Developmental dyslexia in Arabic : devising a diagnostic tool can enrich our understanding of the manifestation of dyslexia amongst monolingual Arabic children

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Developmental Dyslexia in Arabic

Devising a diagnostic tool can enrich our understanding of the manifestation of dyslexia amongst monolingual Arabic children

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Abstract

Increasing awareness of the socioeconomic costs of reading failures is one of many underlying motives that have prompted developed and developing countries to engage in an ongoing interest in such reading difficulties as developmental dyslexia. Empirical research on developmental dyslexia has witnessed remarkable progress over the last hundred years in the English speaking world and cross-linguistic studies of developmental dyslexia in other languages is becoming more popular (e.g., Lundberg 1995, Goswami 1997, 2002, Lamm 1997, Dummer-Smoch 1998, Smythe & Everatt 2000, Caravolas & Volin 2001, Gomez & Reason 2002, Salameh et al. 2002, Goulandris 2003, Hakansson et. al 2003, Share 2003, Miller Guron & Lundberg 2004, Smythe et. al 2004). With the emergence of such comparative cross-linguistic studies has come the realization that developmental dyslexia should be considered in the context of the specific language of instruction in use since the behavioural manifestations of developmental dyslexia cannot be fully investigated outside the framework of the written and spoken traits of the language in use (Smythe & Everatt 2000, Goulandris 2003, Reid 2003, Smythe & Everatt & Salter 2004).

Studies on the occurrence of developmental dyslexia in Arabic have hitherto been rare and far between. This thesis attempts to investigate how developmental dyslexia manifests itself amongst monolingual Arabic children. By exploring the relationship between developmental dyslexia as a specific reading difficulty and Arabic orthography, the current study aims to discover the underlying cognitive deficits that may be responsible for the occurrence of dyslexia amongst monolingual Arabic children. To achieve its aim, the current study devised a diagnostic test to identify and investigate various cognitive profiles of reading difficulties amongst monolingual Arabic children.

Based on normative data collected from Egyptian Arabic speaking children from three government schools in Alexandria, Egypt and using a test battery devised by the researcher, the current study identified a number of monolingual Arabic speaking dyslexics and compared their performance to those of chronologically age matched group normal readers. The study also compared the performance of high and low achieving participants according to their performance on a number of subtests that tap some of the underlying persisting problems dyslexics experience.

The study has shown that phonological deficits generally, and phonemic awareness in particular are impaired amongst monolingual dyslexic Arabic speakers. The study has also implicated orthographic and morphological deficits amongst Egyptian dyslexic children and highlighted the impact of the specific linguistic features of written and spoken Arabic on the manifestation of dyslexia. The unexpectedly high performance of dyslexics on the sub-test of reading accuracy and the sub-test of non-word reading and the holistic visual strategy elected by both dyslexics and low achievers to retrieve words from their lexicon by sight which was reflected on their grapheme discrimination test scores are some examples of the impact of the linguistic features of Arabic on the manifestation of Egyptian dyslexics reported in the currently study. Other findings include the importance of verbal short term working memory and speed of processing as core indicators of dyslexia type behaviour amongst Egyptian dyslexic children in addition to other phonological, orthographic and morphological processing impairments.

Contents

List of tables

List of Figures

INTRODUCTION TO THE STUDY

In our modern literate society, reading ability is considered one of the most important cognitive and communicative skills (Van der Leij, Lyytinen & Zwarts 2001). Lundberg & Hoien (2001) argue that reading is primarily a culturally and socially based practice that is acquired and used in cultural context. It is a skill that is highly valued by society and, in many communities, possesses the key to education (Snowling 2000). Learning to read has become critical to the individual's well being and, as Zeffiro & Eden (2000) maintain, our lives are becoming more dependent on information derived from print and other electronic sources; mastery of reading skills helps one to assume a prominent position in society. "An important prerequisite for subsequent achievement, failure to acquire reading competency adversely affects acquisition of other fundamental cognitive skills". (Zeffiro & Eden 2000: 3).

The importance of learning to read particularly and of literacy and education generally is recognized by almost all the countries of the world; a fact reflected by the adoption of United Nations' resolutions 45/199 and 50/143 stating that "education is a basic human need and a prerequisite for the achievement of development" and that "entitlement to literacy is considered a basic human right and so reflects the central role of reading and writing in all societies". (British Psychological Society Report 1999: 16). Appropriate literacy development for all has become "a global concern as countries attempt to reduce their level of illiteracy" (Firman 2000: 57), prompting the United Nations to call the current decade we live in the 'decade of literacy".

The increase in the conceptual understanding of the importance of literacy in general and reading in particular has resulted in the systematic enquiry and scientific study of literacy and reading, which has, in turn, prompted similar scientific study of the problems associated with learning and reading difficulties. Developmental dyslexia is one of such reading difficulties which intrigued linguists, neurologists, psychologists and educators over the last century and which has recently received "much more attention than at any other time in the past" (Selikowitz 1998: 10).

The diversity of researchers doing work related to dyslexia has broadened and as a result, more relevant information is being constantly generated from a wide range of research areas which currently include linguistics, education, genetics, neuro-anatomy, visual and auditory processing. It is not surprising therefore that dyslexia has become an international concern, although the extent to which it actually becomes relevant at the individual, scholastic or policy level will depend upon a number of factors including the "perceived importance of education in the community and the resources available for special educational provision" (Smythe & Everatt 2000: 12).

There have been a number of improvements in the understanding of developmental dyslexia in the UK, USA, Canada and Scandinavian countries since the term was first coined by Berlin in 1885. These improvements are the result of the advancement in the understanding of brain functions (e.g., Hynd & Hiemenz 1997, Shaywitz 1998, Iles & Walsh & Richardson 2000, McCrory 2001, Galaburda 2001) as indicated by substantial growth in functional brain-imaging studies, advances in neurology and neuro-psychology (e.g., Robertson 2000, Zeffiro & Eden 2000, Stein 2001, Berninger 2004) and in educational research (Peer & Reid 2000). In addition, current theories and research findings on the biological (e.g., DeFries 1992, DeFries& Alarcon & Olson 1997, Fisher & Smith 2001, Gayan & Olson 2001), cognitive (e.g., Ellis 1993, Hulme & Snowling 1997, Snowling 2000) and neurological bases (e.g., Duane 1992, Fawcett & Nicolson 1999, 2001) of dyslexia as well as active-screening policies encouraged by the recent Code of Practice on the Identification and Assessment of Special Educational Needs in Britain (referred to as SENCO) in 1994 and 2002 (Singleton 2000) are contributing to the current active research on developmental dyslexia.

The above advances have culminated in an ever-increasing knowledge concerning the biological, cognitive and behavioural manifestations of developmental dyslexia. Thanks to such developed awareness and conceptual understanding, dyslexia is now well established as a congenital and developmental condition (Sutton 2001) and its nature is much clearer than it was just over a hundred years ago (Turner 2000). The end result is an extensive research field (Nicolson & Fawcett 1999) which is continuously growing and constantly benefiting from increased interests and activities from researchers worldwide, particularly those engaged in classroom and clinical practices (Reid 1998).

However, Smythe & Everatt (2000) note that despite developmental dyslexia being recognized throughout the world, tests to identify the difficulties experienced by individuals with developmental dyslexia exist in relatively few languages. Miles (2000) observes that most research studies concerned with difficulties of dyslexic individuals in acquiring literacy and other relevant phonological difficulties were conducted in the American/British vernacular by US, Canadian, Scandinavian or British researchers. The majority of subjects in such studies were monolingual English speaking participants and assumptions might have been made about the nature of dyslexia "which are dependent on the complex features of that language" (Miles 2000: 193).

Current cross-linguistic research on developmental dyslexia indicates that there are important factors involved when learning to read in an alphabetic writing system. Such factors include the nature of orthography in a language; how consistent the orthography is (Goulandris 2003), the nature of its spoken language (Szczerbinski 2003) and the relevant methods used in teaching literacy in a particular language. Evidence has continued to accumulate in support of the linguistic basis of reading difficulties (Catts & Kamhi 1999) as empirical research has shown the importance of phonological processing (e.g. Goswami & Bryant 1990, Goswami 1997, 2002, Snowling 2000), orthographic processing (e.g. Hultquist 1997, Breznitz 2003, Miller Guron & Lundberg 2004) and other language processes in reading and reading difficulties. Snowling (2000) argues that writing systems differ in the inherent difficulty they pose to young readers, since they differ in the "regularity or transparency of their orthographies" (Snowling 2000: 206). The role of orthography, particularly in an alphabetic script, is very important because of the existence of a particular orthographic structure; in other words, the possibility of one letter following another one in any given syllable, is not the same for all letter combinations (Hultquist 1997). Moreover, cross-orthographic studies have found that readers of English made more errors on single word reading and non-word reading tasks than readers of shallower orthographies (e.g., Goswami 2000, Landerl 2003, Nikolopoulos, Goulandris & Snowling 2003, Share 2003). Wimmer (1993) argues that transparent orthographies such as Italian, Spanish and Greek will pose fewer problems to beginning readers than inconsistent, opaque orthographies such as English and French.

Goswami (1997) explores the various literacy development stages of children exposed to different orthographies before citing numerous studies of how children growing up in different linguistic environments appear to go through the same sequence of phonological development, though difficulties encountered by dyslexic individuals seem to depend on the phonology and orthography of that language. Goswami (op. cit.) argues that children learning to read highly transparent orthographies such as German and Dutch "may gain better conscious access to phonological structures at the phonemic level, because this level is unambiguously represented by the orthography" (Goswami 1997: 149). Goulandris (2003) presents a cross-linguistic comparison that involves the nature of the language and the range of skills required for reading in different languages. She argues that in order to identify and appreciate the signs of dyslexia in a particular language, it is necessary to understand the relevant linguistic features of that language. Focus on the processes involved in the development of reading and spelling as well as the various cognitive skills which underpin the acquisition of literacy development are all highlighted by Goulandris (2003), who maintains that the linguistic features of each language can be influential in the language acquisition in any particular language (Reid & Fawcett 2004).

Paulesu et al. (2001) conducted a cross-linguistic study of dyslexia and compared the brain activity of Italian, French and English dyslexics while they were reading. Their study has two major findings: first, the reading and phonological skills of all dyslexic groups were impaired compared to control groups. Second, when they employed the PET (Positron Emission Tomography) scan technology, they found reduced activity in the same brain region for all three dyslexic group. However, differences in the reading performance of the three groups were reported with the Italian dyslexics attaining higher levels of accuracy on single word reading and non-word reading than the French and English dyslexics. The researchers conclude that although neuro-cognitive basis underlies dyslexia in all three groups, differences in the orthographies of the languages involved in the study influence the severity of the reading, spelling and phonological deficits.

There is currently a growing and substantial body of research information about "learning to read and spell in different orthographies" (Peer 2001), which has been further encouraged by the call of the First International Multilingualism & Dyslexia Conference of the British Dyslexia Association (June 1999) that was dedicated to the issue of "Dyslexia and Multilingualism". Now international studies of dyslexia are gradually emerging, an example of which is the project 'The International Adult Literacy Survey' by Vogel & Reder (2001), who together with other researchers from nine different countries, are attempting a cross linguistic study that looks at dyslexia from an international perspective by investigating the impact of wide range of factors. A current consensus that further research is needed on "the impact of the linguistic environment on the expression of dyslexia" (Fawcett 2002: 24) seems to exist now.

"In this new situation it is beginning to be appreciated that the ways in which dyslexia manifests itself are different in different languages" (Miles & Miles 1999: 44) and that is why people of different countries are now collaborating with each other to "see how dyslexia manifests itself in languages other than English" (Stamboltzis & Pumfrey 2000: 75). Miles & Miles (1999) observe that although research on the weakness of dyslexics in languages other than English has been relatively limited, it is now growing and people from various countries are now collaborating in research. Given the perceived importance of dyslexia assessment, intervention, support and policy throughout the world, Smythe & Everatt (2000) highlight the need for systematic research in order to identify the similarities and differences between different countries and different contexts. Smythe & Everatt (op. cit) conclude that this would ultimately help in the development of culture and language-appropriate diagnostic strategies. Reid & Fawcett (2004) observe that one of the areas which gained momentum in recent years has been the acknowledgement of the need to "promote appropriate and effective practices both in the assessment and in the intervention for students whose first language is not English" (Reid & Fawcett 2004: 13).

The practice of cross-linguistic and cross-orthographic studies of dyslexia is important in explaining the nature of the condition and how it is manifested in different orthographies. Investigating the implications of dyslexia manifestations in different orthographies assists in furthering one's understanding of the condition and of the relevant and subsequent areas of interventions, policies and practices. An appreciation of language specific factors is critical because "in many countries there are as yet few test instruments available to assess and identify children with specific learning difficulties"

(Goulandris 2003: 13). Moreover, Der Leij (2004) argues that since reading is, essentially, a mapping process (between phonemes and graphemes); it is essential that in order to understand the origins of dyslexia and in order to develop instruments and methods for identification and treatment, to understand the processes and systems necessary for the underlying learning processes involved in this mapping processes. In other words, the underlying question which emerges here is whether the cognitive prerequisites of learning how to read and spell are universal; i.e., independent of environmental factors such as language, writing system, orthography, school and home factors?. De Leij (op. cit) argues that although the cognitive prerequisites of learning how to read and spell are universal has been assumed to be the case for a long time, cross-linguistic evidence to support this assumption has only been produced recently.

Studies on the occurrence of developmental dyslexia in Arabic have hitherto been rare and far between. Although learning difficulties is a well-documented field of study and research in Egypt (Shehata 1981, Morsi and Abu Elazayem 1983, Al Molla 1987, Othman 1990), dyslexia is not recognized as a specific reading difficulty and academic research on dyslexia is scarce (e.g.; Gilgil 1995, Abu Rabia 2004), despite endless efforts by the Egyptian local educational authorities[1] to raise awareness of learning difficulties and special educational needs throughout the country. There are currently no methods of identification, assessment or diagnosis for dyslexia available to educational psychologists or special educational teachers.

The current study aims to fill in the existing gap in the corresponding literature in Arabic by adopting a linguistic framework while investigating the relationship between various Arabic relevant linguistic features, notably its orthography, and developmental dyslexia. In trying to do so, the current research adopts the process of scientific enquiry in attempting to find answers to the question "do features of different languages have an impact on dyslexia?" (Cline 2000: 3-11). Available empirical research on developmental dyslexia in English and other alphabetic scripts in addition to advances in educational research and practice in the West will provide a platform from which the current study can progress to discover how dyslexia manifests itself in Arabic.

Having considered all of the above, the current study aims to achieve insight into, and gain an understanding of how developmental dyslexia manifests itself in Arabic. The study aims to find out the *common* features and universal markers of dyslexia across languages as well as the *specific* features relevant to dyslexia in Arabic. The current study attempts, therefore, to investigate the "universality and script-dependency of the prerequisites and underlying processes of reading that may be defective" (Van der Leij 2004: 49). Such common and specific features of dyslexia manifestation in Arabic can be explored by utilizing existing empirical literature on dyslexia assessment and diagnosis in other relevant alphabetic scripts and employing these to devise an Arabic dyslexia diagnostic test. Devising such a diagnostic dyslexia test in Arabic will empower the current study with a vital and critical tool through which further investigation of the manifestation of developmental dyslexia becomes possible and subsequent examination of the relationship between developmental dyslexia and the quasi-regular Arabic language becomes tenable. This achieved, it will, no doubt, provide a powerful impetus to the ongoing international research attempts of investigating the relationship between dyslexia in different orthographies. It is also hoped that the current study will be the catalyst, which triggers further empirical research and systematic investigation of other equally pressing issues such as dyslexia and bilingualism in English/Arabic bilingual learners. One of the aims is to identify universal markers of developmental dyslexia that transcend

[1] Their efforts were given a considerable boost due to the work of Egypt's First Lady, who personally

language and to find out if there are other characteristics that might be specific to developmental dyslexia in Arabic. It is in its attempt to investigate the cognitive profiles of reading difficulties amongst dyslexic monolingual Arabic children, that the current study acquires its exploratory nature.

The purpose of the current study is therefore, broadly, twofold: first, it aims to investigate developmental dyslexia from a primarily applied linguistic perspective. To conduct such an investigation, the literature review of the relatively new research field of developmental dyslexia is first attempted which investigates the various definitions of developmental dyslexia as well as the theories proposed to explain its incidence and the various methods of assessment used to identify dyslexic individuals. The literature review covered in the opening chapters of this study provides a general understanding of developmental dyslexia but concludes with some unanswered questions regarding the likely specific manifestation of dyslexia in Arabic. These questions form and define the research gap the current study tries to fill. To address these questions, an overview of the relevant linguistic features of the quasi-regular Arabic alphabet, notably aspects of Arabic morphology and orthography becomes necessary as it will fundamentally assist in laying the ground-work towards formulating hypotheses concerning the manifestation of developmental dyslexia in Arabic.

Having covered the issues related to developmental dyslexia definitions, theories and assessment and having reviewed the anticipated specificity of dyslexia manifestations amongst monolingual Arabic children, the current study then proceeds to formulate some hypothesis based on the critique presented in its opening chapters before proceeding to effectively test these hypothesis through a process of quantitative data collection and subsequent in-depth statistical analysis. In doing so, the study reconsiders the issue of

initiated the 'Reading for all' programme dyslexia diagnosis in Arabic following the recent relevant empirical studies and research findings since the publication of Gilgil's study in 1995, and notably the abandonment of the exclusionary criterion formerly used to identify dyslexics.

The study concludes with a discussion of its main findings concerning dyslexia manifestations in Arabic. This discussion enriches our current understanding of developmental dyslexia and explains both common (universal) and specific (script-dependent) features of dyslexia in Arabic. Results of the study discussed in its concluding chapter implicate phonological processing impairments as one of the underlying causes amongst monolingual Arabic speaking dyslexic children while emphasising the importance and relevance of other universal markers of dyslexia such as verbal short-term working memory and serial rapid automatized naming. The concluding chapter also represents specific characteristics of dyslexia manifestations amongst monolingual Arabic speaking children, which are primarily, related to the importance of orthographic and/or morphological processing in reading Arabic and supports the view that due to the specific nature of the Arabic language, orthographic processing impairment deficits are present amongst monolingual Arabic dyslexics over and above phonological processing impairments.

Organization of the study

The current thesis is divided into eight chapters. The first four chapters of the study constitute the theoretical framework which furnishes a survey of the research literature on developmental dyslexia in English as an alphabetic script. The first chapter examines the definition and definitional problems associated with the relatively new research field of developmental dyslexia. It investigates the current challenges associated with the lack of a consensual definition for developmental dyslexia and the current general disagreement amongst researchers regarding the need, the validity and the use of intelligence in the definition and assessment of developmental dyslexia. This chapter reports on the division amongst researcher regarding the definition of developmental dyslexia, while remarkably at the same time, represents how such a disagreement over the definition of dyslexia did not hinder the progress in the systematic enquiry of developmental dyslexia.

Having surveyed various definitions of developmental dyslexia historically during the first chapter, the second chapter investigates the various theories proposed to explain the nature and occurrence of developmental dyslexia. It adopts a multi-level approach in dealing with developmental dyslexia by examining both biological and cognitive based-theories of developmental dyslexia. Chapter three provides a rationale of how dyslexia is anticipated to manifest itself due to the nature of the Arabic language. This chapter outlines the challenges caused by the specific nature of the Arabic language and particularly its orthography and morphology. It also represents how such challenges may confuse beginning readers of Arabic and discusses what aspects of reading disabilities are expected in monolingual Arabic speakers. Chapter four investigates dyslexia assessment and explores various methods of dyslexia assessment, which are grounded in and draw upon both definitions and theories of dyslexia while having in mind the specificity of the linguistic features of Arabic. This chapter examines current trends in dyslexia assessment and concludes with an in depth investigation of the Arabic Dyslexia Diagnostic test battery developed by Gilgil (1995).

The literature review covered in the first four chapters of the study shapes a general theoretical framework that needs to be tested in real life. Chapters five covers the research questions, research hypotheses, the setting of the study and the research method. It also includes the various considerations such as ethical, technical and practical one has to consider while conducting the study. Chapter five ends with the various research limitations. Chapter six on the other hand covers the data design and the process of data collection including detailed descriptions of various sub-tests which make up the final ADATI test battery. Chapter seven describes the process of data analysis and includes a detailed description of groups of participants according to their marks on various sub-tests. .These chapters draw upon knowledge previously discussed in the four chapters and are generally characterized by technical, ethical and practical considerations that constitute conducting quantitative research based on data collected from monolingual Arabic speaking Egyptian children. Chapter eight is the final part of the study and it discusses the study results and provides some implications and recommendations for further research.

Chapter One: Definitions of Dyslexia

1.1 Introduction

This chapter investigates one of the central and most important issues of developmental dyslexia that has been undergoing continuous debate for over one hundred years; i.e., the definition of developmental dyslexia. A historical approach is adopted throughout this chapter for two reasons. First, such an approach highlights the predominantly medical origins of dyslexia research and explains the frequency of various medical terms formally used in defining dyslexia. Second, the historical approach stresses an important characteristic of scientific research in general and dyslexia research in particular; i.e., although there has been an on-going debate regarding the definition of developmental dyslexia, this has not dampened the scale nor interest of researchers from diverse backgrounds who conduct their search to discover the underlying causes and/or remediation of the condition.

Due to the complex nature of the reading process where auditory and visual domains are implicated in addition to information processing of such information in the brain as well as expressive and receptive language mechanisms, dyslexia has attracted the attention of a number of diverse professional disciplines. However, it has, in fact, been originally identified by those working in the medical field who tended to describe the clinical features of dyslexia. Such incidents mainly originated from incidents where patients lost any, some or all of the language faculties following an accident or a trauma; a condition that was generally referred to as aphasia. The current study is not however concerned with such incidents and is only concerned with developmental dyslexia; i.e., a congenital specific reading (some times referred to as learning) difficulty which occurs in some children and which negatively influences their reading and writing skills and impedes their literacy abilities. Other acquired forms of dyslexia, which may be due to known neurological damage caused by accidents, strokes or tumours, are not the concern of this study. Therefore, any mention of acquired dyslexia is intended only to explain the link between the two, or to represent a fuller account of the historical development of research interest on developmental dyslexia. The following section gives a historical account of the development of dyslexia definitions starting from the beginning of the nineteenth century right until the present time. These definitions are quoted in order of their appearance and each is followed by brief analysis and critical commentary, which generally highlights the theories and research environment from which these definitions emerge. This section is then followed by an in-depth critical section, which identifies the problems with the various definitions quoted and therefore highlighting both the ongoing debate concerning dyslexia definitions and paving the way for the subsequent section, which is the summary, discussion and the concluding section of dyslexia definition.

1.2 A historical view

By the beginning of the nineteenth century the claim that linguistic ability is localized in a particular area of the left hemisphere of the human brain was popular (Kussmaul 1878, Miles 1961, Catts & Kamhi 1999, Obler & Gjerlow 1999, Miles & Miles 1999, Robertson 2000). Various studies and research findings, notably by Paul Broca (1861, 1865) and Carl Wernicke (1874) concentrated on language problems caused by injuries to various parts of the brain. Such conditions are known as aphasias. Aphasia is the partial or total "defect or the loss of power of expression by speech, writing or signs, or of comprehending spoken or written language due to injury or disease" (Robertson 2000: 5). These drew the initial attention of medical professionals to problems of the loss of language and linguistic abilities due to injury or following an accident.

However, the academic research on developmental dyslexia did not start until 1896, when Pringle Morgan's article, *A case of congenital word blindness*, was published in the British Medical Journal, in which he described the case study of Percy, a 14-year-old boy who despite adequate intelligence and laborious training, was suffering from pronounced reading and spelling difficulties. Morgan referred to Percy's condition as a case of 'a congenital word blindness'. Other early pioneers such as Kussmaul, Kerr and Hinshelwood also introduced the concept of 'alexia', or 'word blindness'. They all believed this "congenital word blindness" to be a specific disability that stems from visual processing problems rather than cognitive/mental problems and eventually causes this apparent 'word blindness'. They all considered "perceptual dysfunctions as being a major cause of reading problems" (Everatt 2002: 87).

This was generally the concept of developmental dyslexia by the turn of the twentieth century but there was a shift in the dyslexia research paradigm to include other educational and linguistic characteristics due to the work of Samuel Tory Orton, whose *Reading, Writing and Speech in Children* in 1937 was highly influential (Ellis 1993). Orton did not encourage the use of 'congenital word blindness', claiming that it was a misleading term, and arguing that such a term overstressed the inherent difficulty and underemphasized the many environmental factors: either specific, such as methods of teaching, or general, such as emotional and social forces. He preferred instead the use of the term 'developmental' to 'congenital' since it included both hereditary tendencies and environmental forces. Although Orton, like Kussmaul, Morgan and Hinshelwood, still attributed the condition to a visual processing deficit, it was not a word blindness *per se*, but rather a 'Strephosymbolia'; a twisting of symbols. Orton believed that the condition was hereditary and he observed that it occurred more in boys than girls. He also claimed that children could be helped with appropriate methods of teaching, thus, drawing attention for the first time to educational and environmentally related causes of dyslexia.

The groundbreaking discoveries of 'congenital word blindness' or 'alexia' were heavily criticized and subsequently came into disrepute following the argument that learning of all modalities are controlled by a unitary brain function and that a problem in the ability to read and write could not possibly "co-exist with ease of learning in other fields or with average or even above average intellectual abilities" (Von Euler 2002: 18). This view resulted in dyslexia remaining broadly defined within the general framework of clinical practices and medical specialists up until the 1960s, when researchers became interested in identifying systematic differences between dyslexics and normal readers, particularly when "Lorenz, Tinbergen and Frisch argued that specific human disabilities and abilities exist in humans" (Von Euler 2002: 18).

The next definition of dyslexia came in 1968, when the World's Federation of Neurology defined dyslexia as "a disorder in children who, despite conventional classroom experience, fail to attain the language skills of reading, writing and spelling commensurate with their intellectual abilities" (Miles & Miles 1999: 169). The same group who worked on this definition also produced a definition for specific developmental dyslexia which considers it as a disorder manifested by difficulty in learning to read "despite conventional instruction, adequate intelligence and socio-cultural opportunity. It depends on fundamental cognitive disabilities, which are frequently constitutional in origin" (Turner 1997: 3).

However, there was dissatisfaction with the above two definitions which lacked a consensus about the positive signs of dyslexia as well as its basis on exclusionary criteria to define dyslexia (Snowling & Stackhouse 1993). Snowling (2000) argues that this definition had a number of ill-defined terms, such as 'conventional instruction' and 'socio-cultural opportunity", while Ellis (1993) disputes the claim of the above definition notably the "frequently of constitutional origin" part of the definition since, in practice, the defining criteria were psychological and social. Adequate intelligence was also heavily criticized in this definition, but this criticism will be dealt with in more detail once the definitional problems of dyslexia and the traditional use of intelligence tests are looked at towards the end of the current chapter.

The World Health Organization and in particular the Diagnostic Criteria for the Diagnosis of Specific Reading Disorder, which is known as the ICD-10, produced the following definition of dyslexia in 1993:

> A score on reading accuracy and/or comprehension that is at least 2 standard errors of prediction below the level expected on the basis of the child's chronological age and general intelligence, with both reading skills and IQ assessed in an individually administered test standardized for the child's culture and educational system.
>
> (Smythe et. al 2004: 6)

The above definition reflects changes in dyslexia research since the definition of the World's Federation of Neurology in 1968. For the first time, a criterion-based (2 standard errors of prediction below chronological age and general intelligence expected levels of performance) definitions for dyslexia is attempted. The two standard error is the criterion in this case and this is used as the cut off point. Smythe, Everatt & Salter (2004) observe that the above definition has moved towards criteria that are more objective by attempting to introduce measures that are more specific. However, researchers do not agree about what cut off points to employ as the above definition depends entirely on the IQ-reading discrepancy that has been criticised as will be discussed towards the end of this chapter.

The next major definition of dyslexia appeared in 1994, when the International Dyslexia Association's[2] Committee of Members defined it as:

[2] American based international organization that was formerly knows as the Samuel Orton Society.

> A neurologically based, often familial, disorder that interferes with the acquisition and processing of language. Varying in degrees of severity, it is manifested by difficulties in receptive and expressive language, including phonological processing, in reading, writing, spelling, handwriting and sometimes in arithmetic. Dyslexia is not a result of lack of motivation, sensory impairment, inadequate instructional or environmental opportunities, or other limiting conditions, but may occur together with these conditions.
>
> (Pumfrey 2001: 144)

In the same year, the International Dyslexia Association's Research Committee defined dyslexia as:

> Dyslexia is one of several distinct learning disabilities. It is a specific language-based disorder of constitutional origin characterized by difficulties in word decoding, usually reflecting insufficient phonological processing abilities. These difficulties in single word decoding are often unexpected in relation to age and other cognitive and academic abilities; they are not the result of generalized developmental disability or sensory impairment. Dyslexia is manifested by variable difficulty with different forms of language, often including, in addition to problems reading, a conspicuous problem with acquiring proficiency in writing and spelling.
>
> (Pumfrey 2001: 144)

The above two definitions are symptom-based definitions, which list symptoms that are widely observed amongst dyslexic individuals without reference to their causation. While both definitions are largely based on exclusion criteria, they have observable education-related behavioural outcome that can be easily identified by educationalists.

In 1996, the British Dyslexia Institute defined dyslexia as:

> Dyslexia is a specific learning difficulty that hinders the learning of literacy skills. This problem with managing verbal codes in memory is neurologically based and tends to run in families. Other symbolic systems, such as mathematics and musical notation, can also be affected. Dyslexia can occur at any level of intellectual ability. It can accompany, but is not a result of, lack of motivation, emotional disturbances, sensory impairment or meagre opportunities. The effects of dyslexia can be alleviated by skilled specialist teaching and committed learning. Moreover, many dyslexic people have visual and spatial abilities which enable them to be successful in a wide range of careers.
>
> (Turner 1997: 11)

The British Dyslexia Association defined dyslexia in 1997 as:

> A complex neurological condition, which is constitutional in origin. The symptoms may affect many areas of learning and function, and may be described as a specific difficulty in reading, spelling and written language. One or more of these areas may be affected. Numeracy, notational skills (music), motor function and organizational skills may also be involved. However, it is particularly related to mastering written language, although oral language may be affected to some degree.
>
> (Reid 1998: 2)

The above two definitions are also symptom-based definitions that have moved away from the traditional exclusionary criteria formerly employed to define dyslexia. Particularly interesting in the above two definitions is that dyslexia is reported to affect more than just the language and literacy and it extends to affect numeracy, motor function, musical abilities and organizational skills. These two definitions have also stated the positive outlook of some of the accompanying traits that co-occur with dyslexia particularly the mention of 'spatial and visual' abilities. Neither definition is, however, functional or operational, and both attempt to describe the condition with only a brief reference to what might be its causes.

The Health Council of the Netherlands produced in 1997 the following working definition of dyslexia:

> Dyslexia is present when the automatization of word identification (reading) and/or spelling does not develop or does so very incompletely or with great difficulty"
>
> (Smythe et. al 2004: 5)

The above definition is more general and does not seem to be limited to a particular language or script like other earlier definitions. However, the removal of the exclusionary criteria from the above definition has resulted in the increase of individuals who may be classified as dyslexics. Smythe et. al (2004) argue that "having freed itself from including a casual element in the definition, it is difficult to see how it could be used to differentiate the dyslexic individual from those with global learning difficulties" (Op. cit: 5).

The Report of C.H. Singleton & the National Working Party on Dyslexia in Higher Education, entitled 'Dyslexia in Higher Education: Policy, Provision and Practice' defined dyslexia in 1999 as:

> A complex neurological condition that occurs in approximately 4 per cent of the population (*British*), and which primarily affects the acquisition and use of written language, memory and organizational skills
>
> (Farmer & Riddick & Sterling 2002: vii)

Another Report by the Working Party of the Division of Educational and Child Psychology of the British Psychological Society defined dyslexia in 1999 as:

> Dyslexia is evident when fluent and accurate word reading and/or spelling develops very incompletely or with great difficulty. This focuses on literacy learning at the 'word level' and implies that the problem is severe and persistent despite appropriate learning opportunities. It provides the basis for a staged process of assessment through teaching.
>
> (British Psychological Society Report 1999: 18)

The above definitions avoid discrepancy and have no exclusionary criteria. They include other identifying positive indicators of dyslexia but is not an operational definition and its authors accept that it requires to be operationalised for different educational contexts. The authors of the report, however, believed that a working definition did not require any causal explanation and as such would be beneficial in its generality and built-in ability to be operationalised at various and diverse levels.

