04	-.09	-.03	-.09	-.49**	-.34	.08	-.24	-.32	.27	.12	-.33	.08	.37	.24

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 9-8-1: Summary of 3-way ANOVA on the odd man out tests (English, Chinese word and Chinese non-word versions)

Source	d.f.	SS	MS	F	p
Group	1	148.31	148.31	9.42	.0033
Error	58	913.65	15.75	-	-
Version	2	93.64	46.82	15.58	.0001
Group x version	2	19.21	9.61	3.25	.0423
Error (version)	116	342.70	2.95	-	-
Position	2	116.34	58.17	12.98	.0001
Group x position	2	4.18	2.09	0.47	.6283
Error (position)	116	519.70	4.48	-	-
Version x position	4	177.71	44.43	18.05	.0001
Group x version x position	4	14.34	3.59	1.46	.2163
Error (version x position)	232	571.06	2.46	-	-

Table 9-8-2: Summary of 3-way ANCOVA on the odd man out tests (English, Chinese word and Chinese non-word versions), IQ, BPVS and English reading as covariates.

Source	d.f.	SS	MS	F	p
English reading	1	13.54	13.54	1.06	.3073
BPVS	1	2.37	2.37	0.19	.6682
IQ	1	160.18	160.18	12.57	.0008
Group	1	79.37	79.37	6.23	.0129
Error	55	700.95	12.74	-	-
Version	2	15.86	7.93	2.65	.0749
Group x version	2	6.64	3.32	1.11	.3329
Error (version)	110	328.75	2.99	-	-
Position	2	4.00	2.00	0.44	.6478
Group x position	2	1.77	0.88	0.19	.8250
Error (position)	110	504.90	4.59	-	-
Version x position	4	21.10	5.27	2.20	.0702
Group x version x position	4	14.56	3.64	1.52	.1984
Error (version x position)	220	527.91	2.40	-	-

Table 9-9-1: Summary of 3-way ANOVA on the English Phoneme Deletion tests

Source	d.f.	SS	MS	F	p
Group	1	17.60	17.60	5.77	.0195
Error	58	176.94	3.05	-	-
Position	1	473.20	473.20	197.16	.0001
Group x position	1	19.84	19.84	8.27	.0056
Error (position)	58	139.21	2.40	-	-
Syllable type	1	182.00	182.00	97.52	.0001
Group x syllable type	1	7.00	7.00	3.75	.0576
Error (syllable type)	58	108.24	1.87	-	-
Position x syllable type	1	155.20	155.20	101.78	.0001
Group x position x syllable type	1	17.60	17.60	11.54	.0012
Error (position x syllable type)	58	88.44	1.52	-	-

Table 9-9-2: Summary of 3-way ANCOVA on the English Phoneme Deletion tests, IQ, English reading and BPVS as covariates.

Source	d.f.	SS	MS	F	p
IQ	1	11.38	11.38	4.04	.0494
English reading	1	2.34	2.34	0.83	.3666
BPVS	1	1.75	1.75	.62	.4341
Group	1	1.78	1.78	.63	.4304
Error	55	155.02	2.82	-	-
Position	1	15.93	15.93	7.16	.0098
Group x position	1	1.43	1.43	0.64	.4270
Error (position)	55	122.42	2.23	-	-
syllable type	1	1.10	1.10	0.58	.4513
Group x syllable type	1	3.24	3.24	1.69	.1994
Error (syllable type)	55	105.51	1.92	-	-
Position x syllable type	1	1.10	1.10	0.69	.4082
Group x position x syllable type	1	4.88	4.88	3.08	.0849
Error (position x syllable type)	55	87.08	1.58	-	-

Table 9-9-3: Summary of 3-way ANCOVA on the English Phoneme Deletion tests, IQ and BPVS as covariates.