The British Psychological society definition above does not solve equally important questions such as how long one has to wait before deciding that the accurate and fluent word reading and spelling are developed 'very incompletely or with great difficulty'. Answers to such questions will involve operationalizing cut off points within a given continuum that will in turn generate further debate and disagreement since these cut off points are by their very nature arbitrary.

However, the above definition has a number of advantages notably that it can effectively accommodate various theoretical explanations of developmental dyslexia. It can be regarded as a proximal definition that gives an opportunity to generate more hypotheses as well as testing current ones "that draw on psychological theory and research linked to different causal explanations" (Report of the British Psychological Society 1999: 19).

For the majority of researchers; particularly those opposed to the notion of IQ inclusion in dyslexia definition and testing, the above description seems to be a step in the right direction, since it is a symptom based definition that identifies characteristics used as defining properties. What is more interesting about the (BPS 1999) definition is the fact that it does not refer to intelligence and it has been therefore repeatedly used to argue against the inclusion of intelligence measure in any dyslexia diagnostic test and it suggests that an IQ measure should only be used as a raw measure of present cognitive functioning.

Cooke (2001), however, disagrees arguing that restricting the definition to difficulties 'at the word level' "has worrying implications for children who have had difficulty at this level in the past but have overcome it" (Cooke 2001: 49). She argues that some dyslexics have difficulties at the word level but overcome it and can read adequately although slowly. Reid & Kirk (2001) highlighted the response of the British Dyslexia Association to the above definition at the time and in particular, they mention that BDA press release on October 29th, 1999 which highlighted that "dyslexia is greater than the sum of reading and spelling problems" (Reid & Kirk 2001: 5). Thomson (2001) has similar concerns and argues that the above definition is largely criticised even as "being too general and might be applied to all children who are poor readers and spellers" (Thomson 2001: 47). Thomson stresses that the important element of this definition is indeed the rejection of the existence of a relationship between reading and intelligence as an important discrepant diagnostic criterion in dyslexia. Reid (2002) disagrees, however, arguing that the British Psychological Report (1999) has indeed opted for a working definition of dyslexia and that whether one agrees or not with this definition becomes irrelevant. Reid (op. cit) stresses that the important point here is service providers, speech therapists, psychologists, education authorities and course organisers "may each have the need for their own working definition which they can operationalise to fit into their own working practices" (Reid 2002: 73). Moreover, Reid & Kirk (2001) point out the value of the above definition which separates working definition from causal definition and therefore helps to "embrace different theoretical explanations in relations to a causal framework for dyslexia" (Reid & Kirk 2001: 5).

Snowling (2000) defines dyslexia as:

> Dyslexia is a specific form of language impairment that affects the way in which the brain encodes the phonological features of spoken words. The core deficit is in phonological processing and stems from poorly specified phonological representations. Dyslexia specifically affects the development of reading and spelling skills but its effects can be modified through development leading to a variety of behavioural manifestations.
>
> (Snowling 2000: 213-214)

Snowling's definition above largely reflects her theoretical views and in particular, the phonological deficit hypothesis she supports. Snowling's definition is a causal-based definition in which she indicates that the underlying cause of dyslexia is a deficit in phonological processing. However, the definition seems to overlook the various findings that some dyslexics have either additional or different and equally important underlying cognitive deficits such as those in the cerebellum or orthographic and morphological processing impairments.

Stein (2000) defines dyslexia as:

> Low literacy is termed 'developmental dyslexia' when reading is significantly behind that expected from the intelligence quotient (IQ) in the presence of other symptoms such as in-coordination, left-right confusions, poor sequencing- that characterize it as a neurological syndrome
>
> (Stein 2001: 12)

Stein's definition however fails to "specify the core deficit in dyslexia that would help us in its identification, measurement and management" (Mutter 2003: 78). His definition also seems to depend on the IQ-reading discrepancy criterion to identify dyslexia which is largely contested as explained in detail in the next section.

Frith (2002) defines dyslexia as:

> Dyslexia can be defined as a neuro-developmental disorder with a biological origin and behavioural signs which extend far beyond problems with written language. At the cognitive level, putative causes of the behavioural signs and symptoms of the condition can be specified. These hypothetical deficits are subject to debate, but serve as a basis for testable predictions at both the behavioural and biological levels. At all three levels, interactions with cultural influences occur. These influences have a major impact on the clinical manifestation of dyslexia, the handicap experienced by the sufferer and the possibilities for remediation. When all these factors are considered together, paradoxes disappeared and a satisfactory definition of dyslexia can be achieved.
>
> (Frith 2002: 45)

Frith's (2002) definition above is one of many attempts to reconcile all the diverse definitions and indeed to provide a general framework within which dyslexia can be identified without apparent contradictions. The definition, although does not specify an underlying deficit, stresses that the underlying deficit is primarily a biological one. It also stresses the behavioural manifestation of dyslexia and more importantly refers to the constant interactions all three levels (biological, cognitive and behavioural) have with the environmental level.

Reid (2003) defines dyslexia as:

> Dyslexia is a processing difference experienced by people of all ages, often characterised by difficulties in literacy, it can affect other cognitive areas such as memory, speed of processing, time management, co-ordination and directional aspects. There may be visual and phonological difficulties and there is usually some discrepancy in performances in different areas of learning. It is important that the individual differences and learning styles are acknowledged since these will affect outcomes of assessment and learning. It is also important to consider the learning and work context as the nature of the difficulties associated with dyslexia may be more pronounced in some learning situations.
>
> (Reid 2003: 5)

The above definition is a working/operational definition proposed by Reid after he examined a number of pre-requisites for a good definition such as processing style, problem-solving style, as well as the well documented difficulties some dyslexics have in phonological processing and observable discrepancies in their performances.

The British Dyslexia Association defined dyslexia in 2003 as:

> A combination of abilities and difficulties which affect the learning process in one or more of reading, spelling and writing. Accompanying weaknesses may be identified in areas of speed of processing, short-term memory, sequencing, auditory and/or visual perception, spoken language and motor skills. It is particularly related to mastering and using written language, which may include alphabetic, numeric and musical notation.
>
> (Peer 2001: 67)

The above most recent definition of dyslexia by the British Dyslexia Association avoids the shortcomings of previous definitions and looks at dyslexic individuals as they really are: individuals who have strengths and weaknesses. Smythe et. al (2004) claim that one of the aims behind the above definition is to use more accessible language that is demanded by parents and teachers. They also argue that the use of the term 'abilities' allows "the distinction to be made between those with specific deficits and those with more general difficulties" (Smythe et. al 2004: 6). This definition, naturally, studies dyslexics as individuals and, as such, assumes no primary underlying cognitive deficit responsible for the condition. Moreover, the use of the word 'accompanying' avoids confirming if the weaknesses are the causes of reading and writing difficulties or additional symptoms.

The above definition also refers to findings in dyslexia research; i.e., deficits in speed of processing, short-term and working memory, sequencing, auditory and/or visual perception, spoken language and motor skills are amongst the general characteristics manifested by dyslexics. Such a definition can be helpful when trying to identify dyslexic individuals for it will affect the choice of test battery while trying to understand the cognitive profiles of dyslexic individuals. However, the above definition fails to "differentiate difficulties at the behavioural level from the underlying processing deficits" (Smythe et. al 2004: 6).

A Working Group of the International Dyslexia Association provided in 2003 the following working definition of dyslexia:

> Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading, comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge.
>
> (Lyon, Shaywitz & Shaywitz 2003: 2)

The above definition, the latest proposed by the International Dyslexia Association, has a number of advantages and reflects recent advancement in dyslexia research. The definition is a working definition that recognizes recent advances in understanding the neural basis for dyslexia. The definition has expanded its defining characteristics of dyslexia to include not only 'problems in single word decoding' which was mentioned in their 1994 definition, but also refers to "accurate word recognition, identifying real words, and to decoding abilities (pronouncing pseudowords)" (Lyon et. al 2003: 6). The definition considers deficits and/or poor spelling to be a characteristic of dyslexia and it stresses the "phonological component of language". The definition, although mentioning that the deficit is "an unexpected in relation to other cognitive abilities" and recognizing that the notion of an unexpected difficulty in learning to read is basic to almost all definitions of dyslexia, does not "embrace the idea and that basic deficits in decoding and word recognition must be significantly lower than IQ" (Lyon et. al 2003: 8). In their comments on the above definition, the group of researchers who proposed it has alternatively suggested that "unexpectedness" should be accessed via comparisons of reading age with chronological age and/or comparing reading ability to educational level and professional level attainment.

The researchers who propose the above definition also stress that a major concern with relying on a discrepancy definition of dyslexia has been the delay in both the identification and the provision of effective reading instruction. Perhaps other advantages found in this definition are the mention of problems in reading comprehension and reading fluency and it seems that the definition has encompassed all the basic skills that are involved in the process of reading; i.e., spelling, reading accuracy, reading fluency and reading comprehension.

Now that a historical view of the development of dyslexia definitions over the last hundred years is completed, the following section summarises the problems posed by various attempts quoted above and searches for the requirements for reaching a consensus on a definition for dyslexia. The following section identifies three traditional criteria that have been formerly used to identify dyslexia and investigates each one of these in some detail. It also provides a critique for the IQ reading discrepancy approach before finally concluding and discussing the way forward for an agreed and an acceptable definition for dyslexia, which can be used by all researchers and practitioners working in the field of dyslexia.

1.3 Problems with the definition of dyslexia

From the above list of dyslexia definitions, it can be realised that different definitions for dyslexia have either used different terms (both accessible and technical), concentrated on different aspects of the condition (difficulties in receptive and expressive language, word decoding, insufficient phonological processing, etc) or offered none or some of either remedial or identification criteria of the condition. Tonnessen (1995) captured these differences in various dyslexia definitions by organizing the latter into three main categories: symptom-based, causal-based and prognosis-based. Reid (2002), in his comments on such differences classifies dyslexia definitions into descriptive definitions, working definitions and operational definitions (Reid 2002: 68).

Dyslexia is a descriptive term and does not offer any clues as to its underlying causes. Doyle (2002) observes that to say someone cannot read because he is dyslexic is similar to saying that someone cannot read because he has difficulty making out words written down. He argues that this is similar to saying that someone has a temperature because he is feverish and does not tell us anything about the underlying causes of the problem. How dyslexia is defined may depend on "the level of description being focused upon" (Mutter 2003: 79). Therefore, the various definitions of dyslexia quoted above are a direct result of the various disciplines and backgrounds of the individuals engaged in investigating the condition. Researchers with medical background defined dyslexia as a condition resulting from neurological, maturational and genetic causes, while those in the field of psychology and educationalists described dyslexia on the basis of specific reading problems evidenced with no reference to causation. While the differences amongst dyslexics are individual, the manifestations of dyslexia are behavioural, the diagnosis is clinical and the treatment is sometimes educational and in some cases medical. This very complex nature of dyslexia had made the definition of the condition somehow challenging.

From the various definitions of dyslexia given in the previous section, one realizes that traditional criteria formerly used to identify dyslexic individuals were based on three major assumptions:

First: A significant *discrepancy* between measured intelligence and literacy attainment. Most definitions represent dyslexia in discrepant terms; i.e., there is discrepancy between measured intelligence (intellectual/mental abilities) and existing educational achievement/attainments. Such a discrepancy is frequently referred to in literature as the abilities-attainment discrepancy, which is now considered unsatisfactory for a variety of reasons discussed below in more detail.

Second: *Exclusion* of other probable causes of literacy difficulty, i.e., social, emotional, familial and other related medical problems such as neurological or visual deficiencies.

Third: *Core indicators* of dyslexia, i.e., visual deficits, such as letter reversals, transpositions, mirror vision or directional confusion, or other relevant cognitive and/or behavioural causes, such as short-term memory, disorientation, clumsiness and left-handedness.

The following section discusses the above traditional criteria formerly used to identify dyslexics in an attempt to provide a critique of the definition of the condition. This, in turn, will provide a framework within which a consensual acceptable definition of dyslexia can emerge.

1.3.1 The abilities-attainment (IQ-Reading) discrepancy

The IQ-Reading discrepancy criteria accounts for the traditional frequent use of most IQ tests in identifying dyslexic individuals. "Among exclusionary factors, intelligence has been given the most attention by practitioners" (Catts & Kamhi 1999: 60). IQ, Intelligence Quotient, is thought to represent a statement of a person's overall intellectual ability based on an arithmetic average of a person's scores on several tests of ability. Turner argues that IQ is a well-established predictor of academic success and claims that this is why it is sometimes used as a basis of a discrepancy definition (Turner 2000).

Traditionally, IQ and literacy skills have been used as a discrepant approach when distinguishing between dyslexics and poor readers. In order to be diagnosed with dyslexia, an individual had to demonstrate a significant difference between general mental abilities, as measured by intelligence tests, and reading achievements. It is Siegel (1989) however, who began to question IQ usefulness in the diagnosis of dyslexia and she supported her argument by claiming that the discrepancy diagnosis uses an IQ test such as Wechsler Intelligence Scale of Children (WISC) in order to work out a person's expected reading ability. The WISC, as argued by Siegel (1989), includes subtests that are either irrelevant to the types of abilities required to predict reading from IQ or try to tap abilities that would be impaired by having a learning disability. Siegel and Himel's study (1998) provided evidence that IQ is related to socio-economic status, which is a measure, at least in part, of the individual's environment. Consequently, individuals from more disadvantaged environments would be expected to achieve lower scores on IQ tests.

Stanovich (1991) argued that there is a lack of evidence that dyslexic children differ from poor readers without a reading IQ-discrepancy, in terms of performance, heritability and neuro-anatomy. Aaron (1994) supported Siegel's (1989) views, arguing that IQ-reading discrepancy is based on two assumptions related to the nature of the relationship between IQ and reading achievement. According to this assumption, the relationship between IQ and reading achievement is unidirectional; in other words IQ determines reading achievement and not vice-versa. The second is the degree of correlation between IQ and reading achievement. According to this assumption, such a correlation is high enough to predict reading achievement from IQ. Aaron concluded that there are well documented observations which confirm that poor readers read less than good readers and as a result "fail to develop sufficient language and vocabulary skills which, in turn, can lower their verbal IQ" (Aaron 1994: 5-6).

In his reference to what Stanovich has called the Mathew Effect (1991), Aaron (op. cit) argued that the IQ reading achievement relationship is not unidirectional. Samuelson's study (2002) also concluded that the IQ-achievement discrepancy definition of dyslexia "does not distinguish between readers with dyslexia and other poor readers on tasks measuring phonological processing skills" (Samuelson 2002: 51).

Torgeson (1989) however, contested the uselessness of IQ in dyslexia definition and testing and argues that reading ability is generally correlated with intelligence and that intelligent people tend to be good readers while less intelligent people tend to be poorer readers. Additionally, Torgeson (op. cit) claims that IQ is not irrelevant to reading ability and points out that even in Siegel's (1989) data, good readers tended to have higher IQ scores while poor readers tended to have lower IQ scores. Turner, on the other hand, asserts that "dyslexia, not IQ, is the focus of the assessment and an IQ-attainment discrepancy is descriptive, rather than definitional, and insufficient by itself for diagnostic purposes" (Turner 1997: 37).

Torgeson (1989), Turner (1997), Thomson (2000), Doyle (2002) and others agree that IQ testing, if administered correctly, can be a useful tool to differentiate between dyslexia and poor reading ability due to underachievement or to otherwise general poor reading abilities. Thomson (2001) claims that "the evaluation of intelligence is an important element of the assessment of dyslexia" (Thomson 2001: 34), a claim which seems perhaps the "most common justification for the use of the IQ-achievement discrepancy" in defining dyslexia (Catts & Kamhi 1999: 61). Turner & Nicholas (2000) quote Neisser's argument that

> The relationship between [intelligence] test scores and school performance seems to be ubiquitous. Wherever it has been studied, children with high scores on tests of intelligence tend to learn more of what is taught in school than their lower-scoring peers... intelligence tests... are never the only influence on outcomes, though in the case of school performance they may well be the strongest.
> (Neisser et. al 1996: pp 77-101 – 82-83, cited in Turner & Nicholas 2000: 70)

However, IQ testing is often saturated in verbal instructions, making it ultimately counter-productive. Reid & Kirk (2001) explain that the nature of the conventional IQ test means that some subtests are challenging for dyslexic individuals and that the aggregate score may not represent the individual's real intellectual ability. Moreover, it is argued that IQ-reading discrepancy criteria is inappropriate because of the body of research which shows that, "on measures assessing decoding, word recognition and phonological skills, high-IQ readers do not differ from reading disabled children with lower IQs" (cited in Reid 1998: 4). Frith disputes the use of IQ in developmental dyslexia definitions and claims that for a discrepancy to be found, the child has to have a relatively high IQ test score, which introduces a bias against less able dyslexics (Frith 1997). Ellis (1993) also questions such definitions when trying to find out what constitutes 'normal intelligence' or how much difficulty in learning to read and write has to be manifested before a child can be called dyslexic (Ellis 1993: 94). Berninger (2001) argues that IQ-achievement becomes invalid for identifying students for early intervention when it is easier to prevent severe reading problems. Moreover, using IQ discrepancy is not an outcome-based procedure (Aaron 1994). Flowers & Meyer & Lovato & Wood (2000) report Thorndike's

(1963) caution that "IQ scores are only appropriate as estimates of current levels of functioning, not as estimates of future potentials" (Flowers et. al 2000: 52).

The IQ-reading discrepancy means that we have to wait for children to fail, which ultimately results in the severe loss of motivation and the consequent low self-esteem and frustration sometimes associated with dyslexics. Smythe & Everatt (2000) argue that this frustration might lead to disruptive behaviour at school or indifference to educational demands; leading to further complications in the process of learning to read and write and thus "producing a spiral of cognitive and emotional difficulties" (Smythe & Everatt 2000: 12-21). Berninger (2001) also argues that IQ-achievement discrepancy is based "just on accuracy measures of reading achievement and not measures of reading rate or spelling that may tap the kinds of persisting problems dyslexics experience" (Berninger 2001: 39).

Since "reading and spelling are not skills that we would expect children to master before starting school", IQ-reading discrepancy criteria seem to rule out any attempts or benefits of early identification (Crombie 2001: 9). Moreover, according to such a criterion, dyslexia can only be identified after the child has been taught for some time, which consequently results in losing the advantages of early identification and intervention.

Stanovich (1991, 1994) argues that the discrepancy definition of developmental dyslexia using IQ as a discrepant factor accounts for the underlying assumptions concerning the concept of potential. Stanovich (op. cit) argues that such a discrepancy assumes that there exists a high correlation between IQ and reading. In making up his case against the use of IQ in dyslexia definition, Stanovich listed numerous studies where researchers find very low correlations between IQ and reading, which include Tunmer et al[3]. (1988), Lundberg, Olfsson and Wall[4] (1980), Tonneus[5] (1984), Stanovich et al[6].

[3] ($r = 0.10$)

(1984), Zifcak[7] (1981), Jule et al[8]. (1986), Vellutino and Scanlon[9] (1987), Helfgott[10] (1976) and Share et al[11]. (1984).

Findings from the above studies are supported by conclusions of the British Psychological Society Working Party Report (1999). This report states that the validity of identifying dyslexia in terms of statistically unexpected contrasts between actual literacy attainments and those predicted on grounds of IQ scores is not supported by the body of evidence, which showed that the children of different IQs perform similarly on a variety of measures in reading and spelling. Catts & Kamhi (1991) confirmed that research has generally failed to find reading and reading differences between subgroups based on IQ-achievement discrepancy. They further asserted that "IQ based subtypes have also failed to show expected differences in response to intervention" (Catts & Kamhi 1991: 74).

Dickman (2001) supports Stanovich's (1991, 1994) arguments and considers the IQ-reading discrepancy as partially responsible for a more serious condition known as the aptitude-achievement discrepancy formula, which according to Dickman, will only declare a child eligible for special education if they fail to achieve, as predicted, in reference to other children who share similar intellectual potentials. Dickman (op. cit) opposes such a view and argues that it is effectively rewarding those who cure, and overlooks those who prevent, simply because prevention is not quantifiable. This, he concludes, implicitly sends the wrong signal to the already counter-productive prevalent system of special education. Flowers et. al (2000) conclude that employing the ability-achievement discrepancy construct "contributes little to our understanding of dyslexia...in

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[4] (r = 0.19)
[5] (r = 0.24)
[6] (r = 0.25)
[7] (r = 0.27)
[8] (r = 0.34)
[9] (r = 0.34)
[10] (r = 0.41)

fact it may be harmful as it promotes a 'wait to fail' approach rather than one of early identification and early intervention" (Flowers et. al 2000: 67).

Siegel, who had started the whole debate, maintained that "calculating an IQ-discrepancy seems an illogical way of calculating whether or not there is a learning disability" (cited in Thomson 2001: 49). Siegel argued that various measures of IQ do not in fact measure intelligence, but rather measure factual knowledge as well as other skills related to reading such as expressive language ability and short-term memory. Siegel concluded that the implications of this for dyslexic children would be that "their scores in relation to factual knowledge, expressive language and short-term memory will provide an artificially depressed IQ score" (cited in Reid 1998: 36-37).

In the report of the American National Institute of Child Health & Human Development (NICHD), Lyon (2003) asserts that the process of distinguishing between disabled readers with an IQ-reading achievement discrepancy and those without such a discrepancy reflects in fact an invalid practice at the beginning stages of reading and he argues that children with and without such a discrepancy do not differ in their information processing skills (both on their phonological and their orthographic coding) which are necessary requirements for accurate and rapid single word reading. Lyon (op. cit) argues that genetic and neuro-physiological (Functional Magnetic Resonance Imaging) studies did not indicate differential aetiologies for reading disabled children with and without discrepancies. Lyon (op. cit) has concluded that converging data from several NICHD sites also indicate that the "presence and magnitude of IQ-reading achievement discrepancies are not related significantly to a child's response to intervention" (National Centre for Learning Disabilities: 2003).

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[11] ($r = 0.47$)

Thomson (2001), nevertheless, argues to the contrary claiming that "it is quite clear that it is possible to examine the relationship between intelligence, however imprecisely measured, and reading" (Thomson 2001: 49) although he fails to elaborate on what intelligence means and what constitutes intelligence in this context or what are the best tests available to measure it. Friedenberg (1995) disagrees and argues that intelligence, by its very nature, is a construct, i.e., is not a physical characteristic like height which can be measured directly and it is not simple to develop a test to measure a level of intelligence. Friedenberg (1995) explains that because intelligence is a construct, psychologists must identify behaviours that reflect intelligence and develop tests of these behaviours and that to be certain that these really measure the desired characteristics, psychologists must reverse the process and examine the relationship between scores on the tests and other independent measures. Friedenberg (op. cit) concludes that "without additional data to confirm that the tests measure intelligence, it is impossible to know what the tests really measures" (Friedenberg 1995: 252).

Other researchers however share Thomson's argument and consider measures of IQ to be indispensable in dyslexia assessment and diagnosis (Gardner 1994, Turner 2000, Stein 2001). Turner insists that IQ components of any dyslexia assessment test "though sometimes a distraction has a serious statistical utility" (Turner 2000: 21), while Gardner claims that a high number of research studies which have been carefully planned do in fact support the use of intellectual abilities tests and their usefulness in predicting children's successes either at school or in higher education. However, Gardner confirms that the latter do not "of themselves take account of other factors important in determining success, such as motivation and perseverance" (Gardner 1994: 89).

For basic psychometric and other important statistical reasons, those in favour of the use of IQ component in dyslexia assessment argued that one needs a general mental abilities factor, otherwise known amongst educational psychologists as the 'G Factor', i.e., a higher order general factor in intelligence. This view of intelligence is based on a theory which was originally proposed by Spearman in 1927 (cited in Doyle 2002) who had hypothesised that intelligence consists of two parts he called factors. The first part is the general factor which he referred to it as the general mental ability and the second part is made up of various specific factors. Spearman claimed that there is only one general factor which, he argued, is found in almost all the population. Specific factors are the various abilities required for different kinds of mental tasks. Spearman's explanation of intelligence in this factorial frame explains why some individuals are good in verbal abilities while poor in mathematical skills and vice versa. (Doyle 2002).

Based on the above theory, Turner (1997, 2000) and Doyle (2002) argued that minimal intelligence or general cognitive and/or mental abilities must be assessed in order to distinguish between underachievers and dyslexics. Without such a critical differentiation, some researchers argued that no dyslexia diagnosis will be reliable. Turner (2000) argues that researchers uncomfortable with cognitive discrepancy have based their criticism for the use of IQ in dyslexia testing on a "precise analysis of diagnostic methodology, rather than on generalized objections to the measurement of individual differences in ability" (Turner 2000: 24). Miles (1996) however disagrees and argues that some researchers take the concept of global IQ for granted while uncritically citing IQ figures without paying any attention or consideration to the sub-skills that make up the IQ figure.

Bakker & Satz (1970) claimed that defects in experimental design and methodology implemented to identify and diagnose dyslexia are responsible for causing confusion over the disorder. They reported that there are various studies based on heterogeneous clinic samples including children from socially and educationally deprived areas. In their opinion, these children, by definition, are unrepresentative of developmental dyslexia. Catts & Kamhi (1991) investigated the methodological issues used in identifying dyslexics, and indicated the specific issue of statistical regression. They concluded that because of regression towards the mean, calculation of IQ-achievement discrepancy "results in the over identification of dyslexia in students with high IQs and under identification of students with low IQs (Catts & Kamhi 1999: 61).

Vellutino (1979) was of the same opinion and he noted that if the theory of dyslexia is that children are characterized by basic deficiency in visual-spatial orientation, then it might be counterproductive to employ, for selection criteria, an IQ test highly saturated with demands requiring spatial reasoning and visual orientation. On the other hand, Frith (1997) claimed that while the behavioural definition of dyslexia as an unexpected reading failure (a discrepancy between the attainment and abilities of individuals) has been frequently attacked on theoretical and statistical background, it has, in fact, been extremely helpful. She maintained that, "objectively measured performance elevates discussion of dyslexia from an unspecified complaint that may be in the mind of the beholder to a reality that is there for all to see" (Frith 1997: 1).

1.3.2 Exclusionary Factors

Traditional definitions of dyslexia were mainly based on exclusionary factors which include sensory, intelligence, socio-economic status, emotional, neurological as well as instructional factors. Therefore, it was customary for hearing and visual acuity to be assessed. In addition, children with low mental abilities (based on their IQ measures) were excluded as well as those who have emotional disturbances or brain damage. Children who suffered from a lack of adequate educational and/or literacy instructions were also excluded.

Miles (1994) claims that definition by exclusion is unsatisfactory since it is "difficult to think of any other diagnostic category either in medicine or education where membership is determined not by what signs are present but what signs are absent" (Miles 1994: 104). Vellutino (1979) claimed that exclusionary criteria employed to define developmental dyslexia are counterproductive because they do not offer clear-cut differentiating characteristics with respect to the critical use of words and, in particular, the written form and other related skills. Further, exclusionary factors such as intelligence, sensory factors, severe neurological and physical disability, emotional and social factors and socio-economic disadvantage are not themselves well defined, notably in their relation to reading disability and "operationalizing this exclusionary criterion can be difficult" (Catts & Kamhi 1991: 59).

1.3.3 Inclusionary Factors

Most of the traditional definitions of developmental dyslexia included minimum inclusionary criteria. These inclusionary criteria included cognitive impairments as one of the underlying causes and these are likely to be congenital. It also listed some specific details regarding the exact nature of dyslexia; i.e., that dyslexia represents problems in single word decoding as well as problems in writing and spelling. Other definitions also confirmed difficulties dyslexics seem to have with phonological processing, storing and retrieving of phonological codes in the memory as well as some problems in phonological awareness based tasks.

Following the above critique of the traditional criteria formerly used to identify dyslexia, the following section investigates the prerequisites for reaching a dyslexia definition that is acceptable to all researchers and practitioners working in the field.

1.4 Conclusion

Numerous attempts have been made to arrive at a general acceptable definition for developmental dyslexia. Miles (1994) lists two very important prerequisites that can be regarded as requirements for a good definition of dyslexia: first, the outcome of the definition must be a classification that is well grounded in research. Second, any criteria specified in the definition must eventually lead to identifying those individuals whom practitioners know to be dyslexic (Miles 1994). Stanovich (1996) argues that, in order to give a sound definition of a biologically based condition, one must be able to identify distinct performance, heritability and neuro-anatomical patterns. Pumfrey & Reason, on the other hand, further argue that a distinct aetiology, identifying characteristics prognosis and responses to intervention must be satisfied in order to define a particular condition (Pumfrey & Reason 1991, cited in the British Psychological Society Report: 1999).

Arriving at a consensus definition for dyslexia is clearly difficult; and a precise definition for the same is elusive because dyslexia is a condition that varies widely in severity (Singleton 2002). Complicating this problem is the fact that the condition often does not exist alone but may occur together with one or more of the three other major clinical entities within the framework of the learning disabilities: motor-perceptual dysfunction syndromes; language delays; and the syndrome of distractibility, hyperactivity, and decreased attention span (Malatesha & Aaron 1982). Hornsby (1995) claims that dyslexia can show itself in various ways, such as inadequate spatial orientation, poor verbal naming, poor reading and writing, organizational and notational skills, and can equally result from various causes.

The explanation of developmental dyslexia has long been problematic and "defining dyslexia has remained an elusive business" (McLoughlin et. al 2002: 10). The British

Psychological Society Report (1999) claims that the UK general public have been formulating their own theories concerning the underlying reasons as to why some individuals fail to acquire literacy and have marked and persistent problems in their reading and writing abilities. The report concludes that as a result, the definition of dyslexia has somehow lost its technical status and is no longer regarded as a specialist term confined within the fields of cognitive psychology or special education alone. The term, the report elaborates, has acquired wide use in societal circles and is being constantly used in popular daily language to refer to various cases of specific reading disabled individuals who have, by their very nature, individual differences amongst them. It is within this context that the perceived link between reading abilities, intelligence and privilege, which may well be still current today, are well rooted in the educational and social history of dyslexia research and practice in the UK (British Psychological Society Report: 1999).

Reid (2002) argues that the various types of dyslexia definitions support the view that dyslexia is representative of a broad range of difficulties associated with "literacy and learning, that individual differences will be present, that some students with dyslexia can have positive attributes and that any difficulties are only part of the overall picture" (Reid 2002: 69). Reid & Kirk (2001) also observe that there is a tendency for definitions of dyslexia to reflect a broader conceptual framework while at the same time acknowledge the individuality of the dyslexic learner. They also confirm that one of the key resulting issues is that people with dyslexia "will not all exhibit the same characteristics nor to the same degree" (Reid & Kirk 2001: 3). However, the term dyslexia is sometimes avoided in educational practice because of its overwhelming emphasis on the causative factors that are within the child, in addition to its perceived effects on social policy. In other words, it is sometimes repeatedly avoided because of its resulting risks of unequal distribution of public resources which are often limited.

To sum up the above arguments, researchers who argued forcefully against the reading-IQ discrepancy criteria view such a discrepancy as based on an outdated and indefensible construct (IQ) which does not, in their views, differentiate between the reading of different groups of poor readers and which has no obvious implications for differential teaching strategies and as such, they saw no reason to maintain the IQ-based diagnostic discrepancy. Those who support the use and validity of the IQ and its application in dyslexia assessment view such a measure as a potential set-back particularly that the issue of psychometric assessment generally and IQ measurement in particular have made great progress and many studies have replicated the validity and the reliability of employing IQ measures when identifying dyslexics.

Although a large number of researchers now view the use of IQ-reading discrepancy criteria in dyslexia definition and assessment as inappropriate, not every one has the same opinion regarding the use of non-verbal reasoning and reading discrepancy in dyslexia testing. Doubts which have been cast on the role of intelligence tests "have resulted in some controversy on their use in a diagnosis of dyslexia" (Reid 1998: 3). A large number of researchers now reject to the use of IQ in dyslexia assessment (Vellutino 1979, Siegel 1989, Stanovich 1996, Reid 1999, Peer & Reid 2000, Smythe et al. 2004). Mather (1998) argues that our knowledge of cognitive correlates of dyslexia have increased to the extent that the "practice of using aptitude-achievement discrepancy formula as the sole determining criterion for the identification of individuals must be discontinued" (Mather 1998: 7). Frith (1999) suggests that "it is time to move away from the restricting definitions of reading failure by reference to arbitrary cut off points on behavioural tests and arbitrary discrepancies between test scores" (Frith 1999: 199).

However, Miles (1994) argues that 'tests of reading and of intelligence and the use of discrepancy and exclusionary criteria are not so much wrong as in need of modifications" (Miles 1994: 105). Berninger (2001) indicates that just because IQ-achievement discrepancy is not adequate, it does not mean that it is irrelevant to learning differences (Berninger 2001). Tonnessen (1995) concludes that a discrepancy can be informative when it suggests a specific difficulty, although absence of a discrepancy should not be used to exclude the possibility of a difficulty. Nicolson (2001), on the other hand, suggests that the advantage of the label dyslexia is that it has "no intrinsic meaning, for it does not in itself provide information on causes or whether it describes visual, phonological, motor or any combination" (Nicolson 2001: 5).

Although it is now clear that there are some serious doubts and problems associated with the use of IQ-reading discrepancy in defining dyslexia, the abandonment of IQ as an exclusionary criterion has not gained wide acceptance. This, as Catts & Kamhi argue, is not surprising given that "normal or above normal intelligence has always been a defining characteristic of dyslexia" (Catts & Kamhi 1999: 62). This is, of course, in addition to the fundamental role IQ tests plays in eligibility for special education. What has helped this view of intellectual abilities tests is the "overwhelming success in their practical application" (Gardner 1994: 89).

Rawson (1995) argues for the need of addressing the question of dyslexia definition. The issue of dyslexia definition is extremely important because it affects the identification, assessment as well as treatment of dyslexia (Catts & Kamhi 1999). Moreover, the negative results of not agreeing on an adequate definition for dyslexia are serious if considering their knock on effect on availability of inaccurate information regarding reading difficulties and subsequent inaccurate remedies and/or interventions techniques (Reid 1998). Definitions are used in this sense to primarily determine who is eligible for remedial services and they are also used to direct the intervention process. Cooke (2001) explains that in order to reach a consensus on a successful and operational technique for helping dyslexic individuals, we have to reconsider one of the most controversial and yet most fundamental issues in the field of special education; i.e., the definition of learning disability generally and dyslexia in particular. Wilkins claimed that definitions are "a matter of convenience and the most apparently unambiguous phenomena are subject to definitional uncertainty" (cited in Turner 2000: 10).

Snowling (2000) claims that difficulties in attempting to define dyslexia are due to the confusion of whether to *describe* or *explain* a particular type of reading problem. While medical advocates of dyslexia described it as a syndrome with an underlying neurological deficit that is manifested in symptoms of reading and spelling deficits, the discrepancy definition of dyslexia focuses on reading achievement and IQ performance and therefore dyslexia is viewed as a synonymous with specific reading difficulty.

Other researchers suggested that it might be possible to supplement traditional IQ-discrepancy with other types of more relevant discrepancies such as single word reading and listening comprehension. However, such suggestions were largely criticised and never pursed. Snowling (2000) proposes that for the sake of clinical utility, the discrepancy criteria needs to be substituted by positive diagnostic indicators in order to allow practitioners to identify children who "show early or residual signs of dyslexia that require intervention and do not depend solely on the extent of the child's reading problem" (Snowling 2000: 25).

A philosophical approach towards the notion of defining and/or labelling a condition may give one an insight into the on-going debate and continuous disagreement regarding the definition of developmental dyslexia. Double (1999) explains that a definition of a word or a term is only an alternative form of words that has the same meaning as the original word or term. To have the same meaning, he elaborates, the original word and its correct definition must pick out exactly the same objects in all logically possible worlds; i.e., in all imaginable situations. He elaborates by giving a definition of a triangle as a three sided plane figure and argues that it is logically impossible to imagine a triangle that is not a three sided plane figure and it is also equally logically impossible to imagine a three sided plane figure that is not a triangle. To test various definitions, he claims that philosophers frequently use counter examples which are logically possible situations to show whether a proposed definition is too narrow or too short. Double (op. cit) concludes that a proposed definition fails "if we can even imagine how something might satisfy one side of the definition, but not the other" (Double 1999: 15).

It follows from Double's explanation of a definition that various dyslexia definitions are either too narrow or too wide. This is largely due to the nature of the condition itself. A high number of epistemology theorists argue that we acquire our knowledge through the senses and since almost all of our senses are involved in reading and writing tasks, problems in any items of information derived from the senses or during the actual processing of these information and the speed of the processing itself will result in an endless number of manifestations of dyslexia in different individuals. Based on this argument, it can be concluded that it may be very difficult to arrive at a unified definition of dyslexia because it will ultimately be too narrow. It is also possible to arrive at another analogy based on the above argument concluding that there can never be a single cognitive profile that can adequately discriminate between children with or without literacy difficulties of a dyslexic nature. This agrees with the views of the British Psychological Society's Report (1999: 67) and agrees with the view of Miles (1995) who argues that it is impossible to arrive at a single authoritative theoretical definition because of the multifaceted and complex nature of dyslexia. Miles (1995) concludes that dyslexia is not a concept that can be summed up in one single formula for "different purposes different facets of dyslexia need to be mentioned. As all these may be valid, 'description' may be a better term to use than 'definition'"(Miles 1995: 37).

Smythe et. al (2004) offer an alternative approach to the debated issue of dyslexia definition based on Wittgenstein's Theory of Concepts. They note that historically, most of the work on dyslexia has been approached from a classical concept perspective and this, in their opinion may be responsible for the current debate and/or confusion over the definition of dyslexia. Following Wittgenstein's theory of concepts, and in particular his concept of family resemblance, Smythe et. al (2004) conclude that an approach to dyslexia which would see the latter as "a network of overlapping and criss-crossing similarities may be more appropriate" (Smythe et. al 2004: 3).

According to Frith (2002), defining dyslexia at a single level will always present problems and paradoxes and instead she proposes a three-level definition which includes biological, cognitive and behavioural. These three levels interact either individually or wholly with cultural and environmental factors. Frith (2002) concludes that there is an emerging consensus that dyslexia is a neuro-developmental disorder with a biological origin that impacts on speech processing with a range of clinical manifestation. "There is evidence for a genetic basis, and it is clear that behavioural signs extend well beyond written language" (Frith 2002: 65).

Snowling (2000) notes that a unitary definition of dyslexia with phonological deficits as its core still seems tenable, so long as we acknowledge "different cognitive subsystems are in constant interaction" (Snowling 2000: 137). Reid (2002) indicates that it is important for dyslexia definitions not to be become mere generic labels that are open to misinterpretation and abuse and that it is important to recognize that a definition of dyslexia should be "contextualised for a purpose and context to make it meaningful for a specific educational or work context" (Reid 2002: 74). It is important to realize that the primary task for practitioners is treatment, while the primary task for educational psychologists is identification of the symptoms and the primary task for theorists is to discover the underlying causes (Nicolson 2001). Such differences in primary motivations need to be integrated and investigated to achieve a full understanding of developmental dyslexia and reach a generally acceptable definition of the condition. In an article entitled *Can there be a single definition of dyslexia*, Miles (1995) concludes:

> Different descriptions of dyslexia may be valid on different occasions...and urge that one should abandon the attempt to produce the authoritative definition. Rather, less ambitiously, one should consider the needs of the moment. Then there will be less temptation to try to push everything in, mixing technical terms with ordinary language. Nor need a description be short; full justice can be given to each point.
>
> (Miles 1995: 44)

Chapter Two: Theories of Dyslexia

2.1 Introduction

The increased interest in dyslexia discussed in the previous chapter has culminated in a substantial body of empirical research which laid the groundwork for a theoretical debate concerning the nature of the condition and the various theoretical frameworks and theories proposed to explain it (British Psychological Society Report: 1999). Knight & Hynd (2002) explain that because reading words is a very complex process that involves the "processing of sensory, phonological, orthographic and semantic information" (Knight & Hynd 2002: 29), this complex nature of the reading process has no doubt increased the number of proposed theories to explain the underlying deficits in dyslexia.

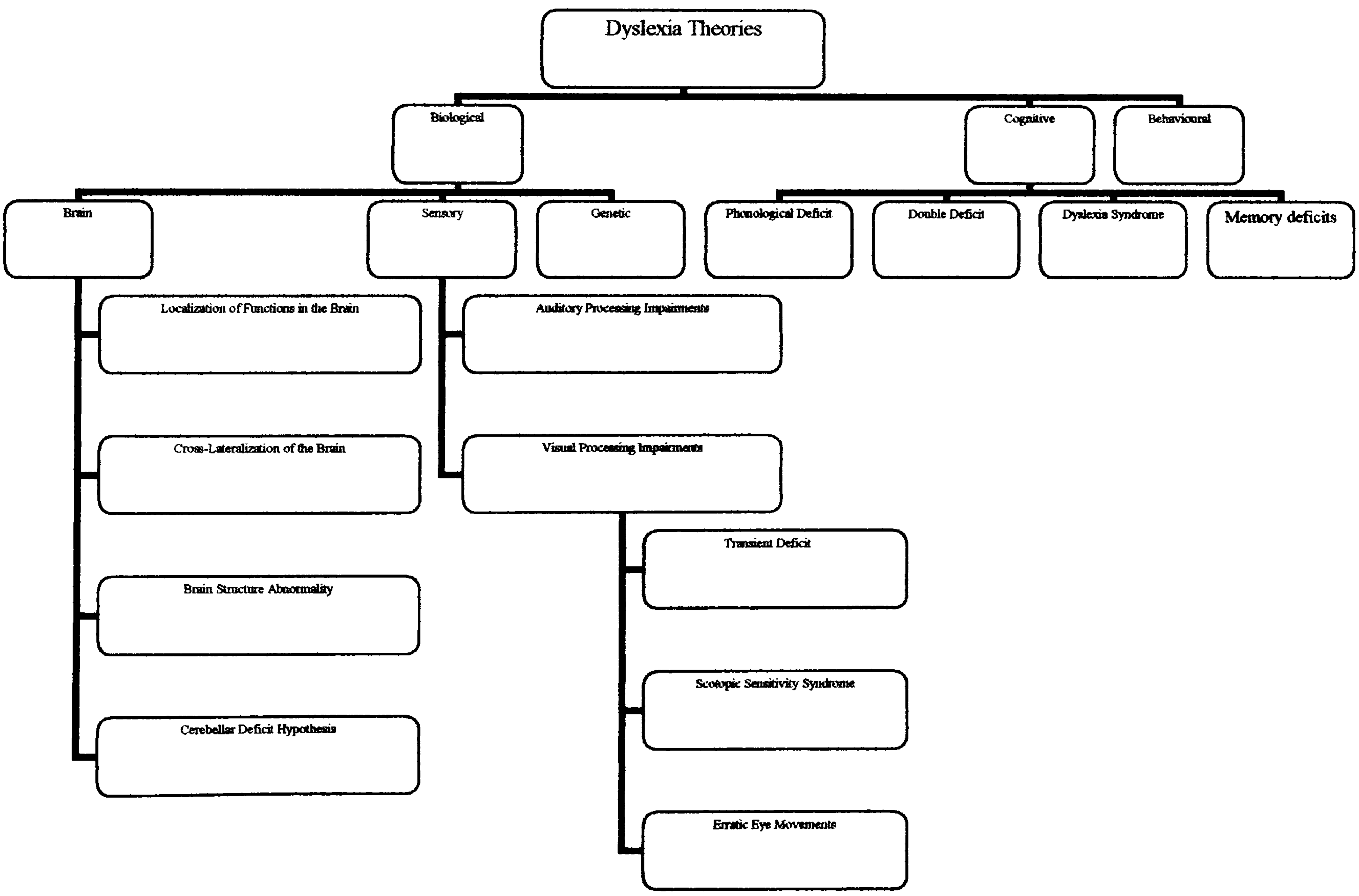
Much of the debate concerning the different accounts of developmental dyslexia stems from the fact that various explanations are derived from various and diverse levels of analysis. Developmental dyslexia is repeatedly attributed to problems related to phonological processing. This, in turn, has led to defining behavioural characteristics of dyslexia as deficits in phonological awareness, rapid naming and other literacy skills. Other difficulties observed by dyslexics implicate problems in perceptual processes, either auditory or visual, memory, automaticity, motor-coordination and attention (Zabell & Everatt 2002). To overcome this problem, Frith (1997) proposes a multi level causative framework within which diverse accounts and explanations of developmental dyslexia can be located and explained. This causal modelling framework (Figure 1) below, makes it possible to explain developmental dyslexia theories if classified into three main categories (levels of explanations) which are biological, cognitive and behavioural.

<table>
<tr><td rowspan="3">Environment</td><td>Brain</td></tr>
<tr><td>Cognition</td></tr>
<tr><td>Behaviour</td></tr>
</table>

(Figure 1: Causal modelling framework: Frith 1997).

What is particularly interesting in the above causal modelling framework (Figure 1 above), is that it explains the state of continuous interplay and interactions environmental factors have with the biological, cognitive and behavioural levels. Environmental factors include different literacy demands and perceived importance of literacy in pre-literate and advanced societies, but the most important environmental factors of all is perhaps the type of language and/or orthography used to analyse the occurrence of dyslexia in a particular sample and/or individual. That is why the current study intends to first investigate the various theories proposed to explain dyslexia and address the specific nature of the Arabic language before formulating hypothesis concerning how dyslexia is likely to manifest itself depending on these specific linguistic features of Arabic.

Biological-based theories of developmental dyslexia identify the brain mechanism and deal with deficits in the cerebellum (e.g., Fawcett & Nicolson 2001), abnormal magnocellular pathways (e.g., Stein 2001, Stein & Talcott & Witton 2001), low-level deficits in the visual system (e.g., Stanley 1994, Iles & Walsh & Richardson 2000, Evans 2001, Everatt 2002), deficits in the control of eye movements (e.g., Maria De Luca et al. 1999) as well as genetic deficits (e.g., DeFries & Alarcon & Olson 1997, Fisher & Smith 2001, Gayan & Olson 2001). Cognitive-based theories examine impairments in the general cognitive skills (e.g., Ellis 1993, 1994) such as phonological processing (e.g., Goswami & Bryant 1990, Goswami 1997, Snowling 2000, Lundberg & Hoien 2001), orthographic processing (e.g., Hultquist 1997, Miller Guron & Lundberg 2004), working memory (Gathercole & Baddeley 1989, 1990, Gathercole 1999), automatization (Fawcett & Nicolson 1995, 1997) as well as general speed of processing (e.g., Badian 1997, Breznitz 2003). Facts and observed performance of reading and spelling tasks and activities are situated in the behavioural-based theories that deal primarily with symptoms such as reading and spelling problems (e.g., Catts & Kamhi 1999). Based on Frith's (1997) causal modelling framework, Figure (2) below illustrates most of the current theories of developmental dyslexia which are reviewed in detail throughout the following section.



(Figure 2: Theories of Developmental Dyslexia)

2.2 The Biological Level

2.2.1 Localization of functions in the brain

As previously discussed at the beginning of the historical view section in chapter one of the study, the claim that linguistic ability is localized in particular area of the left hemisphere of the human brain was popular at the beginning of the nineteenth century (e.g., Paul Broca 1861, Carl Wernicke 1874, Obler & Gjerlow 1999, Miles & Miles 1999, Robertson 2000, Hjelmquist & Von Euler 2002). Although this localization of functions approach was primarily based on the study of aphasias, it was eventually adopted and shaped the early studies of developmental dyslexia. Early pioneers of this approach such as Berlin, Dejerine, Gall, Hinshelwood[12], Kerr, Kussmaul and Morgan[13], based their theory on two general assumptions, first: specific areas of the brain control specific behaviours, second: damage to these areas result in damage to corresponding behaviours.

Left-Hemisphere Dominance	GENERAL FUNCTION	Right-Hemisphere Dominance
Words Letters	VISION	Geometric patterns Faces Emotional expression
Language sounds	AUDITION	Nonlanguage sounds Music
	TOUCH	Tactual patterns Braille
Complex movement	MOVEMENT	Movement in spatial patterns
Verbal memory	MEMORY	Nonverbal memory
Speech Reading Writing Arithmetic	LANGUAGE	Emotional content
	SPATIAL ABILITY	Geometry Direction Distance Mental rotation of shapes

(Figure 3: Cerebral Lateralization of functions in the brain)

12 James Hinshelwood was an eye surgeon working in Glasgow, Scotland.

Figure (3) above illustrates various parts of the brain, which control various cognitive and emotional activities. Kussmaul (1878) conducted descriptive and observational studies through which he concentrated on studying reading problems caused by stroke. He observed that some of his patients were suffering from 'word deafness', while being able at the same time to express themselves in words. He also observed that his patients used many words in the wrong places, particularly in their written language and he concluded that his patients were not clinically deaf as they could perceive calls and noises. He argued that the same applied to 'word blindness' and claimed that word and/or text blindness can exist though the power of sight is intact.

In support for his theory, Kussmaul reported observations by his colleagues of a 45-year-old female, who could see the text, copy it and distinguish the different forms of the letters but was incapable of translating written words into their corresponding spoken words. Kussmaul also reported another case in which his patient completely lost the power to read printing and writing. His patient could see the text but could not understand it, and although the patient's conversation was good, his memory of names of the streets and persons failed him (Miles & Miles 1999).

Pringle Morgan's (1896) *A case of congenital word-blindness*, was published in the British Medical Journal, in which he reported a case study of Percy, a 14-year-old male, who despite adequate intelligence and laborious training, was still suffering from severe reading and spelling difficulties. Morgan attributed Percy's condition to some kind of 'congenital defect' and argued that Percy's visual memory for words was either partially defective or totally absent. He referred to Percy's underlying problem and in particular to the specific brain region he thought to be responsible for the reading activity (the left angular gyrus) as being structurally damaged by disease and was therefore

[13] Pringle Morgan was a general medical practitioner working in Sussex, England.

underdeveloped. He concluded that the total defect and/or delay in the development of particular areas of the brain could negatively affect the process of dealing with textual materials and this was what had been happening in Percy's case.

Both Morgan and Kussmaul considered 'word blindness' as almost an equivalent to a defective visual memory and they both employed the term 'congenital word blindness'. Hinshelwood (1917) claimed that the condition was due to damage to a 'visual word-centre' in the brain and he referred to this centre as 'the mind's eye'. He reported the case of a 58-year-old male teacher who, as a result of a stroke, suddenly lost the ability to read. Although he could see adequately, he was unable to name letters or to read simple words. Hinshelwood attributed the teacher's condition to a loss of the visual memory for words and called it 'word blindness'. He considered the disorder to be related to visual agnosia (mind blindness according to his terminology), as disturbance of the visual memory for different types of stimuli. Hinshelwood based his theory on the assumption that there were separate cortical areas for visual memory of letters, words and other perceptual input (Venezky 1993), and that 'word blindness' according to this theory, resulted from damage to the cortical area of visual memory for words, although other cortical areas related to other visual memory centres may be intact.

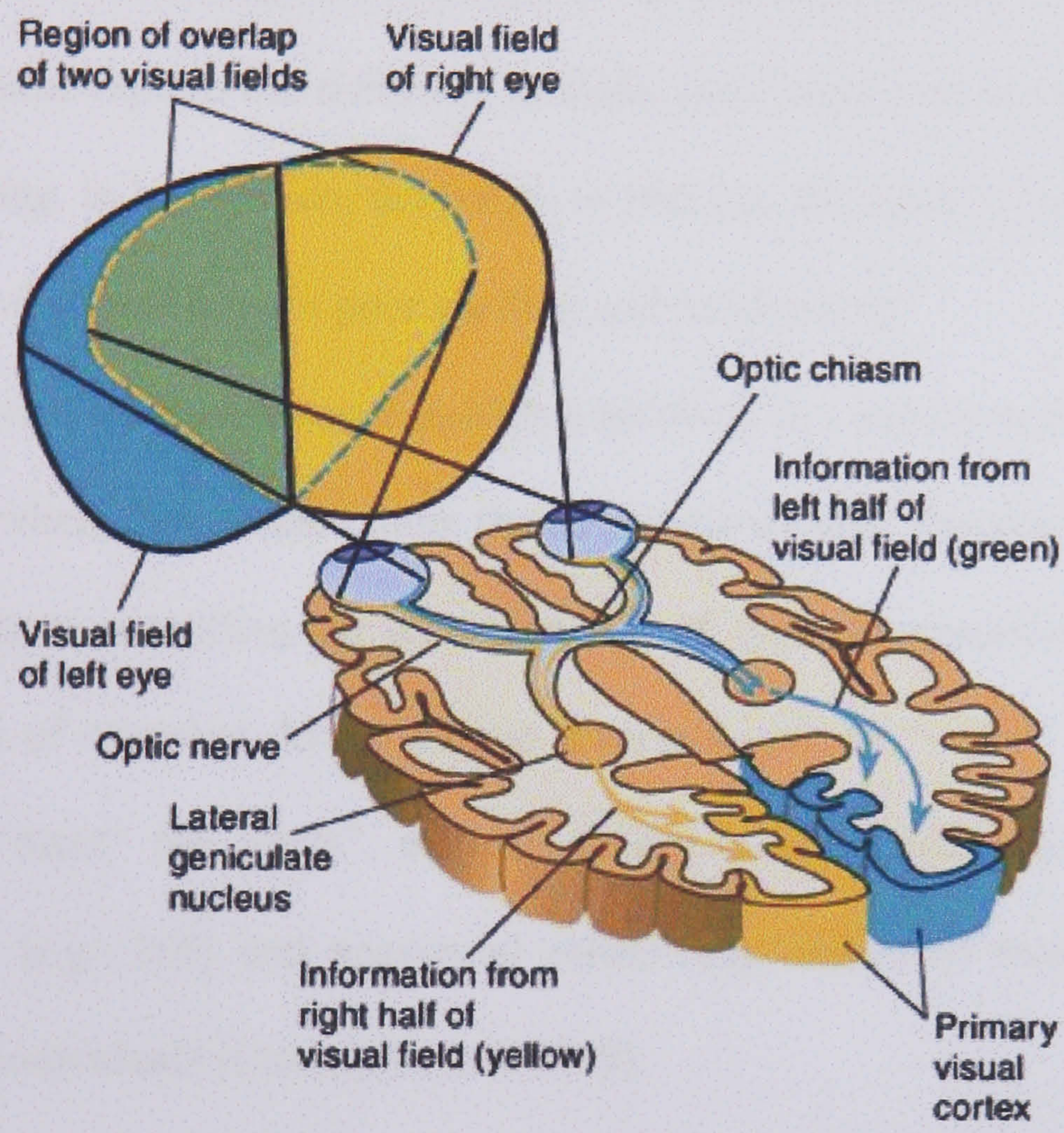
"The whole question of localized functions versus total involvement of the brain is still a matter of debate" (Miles & Miles 1999: 2). Robertson (2000) cited Ojemann & Mateer's study (1979) in which they demonstrated that the localisations of function in the brain theory was not very accurate since language areas in the brain were not strictly localized. Robertson concluded that Ojemann & Mateer's work corrected "previous misconceptions such as the widespread belief that damage to Broca's area results in deficits in language production only" (Robertson 2000: 11).

Generally, the above accounts demonstrate that one can lose language abilities while retaining other aspects of intelligence. The above-mentioned pioneers believed that specific learning disabilities were caused by developmental disturbance to specific language-related areas of the brain (Von Euler 2002), and though most of the cases described in their studies were in fact aphasic-based rather than cases of developmental dyslexia, one can still appreciate how the study of developmental dyslexia started. It also explains the early interest medical professionals had shown in studying learning disabilities generally and dyslexia in particular. Such early interest in the brain and its linguistic areas is to later set the scene for a much-detailed analysis of the brain, which was aided by the recent technological discoveries, and availability of Functional Magnetic Resonance Imaging (fMRI), Computerized Tomography (CT) and Positron Emission Topography (PET). Researchers, mostly physicians, started to realize that there were similarities between acquired 'word blindness' and other reading disabilities experienced by some children (Catts & Kamhi 1999). This realization has triggered a shift of research paradigm, which has brought about the next theory of explaining developmental dyslexia.

2.2.2 Cross-lateralization of the brain

Samuel Orton[14], like Hinshelwood, was interested in 'word blindness', but instead focused his medical attention to lateral dominance and in 1925 published his initial paper on the subject which, for the first time, suggested that developmental reading disorder might be qualitatively different from the reading disability merely caused by environmental factors. He proposed that the causes of the difficulty are to be found in incomplete lateralization of the cerebral hemispheres and that its remediation requires specialist teaching (Miles & Miles 1999, Robertson 2000). He also regarded the 'look and say' method of teaching as being inappropriate and suggested using a multi-sensory approach instead.

Orton inferred that developmental reading disorder was due to a developmental delay in the hemispheric dominance for language. He reported that the two halves of the brain, though very similar in size and design, are in fact reversed in pattern in such a way that the records of the printed letters and words are normally stored as mirror images of each other. Orton argued that during the early stages of learning to read, both hemispheres participate in the recognition of letters and words and that during these early stages of learning to read, the images of letters and words are projected onto both corresponding cortices, one being a mirror image of the other (Venezky 1993). He referred to such mirror images or engrams as 'strephosymbolia' which literally means twisting of symbols. Orton classified these twisting of symbols into two main categories: static reversals and kinetic reversals. These distortions, according to Orton, were associated with deficient visual memory for the stored visual impressions of printed letters and words. The failure of establishing lateral dominance will result in the dyslexic's distorted visual perceptions and will consequently lead to confusion in oral reading. Reading disability, therefore, results from the failure of the dominant hemisphere to suppress the interfering images from the non-dominant hemisphere. Figure (4) below illustrates what cross lateralization of the brain means, by giving an example of the visual fields from both eyes and by showing how these are cross lateralized.



(Figure 4: Primary visual pathway showing cross lateralization of the brain)

Orton (1925) argued that letters are mere objects until they acquire meaning through sound associations. He assumed that in the process of early visual education, the storage of these images occurred in both hemispheres, and that the external visual stimuli equally triggered the cortices of both hemispheres. As a result, these images are stored in both dextrad and sinistrad orientation (Vellutino 1979). Images of objects require neither definite orientation nor recognition, whereas, more importantly, letters are used in one orientation only. If the orientation of the recalled image does not correspond with the

[14] Samuel Orton was an American neurologist

presented symbol, confusion will occur. According to Orton, this theory explained the dyslexic confusions over letters such as: b/d, w/m, and p/q, and in reinforcing his theory, he claimed that poor readers can copy letters and words, which they cannot read, so long as they did not have to rely on their memory. He claimed to have found high correlations between reading disability and left handedness or ambidexterity, as well as a high level of reversals in the readings and writings of the reading disabled. He also suggested that his theory could explain the difficulty in skills associated with reading such as spelling and handwriting. In his opinion, the failure to stabilize the visual representations of letters and words was responsible for poor spelling and handwriting.

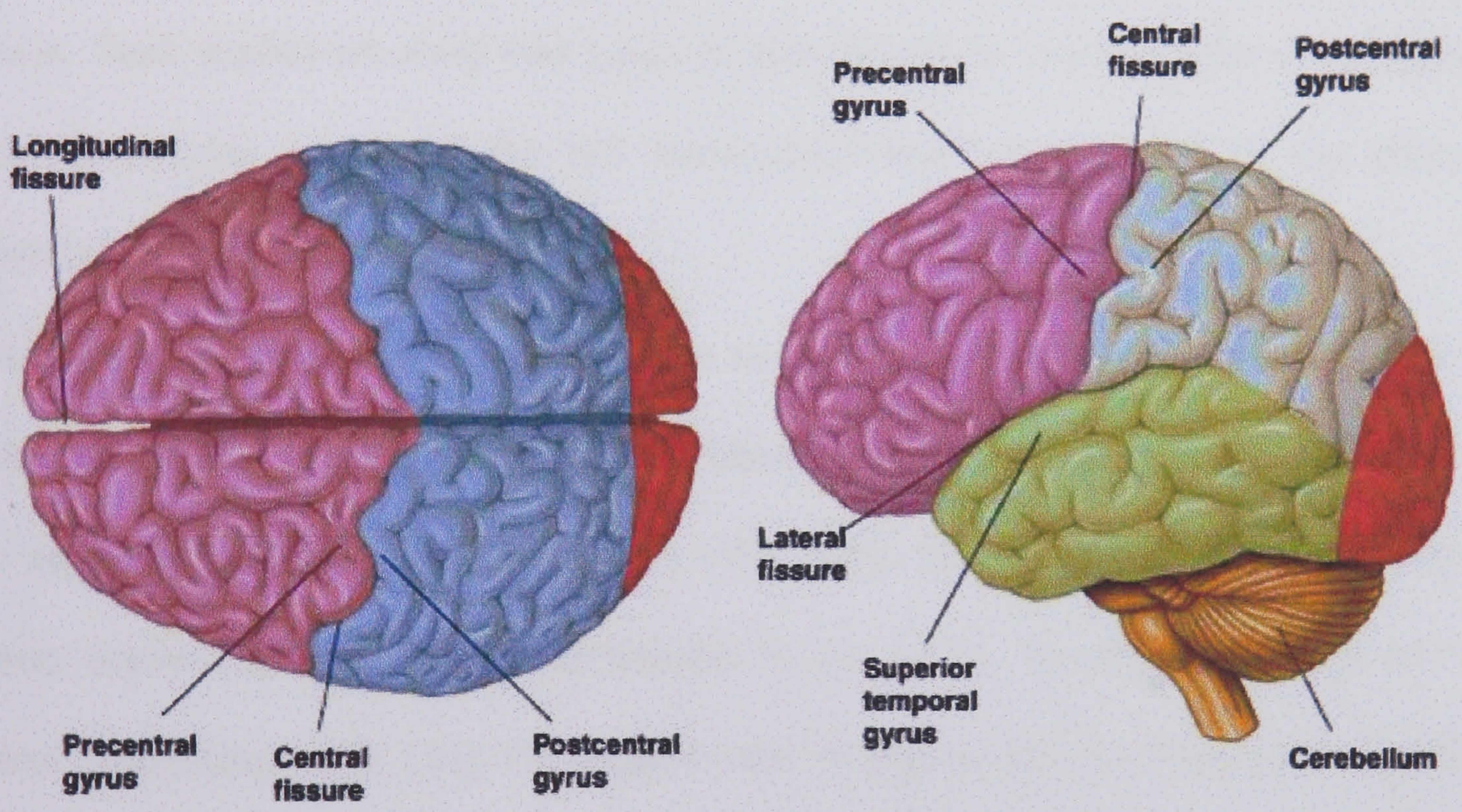
Orton and other colleagues had been involved in a survey in Iowa in the United States in 1925, where they studied more than a thousand cases. Based on this large-scale survey, Orton began compiling an extensive list of typical misspellings. He quoted various examples of mistakes due to kinetic reversals such as "wram" for "warm", "Jhon" for "John", "theet" for "teeth", etc. His theory is best known for its explanation of the reversals (e.g., b/d) and sequential errors (e.g., was/saw) that has been observed in dyslexic individuals (Catts & Kamhi 1999).

Generally, Orton's theory is based upon a template theory. We restore letters and words in our brains as prototypes or what Orton called 'memory engrams', and we retrieve these as and when needed. Developmental reading disorder according to this theory is the failure to retrieve these prototypes, which ultimately lead to stereotypical misperceptions and associated directional errors.

Other researchers, however, did not find any merits in Orton's claims. Critchley (1964) questioned why, as Orton's findings had suggested, verbal symbols would show a dysfuntionality not shared by other visual stimuli such as objects, pictures, and so forth (Venezky 1993). Crosby (1968) on the other hand contested Orton's views and argued that human beings can read because they have the neurological ability to recognize the shapes of the individual letters in their alphabet and the words they form, and they can distinguish the sounds those letters and words make. He also claimed that a significant percentage of children have an impairment of their neurological ability to perceive shapes and sounds correctly and therefore have reading problems. Moreover, Snowling (2000) contested the kinetic and static reversals suggested by Orton and argued that confusing /b/ with /d/ and /p/ with /q/ are only normal features of reading development amongst children.

2.2.3 Brain structure abnormalities

The human brain, at a basic level, is a whole that is divided into two vertical halves known as hemispheres and these seem to be mirror images of each other (Steinberg & Nagata & Aline 1982). The two hemispheres "maintain connections with one another through a bundle of fibres called the corpus callosum" (Ibid: 311). Although the two halves of the brain are alike in size, they are reversed in order; i.e., the left side of the brain controls the right side of the body and vice-versa. Figure (5) below illustrate the different components of the human brain.



(Figure 5: The lobes of the cerebellar hemispheres)

The study of the brain and language has a central role within the study of reading and reading disability (Robertson 2000) and considerable attention has been devoted to the study of the brain and its role in reading disabilities (Catts & Kamhi 1999). The oldest method of studying neurobiological basis of language is the one first used by Paul Broca himself, which is the post mortem examination of the brains of patients who had displayed language disorders while they were alive (Steinberg & Nagata & Aline 1982).