Source	d.f.	SS	MS	F	p
IQ	1	11.17	11.17	3.98	.0510
BPVS	1	3.76	3.76	1.34	.2524
Group	1	13.97	13.97	4.97	.0298
Error	56	157.36	2.81	-	-
Position	1	12.99	12.99	5.80	.0193
Group x position	1	14.00	14.00	6.25	.0154
Error (position)	56	125.37	2.24	-	-
syllable type	1	1.83	1.83	0.97	.3286
Group x syllable type	1	4.80	4.80	2.54	.1165
Error (syllable type)	56	105.73	1.89	-	-
Position x syllable type	1	0.97	0.97	0.62	.4332
Group x position x syllable type	1	14.01	14.01	8.98	.0040
Error (position x syllable type)	56	87.22	1.56	-	-

Table 9-10-1: Summary of ANOVA on the Chinese Phoneme Deletion

Source	d.f.	SS	MS	F	p
Group	1	61.63	61.63	11.81	.0011
Error	58	302.57	5.22	-	-
Position	1	36.30	36.30	11.95	.0010
Group x position	1	6.53	6.53	2.15	.1479
Error (position)	58	176.17	176.17	-	-

Table 9-10-2: Summary of ANCOVA on the Chinese Phoneme Deletion, English reading, BPVS and IQ as covariates.

Source	d.f.	SS	MS	F	p
Eng. reading	1	67.84	67.84	19.22	.0001
BPVS	1	.27	.27	.08	.7841
IQ	1	19.93	19.93	5.65	.0210
Group	1	2.54	2.54	0.72	.4000
Error	55	194.10	3.53	-	-
Position	1	3.34	3.34	1.07	.3044
Group x position	1	1.99	1.99	0.64	.4272
Error (position)	55	171.02	3.11	-	-

Table 9-10-3: Summary of ANCOVA on the Chinese Phoneme Deletion, BPVS and IQ as covariates.

Source	d.f.	SS	MS	F	p
BPVS	1	11.84	11.84	2.53	.1173
IQ	1	18.45	18.45	3.95	.0519
Group	1	47.58	47.58	10.17	.0023
Error	56	261.93	4.68	-	-
Position	1	4.73	4.73	1.55	.2188
Group x position	1	6.62	6.62	2.17	.1466
Error (position)	56	171.18	3.06	-	-

Table 10-2-1: Summary of ANOVA on IQ test during the three testing sessions

Source	d.f.	SS	MS	F	p
Session	2	244.35	122.18	6.39	.0027
Error	78	1491.65	19.12	-	-

Table 10-2-2: Summary of ANOVA on the Visual Paired Associates test during the three testing sessions

Source	d.f.	SS	MS	F	p
Session	2	74.22	34.11	4.13	.0198
Error	78	701.12	8.99	-	-

Table 10-2-3: Summary of ANOVA on Chinese reading during the three testing sessions

Source	d.f.	SS	MS	F	p
Session	2	2970.22	1485.11	145.32	.0001
Error	78	797.12	10.22	-	-

Table 10-2-4: Summary of ANOVA on the Chinese Non-word Odd Man Out test during the three testing sessions

Source	d.f.	SS	MS	F	p
Session	2	475.22	237.61	15.86	.0001
Error	78	1168.78	14.98	-	-

Table 10-2-5: Summary of ANOVA on the Chinese Odd Mna Out test during the three testing sessions

Source	d.f.	SS	MS	F	p
Session	2	412.35	206.18	14.05	.0001
Error	78	1144.32	14.67	-	-

Table 10-2-6: Summary of ANOVA on the Odd Mna Out tests (combined COMO & CNOMO) during the three testing sessions

Source	d.f.	SS	MS	F	p
Session	2	1709.02	854.51	18.96	.0001
Error	78	3515.65	45.07	-	-

Table 10-2-7: Summary of ANOVA on the Chinese Phoneme Deletion test during the three testing sessions

Source	d.f.	SS	MS	F	p
Session	2	694.05	347.03	31.14	.0001
Error	78	869.28	11.14	-	-

<u>Table 10-3-1: Summary of 3-way ANOVA on the Odd Man Out tests</u>

Source	d.f.	SS	MS	F	p
Session	2	284.84	142.42	18.96	.0001
Error (session)	78	585.94	7.51	-	-
Version	1	3.47	3.47	2.04	.1613
Error (version)	39	66.42	1.70	-	-
Position	2	3.70	1.85	.52	.5966
Error (position)	78	277.74	3.56	-	-
Session x version	2	11.02	5.51	2.32	.1048
Error (session x version)	78	185.09	2.37	-	-
Session x position	4	20.51	5.13	1.92	.1091
Error (session x position)	156	415.72	2.66	-	-
Version x position	2	25.92	12.96	7.08	.0015
Error (version x position)	78	142.86	1.83	-	-
Session x version x position	4	16.29	4.07	2.34	.0579
Error (session x version x position)	156	271.93	1.74	-	-