"The cognitive neuroscientific revolution has made it possible, towards the end of the twentieth century to carry out *in vivo* imaging" (Berninger 2004: 91) and it is now possible to "view not only the structure of the brain but also how it functions when engaged in cognitive processing" (Snowling 2000: 152).

"Structural abnormalities have been detected in visual system structures, the thalamus, the corpus callosum and the perisylvian cortical regions" (Zeffiro & Eden 2000: 6). A series of post mortem examinations of dyslexic brains by Galaburda (1999) revealed anomalies which exist at multiple levels and pathways and those areas of perceptual processing and other areas involved in cognitive and meta-cognitive tasks are affected in dyslexia. Such studies involved two types of measurements: "microscopic examinations of the perisylvian region of the left hemisphere and measurement of the planum temporale" (Snowling 2000: 151).

Galaburda (1999) claims that the planum temporale, a region on the upper surface of the temporal lobe, "although asymmetric in almost two thirds of the population, does not show asymmetry in dyslexics" (Galaburda 1999: 186). His microscopic examinations of dyslexic brains reveal several abnormalities in the brains "involving ectopias of the neurons" (Snowling 2000: 151). He suggests that damage to the "cerebral cortex early in development may cause all the other brain differences" (Galaburda 1989, cited in Robertson 2000: 28). Duane (1994) also reports Galaburda's series of investigations in his post mortem studies of dyslexic individuals and concluded that Galaburda's studies "demonstrate a characteristic anatomical pattern in dyslexic subjects of all ages, both at the gross and light microscopic levels" (Duane 1994: 35). Von Euler (2002) reports a study by Lundberg and his colleagues, which found "a complete correspondence between brain symmetry and phonological problems" (Von Euler 2002: 19).

Snowling (2000) reports an important study of 19 participants conducted by Larsen, Hoien, Lundberg and Odegaard (1990) who used MRI scans. The results of their study made a direct link between symmetry in the planum and phonological deficits. Miles (1994) reports the anatomical investigations of Galaburda and his colleagues (1987, 1989; Sherman et al., 1989; and Galaburda 1993: all cited in Miles 1994) where they studied the planum temporale of 8 individuals in a post mortem study who were known to be dyslexics in their lifetime. Their study concluded that disturbances in cell layers are found and that in all 8 cases the "two plana were symmetrical and approximately equal in size." (Miles 1994: 103). This conclusion is in marked contrast to other brain studies that find that approximately 75% of unselected brains have asymmetry, with the left planum usually being the larger one.

The above account of the brain structure abnormality theories represent some general conclusions about the "relationship between variability in the brain morphology and the deficits observed in dyslexia" (Hynd & Hiemenz 1997: 54). These studies are extremely important because they employ very robust brain imaging technology applications that have been developed in the later part of the 20th century and which has finally enabled scientists to prove beyond doubt what their predecessors had been able only to postulate: that clear physiological differences distinguish the brains of people affected by dyslexia. Using these available technology has enabled researchers to turn their attention to investigating other environmental influences and in particular the effect of language being the most important environmental factor which interacts with all other levels as per Frith's (1997) causal framework presented earlier. A very good example of such studies is the one quoted earlier of Paulesu et al. (2001) in which brain activities of Italian, French and English poor readers were scanned and how their linguistic diversity were varied although there was a biological unity of their underlying biological deficit.

2.2.4 Sensory dysfunction

An investigation of the reading and writing processes indicates that many of our senses are involved in these tasks. Receptive and expressive channels which include vision, hearing, speech and movement are in constant interaction to warrant a multi-sensory label for the process of literacy and literacy acquisition. It is therefore not surprising that "in the literature, association between deficits of sensory skills and reading difficulties has had a long and tumultuous history" (Talcott & Witton & Hebb & Stoodley & Westwood & France & Hansen & Stein 2002: 207).

Snowling (2000) notes that recent findings of comparative studies of dyslexics and non-dyslexics' brain structure and function raise the possibility that dyslexia might be caused by deficits in basic sensory processes. Such deficits in sensory processes include visual, temporal and auditory processing impairments or indeed in the speed of processing these information since reading and writing are very complex processes that require extensive and rapid processing of a great deal of information. Proficiency requires that response to printed symbols or the production of the needed symbols has to be "instant and automatic and dyslexic individuals do not seem able to work at the necessary speed" (Cooke 2002: 2). Those who support this theory argue that problems with perception generally and with processing in particular; visual, auditory or temporal and deficiencies in visual-spatial organization, would ultimately result in developmental dyslexia. The following section investigates the two major sensory processing impairments: the auditory and the visual processing impairments theories and highlight their strengths and weaknesses and how they propose to explain the occurrence of developmental dyslexia.

2.2.4.1 Auditory processing impairment

According to Stackhouse & Wells (1997), it is clear that speech processing skills "play a major role in the development of reading and spelling and that without intact input skills, children cannot process what they hear" (Stackhouse & Wells 1997: 15). Goswami (2002) has also proposed that since sensory information processed by the ears is quite complex, it seems logical that there could be problems in processing this information in dyslexia which, in turn, leads to problems in representing it accurately" (Goswami 2002).

Auditory impairment theories maintain that some dyslexics tend to have difficulties hearing subtle acoustic differences that are used to distinguish phonemes. These difficulties seem to adversely affect their ability to analyse phonemic structure of words quickly, which in turn hinders them from learning to read. Speech, due to its very nature, is a complex signal which requires "spectral, temporal and frequency based analysis" (Goswami 2002: 155). Talcott et al. (2002) note that groups of dyslexics have been shown to have reduced sensitivity while performing tasks requiring the detection of small frequency differences between sounds and they concluded that auditory processing could affect the "proficiency with which phonological skills are acquired and represented in the brain, via mechanism of speech perception (Talcott et al. 2002: 204).

Differences in higher order auditory processing "affect rapid temporal integration of both speech and non-speech stimuli" (British Psychological Society Report 1999: 31). Such difficulties, it is hypothesised, may have an underlying neuro-biological basis such as the magnocellular layers of the visual and/or auditory region of the thalamus. According to this theory, the Rapid Auditory Processing 'RAP' deficit causes speech perceptual deficits that compromise the development of phonological representations, and literacy difficulties ensue (Snowling 2001).

Galaburda (1999) claims that difficulties in the processing of rapidly changing sounds observed in some dyslexic children suggest that impaired auditory temporal processing is the primary reason for the phonological problems dyslexics seem to have. This argument proposes that during the process of language acquisition, dyslexics do not seem able to hear certain sounds and therefore cannot represent "a full set of phonemes for a given language" (Galaburda 1999: 185). This results in an abnormal phonological module in some dyslexics which in turn hinders them from segmenting words into their constituent phonemes and the subsequent difficulty of acquiring reading.

Stein et al. (2001) argues that there are large neurons in the auditory pathways which seem to enable individuals to process acoustic transients such as changes in frequency modulation and amplitude. Some dyslexics, according to this theory, tend to have reduced AM and FM sensitivity and they tend to do worse when asked to discriminate pure tones at low frequencies (op cit.). Such difficulties account for the problems some dyslexics have with distinguishing letter-sound relationships, which eventually hinder them from meeting the phonological demand for reading. "Impaired development of such auditory transient processing can lead to auditory confusion of letter sounds and failure to acquire phonological skills" (Stein et al. 2001: 83).

Despite the popularity of this theory, McArthur & Bishop (2001) claim that the results of experiments employed to test this hypothesis are incongruous (McArthur & Bishop 2001) and they question the issues of validity and reliability of rapid auditory processing tasks. They also list a number of explanations why there are contradictory findings of results which include the individual differences in the auditory processing abilities of the populations, the age of listeners, the quality of some of the control groups and the relationship between verbal and non-verbal auditory processing abilities (McArthur & Bishop 2001).

2.2.4.2 Visual processing Impairments

Other sensory-based theories investigate possible visual and visual processing sensory dysfunctions. Stanley (1994) argues that since reading involves looking at print, it is important to investigate various visual factors that might directly or indirectly contribute to reading problems. Snowling (2000) has the same views and argues that since reading requires processing of the spatial location of letters while the eyes move across text, dyslexics might have problems with processes "involved in visual analysis or in the temporal integration of visuo-spatial information over time" (Snowling 2000: 158). Therefore, visual processing impairments have been, and still are, a topic of continuing debate when looking for theories to explain developmental dyslexia.

Catts & Kamhi (1999) note that because the visual system is the primary sensory system involved in the process of reading, it should not be surprising that visual-based explanations of reading disabilities have a long history in the field. Evans (2001) observes that some research studies have found that children with developmental dyslexia report more visual symptoms than good readers. Indeed many dyslexic children report "symptoms which appear to be 'visual' in nature, despite having normal visual acuity" (Stanley 1994: 19). Such reported visual problems include: blurred print, moving print, diplopia (double vision), losing place, omitting words as well as fatigue and reluctance towards reading (op. cit). Catts & Kamhi (1999) classify the visual-based deficits into reversal errors, visual memory, erratic eye movements, scotopic sensitivity syndrome and transient processing deficits. Vellutino (1979) observes that the process of visual perception undergoes several steps before being fully developed. First, the individual's ability to discriminate whole identities and then the ability of the more refined perceptual analysis, before reaching the final and delicate process of synthesizing part-whole relationships. Developmental dyslexics, according to this theory, are deficient in analysing and synthesizing the perceived visual information and visual dyslexia is the result of distorted visual perception or memory.

Reversal errors have always been linked with dyslexia and Orton (1925) listed and classified these errors as discussed earlier. However, Catts & Kamhi (1999) argue that there is, surprisingly, little research that systematically investigates reversal errors. They also indicate that the few studies that are available concluded that reversal errors are not more prevalent in young poor readers than they are in young good readers. All beginning readers seem to make such errors at some point in their reading development, and that is what may have prompted other researchers to claim that children tend to have problems in remembering the right sequence of letters within a word rather than having problems in perceiving letter sequence (Catts & Kamhi 1999).

Other studies dealing with the visual basis of developmental dyslexia concentrated on what is now labelled 'a transient deficit in developmental dyslexia'. It is understood that the reading process proceeds through a series of eye movements and fixations. During fixation intervals, information derived from the printed text is slowly transmitted by the sustained subsystem. The process of the initiation of eye movements and its cessation to the following point of fixation in the printed text is driven by the transient system that is responsible for fast transmission of information. Stein (2001) suggests that the manner through which the magnocellular deficit affects and impacts the reading process related primarily to the role of stability in fixation as well as the need for saccadic eye movements in reading (Reid & Fawcett 2004).

Hogben (1997) claims that the primate visual system, as current understanding indicates, rests on the assumption that there are two parallel pathways linking the retina to the visual cortex. These pathways are known as magnocellular and parvocellular, which although very similar, are differentiated into layers of large (magnocellular) and small (parvocellular) cells. Stein et al. (2001) explain that 90% of the cells making up the retina are the small (parvo) cells which signal the fine details as well as the colours of objects while the remaining 10% are the large (mango) cells which are responsible for signalling the timing of the visual events. They conclude that there is growing evidence which supports the view that the development of the visual magnocellular system is impaired in dyslexics (op. cit). They quote studies by Galaburda and his colleagues on post-mortem brains of dyslexics which confirm two findings: first, while the magnocellular layers were clearly separated in non-dyslexic brains, it was seen to merge together in dyslexic brains. Second, the size of the magnocellular neurons was smaller by almost 30% in dyslexic brains compared with non-dyslexic brains (Stein et al. 2001: 69).

Hogben (1997) quotes studies by Martin and Lovegrove (1984, 1988) which explain differences in contrast sensitivity between dyslexic and control subjects in which dyslexics were found to have "lower contrast sensitivity at lower spatial frequencies where the magnocellular system is dominant" (Hogben 1997: 60). Stein (2001) quotes studies by Martin & Lovegrove (1987) which prove that flicker sensitivity amongst some dyslexics are slower than control groups notably at high temporal frequencies. Stein (op. cit) argues that such a reduced sensitivity to motion stimuli is very significant because it suggests that the visual magnocellular system may be impaired in dyslexics.

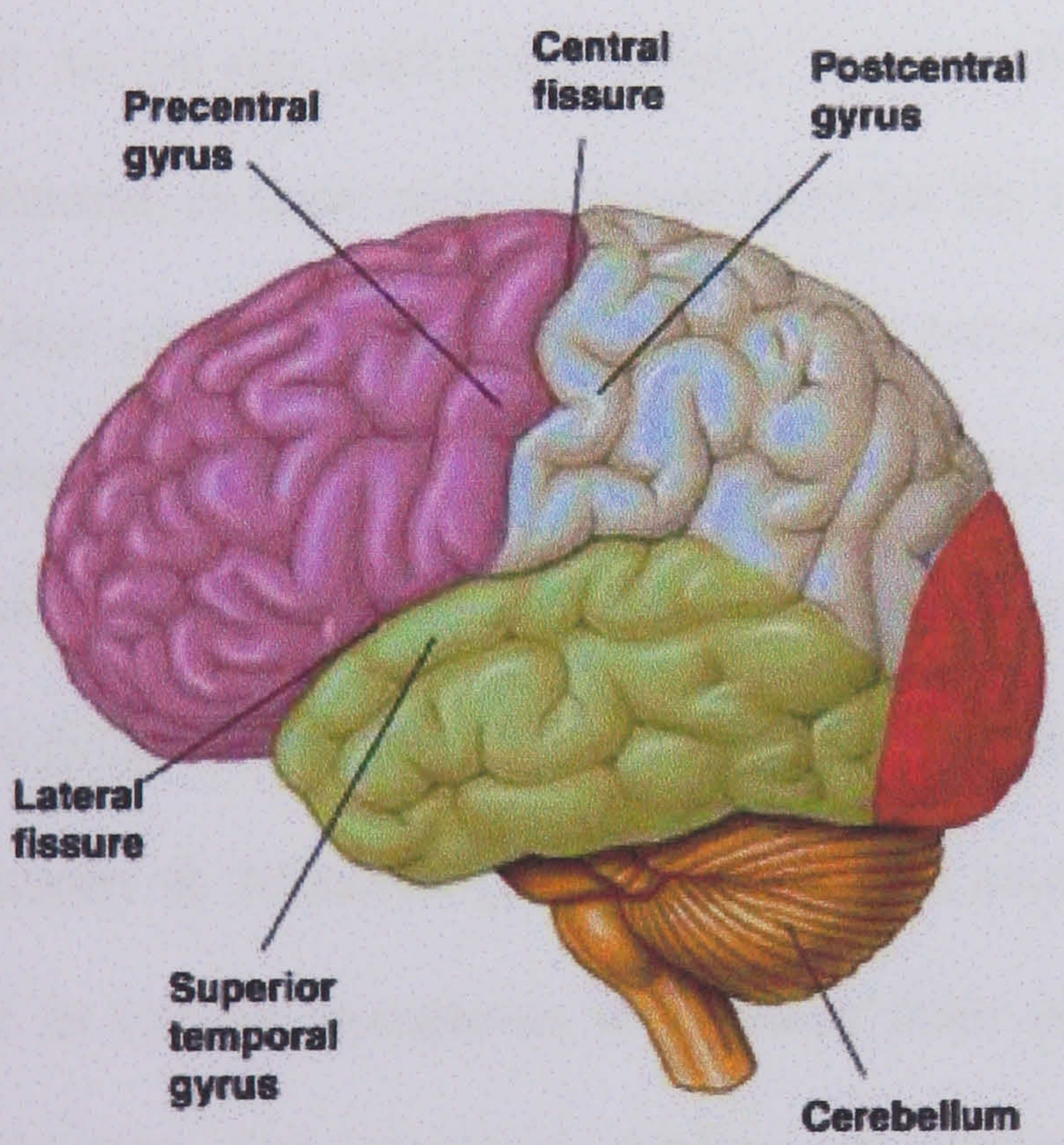
Other researchers, however, questioned the theoretical basis of the magnocellular deficit theory arguing that it is "actually the parvocellular that is implicated in dyslexia" (Skottun & Parke 1999, cited in Robertson 2000: 29) and despite "solid research from Stein group, the relationship between deficits in the magnocellular system and reading was not transparent" (Reid & Fawcett 2004). These researchers argue that if deficits in the magnocellular system result in timing disorder which interferes with the integration of visual information required for efficient reading, then there is a possibility of "intervention being devised in compensation" (Robertson 2000: 29).

Other visual based theories of dyslexia report a deficit in what is called a 'scotopic sensitivity syndrome' which is otherwise known as Irlen syndrome. Irlen introduced her findings in 1983 and concluded that the underlying reading disabilities of some dyslexic individuals are due to a "visual defect that can be alleviated by the use of coloured filters or lenses" (Stanley 1994: 24). However, Stanley (1994) acknowledges the criticism to Irlen's scotopic sensitivity syndrome since the defects appear to be related to difficulties associated with photopic sensitivity, as reading "is most frequently carried out at photopic levels of illumination" (Ibid: 24). Miles & Miles (1999) claim that the misnomer of the word scotopic rather than a photopic does not imply that the phenomena in question 'glare, distortion, visual discomfort and the like' are unimportant or that coloured lenses or overlays are of no use" (Miles & Miles 1999). They, however, refer to a number of unanswered questions regarding the use of coloured lenses particularly whether the alleged benefits were not the direct result of the placebo effect or whether the direct results of some of the investigators were in fact biasing the results.

The sensory impairments theories discussed above are important, but particularly relevant to the Arabic language is the visual impairments theory since, as will be covered in part two of the study when the linguistic features of Arabic language is investigated in more details, there is a high similarity between the graphemic shapes of Arabic letters as well as the elaborate use of dots to differentiate between various Arabic letters. It would therefore be interesting to find out if the close similarity in the shapes of Arabic graphemes will pose an additional strain on the visual processing of these graphemes.

2.2.5 Cerebellar Deficit Hypothesis

The cerebellum is a sub-cortical brain structure situated at the back of the human brain which constitutes between 10–15% of the brain weight and about 50% of its neurons. It is made up of two cerebellar hemispheres and is responsible for controlling the independent limb movement and as such is a critical motor area involved in balance and motor skills. The cerebellum is the brain's major system for integrating sensory information and for predicting expected consequences of actions concerning the muscular outcomes and for tuning and automatizing actions (Fawcett & Nicolson 2004) and is also reported to have a role in the automation of other cognitive skills. Figure (6) shows the basic brain structure and indicates the cerebellum.



(Figure 6: The brain structure showing the cerebellum)

Fawcett & Nicolson (1995, 2001) claim that problems experienced by some dyslexic individuals may be due to cerebellar deficits and they propose two hypotheses which provide the underlying causes of developmental dyslexia. First, they proposed the Dyslexic Automatization Deficit (DAD) hypothesis which, they argue, is found in some dyslexic children and which impairs their ability to automatize any skill, whether motor or cognitive. Second, they proposed Conscious Compensation (CC) hypothesis in which they claim that dyslexic children can effectively overcome their automatization deficit by means of conscious compensation either by trying harder or by using various strategies to achieve the task.

Nicolson & Fawcett (1995) argue that the automatization deficit theory predicts the likelihood of phonological deficits, as the ability to hear the constituent phonemes in a word is a learned skill that normal children master to the extent that it is automatic, whereas dyslexic children may well not achieve such levels of automaticity" (op. cit). They did not dispute the importance of phonological deficits in dyslexia, but they rather suggest that in addition to well-documented deficits in phonological processing, there seems to be an additional minor impairment in the cerebellum. The cerebellar impairment, in their view, is responsible for the lack of automaticity, poor motor control and poor sense of time durations that are sometimes exhibited by dyslexics. They also proposed that dyslexics are prevented from employing conscious compensation in order to overcome their marked difficulties in a number of areas including phonological skills where dyslexics are required to perform at a fluent and automatic level and speed.

Fawcett & Nicolson (2001) explain that damage to parts of the cerebellum might result in various symptoms in humans such as disturbances in balance and lack of coordination and impaired timing of automatic movements. Impairment of the cerebellum also gives rise to difficulties in automatization of skills, notably "immediate recognition of letters and spelling patterns" (Thomson 2001: 81). In addition to the cerebellum's contributions to motor behaviour, the cerebral deficit hypothesis proposes that it may also "contribute to higher-level cognitive activity including linguistic processing" (Robertson 2000: 26).

Their theory is important as it benefits from early identification of dyslexic children rather than waiting for the discrepancy between dyslexic children and normal readers as measured by reading abilities, spelling abilities and closely matched chronological age. Another important advantage of the cerebellum deficit hypothesis is its reported ability to differentiate dyslexics from other garden-variety poor readers, a difference that is otherwise undetectable when using the traditional discrepancy approach.

Fawcett, Nicolson and Dean (1996) investigated the relationship between incidence of dyslexia and posture, muscle tone, hyptonia of the upper limbs and complex voluntary movements and realized that dyslexic individuals did worse than control group on 11 out of 14 tasks and concluded that dyslexics show impairment in cerebellar-based tasks. They realised that dyslexics find it difficult to keep their balance without wobbling if they are prevented from compensating for this by being blindfolded. Miles & Miles (1999) report studies by Fawcett et al. (1996) showing dyslexic children to have problems in tests of cerebellar functions such as balance and muscle tone. These deficits influenced "between 89 and 90 per cent of the sample" (Miles & Miles 1999: 65). These studies by Fawcett and Nicolson helped to stress the role and importance of balance amongst dyslexic children and have led to the inclusion of Postural Stability and Bead Threading tests as components in their Dyslexia Screening Test (Fawcett & Nicolson 1997).

Miles & Miles (1999) note that the idea of a cerebellar deficit in dyslexia was not wholly new when Nicolson & Fawcett started their research but "they were the first to draw out its full implications" (Miles & Miles 1999: 63). Thomson (2001) also indicates that Fawcett & Nicolson highlighted the role of the cerebellum in a number of verbal tasks and argued that a significant part of the brain is often overlooked as a result "of the emphasis on cortical hemisphere function" (Thomson 2001: 80).

Thomson (2001), however, argues that some dyslexics do not appear to have any problems with motor deficiencies, but on the contrary, many dyslexics not only appear to show any motor or balancing deficiencies, but are also gifted in sporting, coordination and balance skills. Researchers who oppose the cerebellar deficit hypothesis question why patients with cerebellar damage do not show reading deficits. Zeffiro & Eden (2001) suggest that since the cerebellum receives input from a variety of brain regions, the problem may be in the cerebellum's inability to optimize various learning processes and the real problem may lie in the sensory pathways or the perisylvian cortex rather than in the cerebellum itself. Stein (2001) views the cerebellum as itself part of the magnocellular structure and that since the cerebellum receives projections from all magnocellular systems throughput the brain, the problem may lie in a magnocellular deficit and not in the cerebellum. Other researchers have claimed that since the cerebellum is too large a structure which contain half the brain's neurons, it is too vague to say that cause of dyslexia lies in the cerebellum.

While some attempts to replicate findings of Nicolson & Fawcett studies have not been successful, others studies (Moretti et al. 2002, Rae et. al 2002, Bower & Parsons 2003, cited in Fawcett & Nicolson 2004) suggest that dyslexics in their samples exhibited deficits in the cerebellum with some of these studies finding a link between deficits in the cerebellum and phonological decoding abilities. Yap & Van der Leij (1994) have also reported partial support for the automatization deficit theory, although Wimmer, Mayringer & Landerl (1998) as well as Stringer & Stanovich (1998) were unable to find any supporting evidence" (Van Daal & Van der Leij: 1999: 76).

2.2.6 Genetic Basis

A considerable amount of research activity has focused on the genetic basis of dyslexia" (Reid 2003) and the role of genetic factors in the case of a disposition for dyslexia has received much attention (Von Euler 2002). Early research reports in developmental dyslexia, as early as Hinshelwood (1917) and Orton (1925) recognized that developmental dyslexia runs in families and that it occurs more in boys than girls. Orton even proposed that spoken language difficulties are common amongst family members of dyslexics (Snowling 2000). Various research attempts have been devoted to the study of genetic basis in developmental dyslexia. Such studies deal with a wide range of topics closely associated with the genetic basis of developmental dyslexia such as: identifying specific genes responsible for developmental dyslexia, hereditary aspects of dyslexia, examining hormone differences between dyslexic individuals and control participants as well as investigating gender differences amongst dyslexic individuals notably in brain morphology studies.

Using twin-based studies while trying to identify genetic indications of dyslexia, research on the biological bases of dyslexia indicates that "it is familial, heritable and genetic" (Goulandris 2003: 4). DeFries, Alarcon and Olson's study (1997), investigated the claim that genetic aetiologies of reading and spelling deficits change differentially as a function of age. They selected a large sample of twins (195 pairs of monozygotic twins (MZ) and 145 pairs of same-sex dizygotic twins(DZ)). In addition, a total of 187 pairs of MZ twins and 117 pairs of same-sex DZ twins comprised their control sample. Their study concluded that aetiologies of word recognition and spelling deficits change differentially as a function of age. They explained that "reading difficulties appear to be more heritable in younger children than in older children, whereas spellings deficits are more heritable in older children". (DeFries, Alarcon & Olson 1997: 34).

Gilger (2003) reports studies which indicate that approximately 40-50% of close relatives (first degree relatives such as children and parents) of dyslexics are likely to have or indeed have had reading problems and that the exact ratio will depend on the sex of the relative and the child as well as other factors. Much of Gilger's (2003) work was on the heritability of reading skills, notably the phonological component. Goulandris (2003) reports studies by Scarborough (1990) which conclude that the offspring of dyslexic parents were significantly more likely to have dyslexia than those from unaffected parents, as dyslexia runs in families and family history is indeed one of the most significant risk factors in dyslexia.

Locke (1994) studied language development among children born from at least one dyslexic parent. When compared with non-risk children, children born from at least one dyslexic parent were found to have a much less rich babbling pattern, suggesting, as Locke argued, a less elaborate segmental system; i.e., delay. Gayan & Olson (2001) analyze data collected from identical and fraternal twins in order to estimate the proportions of genetic and environmental influences on group deficits in both accuracy and speed of recognizing printed words as well as other related phonological decoding, orthographic coding and phoneme awareness skills. They conclude that about half of the group deficits in each of the skills measured were due to genetic influences.

Olson (2002) reports the Colorado Family Reading Study which had originally started by John DeFries in 1973 and in which 133 children with dyslexia and their parents and siblings were tested on measures of reading and other cognitive processes. In addition, there were also 125 children, their parents and siblings who have no trace of dyslexia in their families were also used as a control group. Olson reports that the most basic finding of this study which was completed in 1976 is the "strongest evidence to date for familial transmission of reading and related cognitive disabilities" (Olson 2002: 145).

Snowling (2000) reports various studies (Smith, Kimberling, Pennington and Lubs 1983 & Cardon et al. 1994 & Gayan et al. 1995 & Grigorenko et al. 1997, Schulke-Korne et al. 1997 & Fisher at al. 1999) where gene markers for dyslexia had been identified on chromosome 15 and chromosome 6. However, these and other genetic based studies conclude that there are several key genes that seem to push the individual towards the low end of the reading continuum (Gilger 2003). Fisher & Smith (2001) explain that most of the progress into molecular genetics research within the last ten to fifteen years had made it possible to "identify mutations responsible for some of the single gene disorders" (Fisher & Smith 2001: 39). However, Fisher & Smith (2001) admit that no specific gene had yet been implicated in reading disability, although there has been some success in mapping the exact loci[15] that might be important. In spite of the progress achieved in identifying the exact genetic basis of developmental dyslexia, Fisher & Smith (2001) admit that there were still some considerable difficulties in integrating findings of relevant genetic mapping studies. Such difficulties, as Fisher & Smith argue, were due to the very methodology employed in collecting data because of confusion over definitions and diagnostic tools between studies. In addition, some of these studies are based on incomplete analyzed data of the human genome in their family samples, which in turn results in these studies arriving at generalizations based on incomplete information.

[15] Loci are the sites of genes on chromosomes.

2.2.7 The Dyslexia Syndrome

Malatesha & Aaron (1982) argued that one major controversy surrounding the nature of developmental dyslexia was whether it was a unitary phenomenon or whether it represented a group of disorders. Crosby (1968) argued that dyslexia is not a disease nor a syndrome but a symptom which results from one or more various neurological impairments. He noted that dyslexia most often appears when a person has impaired visual or auditory perception and that these impaired perceptions had no relationship with the functions of the eyes and ears. He also explained that while the condition might be rooted in poor visual perception or imperfect auditory perception, it most often occurs with one or more of several minor neurological disorders. Those minor neurological disorders, as Crosby argued, may include a disorder of tactile perception, impairment in the individual's ability to perform fine motor skills such as tying a knot, threading a bead or walking a straight line, or a poor sense of direction.

Vellutino (1979) proposed that some form of verbal deficit is the most important cause of developmental dyslexia and he dismissed and criticizes studies that attribute dyslexia to other factors. Klasen (1972) on the other hand thought that there was a tendency towards considering developmental dyslexia in its relation to neurological correlates. Several studies show that a high percentage of dyslexic children display certain neurological signs such as awkwardness of movement, in-coordination, lack of fine motor control, directional confusion, incomplete knowledge of body laterality, distorted body image, speech defects, visual or acoustic perceptual difficulties, concentration problems, sensory or motor disinhibition, etc. Such symptoms, Klasen argued, according to many neurologists, must be traced back either to structural or functional disorders or to delayed maturation of the nervous system.

Eustis (1947, cited in Vellutino 1979), while adopting a wider approach altogether, treated developmental reading disorder as one major constituent of a syndrome of associated characteristics that include clumsiness, speech impediments, attention deficit disorder, hyperactivity, language deficiencies, left handedness and related anomalies and suggested that the syndrome was merely the result of an inherent disposition towards slow neuro-muscular maturation.

One of the symptoms of the dyslexic syndrome is the confusion of left and right in the dyslexic's eye movement. The reading disorder, in this case, is believed to be the result of disorientation of left right movements of the eye that occurs at irregular intervals. Maria De Luca et al. (1999) argue that eye movement abnormalities in dyslexics may be considered a consequence of defective processing of verbal material. Knud Hermann (1959, cited in Miles & Miles 1999) supported this theory and assumed that the cause behind developmental dyslexia lies in the inadequate development of the "directional function" which is but a form of directional disturbance related to lateral orientation of the body direction. As a result of this disturbance, the concepts of direction are uncertain or completely diminished. This condition also manifests itself in orientation problems. It can be detected in left-right confusion, rotation, reversals and sequencing errors. Mistakes in numbers and musical notations give credence to this theory. Davis (1997) claims that dyslexia is a syndrome with a wide range of symptoms and that it is a self-created condition with no two identical dyslexics and that dyslexics do not always make the same mistakes when reading or writing or spelling. Ellis (1993) had also listed many possible ways in which dyslexia can be detected, depending on which aspects of speech processing have been impaired, as: surface dyslexia, deep dyslexia, neglect dyslexia, attentional dyslexia, central dyslexia (non-semantic reading) and phonological dyslexia.

Generally, the symptoms of dyslexia according to the dyslexic syndrome theory are problems with phonological awareness and with language in general such as verbal naming and word retrieval. These problems can also be associated with short-term memory, clumsiness, left-handedness and attention deficit disorder. The dyslexic syndrome theory is widely adopted due to various findings which confirm that dyslexic individuals always have other accompanying symptoms such as those listed above.

Now that the various biological-based theories have been discussed above, the following section examines the cognitive-based theories, and in particular the phonological processing hypothesis and the double deficit hypothesis.

2.3 The Cognitive Level

2.3.1 Phonological Deficit Hypothesis

Learning to decode and spell words in an alphabetic language is essentially understanding the relationship of alphabetic letters and their corresponding phonemes (grapheme-phoneme relationship), i.e., phonemic analysis or what is also referred to as the alphabetic principle. Dyslexics seem to be slow in developing this skill[16]. The work of early pioneers in developmental dyslexia laid the foundation for the more widely accepted view today that reading problems generally reflect limitations in language (Catts & Kamhi 1999). The existence of a linguistic problem and in particular a phonological weakness which impairs the process of learning to read and spell has become clearer in recent years (Lundberg & Hoien 2001). There is now enough evidence to support the view that phonological awareness abilities, as measured by various tasks such as rhyme detection and phoneme deletion, is causally related to reading ability (Farmer et al. 2002).

According to the phonological deficit hypothesis, a written word is thought of in a three dimensional perception; i.e., a written word represents the sound of the word (phoneme), the meaning of the word (lexeme) and the shape of the word (grapheme). Goswami & Bryant (1990) argue that when children first learn to talk, they are more interested in the meaning of the words they speak and hear than their constituent sounds. Yet, when they start learning how to read and write, they have to learn these component sounds. Goswami and Bryant (op. cit) argue that in the case of alphabetic scripts, children learn by using phonological codes such as grapheme-phoneme relations, or by using intra-syllabic units. This is the case in learning English and other similar alphabetic scripts. However, children learn non-phonologically in the case of logographic scripts by

[16] Goswami mentioned that there seems to be a difference between learning to read and spell a phonetic alphabet "transparent alphabetic code", and a non-transparent alphabetic code in dyslexics.

using visual/global strategy. This is the case in learning Chinese and Japanese (Kanji script). Global strategy according to Goswami and Bryant means that children may respond to the words as a whole, but as a sequence of letters rather than a distinctive visual shape. Children look at the initial consonant cluster and read what they *think* the word is rather than what the word really is. This theory explains some of the common reading mistakes some dyslexics make such as reading "nuclear" for unclear, "saw" for "was" and so on.

Phonological awareness is a meta-linguistic skills which involves knowledge about sounds which make up words. Goswami and Bryant (op. cit) stress the importance of phonological awareness and its relationship with reading and spelling development and they explained that syllables could be divided into onset and rime units; i.e., the onset in the syllable corresponds to the initial consonant or consonant cluster while the rime refers to the vowel and the succeeding consonant or consonant cluster. They found that children find it easier to divide a syllable into onsets and rime than into phonemes and they infer that phonemic awareness is a consequence of literacy development while the awareness of onset and rime occur in the pre-schooling period, and consequently might have important effects on literacy development. They listed studies carried out on illiterate people and studies of people who read non-alphabet script and they gave evidence that children can use analogies between words that they have been taught to read new words, which they have been introduced to at an early stage of literacy development. Goswami and Bryant (op. cit) concluded that there was a significant relationship between children's ability to make rime analogies while reading and rime judgments and that children might have employed similar analogies early in the development of their spelling. Thus, they de-emphasized the use of spelling sound knowledge in early reading and spelling development and instead focused their interests on the use of larger units; i.e., rime analogies.

Snowling (1997) argues that a central aspect of phonological development is that children throughout the phonological process tend to link their phonetic input (the speech they hear) with their phonetic output (the utterances they produce). These links develop gradually with time and with the development of the child's phonological system. She claims that reading development works more or less in the same manner, where a child sets up direct connections between representations of the printed words and representations of the spoken words in their language system. These accumulated representations eventually determine the speed and ease with which they can read. Studies have shown that children's early phonological awareness abilities tend to be good predictors of their later reading abilities (Farmer et. al 2002). She also argues (1997, 2000) that deficiencies in these representations are the main cause of failure to acquire literacy at the normal rate. According to this view, phonological awareness is the ability to reflect upon speech; i.e., the ability to correspond printed letters with their sounds. Snowling claimed that the "deficit in dyslexia is in the way in which the brain codes or 'represents' the spoken attributes of words" (Snowling 2000: 35). Lundberg & Hoien (2001) list several indicators of meta-phonological problems that play a part in reading difficulties including: problems in segmenting words into phonemes, problems in storing linguistic material such as strings of sounds or letters in short term memory, problems in both reading and retrieving non-words and slow naming speed.

De Luca et al. (1999) conducted a study in which they quoted two-thirds of dyslexics to have problems in the phonological translation of orthographic symbols. They also claimed that this deficit might not be as great in other languages such as Italian or German, since such languages have regular spelling-sound correspondence.

Dyslexics, according to the phonological deficit hypothesis, are thought to experience a specific difficulty with the representation of segmental phonology. Their spoken language or output seems normal despite signs of phonological processing difficulties when under pressure. These difficulties can be understood, bearing in mind the underlying profound effects of learning to read and spell on the segmental structure of the dyslexic's phonological representations. Another piece of evidence are the reported findings that training in phonological skills has a positive effect on reading and spelling skills, particularly if the former is "introduced with emphasis on the sound-letter mappings" (Goulandris, McIntyre, Snowling, Bethel & Lee 1998: 31).

The phonological deficit hypothesis is one of the core cognitive theories of developmental dyslexia because of the "broad empirical support it commands" (British Psychological Society Report 1999: 44) and because of the impact of phonology on the other hypothesis (Reid & Kirk 2001). However, despite the wide acceptance the phonological deficit hypothesis has gained amongst researchers as a core cognitive deficits in dyslexics, the problem with this approach is that it only focuses on reading and spelling difficulties and "problems in broader areas of functioning have not been addressed" (McLoughlin et. al 2002: 13). Nicolson & Fawcett (1995) argue that there was already some persistent evidence which indicate that dyslexic children suffer from problems in some skills which are quite independent of phonological processing, and it is widely agreed that "not all those with reading problems have significantly impaired phonological ability" (Stein 2004: 76). Nicolson & Fawcett (1995) also refer to anecdotal evidence which indicates that "forgetfulness, distractibility and clumsiness all tend to accompany dyslexia and that these impressions have been substantiated by careful research by dyslexia practitioners" (Nicolson & Fawcett 1995: 20). Stein (op. cit) has also reiterated other researchers' argument that a "commoner cause of impaired phonological ability is specific language impairment, developmental dysphasia, rather than developmental dyslexia" (Stein 2004: 79). Reid & Kirk (2001) believe that in the case of adults, the phonological deficit hypothesis may be less important than other factors and they suggest that dyslexia should in the case of adults be viewed "in a functional and situational manner which includes literacy, communication skills, processing speed and self-esteem" (Reid & Kirk 2001: 6).

2.3.2 The Double Deficit Hypothesis

The double deficit hypothesis maintains that dyslexic individuals suffer from naming speed deficit in addition to a phonological processing deficit (Badian 1997). The theory proposes that Rapid Automatized Naming (RAN) and deficits in phonological processing are "separable sources of reading dysfunction" (Compton, DeFries & Olson 2001: 124). Wolf (1999) and Wolf & O'Brien (2001) report studies of Geschwind (1974), Denckla (1972) and Rudel (1976) which all support the view that naming speed as well as rapid automatized naming constitute another kind of deficit which is independent of the well-documented phonological deficit.

In a collaborative study, Wolf (1999) and Bowers reanalysed data that was earlier collected in Canada and Boston. They classified their participants into four main groups according to types of deficits involved. The first group consisted of average reader participants who had no deficit. The second and third groups were participants suffering from phonological deficits and naming speed respectively. The fourth group consisted of participants who show signs of both deficits together, i.e., phonological deficits and slow naming speed. Bowers and Wolf realized that participants of the fourth group were the most impaired readers and that they had both naming speed and phonological awareness problems.

According to this classification, Bowers and Wolf (op. cit) propose that there are three separate subtypes of individuals who are reading disabled. First: those who are suffering from phonological deficit manifested in their poor phonological processing but with otherwise sound naming speed processing. This group, according to this study has poor word identification accuracy measures (Compton et. al 2001: 125-149). Second: those who are suffering from naming speed deficit but with otherwise relatively normal phonological processing. Third: those who are suffering from both phonological processing and naming speed deficits.

Wolfe (1999) concludes that the primary advantage of the double deficit hypothesis was that it placed equal and critical emphasis on both speed of processing and phonological awareness. This way, Wolfe argues, individuals who had developed adequate decoding skills but later displayed comprehension problems do not slip through screening batteries. Wolfe, however, agrees that the most apparent drawback of such a perception was that the "heterogeneity of children with reading disabilities will never be capture by a single, double or even triple deficit theory" (Wolfe 1999: 21).

Compton, DeFries & Olson (2001) investigated the relationship between Phonological Awareness (PA) and RAN in 476 children ranging between 8–18 years old. They employed a hierarchical regression analysis which concludes that both PA and RAN have an added effect on reading and spelling measures. Compton et al. (2001) also report Lovett, Steinbach & Frijters' study (2000) in which they performed an analysis of data collected on a large clinical sample of reading disabled children. Lovett et. al (2000) compared the scores of the subgroups on a number of written language measures and they concluded that participants in the double-deficit group are more globally impaired than those in single deficit groups on measures of reading and writing.

In a study of 90 children (6-10 years) whose reading was low for their age and for the expected level, Badian (1997) found that the dyslexic group in his study scores significantly lower than the non-dyslexic poor readers and the low verbal IQ good readers on most measures. Badian concluded that the findings "support the double deficit hypothesis of Bowers and Wolf" (Badian 1997: 69).

2.4 Conclusion

The underlying cause of dyslexia has proved frustratingly elusive (Nicolson & Fawcett 1999). Although all the above different theories and perspectives of developmental dyslexia have their merits and are indeed indispensable when attempting to reach a full understanding of the condition, Wolf (1999) notes that the history of dyslexia research, the heterogeneity of dyslexic individuals and the complexity of the reading process itself "argue against any single-factor, two-factor, or even three factor explanation" (Wolf 1999: 5). Early pioneers in the field of developmental dyslexia, who had a primarily medical background, concentrated on the biological causes of the condition and in particular the visual domain and the visual aspects of reading disability while adopting a neurological approach as their point of departure. Localization of functions in the brain and cross-lateralization of the cerebral hemisphere are two examples of early neurological-based theories. Catts & Kamhi (1999) observe that because early dyslexia definitions emphasize the constitutional nature of developmental dyslexia, the majority of research has been driven towards finding intrinsic causes of the condition and as a result, there is now a large body of evidence that indicates the significance of biological factors in reading development and disorders. The search for cognitive explanations of developmental dyslexia, however, did not really start until the 1960s and was mainly adopted by psychologists.

Fawcett (2002) explains that one of the major tensions in the current dyslexia research is the high number of conflicting viewpoints that have to be accommodated. This is particularly true when considering the underlying cause of developmental dyslexia. For further progress to be achieved, Fawcett (2002) recommends the emerging consensus on causal theories to be acknowledged and addressed and the issue of co-morbidity explored. Nicolson & Fawcett (1995) assert that identification of the causes of dyslexia will lead not only to better theoretical understanding, but also to sharper and better diagnostic and remediation method. Frith (1997) argues that a unifying explanation of dyslexia as having an underlying biological cause and a persistent and universal cognitive deficit makes it most likely that the cognitive level of description "will offer a unifying theory of dyslexia at the present time" (British Psychological Society Report 1999: 29).

It is the requirement of a good research approach that all specialists should cooperate and work towards a 'general theory' that would take into account all of the above perspectives and cover all related aspects. Reid & Fawcett (2004) observe that there is an emerging synergy between theoretical developments which is leading to more satisfactory explanation of the symptoms dyslexia than that provided by individual theories. Although they confirm that it would be premature to describe an emerging consensus regarding a unifying theory of dyslexia, they state the current general acknowledgement of the need to consider a range of theories together in order to understand dyslexia. Almost all researchers agree that adopting Frith's causal framework (1997) is a very good starting point and one that acknowledges the complexity of dyslexia while benefiting from the multilevel explanations the framework offers. Reid & Fawcett (2004) have also expressed the need to consider co-morbidity between various and overlapping developmental disorders. Reid & Fawcett (op. cit) also indicate that while such an interdisciplinary approach to the study of dyslexia is still in its infancy, it is beneficial to recommend the sharing of research methodologies adopted by researchers from diverse background and to stress the importance of choosing study subjects who are drawn from ecologically valid school-based backgrounds.

The multi-level analysis approach adopted above while investigating the different theories proposed to explain the occurrence of developmental dyslexia is extremely important because it address dyslexia from various standpoints and in diverse contexts.

What is particularly interesting while providing a critique for the theories discussed above is the emerging brain imaging technology that has been developed in the later part of the 20th century and which has allowed scientists to prove beyond all doubt what their predecessors had been only able to postulate; i.e., that there are clear physiological differences which differentiate the brains of dyslexics. As with other neurological conditions, both genetic and environmental conditions have been implicated in the case of dyslexia. One of the most important environmental factors involved is the type of language; a specific area of research that has witnessed increased interest in recent years. It is extremely important in this regard to find, now that various theories of dyslexia have been covered, if the phonological deficit hypothesis is the underlying cognitive impairment responsible for the occurrence of dyslexia amongst monolingual Arabic children. It is also interesting to find out if the manifestations of dyslexia in Arabic will be similar to those in other transparent orthographies such as German, Greek, Italian and Spanish. However, in order to do so, one must first appreciate the specific linguistic features of the quasi-regular Arabic orthography so that one can have a clearer idea of how dyslexia is likely to manifest itself amongst monolingual Arabic children. The following section investigates in detail these linguistic features of the Arabic language.

Chapter Three: Arabic Language

3.1 General overview

As argued in the previous chapter, in order to fully understand and identify the presenting signs of dyslexia in a particular language, it is very important to understand the relevant linguistic features of that language. The following section investigates such relevant linguistic feature of Arabic; i.e., how it originated, how it developed, its various types and vernaculars and what specific features it shares with other alphabetic scripts. Having identified the general linguistic framework of the Arabic orthography, phonology and morphology, the chapter then moves on to identify the specific issues that are relevant to the type of Arabic used in Egypt since the latter will be the setting of the data collection. A full understanding of the linguistic features of Arabic used by monolingual Egyptian Arabic children is important to fully understand how dyslexia is likely to manifest itself amongst monolingual Egyptian Arabic children.

Arabic is the sole or joint official language of some 22 independent countries with an estimated 300 million native speakers. It is a Southern-Central Semitic language; a family of genetically related languages that is thought to have been developed from a common parent language 'Proto-Semitic', presumably existed about $6^{th}/8^{th}$ millennia BC and was perhaps located in the present day Sahara. The term 'Semitic' designates "a group of languages, some dead, some still living, and some having a marginal status today as liturgical language, which all show a sufficient degree of similarity of structure in their phonology and morphology" (Holes 1995). Arabic belongs to this Semitic group of languages as spoken in a large area including North Africa, most of the Arabian Peninsula and other parts of the Middle East. Other living languages of this group are Modern

Hebrew, Amharic and other spoken languages of Ethiopia, Aramaic dialects current in parts of Syria and Iraq and Maltese (Haywood & Nahmad 1993).

Arabic, with its alphabetic script, is believed to be the second most widely used language in the world: a fact largely due to the Islamic faith (Holes 1995). It is the language of Islam's holy book, the Qur'an and is therefore the religious and liturgical language of all Muslims, regardless of their origin or mother tongue. Arabic has gained universal prominence as the "language *par excellence* of Islam" (Thackston: 1994: xi) and the Arabic script began to be adopted by the people who converted to Islam. It is also believed that the Arabic alphabet is the second most widely used alphabet in the world because it has been adopted to various other languages such as Urdu, Farsi, Kurdish , Pashto, to name but a few.

With the advent of Islam, and ever since, Arabic has been undergoing many a change from the etymological as well as phonetic point of view; a sign of the language interaction with society and its subsequent growth (Shaikh 1978). This change has led to the general notion found in the current linguistic literature which often classifies Arabic-speakers as being diaglossic, reserving a 'high' form of the language for formal usage, and using a 'low' form in domestic and casual settings. It can be argued that, in effect, at least two distinct forms of the Arabic language are currently in use by each group of speakers, and thus, a 'polyglossic', rather than a 'diaglossic' label might be warranted. Four forms, representing main stations, on a vertical continuum, are identified below:

Classical Arabic, is used almost exclusively for liturgical purposes, with some further decreasing use in classicising literature. Classical Arabic is a highly formalized language that is virtually immune to the pressures of linguistic evolution, and is accepted as the definitive linguistic reference across the Arab world. This form of Arabic surpasses all other forms "in its wealth of synonyms, harmonious patterns, concision, clarity and eloquence" (Salloum 2003).

Modern Standard Arabic, is used in modern literary production and all other publications, in formal communications, and in the media, both written and broadcast. MSA derives its syntax, morphology and phonology from Classical Arabic, but is thoroughly infused with terminology and usage inspired and/or adapted from Common European (notably English and French) languages. Although MSA varies slightly from one Arab locale to another, it is intended as a "unified and codified" pan-Arab communication tool (Holes 1994: 4). MSA has not undergone significant phonological or syntactical change in its literary form (Salloum 2003).

National dialects are used in the local media, in the performing arts, and in semi-formal settings. The national dialect of each Arab State is a polished version of its most prestigious sociolect, typically the capital city's elite dialect. While being informed by MSA, the national dialect usually exhibits considerable departure from the Classical Arabic-inspired syntax and phonology. Although Arabic speakers are usually capable of understanding the national dialects of adjacent states, intelligibility, however, decreases with distance. A notable exception is the Egyptian national dialect, which, by virtue of the prolific output of Egyptian film, television, and the music industries, qualifies, next to MSA, as a second (and more popular) *lingua franca* in the Arab world.

Local dialects, frequently referred to as Colloquial Arabic, are used in regional and familial settings. Local dialects vary extensively, in all linguistic features, both within each Arab state and across the Arab World. Local Arabic dialects are usually dialects that have a weaker grammatical base and primarily represent the distinct local accents of its speakers.

The above brief account of the different types of Arabic highlights an important point; i.e., the emergence of the MSA as the unifying Pan-Arab language, which has been adopted by almost all the majority of the Arab countries in the Middle East. MSA is therefore the language of education in almost all the Arab world while it is in fact slightly different from the various national and local dialects employed by monolingual Arabic speakers. To put this in the context of monolingual Arabic Egyptian children, this means that the language being learnt at school as well as the curriculum materials which make up their syllabus (MSA) are in fact different from the language of instruction used inside their schools and the language spoken at home (Colloquial Egyptian Arabic); a diaglossic situation which creates an additional challenge[17] for monolingual Egyptian Arabic beginning readers.

It would be therefore interesting to be able to investigate the impact of the phonemic and lexical distance between spoken and standard Arabic of Egypt on the acquisition of basic reading processes. This is a good example of an idea for an investigation that can not be undertaken without first studying the impact of specific linguistic features on the incidence of dyslexia and the latter's manifestation amongst monolingual Egyptian Arabic children which is being addressed in the current study.

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[17] Saiegh-Haddad presented a paper on the relevance of linguistic and sociolinguistic features of Arabic diglossia to the acquisition of various reading skills amongst the Arab of Israel, BDA 6th International Conference, University of Warwick, UK, March 2004.

3.2 Arabic Orthography

The Arabic script evolved from Nabataean and Aramaic and is therefore a Southern-Central Semitic[18] language which has existed without change since the seventh century AD. Like other Semitic languages, Arabic is written from right to left[19]. The Arabic script is defective, i.e., short vowels are not regarded as independent graphemes in the script but are represented as extra diacritical markings which are only present in poetry, textbooks for foreign learners, children's books and the Qur'an or in otherwise fully vocalized texts. These short vowels are otherwise largely neglected in non-vocalized texts. The Arabic script is cursive; by default, Arabic letters are joined to each other by means of ligatures. Apart from 6 non-connecting letters (symbols that join to preceding ones only), the remaining 22 letters of the Arabic 28 conventional alphabet are connectors; i.e., they join to both preceding and following letters. There are no capital letters in Arabic.

The Arabic alphabet is phonemic; i.e., it consists of consonants only with the exception of 3 letters which are used as both long vowels and diphthongs. The Arabic script consists of 17 characters, which, with the addition of dots that are placed above or below, make up the 28 letters of the Arabic alphabet. Dots are, therefore, extremely important in the Arabic script and differ in their number (one, two or three) and in their position (below or above the letter). For example, the difference between / ب b/, /ت t/, / ن n/ or /ث Θ/ is in the number of dots (one as in the /b/ and the /n/, two as in the /t/ or three as in the /Θ/) or their position (above as in the /t/, /n/ and /Θ/ or below as in the /b/ the letter). Such an elaborate use of dots may pose additional challenges for dyslexics by impeding their grapheme segmentation skills. Arabic letters modify their graphic shape according to their

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[18] It was formerly called Hamito-Semitic by the German Egyptologist Karl Richard Lepsius in the 1860s, Afro-Asiatic by the American linguist Joseph Greenberg in 1950 and Afrasian by the Russian linguist Igor Diakonoff.

19 Although Arabic words are written in horizontal lines from right to left, Arabic numerals are written from left to right.

position within the word (i.e., initial, medial, final or isolated). Moreover, some additional letters are used in Arabic when writing places names or foreign words containing sounds which are not represented by a letter in MSA, such as /p/ or /g/.

Arabic has a 28-letter alphabet and 33 phonemes and as such can be classified as a straightforward transparent (shallow) orthography that has almost a one to one correspondence between phonemes and graphemes. This is an important linguistic feature of Arabic orthography and one that is expected to impact the accuracy of single word reading amongst monolingual Arabic children. In view of the above specific feature of Arabic orthography, one would expect that the performance of children learning to read Arabic, according to the phonological deficit hypothesis presented in the previous chapter, would be better than the performance of children learning to read in opaque orthographies. Monolingual Arabic children learning to read Arabic are expected to develop orthographic representations at a much finer level (the level of the phoneme) than their counterparts learning to read in an opaque orthography who are expected to develop their orthographic representations at the level of onset-rime

However, the fact that the script is defective (i.e., short vowels do not appear graphemically in the Arabic script), gives rise to different pronunciation of the same phoneme. According to Holes (1995), this means that words with quite different meanings such as (دَرَسَ *darasa*) he studied, (دُرِّسَ *durrisa*) it was studied, (دَرْس *dars*) lesson, (دَرَّسَ *darrasa*) he taught and (دُرِسَ *durrisa*) it was taught, are homographic in normal handwriting or print. Homographic words can either be homophonic (words which sound similar) or hetrophonic (words that sound different) which are all derived from the same consonantal root. Therefore, a large number of words which appear in regular unpointed text are homographic when presented out of context. This is another important specific linguistic feature of Arabic and one that will impact the choice of reading accuracy test as presenting single words (out of context) might disadvantage dyslexic individuals in case of unpointed text and it is therefore preferred to present a passage or indeed other forms of tests to examine the reading accuracy of monolingual Arabic children instead of a list of single unpointed words.

To compensate for this lack of short vowels in the script, Arabic makes full use of diacritical marks. However, and save from elementary teaching books and the Qur'an, these diacritical marks are not used in every day life Arabic. This, in turn, leaves the beginner Arabic reader vulnerable to their own interpretation and/or understanding of the semantic connotation derived from a given context.

The above are other important linguistic features of Arabic orthography which are expected to impact the performance of reading comprehension of monolingual Arabic children. Although the transparent nature of the Arabic orthography is expected to provide Arabic monolingual children with a head start when reading and would in turn increases the accuracy of their single word reading, the high number of homographs and, as is explained blow in the Arabic morphology section of this chapter will, the highly inflected and derivational nature of Arabic morphology would, nevertheless, impact reading comprehension which is expected to be less smooth a task than reading accuracy.

Although most elementary educational books in the Arab world generally and in Egypt in particular are written with the Nashki[20] script, there exists some different types of Arabic handwriting which are introduced at an early age for beginning learners and which may cause confusion. This is particularly true in the case of the Riqa' script which is frequently used because of its ease and speed to the extent that it is sometimes referred to as almost the Arabic short hand. In this script, dots are joined to each other and become horizontal stroke. Also individual letters are written above each other by means of ligatures so that space and speed is attained.

The cursive nature of the Arabic orthography, the confusion over the type of script used (Nashki vs. Riqa' scripts) coupled with the extra confusion caused by the 6 non-connecting letters are expected to make word boundaries in Arabic unclear. The cursive nature of Arabic orthography means that words are written joined up and as such spaces in a continuous line of writing in Arabic should indicate spaces between different words. However, the six non-connecting letters (ا ، و ، د ، ذ ، ر ، ز) in Arabic will create a space or even more within the same word; i.e., such as the Arabic word for student which is (طالب) which contains a space in the middle of it. Such confusion, it is anticipated might cause problems to Arabic monolingual children particularly when word boundaries and word endings are concerned.

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[20] Naskhi script is the most popular script across the Arab world and literally means 'copying'. It is generally used for its clarity and basic components but is sometimes neglected because it is much

3.3 Arabic Morphology

The most salient Semitic feature of Arabic is its basis of consonantal roots and its productive and derivational morphology. The characteristic features of Semitic languages are their bases of consonantal roots which are mostly trilateral; consisting of three letters. Variations in shade of meaning are obtained first, by varying the vocalization of the simple root, and secondly, by the addition of prefixes, suffix and in-fixes. The Arabic root system, as Wightwick & Gaafar (1998) notes, is the key to understand how Arabic grammar works. Once learners understand how roots work, they can start to identify which are the root letters of a word and understand the patterns they produce. The learners will then be able to form different structures following the patterns and use their knowledge to pronounce words correctly and even guess the meaning of new vocabulary. The root generally constitutes the semantic core of the Arabic word and the majority of Arabic roots are made of three consonants. Verbs are inflected for three numbers (singular, dual and plural) and two gender (masculine and feminine). There are two tenses in Arabic, the perfect which is formed by the addition of suffixes and the imperfect which is formed by the addition of prefixes and occasionally suffixes.

Arabic, therefore, shows the fullest development of typical Semitic word structure, and as such, should be described in reference to its very complex and productive morphology. Arabic roots are primarily consonantal and are embedded into morpho-phonological vocalic infixes and syllabic prefixes and suffixes. Variations in these patterns bring about variation in the meaning. However, consonantal roots remain in exactly the same order in any word derived from this root; variations in meaning result from changes in either internal vowels, from doubling one of the consonants, from specific additional letters or affixes or from any combinations of these. Number, gender, tense and case, (i.e., definite

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longer and laborious to write than other shorter scripts.

or indefinite), are all achieved by inflecting roots. Moreover, affixed and suffixed pronouns, possessives, prepositions and conjunctions are also frequently used in Arabic. In other words, Arabic roots represent the conceptual content of the word and as such its semantic function while the patterns represent their grammatical functions (Schulz & Krahl & Reuschel 2000).

Thus, in general, Arabic words can be decomposed into two abstract morphemes, the root and the phonological pattern. Roots and phonological patterns are abstract structures and only their joint combinations (after the application of phonological and phonetic rules) form specific words. Because of the productive nature of the Arabic morphology, Arabic writing was mainly designed to convey primarily the root information. Hence, the Arabic writing system represents mainly consonants. Arabic is also a highly agglutinative language. One word can correspond to a whole English sentence, merely because negative suffixes, tense suffixes, person prefixes can all be added to the word base in Arabic. This results in a highly derivational, highly dense morphology, which although helpful in communicating the core semantic meaning of the root embedded in the various patterns (prefixes, infixes and suffixes), demands a lot of unpacking from the part of the reader in order to arrive at the exact meaning of the Arabic word. This morphological knowledge is of extremely important when learning to read Arabic as knowledge of related words (derivations) and/or knowledge of different forms of the same words (inflections) tend to usually provide clues to orthographically correct spelling" (Szczerbinski 2003). A good example of this specific linguistic feature of Arabic is the overriding tendency of written Arabic to preserve morphological clues over phonological transparency This is present in the case of Otiose *Alif* (also sometimes referred to as Redundant *Alif*) as in (كتبوا katabu) wherein *Alif* is not pronounced but merely serves to indicate the verbal form (Thackston 1994). The *Alif maqsura* (*Alif* in the shape of a *Ya*) is another example of how morphological clues is given precedence over phonological transparency in Arabic. The *Alif maqsura,* which only occurs at the end of some words, although written like *Ya* (except that it is written without the two dots below it) is actually pronounced *Alif*; i.e., *Alif* in the shape of a *Ya* is written at the end of the word to serve a grammatical purpose; mainly to indicate that the final *Alif* in this word was not really an *Alif* in the original root of the word, but were either a *Ya* or a *Waw* or as a sign of the feminine gender in case of adjectives.

3.4 Conclusion

Considering the above description of the specific linguistic features of the Arabic language, one can conclude that even in a language with a regular grapheme-phoneme correspondence like Arabic, there seems to be other complexities which are likely to pose challenges to monolingual Arabic dyslexics. The shallow nature of the Arabic orthography and the ease with which monolingual Arabic children are expected to map their orthographic representations prompt one to expect that accuracy of single word reading will be better than other speakers of opaque orthographies. The cursive nature of Arabic orthography and the highly inflected and derivational morphology of Arabic, on the other hand, pose additional challenges to monolingual Arabic dyslexics as one expects to find apparent and significant contribution of morphological knowledge to Arabic reading acquisition. Therefore, it is anticipated that morphological knowledge is likely to be a source of individual differences in the reading ability of monolingual Arabic children because Arabic roots are phonologically highly opaque and manifest at the surface level in a variety of syllable forms. This morphological density demands considerable unpacking on the part of the reader and creates an additional source of homography (Share 2003).

The specific linguistic features of Arabic examined above will impact the choice and contents of subtests when deciding upon which ones to include while devising a dyslexia diagnostic tool to identify monolingual Arabic dyslexic children in Egypt. However, before attempting to do this, the following section first investigates the issue of dyslexia assessment in order to arrive at a better understanding of its underlying procedures, requirements and protocols before devising a diagnostic tool of dyslexia in Arabic.

Chapter Four: Assessment of Dyslexia

4.1 General overview

Assessment is an information-gathering procedure and a test is a particular type of assessment that uses specific procedures in order to gather information (Friedenberg 1995). Information derived from an administration of a test is then converted into numbers and scores; the latter acquires significant meaning and relevance when viewed within the context of the overall test scores. Friedenberg argues that although tests are a specific type of assessment used to gather information about individuals, this information is eventually used in an evaluative manner; in other words, the data produced by this information are used to assist in making decisions regarding rating, placement, selection and/or diagnosis (Ibid).

A test is an objective and standardized measure of a sample of behaviour (Thomson 2001), a definition which refers to two very important characteristics a psychological test should represent. First, an objective test is a test that yields the same result if re-administered. Second, a test is objective because it is not based upon someone's subjective judgement of an individual's underlying personal abilities. A test is also standardized if re-administered using the same techniques every time and if it has been originally administered on a large sample of individuals. Thomson (op. cit.) argues that the notion of 'a sample of behaviour' is very critical as it is only a sample of the participant's behaviour at the time when the test is administered. There are other factors that can influence such behaviour either positively or negatively. That is why there will always be a "built in error of measurement in any given test" (Thomson 2001: 18).

Dyslexia assessment is a dynamic process that works in exactly the same manner. Relevant information is gathered concerning the performance and/or behaviour of individuals on a selected number of tests. These tests are different in what elements of abilities and/or skills they aim to assess, but generally tend to include representations of the individual's mental abilities, their academic/educational achievements as well as some of the skills that tap the underlying deficits in dyslexia as supported by empirical research in the field of dyslexia assessment. Reid (2003) notes that although there are a number of tests that contain the word dyslexia in their title, there is no single dyslexia test because the identification of dyslexia is a process and that process includes "more than the administration of a solitary test" (Reid 2003: 89).

Dyslexia assessment tests are diagnostic tests and their aim is to ultimately diagnose dyslexics or give a general indication as to whether an individual is at risk of being dyslexic. Diagnostic testing, by its very nature, establishes an individual's proficiency in information processing (Turner & Nicholas 2000). The overall purpose of dyslexia assessment is to ascertain whether the individual is actually failing, and if so, to what degree. Miles (1999) maintains that the primary aim of dyslexia assessment should be "that of clarification of the person's strengths and weaknesses" (Miles 1999: 108).

The dyslexia assessment process aims to establish the individual's current level of performance in attainments by identifying the individual's level of academic/educational achievements, and in particular their reading, writing and spelling skills. One of the key functions which an assessment should perform is the "profiling of the individual student's strengths, weaknesses and learning style" (Farmer et. al 2002: 117) and the purpose of collecting assessment information regarding dyslexia is to arrive at a greater understanding of an individual's needs (Stackhouse & Wells 1997). In additions, dyslexia assessment assists in identifying the individual's learning styles and establishing various aspects of the curriculum and curriculum activities that motivate or de-motivate them (Reid 2003). In short, a dyslexia assessment is a form of psycholinguistic assessment where participants' performance on a range of tasks can be interpreted from a psycholinguistic perspective (Stackhouse & Wells 1997).

"A significant feature of the present dyslexia scene is the absence of agreed criteria for diagnosis" (Miles 1994: 101). As discussed in chapter one of the study, this is due to the confusion over the definition of the condition and the confusion over the validity and reliability of including IQ measures in dyslexia diagnosis. Some researchers, However, made a distinction between individuals' underlying abilities and their current performance, otherwise known as the IQ-reading discrepancy approach. This IQ-reading discrepancy approach, although heavily criticised in dyslexia definitions as previously shown, is still the hallmark of dyslexia assessment amongst some practitioners (Torgeson 1989, Turner 1997, Thomson 2000 & Doyle 2002). It is sometimes possible to look for unexpected contrasts between an individual's level of attainments on academic/achievements tasks such as reading accuracy, reading comprehension, reading speed and his/her expected scores based on the basis of IQ measures. Such a technique is however heavily criticised on theoretical grounds and the "calculation of discrepancy does not link with the theoretical explanation of dyslexia" (British Psychological Society Report 1999: 58).