Table 10-3-2: Summary of 3-way ANCOVA on the Odd Man Out tests, IQ & reading ability (at the first session) as covariates

Source	d.f.	SS	MS	F	p
IQ	1	79.78	79.78	6.82	.0129
Reading	1	482.44	482.44	41.27	.0001
Error	37	432.50	11.69	-	-
Session	2	80.38	40.19	5.98	.0027
Error (session)	74	497.60	6.72	-	-
Version	1	0.17	0.17	0.10	.7589
Error (version)	37	64.93	1.75	-	-
Position	2	1.32	0.66	0.18	.8375
Error (position)	74	274.19	3.71	-	-
Session x version	2	1.04	0.52	0.21	.8094
Error (session x version)	74	182.05	2.46	-	-
Session x position	4	5.93	1.48	0.56	.6956
Error (session x position)	148	395.26	2.67	-	-
Version x position	2	0.15	0.07	0.04	.9616
Error (version x position)	74	138.99	1.88	-	-
Session x version x position	4	13.78	3.44	1.97	.1023
Error (session x version x position)	148	259.00	1.75	-	-

Table 10-4-1: Summary of 2-way ANOVA on the Phoneme Deletion test

Source	d.f.	SS	MS	F	p
Session	2	347.03	173.51	31.14	.0001
Error (session)	78	434.64	5.57	-	-
Position	1	124.70	124.70	37.47	.0001
Error (position)	39	129.80	3.33	-	-
Session x position	2	22.71	11.35	6.59	.0023
Error (session x position)	78	134.29	1.72	-	-

Table 10-4-2: Summary of 2-way ANCOVA on the Phoneme Deletion test, IQ and reading (at the first testing) ability as covariates

Source	d.f.	SS	MS	F	p
IQ	1	67.66	67.66	4.78	.0351
reading	1	257.64	257.64	18.22	.0001
Error	37	523.33	14.14	-	-
Session	2	63.61	31.81	5.76	.0249
Error (session)	74	408.37	5.52	-	-
Position	1	10.16	10.16	2.94	.0947
Error (position)	37	127.80	3.45	-	-
Session x position	2	7.78	3.89	2.18	.1202
Error (session x position)	74	131.98	1.78	-	-

Table 10-12: T-test of sex differences on the all tests

Session 1

Tests	Means		difference(boys-girls)	t (d.f.=38)	p
	boys (N=18)	girls (N=22)			
Coloured Prog. Matrices	18.78	17.82	0.94	0.50	.62
Visual Paired Associates	7.56	8.95	-1.40	-1.09	.28
Chinese Reading	2.89	10.14	-7.25	-2.61	.01
Chinese Nonword Odd Man Out	8.22	10.05	-1.83	-1.42	.16
Chinese Odd Man Out	9.72	10.73	-1.01	-.83	.41
Chinese Phoneme Deletion	5.39	8.55	-3.16	-1.97	.0564

Session 2

Tests	Means		difference(boys-girls)	t (d.f.=38)	p
	boys (N=18)	girls (N=22)			
Coloured Prog. Matrices	20.28	21.09	-0.81	-0.35	.73
Visual Paired Associates	8.22	10.27	-2.05	-1.29	.20
Chinese Reading	3.88	10.95	-7.07	-2.59	.01
Chinese Nonword Odd Man Out	10.56	14.32	-3.76	-1.87	.07
Chinese Odd Man Out	9.78	13.82	-4.04	-2.19	.03
Chinese Phoneme Deletion	10.44	13.55	-3.11	-1.97	.0559

Session 3

Tests	Means		difference(boys-girls)	t (d.f.=38)	p
	boys (N=18)	girls (N=22)			
Coloured Prog. Matrices	20.33	22.68	-2.35	-1.13	.27
BPVS	22.83	21.95	.88	.32	.75
Visual Paired Associates	9.78	10.64	-.86	-.62	.54
Chinese Reading	13.78	21.18	-7.40	-2.78	.01
Chinese Nonword Odd Man Out	13.39	14.41	-1.02	-.66	.51
Chinese Odd Man Out	14.61	14.91	-.30	-.17	.87
Chinese Phoneme Deletion	10.61	13.68	-3.07	-2.14	.04