Those in favour of utilizing the attainments/achievements discrepancy approach (Torgeson 1989, Turner 1997, Thomson 2000 & Doyle 2002) claim that the underlying abilities can be assessed by measuring the individual's mental abilities which are generally found to correlate to their educational potentials. Those who are against the use of the attainments/achievements discrepancy approach (Siegel 1989, Stanovich 1991, 1994, Aaron 1994, Berninger 2001, Crombie 2001, Dickman 2001, Samuelson 2002) are arguing against the use of such an approach on empirical, logical as well as equal-opportunities grounds and quote instances where a correlation between actual performance and expected performance based on mental abilities are either absent or too weak to be considered as statistically significant.

Current educational and/or academic attainments can be measured by tests of reading, writing and spelling. Some researchers argue that a discrepancy between the underlying abilities based on that expected from IQ scores and the current performance will indicate the presence of a problem, although it does not explain the nature of the problem. The types of errors observed in current performance and attainment tests may indicate particular skill deficits that are indicative of dyslexic-type problems, but are by no means exclusive or definitive. A third part of assessment is generally needed in order to relate the deficits in current performance skills to theories of dyslexia. This part of the assessment is generally referred to as positive indicators of dyslexia and usually consists of specific sub-tests that have been empirically proven to be associated with dyslexic type behaviour. For example, dyslexic individuals seem more likely to have weaknesses in short term verbal memory than do good readers and a test to measure this ability can be used in this section. Besides, large number of dyslexics are reported to have deficient phonological awareness or deficit in speed of information processing (Turner & Nicholas 2000). Tests to measure these abilities are included in this part of the assessment.

The above aims and purposes of dyslexia assessment are translated into a three level assessment approach: abilities, attainments and core indicators of dyslexia. Abilities can be assessed by administering a mental abilities test. IQ is a statement of a person's overall intellectual ability based on an arithmetic average of that person's scores on several tests of ability. IQ is still regarded by some researchers as an indispensable component when attempting to identify dyslexia at-risk individuals. IQ is the "first port of call" (Turner 1997: 39) and the "anchor for a regression matrix, which includes co-normed measures of attainment in basic skills" (Ibid: 39). Furthermore, IQ is a "significant predictor of academic success" (Turner 2000: 27) and is regarded as the most critical discrepant factor used to distinguish between 'garden-variety' poor readers and dyslexics.

Debate concerning the validity of IQ and its importance in dyslexia testing has been discussed in detail in the first chapter of this study (Siegel 1989, Torgeson 1989, Stanovich 1991, 1994, Aaron 1994, Turner 1997, Thomson 2000, Berninger 2001, Crombie 2001, Dickman 2001, Doyle 2002, Samuelson 2002). However, a number of dyslexia assessment batteries make use of various mental abilities tests or particular components of well-known IQ tests. Wechsler Intelligence Scale for Children WISC III, Raven's Matrix and the British Abilities Scales are but few examples of these tests. Nevertheless, these dyslexia assessment batteries differ in the way they choose to include verbal and non-verbal reasoning components. Due to criticism of employing verbal reasoning test when identifying dyslexics and its apparent counter productivity which is discussed in detail in the first chapter of the study, recent dyslexia assessment batteries tend to prefer the use of non-verbal reasoning abilities test components when assessing for dyslexia.

The second level of dyslexia assessment is the current attainments of individuals; i.e., their academic/educational achievement level. Reading, writing and spelling are the most important skills empirical research has found to be closely linked to dyslexia. Indeed, reading and spelling are two critical components in any dyslexia test. Reading skills generally include reading accuracy, reading fluency and reading comprehension, depending on the type of skill measured when reading. Depending on the type of language used when assessing for dyslexia and following our discussion of the specific linguistic features of Arabic, It is anticipated that reading accuracy will be less of a good predictor in Arabic than reading comprehension which is considered to be better a predictor. Both reading and spelling tasks are very valuable in explaining types of errors individuals make during dyslexia assessment which can be very informative in explaining the way dyslexia manifests itself notably when examining these skills across languages.

Once the first two parts of the assessment are completed, a number of groups of individuals can be identified: First, there is a group of individuals who have high scores in the abilities test and high scores in the attainments test. These individuals, it is argued, tend to be advanced learners and are generally found to acquire literacy with ease and progress smoothly at school. This group generally contains high achievers and individuals of average or above average cognitive abilities and/or educational achievements. Second, there is a group of individuals who have low scores in the abilities test and low scores in the attainment tests. These individuals, it is argued, tend to be perceived as either underachievers or slow learners and are generally found to usually have problems in acquiring literacy and progress slowly at school. This group is also called 'garden variety' poor readers and under-achievers.

Third, there is a group of individuals who have high scores in their cognitive abilities test but low scores in their attainments test and there is a discrepancy between their abilities and their existing performance. There are different reasons to explain the discrepancy in the third group. For these individuals, a third level of assessment is required in order to understand their pattern of difficulties. The third level of assessment includes well-documented positive indicators of dyslexia which include the following:

- ❖ Cognitive deficits: include verbal short-term memory; i.e., a poor ability to store information in the short term memory as manifested in poor scores on backward digit span tasks, slow speed of processing, slow speed of access to orthographic memory.
- ❖ Poor phonological memory: manifested in slow ability to name familiar pictures and objects and poor phonological awareness as manifested in poor rhyme and the inability to read non-words.

There is also a fourth group which are individuals who scored high in their reading and academic achievement but low on their IQ and which were called hyperlexic group by Siegel (1989). This multi-level approach of assessment is adapted in some dyslexia assessment batteries. However, it is generally appreciated that depending on the nature of the language in which dyslexia assessment is taking place, different tasks might lead to different results. For example, it is generally well-established that dyslexics in English tend to do less well on phonological awareness-based tasks than their German or Italian counterparts (e.g., Landerl 2003, Miles & Miles 1999). This is reported to be largely due to the close and consistent phoneme grapheme relationship in both German and Italian which in turn influenced the acquisition of the alphabetic principle in these scripts and consequently the comparative ease with which German and Italian monolingual speakers acquire literacy faster and easier than their British and American counterparts (Wimmer 1993, Goswami 1997, 2002, Frith, Wimmer & Landerl 1998, Paulesu et al. 2001, Frith 2002, Muter 2003). Further, it is generally believed that spelling abilities are a marker for dyslexia across languages (Miles 1994, Goulandris 2003, Nikolopolos, Goulandris & Snowling 2003). Therefore, it is increasingly thought that the nature of the language in which the dyslexia assessment is taking place seems to dictate the type of errors dyslexics are making which in turn accounts for the different manifestations of dyslexia in different languages.

Studies of dyslexia in Hebrew, a Semitic language with a transparent script, have repeatedly emphasized the role of morphology and have found that morphological deficiencies appear to play a causal role in reading and writing difficulties in Hebrew (Ben Dror et al. 1995 & Cohen et. al 1996, all cited in Share 2003). In a cross-orthographic study of error patterns in word reading among primary school children in both Sweden and English, , Miller-Guron & Lundberg (2004) found that English children read words more quickly and more efficiently than Swedish children.

The above account of various methods of dyslexia assessment together with the previous chapter concerning the specific linguistic features of the Arabic languages have now provided one with a chance to start appending a dyslexia diagnostic tool which, in addition to shedding light on how dyslexia manifest itself in Arabic, will also give one the opportunity to test one of the theories proposed in the second chapter of the study; i.e., the phonological deficit hypothesis. However, before doing so, it is fortunate that an earlier study by Gilgil (1995) has been in fact devoted to the aim of developing a dyslexia diagnostic test for monolingual Arabic children in Egypt. The Arabic dyslexia diagnostic test which was devised by Gilgil in 1995 represents an ideal opportunity to understand how a dyslexia assessment may be conducted in Arabic as well as understand how Gilgil managed the various challenges posed by the specific linguistic features of Arabic. A close investigation of the Arabic dyslexia diagnostic test will also assist in understanding Gilgil's thinking behind including particular subtests as well as discovering if such subtests are good predictors of dyslexia type behaviour amongst monolingual Arabic children in Egypt. Such a real life investigation of a test will ultimately shape one's thinking and affect one's preferences regarding specific subtests while devising an up-to-date diagnostic tool to screen for cognitive profiles in reading and writing difficulties amongst monolingual Arabic children in Egypt.

4.2 The Arabic dyslexia diagnostic test (Gilgil 1995)

The Arabic dyslexia diagnostic test (Gilgil 1995) was designed as part of a field study of a PhD programme Gilgil conducted in 1993. This test was subsequently published in a book entitled, *Dyslexia: A Diagnostic and remedial study* (op. cit). The test is criterion-referenced and is based on data collected in 1993 from eight mainstream government primary schools with monolingual Arabic children in Tanta, a Governorate in the Nile Delta of Egypt.

The test consists of three major parts: mental abilities, academic achievement and a third part that includes various exclusion tests such as: emotional, medical, familial, societal and behavioural components. Gilgil's (1995) data sample was (n = 388) participants: 185 males (47.6%) and 203 females (52.4%). The minimum age of participants was 7.8 years and the maximum was 12.4 years with an average age of 9.3 years. Participants were all fourth grade students who had been referred to Gilgil by their respective teachers. The basis of the selection criteria for teachers' referrals that Gilgil identified included: participants who have problems expressing themselves in words, participants who shy away from participating in classroom activities, or who seldom participate in extra curricular activities, participants who find it difficult to concentrate on various classroom tasks and finally participants who have problems in doing their homework. The following section provides a test by test description of her test battery.

4. 2.1 Part One: Mental abilities

4.2.1.1. Wechsler-Bellevue Intelligence Scale for Children (WBISC): This is the standardised Egyptian version of the Wechsler-Bellevue Intelligence Scale for Children that has been normed on the Egyptian population and which suits the Egyptian environment. Gilgil used this test to differentiate between participants with poor mental abilities and others with average or above average mental abilities. Gilgil adopted the 90% standard score as a cut-off point and she regarded participants who scored less than 90% on this test as having below average IQ scores and excluded them.

4.2.2 Part Two: Academic achievements

4.2.2.1 Silent Reading test (Ghaith: 1977): This test was designed by Ghaith (1977) and consisted of 13 reading passages. The test is intended to measure reading comprehension and includes two parts; the first part consists of 5 passages followed by multiple-choice questions with four answers each, with only possible correct answer and participants are required to circle mark the correct answer. The second part of the test consists of 8 passages and contained similar test items.

4.2.3 Part Three: Exclusion criteria

4.2.3.1 Dyslexia Diagnostic test: This test was designed by Gilgil she consulted Arabic teaching specialists to ascertain the suitability of the test components to the age and literacy ability of the participants. The test takes 45 minutes to administer and contains two parts: silent reading test and oral reading test.

4.2.3.2 Quick Neurological Screening test: This test was designed by Mutti & et. al. (1978, cited in Gilgil 1995) and was adapted by Kamel (1989) to suit the Egyptian environment. It is a short individually administered test which takes approximately 20 minutes to complete and generally gave an indication of the participants' neurological integration and its relationship to the learning process. The test consists of 15 tasks that could be observed by the test administrator and which classifies participants' scores into three general scales; 56 and above which indicates a high risk factor of learning difficulties; 31-56, which indicates the possibility of learning difficulties and finally 31 or less, which indicates the normal standard of learning abilities.

4.2.3.3 Conners Behaviour List: Samadoni (1991, cited in Gilgil 1995) adapted Conners list to suit the Egyptian environment (1991). This list is used by teachers to evaluate and identify the students' deficits in behaviour inside and outside the classroom. The list consists of 39 traits which describe the students' behaviour in a number of situations and they include what Conners called aggressivity, inattention, anxiety, hyper activity and sociability.

4.2.3.4 Auditory Discrimination test: This test was designed by Essa (no date given and is unpublished test that is referred to in Gilgil 1995) which aims to identify students' abilities of auditorialy distinguishing between words (i.e. listen to the words and then confirm whether they are similar or different). The test consists of two parts, the first contains 50 pairs of words recorded on a tape. Participants are asked to listen to the tape and indicate whether the words they heard are similar or different. The second part of this test contains two passages which participants have to listen to before they are asked to identify the passages they heard on the tape from a number of written passages on their answer sheet.

4.2.3.5 Visual Discrimination test: This test was designed by Essa (no date given and is unpublished test that is referred to in Gilgil 1995) which aims to measure participants' abilities to visually distinguish between words, letters and numbers. The test consists of 9 subtests, each measuring a separate skill such as general recognition; digit recognition; letter use; shape-background recognition; letter transposition and so on.

4.2.3.6 Economical and Social Background Questionnaire: This is a questionnaire which was designed by Kamel (1989, cited in Gilgil 1995) and contains a number of questions about participants' background, their parents' education, places they had visited and other cultural activities participants' and/or their families had engaged in.

4.2.4 The Arabic Dyslexia Test Administration

Starting with an initial data set of 388 participants, Gilgil first applied the silent reading test to identify participants who had reading problems. Based on participants' scores on this test, Gilgil classified participants into two groups employing the 33.3% cut-off point. She excluded participants who scored more than 33.3% and regarded them as average or good readers and kept participants who scored less that 33.3% as poor readers. Participants who fitted this criteria were 127.

Gilgil's next step was to administer the WBISC on the 127 participants she considered poor readers. She employed 90% as a cut-off point on the WBISC and regarded participants who scored below 90% as having below average mental abilities and excluded them. Only participants who scored 90% or above were kept in her sample. After employing this cut off criterion, she was left with (n = 88).

Gilgil started excluding participants according to her various exclusionary criteria. She excluded participants who were socially and/or economically disadvantaged, those who were not living with their parents and those who had illiterate parents. These criteria resulted in excluding further 10 participants. She then administered the dyslexia diagnostic test she had devised on the remaining 78 participants but ended up keeping them all.

Gilgil also administered the Quick Neurological Screening test which resulted in excluding 11 more participants. The visual discrimination test was applied on the remaining 67 participants which resulted in excluding further 8 participants. Gilgil then applied the auditory discrimination test and excluded a further 21 participants. Eventually she was left with 38 participants on whom she administered Conners' Behaviour list, but did not exclude any participants. Gilgil considered the remaining 38 participants left after employing her exclusion criteria to be dyslexic. She finally concluded that the percentage of dyslexics (n = 38) amongst her original sample (n = 388) is 9.7%.

4.3 A critique of the Arabic dyslexia diagnostic test

Gilgil's Arabic dyslexia test is criterion-referenced and the final scoring of the test does not represent performance as a criterion of comparison of the participants' performance to other people's performance, but rather represents each participant's performance independently. The comparison between participants is achieved by a standard frame of reference; i.e., a criterion that is defined according to experts' opinion (teachers of Arabic in the local educational authority within which her sample was selected). Ideally, a norm-referenced test compares the score to that of other similar individuals, usually belonging to the same age groups (Thomson 2001). Scores in this case are relative and would be less vulnerable to freedom from distractibility; i.e., the tendency for some important diagnostic indicators to "signal trouble for many quite different reasons with different subjects" (Turner 2000: 60) as well as the problem of subjectivity that is always associated with teachers' referrals.

Criterion-based tests simply set a particular criterion, which is an absolute score rather than a relative one. Establishing norms is a characteristic of norm-referenced tests and is very important since these are used in developing percentile ranks. The latter is to be used as an independent/standard average performance against which any individual's performance can be judged in comparison with points they score. "Co-norming permits an optimal investigation of underachievement, the first criterion of dyslexia diagnosis" (Turner 2000: 64). Turner argues that normative psychometric tests are the best established as well as the most used and that norm-referenced tests overcome the drawbacks of criterion-referenced tests which are regarded as "largely hypothetical" (op. cit).

Gilgil's dyslexia diagnostic test totally depends on traditional criteria formerly used to identify and diagnose dyslexics. The test is entirely based on exclusionary criteria and in particular excluding economically, socially and behaviourally disadvantaged participants. In addition, Gilgil depends on WBISC in order to measure participants' mental abilities. WBISC was the first published test of adult intelligence by David Wechsler (1896-1981) and is regarded as a pioneering test. Although quite well-known, the test is rather long and consists of 12 subtests divided into two parts; oral and performance respectively. Another problem with WBISC is that it requires individual administration. Turner (2000) argues that measurement of the verbal and visuo-spatial groups of abilities "would not always now be done using Wechsler's measures of Verbal and Performance IQs" (Turner 2000: 44). Turner (1994) lists some disadvantages of using WBISC and concludes that the block design component of WBISC is "only pure measure of spatial ability, the arbitrariness of Object Assembly and Comprehension and finally that factor structure does not in fact separate IQ from information skills" (Turner 1994: 114).

Miles & Miles (1990) and Aaron (1994) point out that dyslexic individuals perform poorly on the WISC subtests which have significant loadings on "speed of information processing" (Aaron 1994: 15) and that dyslexic individuals generally perform poorly "on the verbal part of the Wechsler Scales" (Ibid: 15). Reid & Kirk (2001) note that in the case of employing WISC, there is a conflicting evidence regarding the use of sub-test profiles to identify a dyslexic cognitive profile. Miles (1994) also confirms this view when he argues that, in the case of WISC, there are good reasons for regarding it as "inappropriate to look for discrepancies between verbal IQ and performance IQ" (Miles 1994: 106) and he concludes that to use this measure is to ignore the existence of the ACID profile – a pattern of scores found in the case of many dyslexic subjects comprising relatively low scores on the Arithmetic, Coding, Information and Digit Span sub-tests" (Ibid: 106). Farmer et. al (2002) argue that where there is room for improved diagnostic procedures is in the replacement of lengthy and tiring IQ tests such as the full WAIS with shorter tests that provide reasonable estimates of general cognitive ability. "In the longer term we need to reconsider which tests best measure the kind of cognitive abilities we consider to underpin reading ability" (Farmer et. al 2002: 6). It is not surprising therefore that current trends in dyslexia assessment seem to ignore the verbal components of IQ tests due to their apparent counter productivity and the length of time taken to administer the whole IQ test components.

Gilgil (1995) tested participants on reading more than once, first: she used reading as a literacy skill component; i.e., attainment data which indicate the current level of attainment of the study participants. Secondly, she used reading as a diagnostic test in her dyslexia diagnostic tool as an evidence of reading behaviour; i.e., to show how participants behave when reading aloud and what types of errors they commit notably in the case of dyslexic participants. Such repeated use of reading tests may have a negative impact by increasing the period of time of the overall test administration and indirectly increasing the difficulty as well as the probabilities of tiredness. It must be noted however that analysis of error patterns are extremely useful in such cases and perhaps the title of that particular subtest in Gilgil's test battery should have been changed.

Both visual and auditory recognition tests are highly relevant to dyslexia and are central to Gilgil's construction of her overall battery of tests. In addition, her test battery covers a wide range of skills that are reported as relevant to dyslexia. Her test contains some core indicators of dyslexia such as short term working memory. However, her battery of tests is very big and takes too long to administer, which in turn, may have negative effects on participants' performance and thus on the overall reliability and validity of her test battery. Lengthy and large test batteries are undesirable because many differences will arise because of "fatigue, anxiety and boredom rather than genuine cognitive differences" (Farmer et. al 2002: 11). In addition, excluding participants from disadvantaged backgrounds is not a good practice and may seriously undermine ethical and equal opportunities, thus producing a bias against less advantaged participants.

Although various test batteries tend to differ in the number and contents of their sub-tests, depending on the theoretical background adopted by their authors, there is now a major consensus that phonological impairment is a major cause of dyslexia and one would not only expect significant theoretical overlap, but also agreement on the specific tests that should be used for differences in these areas of agreement (Turner 1997, Fawcett & Nicolson 1995, 1996, Reid 1998, Smythe & Everatt 2000, Farmer et. al 2002, Muter 2003). This is not observed in Gilgil's battery of tests which does not include any subtests on phonological awareness.

The Arabic dyslexia diagnostic test depends on exclusionary criteria throughout; a practice that was severely criticised and is no longer used. The test also depends on teachers' referrals, which may be biased towards male subjects specifically as noted from the following extract:

> From 60% to 80% of individuals diagnosed with dyslexia are males. Referral procedures may often be biased toward identifying males, because they more frequently display disruptive behaviours in association with Learning Disorders. The disorder has been found to occur at more equal rates in males and females when careful diagnostic ascertainment and stringent criteria are used rather than traditional school-based referral and diagnostic procedures.
>
> Diagnostic and Statistical Manual of Mental Disorders IV (2000: 52)

Nevertheless, the test is a good start and one that needs to be revised and developed. Future amendments and/or modifications of this test should consider using group administered subtests rather than individually administered ones in order to save time and effort. The test battery does not include any phonological awareness subtest and it is advisable to include these in any future development of the test battery. Further, the test does not include any items on spelling, on either single word or non-word level, which are extremely important tasks. Spelling is considered by some researchers as a universal marker of dyslexia and it is recommended that any future development of this diagnostic test should include spelling as one of its component subtests.

Now that the issue of dyslexia assessment is covered and a critique of what seems the first dyslexia diagnostic test is provided, one is left with some unanswered questions regarding the manifestation of dyslexia in Arabic and how this will impact our understanding of the nature of the condition. The scene is therefore set to progress and investigate the current research's questions and to formulate some hypothesises based on understanding gained so far from the previous four chapters. The process of collecting data and conducting a quantitative study is therefore important here since it will provide one with the opportunity to try and find answers to the research questions and to test the research's hypothesis. Moreover, devising a diagnostic test to identify Arabic monolingual dyslexics children in Egypt will avoid the shortcomings of Gilgil's diagnostic test discussed above and will benefit from recent developments in the area of dyslexia assessment since the publication of Gilgil's study in 1995. Above all, devising such a test and collecting normative data from schools in Egypt will provide one with the opportunity to test the phonological deficit hypothesis and its relevance. This will be of course attempted within the applied linguistic framework specified while considering specific linguistic features of Arabic and in particular its orthography. The following chapter covers the methodology chapter which will provide the research questions, the research hypothesis as well as other important relevant elements one has to observe when conducting a quantitative research in the real world. Subsequent chapters will deal with the process of developing a diagnostic test, collecting the date and analysing it before finally discussing the results and research findings.

Chapter Five: Quantitative Research

5.1 Research Questions

Based on general understanding of the definition and theories proposed to explain the occurrence of dyslexia discussed in the first two chapters of the current study. And based on general understanding of the specific linguistic features of Arabic and subsequent investigation of the various methods of dyslexia assessment discussed in the third and fourth chapters of the current study, the following number of questions have emerged and which the current study attempts to address and finds answers to:

1. What is general and what is specific about developmental dyslexia in Arabic? (Abu-Rabia & Siegel 1995, Goulandris 2003, Share 2003)
2. Do various linguistic features of Arabic have an impact on the occurrence and manifestations of developmental dyslexia amongst monolingual Arabic children? (Elbeheri 2004, Saiegh-Haddad 2004).
3. Does the complex nature of Arabic morphology constitute an additional challenge for monolingual Arabic dyslexic children?
4. What is the underlying cognitive deficit which explains the occurrence of developmental dyslexia amongst monolingual Arabic children? (Abu-Rabia 2004)
5. Is the phonological deficit theory the underlying core cognitive theory which best explains the incidence of developmental dyslexia in Arabic?
6. Is there a similarity in the incidence and causes of developmental dyslexia in Arabic and elsewhere? (Szczerbinski 2003)
7. In light of recent progress in dyslexia assessment, what general and/or specific tasks should be included when attempting to compile a dyslexia diagnostic tool to identify monolingual Arabic dyslexics?

5.2 Research Hypotheses

The current study is based on the following hypotheses:

1. There are no significant statistical correlations between high and low achieving Arabic speaking Egyptian children or between dyslexic and chronologically age matched normal readers on non-verbal deductive reasoning and spelling, reading accuracy or reading comprehension. There is no linear relationship between deductive reasoning test and reading accuracy, reading comprehension or spelling.

2. There are significant statistical correlations between scores of high and low achieving Arabic speaking Egyptian children or between dyslexic and chronologically age matched normal readers on tests of rhyme detection, non-word reading and phoneme deletion and their scores on spelling, reading accuracy and reading comprehension. Both dyslexics and low achieving Arabic speaking Egyptian children have underlying phonological processing impairments.

3. There are significant statistical differences between scores of high and low achieving Arabic speaking Egyptian children or between dyslexic and chronologically age matched normal readers on the word sentence chain test and their scores on spelling, reading accuracy and reading comprehension. Both dyslexics and low achieving Arabic speaking Egyptian children have underlying orthographic and morphological processing impairments.

4. There are significant statistical differences between scores of high and low achieving Arabic speaking Egyptian children or between dyslexic and chronologically age matched normal readers on the backward digit span and

rapid naming tests and their scores on spelling, reading accuracy and reading comprehension. Both dyslexics and low achieving Arabic speaking Egyptian children have underlying deficits in verbal short term working memory and deficits in their ability to access their phonological representation in the long-term memory.

5.3 The Setting of the study

The current study is based on normative data collected from fourth and fifth year monolingual Arabic primary school participants from three different primary mainstream government schools located within the Central Educational Authority, Alexandria Governorate, in Egypt. Particulars of the research methodology employed in the current study as well as selection criteria of participants, description of the test design and subsequent data analysis are discussed in subsequent sections of this chapter. First: the following is a brief description of the setting of the study; vis-à-vis description of the educational system in Egypt and the perceived importance of literacy amongst its people and a brief account of the educational system in Alexandria, where the data is collected.

The Arab Republic of Egypt gained its independence in the first quarter of the twentieth century (1922), and since then successive Egyptian governments have been working hard to guarantee access to free education for all Egyptian nationals. The population of Egypt has been increasing ever since, and so has the number of Egyptian children admitted to school. This tremendous increase in the intake of students all over the country and the increasing awareness of the importance of literacy in Egypt have necessitated increased spending on education. With limited resources and ever-increasing ambitions of higher standards of living, most Egyptian nationals view education as a cost-effective means to achieve desirable social change. It is safe to say that this can generally be accomplished through the current, generous, free educational system that extends to cover post-secondary education. Now all individuals in Egypt have access to free mainstream government education. There are a large number of privately run primary and secondary schools across the country in addition to a few private universities which have a long-standing reputation for delivering a good standard of education that caters to diverse ethnic groups and which focuses on learning additional foreign languages. The Ministry of Education in Egypt is responsible for education during the primary, preparatory and secondary schools; while higher and further education are the responsibilities of the Egyptian Ministry of Higher Education and Scientific Research.

Basic elementary education in Egypt is compulsory, starts at the age of six and continues for 8 years. Children first join primary school for five years and then join preparatory school for three years. Those interested in continuing their education enrol thereafter in secondary school for three years before finally joining a university of their choice depending on their secondary school final marks.

The current research's data is collected from Alexandria, the second biggest city in Egypt with a population estimated to be in excess of ten million. The city is situated along the Mediterranean Sea and has been known for its past glorious[21] history as a centre of learning. The city is currently geographically divided into three large local educational authorities (LEAs): Eastern, Central and Western. The data of the current study is collected from schools that are controlled by the Central Educational Authority.

The scientific study of learning disabilities in Egypt does not include such learning disabilities as dyslexia and unfortunately no comprehensive data on disabilities is currently available. The Egyptian government collaborates with governmental and non-governmental organization to address disability issues. The Egyptian Ministry of Education provides special educational services for children with disabilities and offers "education services for the visually, hearing and mentally impaired through 165 specialized schools as well as 204 schools with at least one or more special classrooms for children with learning disabilities" ((Report of Japan International Cooperation Agency 200: 9).

5.4 Research Method

Encouraged by the emerging cross-linguistic studies of developmental dyslexia, the current research aims to investigate both *universal* and *language-specific* aspects of developmental dyslexia in Arabic by adopting a quantitative research method. In order to investigate the manifestation of developmental dyslexia amongst monolingual Arabic speaking Egyptian children, the current study devises a diagnostic tool which, will enable full investigation of developmental dyslexia in Arabic. The diagnostic tool is then used to collect data from monolingual Arabic speaking Egyptian children. Data collected enables hypothesis testing which in turn is based on theories of developmental dyslexia and specific nature of the Arabic language discussed in previous chapters.

While attempting to collect data and to devise a dyslexia diagnostic test in Arabic, the current research is shaped by three broad sets of considerations: ethical, technical and practical. Ethical considerations examine how ethically sound the research is and considers the various preliminary stages one has to undertake in order to ensure adherence to sound ethical considerations towards study participants, data collection, reporting of the data set and the study's findings. Technical aspects of the study

[21] It had once housed one of the ancient wonders of the world (Alexandria Lighthouse) in addition to one of the oldest and biggest libraries in the world (Bibliotheca Alexandrina)

investigate the choice of the data sample, the procedures involved in data collection, the validity and reliability of the test battery and subtests as well as other relevant statistical analysis and procedures. Practical aspects of the study represent the challenges and constraints inherent in carrying out investigations in the 'real world'; i.e., trying to develop a well founded understanding of the current research's aims, while recognizing the complexity of the environment and the research's ability to control all potential influencing factors. Finally, practical considerations examine issues relating to budget, deadlines, and the overall purpose of the research. These considerations are discussed in detail in the following section.

5.5 Ethical Considerations

Conducting a quantitative research that involves collecting data from young children requires adherence to strict sound ethical considerations which one has be aware of and strives hard to implement at all times. Ethical responsibilities extend to various types of people who either might be affected by the research itself or by its results. Saunders & Lewis & Thornhill (2003) explain ethics refers to the appropriateness the researcher's behaviour in relation to the rights of those who become the subject of the researcher's work (Saunders et. al 2003). De Vaus (2000) notes that amongst the individuals that might be affected by a research are the research participants, the profession and professional colleagues, the wider public and sponsors and/or those who fund the research. In view of this definition of ethics in research, one observes that the current research is faced with various ethical considerations which can be generally classified into four main categories: research participants, permissions, data collection and data reporting. The following section investigates each of these categories in more detail.

De Vaus (2000) lists a number of extremely important ethical responsibilities towards the research participants such as: voluntary participation, informed consent, no harm, confidentially and privacy. Voluntary participation means that children in the current study can not be forced to participate in the test battery. Due to participants' age and in order to adhere to this principle, a letter is distributed to parents of participants in the current study requesting permission for their children to participate in the test battery. Although voluntary participation can sometimes conflict with the other equally important methodological principle of representative sampling; fortunately, the current study has not met with any such problem as there are no particular selective criteria employed in its test battery and in essence, the data cohort in the current study can be considered as a pilot study which represents almost all participants from three mainstream government schools in Alexandria. Similarly, the data collected and reported on can be effectively used to develop representative norms for this area of Alexandria, Egypt.

Aims of the current study are explained to participants who are also assured that participation in the test battery does not affect their school curriculum nor their academic marks in any way. There is no harm caused to participants as a result of their participation in the test battery and the types of skills involved and required in all subtests are similar, if not the same, to existing English tests currently used to identify developmental dyslexia amongst monolingual English speaking children. Test components are all safe to administer on participants of that age range and there are no tools used in the test battery that may compromise the health or safety of participants. All efforts are made to guarantee that participants are not under duress in any way to participate in the test battery. The fact that administration of the test battery is conducted within participants' own classroom surroundings, will no doubt create a natural habitat for the test administration and the data collection.

Anonymity and confidentiality of participants are also observed in the administration of the test battery and results of the study are for research purposes only and are not made public to anyone. Participants' identities are not disclosed to any third party and their privacy is respected.

Permissions, obtained either before the data is collected or during the process of data collection, are of three types:

1. Copy right permission to use some of the subtests used in the test battery **A**rabic **D**yslexia **AT**-risk **I**ndicator (ADATI),
2. Permission from the Central Local Educational Authority in Alexandria, Egypt to gain access to primary schools to collect data,
3. Permission from participants' parents and/or guardians approving data collection from participants.

ADATI utilizes other existing available diagnostic tests in both English and Arabic. Permission is granted from the Psychological Corporation (Appendix 3) to use both the Backward Digit Span Test and the Rapid Naming Test which are both standard components of the Dyslexia Screening Test (Fawcett & Nicolson 1995). Permission is also granted from Louise Miller Guron to adapt the idea of the Word Chain (Miller Guron 1999) test and to develop an Arabic Word & Sentence Chain test (Appendix 4).

Although no success is so far achieved in obtaining copyright permission, continuous efforts are still being taken to request permission to use the Non-verbal deductive reasoning (Pictorial Non-verbal Mental Abilities) test, Sirs Ellayan Silent Reading test and the Grapheme Discrimination test. Though permission could not be obtained and as such is not yet available for using these tests, full acknowledgement of their authors were repeatedly indicated throughout the research.

Permission from the Central Local Educational Authority of Alexandria, Egypt was granted to access 3 primary mainstream government schools (El Hadara, El Shaheed Ali Salih and El Khaldeen primary schools). The Central Local Educational Authority of Alexandria, Egypt requested proof of study status, detailed description of the topic of study as well as other necessary supporting documentations. These necessary documents are facilitated through cooperation between Durham University, Egyptian British Chamber of Commerce and the Egyptian Consular Services in London.

5.6 Technical Considerations

Technical considerations are related to the way tests are administered and the manner in which these tests are corrected, marked and how scores are entered. Other technical considerations relate to the choice of subtests in as much as how suitable these are for collecting normative data from monolingual Arabic participants from Alexandria, Egypt. The choice of the layouts of various subtests as well as the marking sheets are all thought of in advance so as to facilitate the marking procedures of tests and to guarantee their accuracy. Particular care is given when designing some of the subtests so that the end result aspired to measure the required construct without having to neither depend on the participants nor no other overlapping skills; i.e., without measuring another intervening skills or variable. An example of this was in the rhyme detection test and the reading tests where participants are required to circle the correct answer only rather than writing it down. The same caution leads to the choice of the non-verbal deductive reasoning test employed in ADATI which, in addition to only requiring ten minutes to administer, and its group application facilities, does not require participants' verbal abilities nor does it require measuring them which would have otherwise constituted a bias against less able readers and/or dyslexics as well as being a counterproductive measure.

Technical considerations also shape the entire statistical analysis of the data, because they judge the dependence and independence of the many constructs and variables involved in the test battery as well as makes sure that possible intervening factors when analysing relationship between constructs are accounted for. An example of such a technical consideration is the care with which the dyslexics and control group are chosen. Fortunately, some subtests used in the test battery are established and well-known subtests in other existing dyslexia diagnostic tests; and as such it is felt that establishing validity and reliability of these are not critically important since the latter are already established elsewhere. However, and where possible, participants' scores on ADATI (continuous scores) are converted into dichotomous scores (0 for a wrong answer and 1 for a right answer), so that further statistical analysis such as internal consistency and factorial analysis can be carried out on individual subtests. Examples of these are appendices 5, 6 and 7 which represent ADATI internal consistency analysis in rhyme detection, word & sentence chain and grapheme discrimination respectively. Moreover, all ADATI tests start with detailed examples of what is required so that participants are clear as to what is required from them once the test starts.

5.7 Practical Considerations

Practical considerations refer to the overall process of data design, data collection and subsequent data analysis as well as how practical procedures are involved in making these available. Practical considerations are adopted in deciding the number and locations of schools involved in the study. There are 3 schools participating in the study and had the number of participating schools been higher, the number of participants would have been too many to handle and the time taken to collect data would have been too long to afford. The location of participating schools is also a result of practical consideration. The participating schools are all very close to each other (within a quarter of a mile radius) and as such very practical to move from one school into the other. This, of course, provides ease of access to the participating schools as well as saving time while travelling from one school to another which have all facilitated the process of data collection and test administration.

The initial aim of the current study was to collect data that is locally representative of the entire city of Alexandria. However, this is too ambitious to achieve within the time frame and financial resources available to the current study. To continue with the original aim would mean that data would have to be collected from various schools that are geographically diverse, and would have represented various economical, social and cultural backgrounds of monolingual Arabic speaking children of Alexandria. This, of course, would have been practically possible to conduct had there been sufficient funds to do so, as Alexandria is a big city and to conduct such a locally representative study of the whole city, more participants from different backgrounds would have been required. The initial aim is therefore abandoned as being impractical in terms of financial and logistical resources available for the current study.

However, the fact that there are quite a large number of empirical studies on dyslexia assessment in English makes the choice of test components and test design of ADATI more practical as some of these tests are readily available and easily accessible. Practical considerations also necessitate the beneficial usage of existing Arabic tests (such as the non-verbal deductive reasoning test, Sirs Ellayan silent reading test and the grapheme discrimination test) which are considered preferable than re-devising other tools. For practical considerations, other English subtests such as the backward digit span and the rapid naming tests are also used instead of re-devising these in Arabic since these two tests are not language-dependent and can therefore be used in Arabic without any need of translation and/or adaptation following Peer & Reid's (2000) assertion that

> It is not a viable proposition to trust the use of translation for administration of tests for children whose native language is not the language in which the tests were designed...for there are problems of culture bias, differing syntax and structure which would make them unreliable, hence their scoring invalid.
>
> (Peer & Reid 2000: 4)

In summary, practical considerations are one of the most important driving forces in choosing the data sample (the participating schools), the data set (the number of participants), the test battery contents (through the utilization of existing subtests either in English or in Arabic) and finally the layout of some tests (layout is easier to mark, does not require knowledge and/or skills relevant to other constructs which may intervene in the measured test and thus producing either a depressed or over-represented score).

5.8 Research Limitations

One of the first challenges that confronts the current research is the lack of materials and references in Arabic, which, fortunately, is in marked contrast to the large volume of resources available in English. Gilgil's study (1995) is therefore very relevant and represents a platform and a term of reference, particularly when considering previous methods of developmental dyslexia diagnosis in Arabic. Gilgil's study (1995), and notably her diagnostic test, although groundbreaking, depends on IQ-reading discrepancy and exclusionary criteria, which are no longer used when identifying developmental dyslexics due to their unreliability and invalidity; aspects that are discussed in detail in previous chapters. This has a knock on effect on the current research, for instead of solely devoting the current study to investigate the cognitive profiles of reading and writing difficulties amongst monolingual Arabic dyslexia children as one had originally hoped, the study is directed towards devising a more valid and reliable diagnostic tool to identify developmental dyslexics in Arabic. It is felt that investigating the cognitive profiles of reading difficulties amongst monolingual Arabic dyslexic children is an analytical task that can not be attempted without a preliminary valid and reliable Arabic developmental dyslexia diagnostic tool. It is also felt that devising such a diagnostic tool using normative data rather than criterion-referencing will warrant a pilot and/or an exploratory study in itself; hence initiating an opportunity for subsequent studies for the investigation of the cognitive profiles of reading and writing difficulties amongst dyslexic monolingual Arabic children. It is hoped that such a limitation is a blessing in disguise by presenting another challenge for further cross-linguistic research that is critically needed and is hugely under-represented in the corresponding literature in Arabic.

Another limitation facing the current research is the lack of sufficient financial resources. The study is self-funded and at times the amount of financial resources needed turned out to be far greater than was originally anticipated, especially in areas related to data preparation, implementation and data analysis. A huge amount of photocopying and printing are needed to prepare test materials for the initially 749 participants used for the initial procedures. These costs were much more than what had been originally planned for. Travelling to Alexandria and preparing materials (tests) and initially implementing the same on 749 participants, which included administering the battery of tests (ADATI) and the markings of the eleven subtests in order to collect the norms were also costly. Out of the ten subtests that make up ADATI, four were individually administered, which means that a considerable amount of time has to be spent with every participant to collect data for these tests.

Obtaining the necessary permissions to access primary schools from the Central Local Educational Authorities in Alexandria also took longer than originally anticipated, particularly after repeated interviews with educational officials who grant such access permissions. However, what proves to be the most challenging obstacle of all was that participating schools in the study had granted permission for data collection provided that these are only carried out during free class times as agreed with the respective head-teachers. This practically means that only one hour of testing is at all possible in any one school per day. Fortunately, the schools were not far from each other so that a maximum of three hours a day could be carried out. This has of course meant that the data collection took much longer than originally anticipated (over 18 weeks in total).

The three schools from which data was collected fell within one district in Alexandria, Egypt. Although care is taken for the data sample to be representative of the environment, the current study does not claim to be locally representative of Alexandria as a whole, but can only be considered a locally representative of one district of Alexandria. Any future developments the test should consider collecting data from various cities and schools as well as various backgrounds (private and main stream state schools, poor, middle class and rich areas, etc.) so that it can be representative of Egypt as a whole.

Some scores in the test battery are converted into dichotomous scores to assess validity and reliability of the whole test battery. However, ADATI contains 10 subtests which have 12 continuous variables in addition to a categorical variable. Some tests have a maximum score of 30 and converting these continuous scores into dichotomous scores to calculate internal consistency would have taken a long time. In additions, some of these subtests are already well-established components that are used with permission from another studies and their consistency and validity were already established before (such as the non-verbal deductive reasoning test, the backward digit span test and the rapid naming test). It is felt therefore that converting the continuous scores into dichotomous scores for some of these subtests, although preferable, is not critical, and therefore is dropped for practical reasons. It is advisable however, that in future developments of the test, all constituent subtests are assessed individually and internal consistency and factorial analysis are calculated, even though such tests are well established components in other diagnostic tests. These procedures will safeguard the overall reliability and validity of the battery of tests and will eventually guarantee that all constituent tests are coherent, relevant, vary in difficulty and measure all the required relevant skills.

Chapter Six: Data Design and Collection

6.1 Introduction

In deciding on what to include in ADATI, one was guided by substantive, observational and methodological considerations. As previously noted, it is very fortunate that the topic of dyslexia assessment is amply discussed in the research literature on developmental dyslexia in English; a fact that has made one's task easier. ADATI benefits from some of the well established measures and components used in existing dyslexia diagnostic tests and it is not surprising that some of the subtests used in ADATI require little justification since their use and validity in reading development generally and in developmental dyslexia testing in particular, are well documented elsewhere.

Generally, ADATI is intended to be used as an open diagnostic tool as opposed to a closed test that is only available to educational psychologists and/or other psychological assessment specialists. ADATI, it is hoped, can be used as a diagnostic tool by teachers in Egypt who should only need a few classroom sessions for their administration. The test battery is trying to fulfil a need for such cognitive diagnostic tools that are expected to be used widely in developed countries such as Egypt because they are teacher administered, affordable and easy to use tools.

There are a number of different tests that investigated a number of areas of difficulties which have come to be characteristics of dyslexia. These include tests of phonological discrimination and segmentation, non-word reading, word naming, word retrieval and working memory tests such as remembering different shapes, sequences of movements and numbers such as digit span tests (Cooke 2002). Some of these tests are considered core indicators of dyslexia and are believed to measure some of the behavioural manifestations of the likely underlying cognitive and/or biological deficits of dyslexia.

"The major factor when deciding the components of a particular test battery is the theoretical orientation" of the individual devising the test (Farmer et. al 2002: 12). An example of this is the Postural Stability Test used by Fawcett & Nicolson (1997) which is grounded in their theory that impairment in motor control movements which are found in the cerebellum can be detected amongst dyslexics. However, when deciding on the number and type of subtests to include in ADATI, one is faced with additional challenges because some of these well established dyslexia assessment components can not be employed or replicated in Arabic due to the specific nature of the Arabic language, and in particular the transparent nature of its orthography.

It is with these challenges in mind and subsequent cautious in practice that particular care is taken to include specific components that are widely used in the current dyslexia assessment batteries in similar relevant alphabetic scripts but which are also specifically relevant to developmental dyslexia diagnosis amongst monolingual Arabic children. However, it is still felt that ADATI test battery will benefit greatly from further developments and/or modifications which can improve its overall reliability and validity while making it easier and more effective for dyslexia diagnosis in Arabic.

Following the detailed investigation of similar available tests, a test battery, ADATI, is developed which consists of 10 subtests. Based on similar tests in other alphabetic scripts, particularly English, ADATI can be divided into three major parts: tests of current cognitive abilities such as the non-verbal (performance) deductive reasoning test, tests of educational achievement "attainment" (literacy skills such as spelling, reading accuracy and reading comprehension) and other core (positive) indicators of dyslexia; such as verbal short term memory, rapid automatized naming and phonological awareness.

Part one of ADATI consists of a cognitive abilities test which is employed in ADATI to serve two purposes, first: to measure for current cognitive abilities in the data sample and to control for global deficient monolingual Arabic children. Second, to be able to test the first hypothesis of the study and find out if IQ-reading discrepancy can be used as a basis of a discrepancy criterion to identify monolingual Arabic dyslexics. Following the IQ-reading discrepancy formula and the achievement-potential argument discussed fully in the first chapter of the current study and the further investigation of IQ as a standard component in some dyslexia assessment tools, ADATI benefits from the use of a performance non-verbal deductive reasoning (pictorial mental abilities) test which was standardized to suit the Egyptian environment. This pictorial non-verbal mental abilities test is an easy to use group administered test which is easy to administer on large data samples (can be used on a whole classroom of up to 50 children at one time) and which only takes ten minutes to complete.

The second part of ADATI assesses participants' current performance on tests of literacy attainment as indicated by their educational/academic achievement. This part examines participants' reading (both accuracy and comprehension) as well as their spelling abilities. This part consists of a silent reading test and a spelling test. The reading test, Sirs Ellayan Silent Reading Test, consists of two separate sub-tests; reading accuracy and reading comprehension. This test is also group administered and is useful to quickly assess the reading skills of monolingual Arabic speaking children in Egypt. The reading accuracy subtest consists of a word recognition from a picture section, a sentence recognition from a picture section and a sentence completion section. The reading comprehension sub-test contains sentence and passage comprehension which is followed by multiple choice questions where participants choose the correct answer from a multiple choice section that followed each passage. This test was also standardized to suit the Egyptian environment.

The third part of ADATI consists of 8 subtests that are frequently used in epidemiological studies. These tests are frequently regarded as core (positive) indicators of dyslexia and they include phonological awareness based tests (rhyme detection, phoneme deletion and non-word reading). This part also includes tests which measure participants' visual discrimination skills (grapheme discrimination) and tests which measure participants' verbal short term working memory (backward digit span). Tasks which measure speed of processing and orthographic knowledge (rapid naming and word and sentence chain) are also included in that section.

6.2 Test Design

6.2.1 Part One: Tests of Abilities:

6.2.1.1 Non-verbal deductive reasoning test (Appendix 1 & 2): The Pictorial Mental Abilities test is a norm-referenced non-verbal deductive reasoning test which was standardized to suit the Egyptian environment by Salih (1978, cited in Gilgil 1995). The test consists of sixty sets of pictures; each set contains five pictures. Four out of the five pictures in each set are related and can be grouped according to a particular theme or an idea while the fifth picture is unrelated to the rest of the group and as such is considered to be the odd one out. The task of participants are to identify the odd picture out and circle it. The test starts with six examples where the instructor makes sure that participants understand fully what is required from them before starting the actual test. The test is group-administered, timed and takes 10 minutes to complete. The test has an answer key for quick scoring which contains the correct answers. In addition, the test has an absolute matrix which contains the various ages of participants (starting from 8 until 17 years of age) as well as the equivalent standard score[22] for every raw score[23] achieved and a percentile rank that shows the percentile of each participant in relation to their closely age-matched peers in Egypt.

The non-verbal deductive reasoning test manual indicates that the test can be employed to find out the non-verbal IQ of individuals with a minimum age of 8 and a maximum age of 17. Method of assessing the test's reliability is reported in the test manual (between 0.75 minimum achieved and 0.85 maximum achieved) using the factorial analysis technique and the split level test along with methods of assessing its validity (0.61 criterion validity) as well as other construct validity obtained by comparing the test to other well established tests.

Tests of mental abilities which are also sometimes called intellectual capacities have been frequently used in dyslexia assessment for quite sometime now. As discussed amply in the definition and definitional problems of developmental dyslexia in the first chapter of this study, traditional definitions and/or assessments of dyslexia were largely based on the assumption that there is a linear relationship between an individual's mental abilities and their educational/academic achievement. Doyle (2002) argues that one of the greatest influences on a child's ability to read will be his intelligence level. Such a relationship is reported to be generally found in the general population and some researchers argue that such a relationship is so strong that educational/academic achievement can be predicted from mental abilities. However, as previously discussed, such a view is under criticism and is reported to have no theoretical grounds (British Psychological Society Report 1999). Other researchers argue that as dyslexic children can be disadvantaged by their poor reading skills, it is especially important that they are given non-verbal reasoning tests (Cooke 2002).

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[22] Standard Score shows how "raw score compares with other scores achieved by other children of the same age and is expressed as a number in relation to the average for the age group" (Cooke 2002: 19).

It is decided to include the non-verbal reasoning test described above for the following reasons: first, without such a test, the first hypothesis of the current study can not be tested. Second; such a test enables one to measure for global deficiency amongst the population of the data set, and without which such a global deficiency can not be assessed or controlled. Third; ADATI does not depend on teachers' referrals in selecting participants who show reading and writings problems due to the subjective and judgemental nature sometimes associated with teachers' referrals. Therefore, the current non-verbal reasoning test is useful when identifying global deficient participants while at the same time avoids the subjectivity of teachers referrals.

The pictorial mental abilities test is a performance test and as such avoids bias and counter productivity against monolingual Arabic dyslexic participants. In addition, participants are required to discover the relationship between the four pictures which is a deductive reasoning exercise in itself and is not intended to measure factual knowledge as other components of mental abilities do and as such counter-productivity is again avoided. Such a deductive reasoning ability is primarily free from verbal skills and as such may potentially be suitable to differentiate between dyslexics and garden variety poor readers.

6.2.2 Part Two: Tests of Attainment:

6.2.2.1 Sirs Ellayan Silent Reading test: Silent reading is the most frequently used reading technique and it has its own underlying skills. Silent reading can sometimes be twice as fast as oral reading and a child who is to become a practised skilled reader

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[23] A raw score is the actual number of correct responses participants' achieve. "It refers to any piece of data that provides an absolute (rather than relative) assessment of one's standing on a quantitative variable" (Huck 2000: 67).

has to develop the skill of silent reading quickly (Cooke 2002). Sirs Ellayan Silent reading test is a ready to use test which is widely used and was standardized in Egypt. The test contains various sub-sections which seem to tap on almost all the sub-skills involved in the process of reading. The test consists of two main parts: reading accuracy and reading comprehension, and these two subtests are discussed below in more detail.

6.2.2.1.1 Reading Accuracy test (Appendix 9): This test includes three sub-sections, with a final score of 30.

- *Word recognition from a picture*: This section contains 14 pictures; each picture is followed by a set of 4 words and only one of them is correct in describing the picture. Participants are required to mark the word which corresponded to the picture. The final score in this section is out of 14. It is argued that poor readers can not rely on instant word recognition because their skills are somehow inadequate; hence the importance of this component in an overall reading accuracy test.
- *Sentence recognition from a picture*: This section contains 6 sets of 3 pictures each. There is a sentence underneath each set of pictures which only describes one of the pictures in that set and participants are required to mark the picture that corresponded to the sentence. The final score in this section is out of 6.
- *Sentence completion*: This section consists of 10 sentences each missing a word that completes its meaning. Each sentence is followed by a set of 4 words with only one correct word that can fit in the missing space and provides the correct answer. Participants are required to mark the correct word that fits in the missing sentence. The final score in this section is out of 10. Sentence completion tests are much more demanding than single word reading because the sentence must be

read sufficiently correctly to allow correct choice of the missing word (Cooke 2002). Such tests combine three different tasks which are: word recognition, sentence reading and comprehension hence their demanding nature.

The above three sections make up the first subtest of Sirs Ellayan Silent Reading test and together they provide a clear picture as to whether the participant could be read accurately or not.

6.2.2.1.2 Reading Comprehension test (Appendix 10): This test consists of one section only: i.e., passage comprehension. The test has 20 passages in total which varies in length and grade of difficulty. These passages start with a simple sentence which is made of two or three words and ends with a 4/5 lines passage. Each passage is followed by one, two, three or sometimes four questions based on the understanding of the passage. Each question is followed by four answers and only one of these is correct. Participants are required to mark the correct answer to the question and the final score for this test is out of 26.

Short passages which have to be read and comprehended so that correct answers can be given included a number of underlying skills such as reading accuracy, use of context as well as understanding (comprehension).

Assessment of educational attainments/achievements is an important component of any dyslexia diagnostic test. As noted above, one of the traditional defining criteria of developmental dyslexia is that participants' attainments are below that would be predicted by their mental abilities. It has been customary to assess different aspects of reading such as word decoding, reading accuracy, sentence reading, reading comprehension and spelling.

Reading comprehension refers to the "children's understanding, retention and recall of what they have read" (Mutter 2003: 10). It is a "demanding cognitive process which makes it possible for the reader to extract meaning from the text, think about it, draw conclusions and make inferences" (Hoien 2002: 54). It is in fact the ability to read for meaning and as such the most important reading skill. Although reading comprehension is much more complex than word recognition; the former in fact depends on the latter and the efficiency in the word recognition would ultimately improve reading comprehension. Stackhouse & Wells (1997) explain that the final scores in reading comprehension tests are affected by the participant's existing verbal language comprehension skills. Reading accuracy, on the other hand, refers to "children's ability to recognize words in printed form accurately" (Mutter 2003: 10).

6.2.2.2 **Spelling test:** (Appendix 11): This test consists of a dictation passage. The passage is a very short story and the test is not timed. The test administrator reads the story out loud, repeating each word as many times as participants request. The final score of this test is out of 10, but if participants make the same error twice, it is only marked as one mistake. In other words, each spelling mistake have to be different from the rest.

This spelling test is important due to the importance of spelling skills as a deficit manifested by dyslexics regardless of the language used. Indeed, various studies of developmental dyslexia indicate that poor spelling is a concomitant of reading disability (Aaron 1994). It is argued that being generally weak in phonological skills, dyslexics usually make unusual high number of spelling errors because they in fact depend on spelling-to-sound relational rules when participating in a dictation test.

Snowling (2002) claims that "one of the very significant and persisting consequences of phonological processing deficits is a difficulty with spelling" (Snowling 2000: 96). Moreover, spelling provides a direct link to students' representations of spoken phonemes in written form and might "provide a window on the nature of phonological abilities and deficits affecting dyslexic students" (Sawyer & Wade & Kim 1999: 138). Snowling (2000) argue that although dyslexic children are sensitive to statistical regularities of the orthography, their ability to "deal with its inconsistencies when spelling words is almost always impaired" (Snowling 2000: 96).

It is anticipated that spelling will be more difficult than reading for monolingual Arabic children due to the highly inflectional nature of the Arabic language. To spell Arabic correctly, participants have to have extensive knowledge of grammatical rules which govern the inflection of nouns and adjectives in Arabic as well as the conjugation of verbs.

6.2.3 Part Three: Core (Positive) Indicators of dyslexia:

Research studies and clinical observation provide a good deal of evidence that children with dyslexia have difficulties with aspects of phonology (Cooke 2002) and it is now generally acknowledged that "impaired phonological awareness is a core deficit of dyslexia" (Farmer et. al 2002: 5). There are a number of subtests in ADATI which are dedicated to measure aspects of phonological awareness skills such as the non-word reading, the rhyme detection and the phoneme deletion tests. Other core 'positive' indicators of dyslexia include documented problems in rapid automatized naming and in backward digit span. Both the grapheme discrimination and the word & sentence chain tests are also included in ADATI based on the specific linguistic characteristics of Arabic and the anticipated confusion these may cause for a monolingual Arabic dyslexic children.

6.2.3.1 Non-word Reading test: (Appendix 12): Due to the lack of non-word reading tests in Arabic, one had to devise a non-word reading test to be used in ADATI. This test contains 10 nonsense words that although are orthographically realistic, have no meaning in Arabic. In order to read these words, participants have to phonologically decode each word. The test is individually administered and participants are shown each word one at a time. For each correct read word, the tester scores a point and no points are scored to incorrect answers.

The nonsense words help to train pupils to apply phonic principles accurately without being able to check for meaning (Cooke 2002). The most direct way of assessing a child's decoding skill is by asking them to read words they have not encountered before (Snowling 2000) or words with which he or she is unfamiliar (Aaron 1994). This task is generally acknowledged to reflect a person's phonological abilities because it requires both "grapheme-phoneme transcription and then a blending of the resulting sound" (Farmer et. al 2002: 17).

"Unlike known words that have usually been read several times and can be mapped on to an existing phonological representation, non-words are completely unfamiliar" (De Jong 2003: 42). Non-word reading tests measure phonological decoding skill and are considered to be one of the most important positive indicators of developmental dyslexia. The use of non-words is well established as a research tool in dyslexia. Turner claims that "if ever there was a marker for dyslexia, this is it" (Turner 1997: 96). The test is extremely important and strong predictor of typical dyslexic-type errors in English dyslexia assessment test batteries. Participants can not depend on sight reading to decode nonsense words and have to phonologically decode words. The typical dyslexic individual find this kind of "investigation of his/her alphabetic coding skills to be difficult" (Turner & Nicholas 2000: 75).

In English orthography, non word reading test is a matter of mapping morphophonemic letter-patterns with their underlying phonological representations and the inability of individuals to decode non-words stresses the underlying difficulty in phoneme-grapheme mapping problems which may represent the individual's specific difficulty. Frith (2002) argues that poor non-word reading suggests that individuals' have not yet achieved competence in the alphabetic strategy. Dyslexics, as Frith claims, may have problems in acquiring this strategy "which enable them to access a word's meaning as quickly as the word's sound" (Frith 2002: 52).

6.2.3.2 Rhyme Detection test: (Appendix 13): Rhyme is the identical sound of the end chunk of two or more words, irrespective of spelling (Townend 2000). Rime, on the other hand, is the end chuck of a word and words rime when they sound and look the same. However, due to the specific nature of the Arabic language and particularly the challenge posed by word boundaries, it is rhyme and not rime that this subtest is concerned with. From now on, only reference to rhyme is made and intended throughout the remaining part of the current study.

The rhyme detection test in ADATI is developed by the researcher. The test consists of ten sets of five words each. Four out of the five words in each set rhyme while the fifth word does not. Participants are required to decide which items rhyme and which do not and then mark the word that does not rhyme with the rest of the group. Each correct marked word is given one point and no points are given to incorrect answers. The test final score is out of 10.

Bradley & Bryant (1983) argued that a problem in carrying out this task is a powerful predictor of developmental dyslexia (cited in Mutter 2003). Rhyme detection test is another phonological awareness based task that is frequently used in English dyslexia test batteries. Stackhouse & Wells (1997) argue that in order for participants to understand the concept of rhyme, participants need to detect the common elements that rhyming words have and how they differ from each other. However, Cooke (2002) argues that success with the odd-one-out kind of test may also depend on the child's ability to remember and recall the three words presented.

6.2.3.3 Phoneme Deletion test: (Appendix 14): One was prompted to devise the phoneme deletion test due to the lack of available phoneme deletion tests in Arabic. The phoneme deletion test consists of nine words which are classified into three groups. The first group consists of three words where participants are required first to read the presented words and then delete the initial sound before re-reading the words again without the initial sounds. The second and third groups work in exactly the same manner but participants are required to delete the medial sound in the second group of words and the final sound in the third group of words respectively before re-reading the words again. The test administrator scores one point for each correct read word and no points are scored for incorrect answers. The test final score is out of 9.

Deficits in phoneme deletion tasks have been shown to be powerful predictors of developmental dyslexia (Mutter 2003). Participants are required to remove a phoneme from a given word and then report the result and the phoneme which is deleted can be the initial, medial or final. "Phoneme Deletion is a task that is frequently used to measure for phonemic awareness" (Farmer et. al. 2002: 16).

6.2.3.4 Backward Digit Span test: (Appendix 15): The idea of ADATI backward digit span test is taken with permission from the Dyslexia Screening Test (DST) developed by Fawcett & Nicolson (1995). The test measures verbal short term phonological working memory which is reported to be associated with developmental dyslexia. Digit span is the number of digits participants can remember in the right order. There are two types of digit span tests; forward and backward digit spans, but backward digit span test is thought to be usually more sensitive to developmental dyslexia than forward digit span (Fawcett & Nicolson 1995).

Participants are required to recite back in correct order sequences of digits that are read out by the tester. This digit span subtest "although involving elements of attention and concentration, is essentially a test of auditory sequential memory" (Thomson 2003: 8). This test is based on the documented belief that "dyslexics have shorter digit spans than non-dyslexics and this test is one of the so called ACID[24] tests of dyslexia" (Farmer et. al 2002: 18). Working memory refers to "a set of systems responsible for the temporary storage of information during the performance of cognitive tasks" (Mutter 2003: 39). Because the digit span test involves working memory, "it has long been used as one of the diagnostic tests for dyslexia" (Miles 1999: 49). "Crucially, the backward digit span test involves phonological/naming and working memory skills which are well known to be weak in dyslexics" (Thomson 2003: 8). One of the most reliable and "often quoted associated characteristics of developmental dyslexia is an inefficiency in short term memory" (Rack 1994: 9, cited in the Report of the British Dyslexia Society: 1999: 33).

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[24] ACID stands for Arithmetic, Coding, Information Processing and Digit Span.

6.2.3.5 Rapid Naming test: (Appendix 16): This test is taken with permission from the Dyslexia Screening Test (Fawcett & Nicolson 1995). The test consists of two sets of twenty-pictures in each set. The first 20 pictures are repeated once again in the second half of the test; thus the test contains 40 pictures in total. The test involves asking children to name highly familiar objects under speed conditions. In the rapid naming test of ADATI, the names on the naming card are not read to participants. Participants are asked to read as many as they could in as quickly as possible.

The rapid naming test is used in ADATI to measure speed of rapid serial naming, and the use of the test depends on the documented evidence that there is a strong relationship between naming speed and reading skill. Denckla (1999) argues that this test measures participants' abilities which are separate from phonological processing domains. It is generally agreed that children with reading difficulties tend to name visually presented items; "including, numbers, colours, pictures of common objects and letters more slowly than normally-achieving readers" (Davis et. al. 2001: 232). Rapid naming is a test "of access to spoken words (names) and therefore comes under the general umbrella of phonological ability" (Farmer et. al 2002: 18).

"There is increasing evidence that speed of processing is both a significant underlying cognitive factor and identifier of dyslexia and this can be assessed by measures of rapid naming" (Smythe & Everatt 2000: 18). Rapid naming is amongst the list Gardner (1994: 85-100) mentions as a checklist of symptoms associated with dyslexia and which can be picked up on by observant school teachers. Gardner refers to it as "verbal retrieval difficulties, where the pupil appears slow or unable to access words from his/her word store, sometimes meaning that they cannot put names to familiar objects" (Gardner 1994: 87). Naming speed tasks are reported to tap into the children's ability to access their phonological representations in the long-term memory and there is evidence that "dyslexics are slower at naming, even with familiar pictures" (Fawcett & Nicolson 1998: 52).

Naming, as argued by Stackhouse & Wells (1997), requires the child to access their own representations of the word semantically first before converting this visual stimuli into a spoken form. Participants have to identify the picture presented and verbally produce its name without having heard it first by the test administrator. "Naming is a direct production of the child's representation of the test picture" (Stackhouse & Wells 1997: 82). Miles & Miles (1999) noted that 'naming' is another area which dyslexics seem to have difficulty with. "Even when the stimulus is something completely familiar, the time needed for dyslexics to 'find' the appropriate word appears to be longer" (Miles & Miles 1999: 36).

6.2.3.6 Grapheme Discrimination Test: (Appendix 17): This test is devised by Gilgil (1995) and is used in her dyslexia diagnostic test which was discussed earlier in chapter four of the current study. The test originally consists of 40 sets of either identical or very similar pairs of words in Arabic. Participants are asked to look at each pair of words silently before indicating whether each set is different or the same. However, 40 pairs of words might be slightly longer than needed and a decision to use only the first 25 sets in ADATI is preferred.

Participants are given a point for each correct answer and no scores are given for incorrect items. The test is thought to measure visual discrimination of Arabic letters and is particularly relevant since Arabic symbols are orthographically similar and the elaborate use of dots might confuse some Arabic readers. This test is therefore designed to investigate whether participants can effectively discriminate visually between presented Arabic words.

6.2.3.7 Word & Sentence Chain test: (Appendix 18): The idea of this test is adapted from the English version of Word Chain Test, by Louise Miller-Guron (1999). However, the current test adds a new section regarding the sentence chain part. The current test consists of two parts: word chain and sentence chain. Participants are required to insert a slanted line between continuous chains of words that are written joined together. The second part of the test consists of a chain of words that make up a complete meaningful sentence in Arabic, and participants are required to insert a slanted line after the end of each meaningful word.

The word & sentence chain test, it is hypothesized, is of particular relevance to both orthographic processing[25] and morphological density of Arabic and the cursive nature of Arabic orthography which were all discussed in chapter three of the current study. The test is designed to measure orthographic knowledge of monolingual Arabic children and to assess how relevant it is when learning to read Arabic. Based on the specific nature of the Arabic language discussed earlier in detail, particularly its morphological density and the cursive nature of its orthography, it is anticipated that orthographic knowledge will play a critical role in reading and spelling in Arabic.

6.3 Test instruments

There are no special instruments required for the implementation of ADATI and the following list contains all ADATI components (most of these are found in the Appendix):

1. Non-verbal deductive reasoning test (Pictorial Mental Abilities test): test booklet, answer key and percentage/percentile matrix for converting raw scores into standard scores. Participants answer in the test sheets which are then collected for markings.

[25] "Orthographic processing refers to the visual processing of letters and letter patterns into words and word parts" (Badian 1997: 71).

Raw and standard scores can be collected but since the rest of the scores in ADATI are raw scores, only raw scores on the non-verbal reasoning test are used for subsequent statistical analysis.

2. Sirs Ellayan silent reading test: test sheets which are divided into two main subtests The first subtest contains three sections which are: word recognition from a picture, sentence recognition from a picture and sentence completion. The second subtest consists of reading comprehension passages. Participants answer in the same test sheets, which are then collected for markings.

3. Non-word reading test: test sheet and instructor's marking sheet. The test sheet is given to participants which contain examples and test items. The test instruction, which also contain the marking table, is given to the test instructor.

4. Spelling test: test sheet and participants' answer sheet. The test sheet contains a short written passage and is given to the test instructor while participants are given answer sheets. Participants' answer sheets, which contain their names, class, and date of birth, are then collected and retained by the test instructor for markings.

5. Rhyme detection test: test sheet and instructor's sheet. The test sheet is given to participants. These contain few examples and the test items. The test instruction, which also contains the marking table, is given to the test instructor.

6. Phoneme deletion test: test sheet and instructor's sheet. The test sheet is given to participants and it contains examples as well as the test items. The test instruction, which also contains the marking table, is given to the test instructor.

7. Backward digit span test: test sheet and instructor's sheet. The test sheets are given to participants and it contains examples and test items. The test instruction, which also contains the marking table, is given to the test instructor.

8. Rapid naming test: rapid naming card and scoring sheet. The rapid naming card is shown to participants and a scoring sheet is used by the test administrator to calculate the time in seconds that participants take to read the whole objects on the rapid naming card. This is added to the number of mistakes participants commit while naming these objects. Each mistake is then calculated as equal to five seconds and these are added to the overall time participants take to read the rapid naming card.

9. Grapheme discrimination test: test sheet and instructor's sheet. The test sheet contains 25 pairs of words which are preceded by some examples so that participants know what is required from them. It also has spaces for participants to fill in their names, classes and date of birth. These are checked against the central register of each class provided by each school. The instructor's sheet contains background information about the test as well as the best way of administering it. Answer sheets are then retained by the test administrator for markings.

10. Word & sentence chain test: test sheet and instructor's sheet. The test sheet consists of word chains and sentence chains and each section is preceded by examples so that participants are familiar with what is required from them. The instructor's sheet contains background information about the test and the best way of administering it. Answer sheets are then retained by the test administrator for markings.

6.4 Sample and data selection

Normative data of the current study is collected from fourth and fifth grade monolingual Arabic speaking primary school children from a primarily working class background in Alexandria, Egypt. There are no teachers' referrals and therefore the whole data set can be considered a pilot study in as much as it aims to explore the various cognitive profiles of reading difficulties amongst dyslexic monolingual Arabic children in Alexandria. Teacher's referrals are avoided as being both subjective and judgemental. Instead, a pilot study of almost the whole fourth and fifth grade primary participants in the three chosen schools is attempted. There are no specific selection criteria for choosing participants in ADATI and all participants are randomly selected.

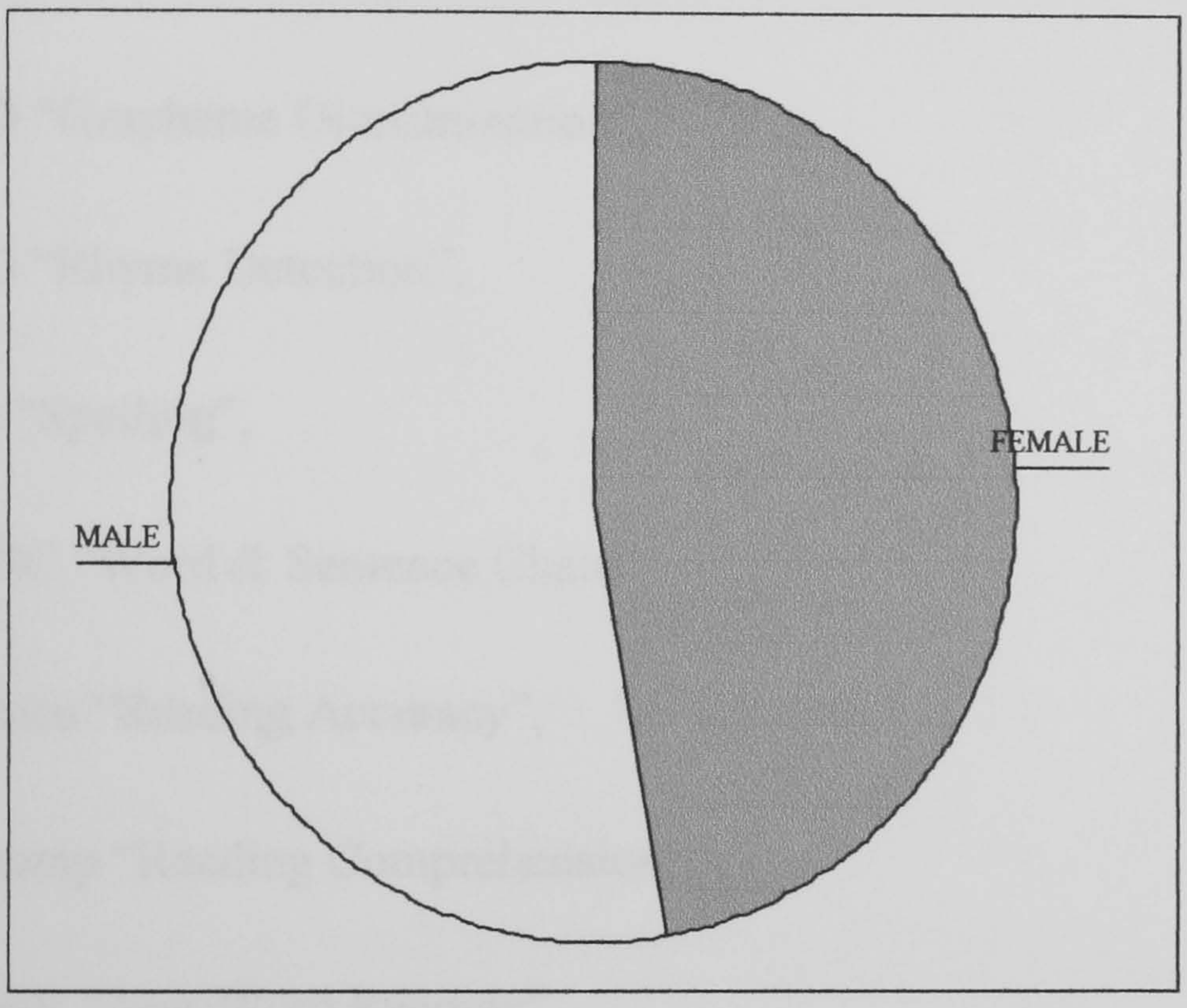
As previously discussed, Alexandria has been chosen for reasons of practicality, since it is the researcher's hometown and familiarity of the existing system and schools certainly facilitated data collection and test administration. Norms for ADATI are not nationally representative of the Egyptian population nor locally representative of the city of Alexandria as they are collected from only three schools that had participants from primarily working class parents and are located in only one area of Alexandria. The three mainstream primary schools, from which data is collected, all came under the supervision of the Central Local Educational Authority of Alexandria, Egypt. Participation depends on parental permission and permission slips are distributed to the parents or guardians of all the children who take part in the study.

The original data sample was 749 participants. However, there are insufficient data scores for all participants in all the test items due to either absence of some of the participants during some test administrations, or due to incomplete answer sheets submitted by participants (some answer sheets although complete, did not have the name of participants!). Due to missing fields in the data set, only a final figure of 382 records complete data set is eventually kept. Table (1) and Graph (7) below list the gender number and distribution of ADATI participants.

Gender Distribution of ADATI Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FEMALE	180	47.1	47.1	47.1
	MALE	202	52.9	52.9	100.0
	Total	382	100.0	100.0	

(Table 1: Number and gender distribution of ADATI participants).



(Figure 7: ADATI male and female distribution graph)

Table (1) and Figure (7) above report the overall number and gender distribution of the whole ADATI data set. Out of the 382 participants in ADATI, 52.9% are males and 47.1% are females and the data set, can therefore be viewed as having a balanced distribution of both genders.

6.5 Test administration, scoring and data entry

The kind of scoring used in ADATI test battery depends on the nature of the individual subtests as well as the subsequent statistical analysis required from each subtest.

Responses are largely marked as right or wrong, giving a quantitative measure that could be used for statistical analysis. The complete data set of ADATI contains the following information: participants' names, gender, date of birth, age "this is calculated using the critical date 'date on which the test is administered' and their dates of births" as well as their total scores in 11 other variables which are abbreviated as follows:

1. Non-verbal reasoning test raw scores PMARS (Pictorial Mental Abilities Raw Score),
2. GD "Grapheme Discrimination",
3. RD "Rhyme Detection",
4. Sp "Spelling",
5. WSC "Word & Sentence Chain",
6. Raacu "Reading Accuracy",
7. Rcomp "Reading Comprehension",
8. NWR "Non-Word Reading",
9. PD "Phoneme Deletion",
10. BDS "Backward Digit Span",
11. RN "Rapid Naming".

Names of participants are entered using the schools' authorized registry and then compared with names of participants which are required on every test of ADATI test battery. However, participants' names had to be entered carefully and further revised as some participants had very similar initial, medial and even family names.

Scores of participants on the rapid naming test 'the time in seconds participants take to complete the test', is entered first and then inverted so that a correct raw score is eventually calculated. At the end of the data entry, the complete data set is then exported into SPSS format so that further statistical analysis can be attempted. The data set is also screened to check for errors and/or out layers and to make sure the data set is free of errors that may affected the data analysis.

After discussing the various procedures involved in ADATI test design and explaining their rationale and after describing the process of data collection from monolingual Arabic speaking Egyptian children, the next chapter investigates the process of data analysis in detail. The next chapter reports the various statistical processes involved in calculating ADATI's reliability and validity. It also adopts a classification of participants according to their scores into high and low achievers' approach which allows maximum investigation of the underlying cognitive abilities involved when assessing for dyslexia. The following chapter classifies the data cohort into 23 groups so that in-depth data analysis of the various sub-tests and their impact on the reading accuracy, reading comprehension and spelling performance of monolingual Arabic speaking Egyptian children can be fully investigated.

Chapter 7: Data Analysis

7. 1 Introduction

Table (2) below reports ADATI descriptive statistics; the minimum and maximum scores in each test as well as the mean and standard deviation:

ADATI Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	382	9.00	14.45	10.2638	.74378
Non-verbal reasoning	382	2	42	23.43	9.238
Grapheme Discrimination	382	0	25	22.72	4.928
Rhyme Detection	382	0	10	7.36	3.092
Spelling	382	0	10	4.62	3.157
Word & Sentence Chain	382	0	25	13.60	5.492
Reading Accuracy	382	5	30	27.66	3.352
Reading Comprehension	382	0	26	17.23	4.822
Non-word Reading	382	0	10	7.39	2.707
Phoneme Deletion	382	0	9	7.59	2.094
Backward Digit Span	382	0	10	4.94	1.917
Rapid Naming	382	1	78	59.31	11.673
Valid N (listwise)	382				

(Table 2: ADATI descriptive statistics)

Some of ADATI participants are children who either failed in previous years and had to repeat the academic year (either the fourth grade or the fifth grade) or are originally admitted to school later than or earlier than the rest of their colleagues; hence the difference in the age of participants (minimum 9.00 and maximum 14.45). However, all subtests used in the ADATI battery are suitable for this age range and are very similar in their contents to relevant materials currently used in their school curriculum.

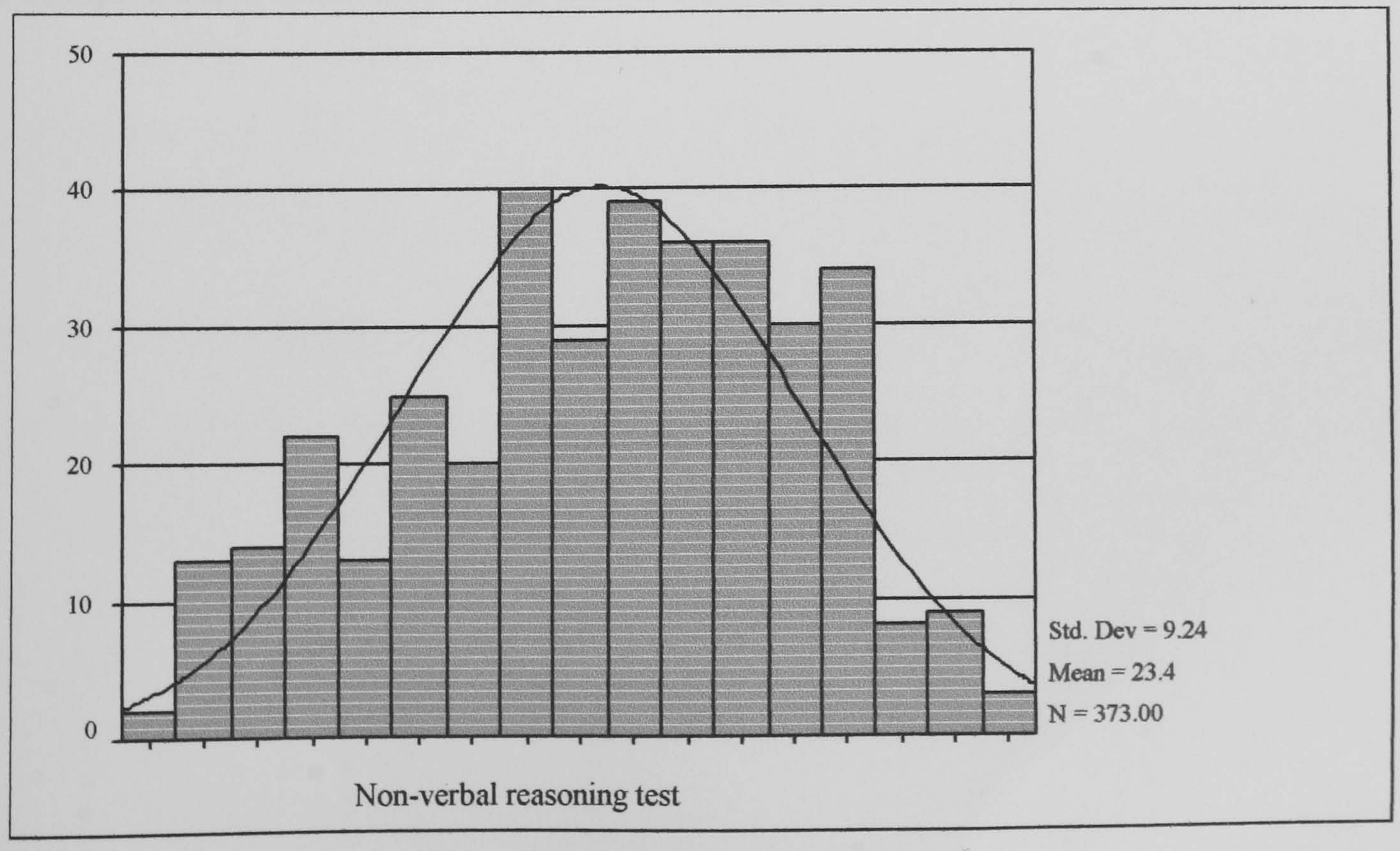
Scores of the grapheme discrimination, rhyme detection, reading accuracy, non-word reading and phoneme deletion tests are very high and close to ceiling. This is an important observation and one that is discussed in detail in the next chapter. On the other hand, scores of the word & sentence chain, rapid naming, backward digit span and reading comprehension tests are not as high as the tests mentioned above and participants' scores on these tests are not close to ceiling. This is an important observation and one that is also discussed in detail in the next chapter.

Table (3) below lists the descriptive statistics of the non-verbal deductive reasoning test in ADATI. The minimum raw score of the non-verbal deductive reasoning test is 2 and the maximum score is 42 and the mean is **M = 23.47**. The non-verbal deductive reasoning test scores, its standard deviation and variance all indicate that the test contains items that are graded in difficulty. The test has a high variance (**84.192**) which indicates wide distribution of scores amongst its participants.

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
PMARS	382	40	2	42	8964	23.43	9.238	84.192
Valid (N)	382							

(Table 3: ADATI Non-verbal deductive reasoning test descriptive statistics)

Figure (8) below demonstrates the non-verbal deductive reasoning graph with a superimposed normal distribution curve to find out how close the non-verbal reasoning test distribution is from the normal distribution as represented by the normal distribution curve.



(Figure 8: ADATI Non-verbal reasoning test graph)

7.2 Reliability

The reliability of a scale indicates how free it is from random errors (Pallant 2001). Reliability is an important aspect of a test and it basically examines whether the test achieve consistent scores when re-administered; i.e., "a measure is reliable if it produces the same result every time under identical conditions" (Smithson 2000: 32). There are a number of well-established methods of testing the reliability of indicators (De Vaus 2002) but two indicators are frequently used to assess the reliability of a scale: test-retest reliability (sometimes referred to as temporal stability) and internal consistency. ADATI reliability is calculated using both techniques. In order to assess the test-retest reliability of ADATI, 5 tests are re-administered for the second time on 100 ADATI participants after almost 12 weeks of the original first administration of these tests. Test-retest reliability is then calculated for these 5 subtests using the Paired Samples t-test technique. These five subtests are non-verbal deductive reasoning, spelling, word & sentence chain, reading accuracy and reading comprehension. Table (4) below reports scores of the Paired Samples t-test reliability of the above sub-tests:

ADATI Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pictorial Mental Abilities Standard Score First time	47.48	94	31.757	3.275
	Pictorial Mental Abilities Standard Score Second time	79.01	94	21.447	2.212
Pair 2	Spelling First time	5.77	98	3.109	.314
	Spelling Second time	6.63	98	2.578	.260
Pair 3	Word & Sentence Chain First time	16.59	93	4.663	.484
	Word & Sentence Chain second time	16.26	93	5.954	.617
Pair 4	Reading Accuracy First time	28.16	96	2.727	.278
	Reading Accuracy Second time	28.24	96	2.966	.303
Pair 5	Reading Comprehension First time	18.91	98	4.435	.448
	Reading Comprehension Second time	20.10	98	4.705	.475

(Table 4: ADATI Paired Sample Statistics)

By comparing the means in all the sub-tests listed in Table (4) above, one realizes that there is a significant increase in the means of participants' scores on the non-verbal reasoning test between the first time (**M= 47.48**, **SD= 31.75**) in January 2003 and second time (**M= 79.01**, **SD= 21.44**) in April 2003. Such an increase in the mean is sometimes expected as some participants may have gained positive experience of the test which positively reflects in their scores the second time round. The spelling paired sample t-test probability value is (.000). If means are compared, one realises that it is (**M= 5.77**, **SD= 3.10**) the first time round (January 2003) and it slightly increases to (**M= 6.63**, **SD=2.57**) the second time round (April 2003).

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pictorial Mental Abilities Standard Score First time - Pictorial Mental Abilities Standard Score Second time	-31.53	31.417	3.240	-37.97	-25.10	-9.731	93	.000
Pair 2	Spelling First time - Spelling Second time	-.87	2.241	.226	-1.32	-.42	-3.831	97	.000
Pair 3	Word & Sentence Chain First time - Word & Sentence Chain second time	.33	4.458	.462	-.58	1.25	.721	92	.473
Pair 4	Reading Accuracy First time - Reading Accuracy Second time	-.08	2.146	.219	-.52	.35	-.381	95	.704
Pair 5	Reading Comprehension First time - Reading Comprehension Second time	-1.19	5.131	.518	-2.22	-.17	-2.304	97	.023

(Table 5: ADATI Paired Sample test)

Using a test–retest reliability technique, there is a strong correlation between participants' scores on the first and second time the spelling test is administered.

ADATI Spelling Test Retest Correlations

		Spelling First time	Spelling Second time
Spelling First time	Pearson Correlation	1	.704**
	Sig. (2-tailed)	.	.000
	N	98	98
Spelling Second time	Pearson Correlation	.704**	1
	Sig. (2-tailed)	.000	.
	N	98	98

**. Correlation is significant at the 0.01 level (2-tailed).

(Table 6: ADATI spelling test-retest correlation)

Neither the mean nor the standard deviation of the reading accuracy test in ADATI has changed much between the first and second time the test is administered (First time **M= 28.16**, **SD= 2.72**), (Second time **M= 28.24**, **SD= 2.96**), which resulted in a high degree of correlation between them as indicated by Table (7) below:

ADATI Reading Accuracy Test-Retest Correlations

		Reading Accuracy Second time	Reading Accuracy First time
Reading Accuracy Second time	Pearson Correlation	1	.719**
	Sig. (2-tailed)	.	.000
	N	98	96
Reading Accuracy First time	Pearson Correlation	.719**	1
	Sig. (2-tailed)	.000	.
	N	96	96

**. Correlation is significant at the 0.01 level (2-tailed).

(Table 7: ADATI reading accuracy test-retest correlations).

There is a high correlation between the first and second time the word & sentence chain test is administered. Table (8) below reports this correlation:

ADATI Word & Sentence Chain Test Retest Correlations

		Word & Sentence Chain First time	Word & Sentence Chain second time
Word & Sentence Chain First time	Pearson Correlation	1	.672**
	Sig. (2-tailed)	.	.000
	N	93	93
Word & Sentence Chain second time	Pearson Correlation	.672**	1
	Sig. (2-tailed)	.000	.
	N	93	98

**. Correlation is significant at the 0.01 level (2-tailed).

(Table 8: ADATI word & sentence chain test-retest correlations).

Tables (6), (7) and (8) above indicate high test-retest reliability as supported by the high test-retest correlation coefficients (**r = 0.704**) in spelling, (**r = 0.719**) in reading accuracy and (**r = 0.672**) in word & sentence chain.

Instead of focusing on stability across time, some researchers tend to assess the degree to which their measuring instruments possess internal consistency (Huck 2000). This can be achieved by calculating the internal consistency of a scale, which is "the degree to which the items that make up the scale are all measuring the same underlying attribute" (Pallant 2001: 6). The most common statistical procedure used to measure internal consistency is Cronbach's Coefficient Alpha[26]. The overall reliability of ADATI is calculated, Table (9) below, using Alpha Cronbach coefficient whish is (**Alpha= 0.6256**). This figure indicates that ADATI can be considered a reliable test and one that can greatly benefit and improve with further development.

ADATI Reliability Analysis Scale (A L P H A)

		Mean	Std Dev	N of Cases
1.	PMARS	23.4660	9.1756	382.0
2.	GD	22.7173	4.9277	382.0
3.	RD	7.3586	3.0917	382.0
4.	SP	4.6230	3.1572	382.0
5.	WSC	13.5969	5.4920	382.0
6.	RACCU	27.6597	3.3523	382.0
7.	RCOMP	17.2304	4.8217	382.0
8.	NWR	7.3901	2.7065	382.0
9.	PD	7.5864	2.0940	382.0
10.	BDS	4.9424	1.9174	382.0

N of Cases = 382.0

Statistics for	Mean	Variance	Std Dev	N of Variables
Scale	136.5707	476.0882	21.8194	10

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	13.6571	4.6230	27.6597	23.0366	5.9830	73.3895

Reliability Coefficients 10 items

Alpha = .6256 Standardized item alpha = .7516

(Table 9: ADATI reliability analysis-scale A L P H A)

26 Although some researchers argue that for the Cronbach's Coefficient Alpha to work, test items must be arranged in order of difficulty.

Reliability for internal consistency for some for rhyme detection, word & sentence chain and grapheme discrimination27 tests are calculated using Kuder-Richardson 20 formula. Although almost all ADATI tests' internal consistency should have been calculated using Kuder-Richardson 20 formula, this could have been possible once continuous scores of ADATI participants on these tests are converted into dichotomous scores (0 for a wrong answer and 1 for a correct one). This, however, is impossible due to time and other limitations mentioned earlier. Table (10) below reports the results of the internal consistency analysis of the rhyme detection, word & sentence chain test and grapheme discrimination tests using the Kuder-Richardson 20 formula which are:

	RD	W&S Chain	GD
Kuder-Richardson 20 formula value	0.89	1.042	0.935

(Table 10: Kuder-Richardson 20 formula scores)

7.3 Validity

The validity of a scale refers to the degree to which it measures what it is supposed to measure (Pallant 2001). Validity is a general term which "denotes the extent to which measurement is not contaminated by error" (Smithson 2000: 32). Huck (2000) claims that whereas the best word to be synonymous with reliability is consistency, the "core essence of validity is captured by the word accuracy" (Huck 2000: 100).

Pallant (2001) notes that although there is not a clear cut indicator of a particular scales' validity; there are various types of validity such as content validity, criterion validity and construct validity. Two types of construct validity are calculated in ADATI using both convergent validity and discriminant validity. A convergent validity between

[27] See Appendix 5, 6 and 7 for full tables of Internal Consistency analysis.

non-word reading and phoneme deletion tests are calculated using correlation coefficients between these two tests. Non-word reading and phoneme deletion are two alternative ways to measure the same construct and should correspond to one another. The correlation coefficient between these two variable are reported in the Table (11) below:

Correlations

		NWR	PD
NWR	Pearson Correlation	1	.689**
	Sig. (2-tailed)	.	.000
	N	382	382
PD	Pearson Correlation	.689**	1
	Sig. (2-tailed)	.000	.
	N	382	382

**. Correlation is significant at the 0.01 level

(Table 11: Pearson correlation between non-word reading and phoneme deletion)

The Pearson correlation coefficient of the non-word reading and the phoneme deletion tests (**r = 0.689**) is high and proves that there is a convergent validity between these two tests. ADATI scores in some of its subtests are high and close to ceiling. In order to rule out the concept that the tests are too easy for participants and to make sure that the tests are really discriminating amongst ADATI participants, Ferguson's Delta formula is employed on three subtests of ADATI: the rhyme detection test, the word & sentence chain and the grapheme discrimination, in order to establish the index of discrimination. These are reported in appendices 5, 6 and 7. The figures of the index of discrimination are (**0.831**) for the rhyme detection, (**0.988**) for the word & sentence chain and (**0.776**) for the grapheme discrimination. These figures are strong and indicate that the three subtests produce a spread of scores which reflect differences in participants' achievement on these tests and that these tests discriminate amongst participants.

The above section deals with the reliability and validity of ADATI test battery and quotes some important and strong figures in support of considering ADATI a reliable and valid tool. To test the research hypotheses, investigate the data cohort and examine the cognitive profiles of reading difficulties amongst monolingual good and poor Arabic speaking Egyptian children, it is decided that dividing the data cohort into groups of high and low ability participants (high and low achievers) according to their scores in various variables will provide different platforms for comparing these various groups. These are, of course, in addition to the whole data sample, the dyslexic and the control group. Classification of the data sample in this manner allows maximum investigation of how participants' scores will differ depending on the various variables taken as the basis of comparison and how each variable affects the reading (accuracy and comprehension) and spelling development of participants. Investigating the data set in this manner will also enable one to understand the cognitive profiles of good and bad readers and to draw conclusions regarding the general patterns of relationships which may be statistically important and which may shed light on what aspects of cognitive processes seem to influence the process of reading (accuracy and comprehension) and spelling amongst monolingual Arabic speaking Egyptian children. This method of comparing good and bad readers is frequently adopted in the research literature (e.g., Vellutino 1979, Snowling 1992, Ehri 1992) in order to "identify underlying capabilities that distinguish them and account for learning difficulties"(Ehri 1992: 63).

Depending on this approach, ADATI participants are divided into 21 subgroups and participants in each group are matched for chronological age. These subgroups are: the whole data set, high & low achievers in spelling, reading accuracy, reading comprehension, rhyme detection, non-word reading, phoneme deletion, word & sentence chain, rapid naming, backward digit span and non-verbal reasoning. The following section deals with each one of these subgroups in more detail.

7.4 Group by group analysis

7.4.1 Group 1: The Whole Data set

Table (12) below represents the Bivariate relationships amongst ADATI 11 variables using Pearson Correlation Matrix scores of the whole data set.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	BDS	NWR	PD	RN
PMARS	1										
GD	.024	1									
RD	.120	.137	1								
SP	.032	.156	.207	1							
WSC	-.020	.156	.131	**.497**	1						
RACCU	.160	.163	.281	**.452**	.360	1					
RCOMP	.008	.151	.213	**.464**	**.461**	.376	1				
BDS	.163	.141	.075	.319	.204	.160	.203	1			
NWR	.134	.112	.214	**.538**	.263	.379	.282	.299	1		
PD	.116	.064	.259	.395	.182	.293	.197	.244	**.689**	1	
RN	.254	.070	.180	.263	.215	.316	.224	.105	.294	.271	1

(Table 12: ADATI whole data set correlation matrix)

Table (12) above shows the correlation matrix of ADATI 11 variables. The correlation coefficients between the non-verbal deductive reasoning test employed in ADATI (pictorial non-verbal mental abilities test) and ADATI tests of literacy skills (spelling, reading accuracy and reading comprehension) are weak; (**r = 0.032**) for spelling, (**r = 0.154**) for reading accuracy and (**r = 0.003**) for reading comprehension. These correlation coefficients indicate that the relationship between non-verbal reasoning and literacy skills in ADATI whole data set is not unidirectional. Therefore, non-verbal reasoning can not be used to predict literacy skills amongst ADATI's population because of a lack of linear relationship between them.

There are small correlation coefficients amongst the grapheme discrimination test and almost all other subtests employed in ADATI. Grapheme discrimination test is thought to measure the visual discrimination ability of Arabic graphemes amongst monolingual Arabic speaking Egyptian children participating in ADATI by presenting similar and different visual stimuli (minimal pairs or similar words) and asking participants to look at these and then indicate whether each pair is similar or different. Due to the high number of dots (one, two or three) as well as the high number of their applications to differentiate between various graphemes (dots are used in 15 graphemes in Arabic; an alphabet which consists of 28 letters) as well as the similarity of a large number of Arabic graphemes (a fuller account is given in chapter three of the current study), one had expected to find a higher correlation between grapheme discrimination and literacy skills than reported above; (**r = 0.156**) in spelling, (**r = 0.163**) in reading accuracy and (**r = 0.151**) in reading comprehension. However, this issue will be revisited once both scores of high and low achievers on various variables are closely examined which may or may not confirm one's expectations that deficits in grapheme discrimination does impair the development of literacy skills amongst monolingual Arabic children. *A priori*, Arabic orthography seems to be visually demanding and accordingly the visual discrimination abilities may correlate with other literacy skills. The correlation coefficient presented above is too small to support such a claim yet.

Spelling has a substantial linear relationship with word & sentence chain (**r = 0.497**), non-word reading (**r = 0.538**), reading accuracy (**r = 0.452**), reading comprehension (**r = 0.464**) and phoneme deletion (**r = 0.395**). At a first analysis, it seems that these skills affect the spelling performance of monolingual Arabic children. However, this is an issue that will be discussed in detail in the coming group by group analysis. Word & sentence chain test has a substantial linear correlation with all literacy skills in ADATI: (**r = 0.497**) in spelling, (**r = 0.360**) in reading accuracy and (**r = 0.461**) in reading comprehension. Word & sentence chain test is believed to be a measure of orthographic knowledge (processing) and/or morphological knowledge which seems to correlate with literacy skills amongst monolingual Arabic children. It will be interesting to wait and see how the word & sentence chain test will behave in relation to literacy skills as the nature of the

Arabic language prompts one to anticipate that such a measure will be relevant to monolingual Arabic children reading skills.

Although there are significant correlation coefficients between reading accuracy and reading comprehension with non-word reading, phoneme deletion and rhyme detection, such a linear relationship is not strong. Non-word reading, phoneme deletion and rhyme detection are tests believed to measure phonological awareness. It seems therefore that measures of phonological awareness in Arabic, although correlate with reading, such a correlation is not as strong as it is reported in the case of the English language. However, it is too early to support and/or refute such a claim and the group by group analysis will, not doubt, assists in investigating the phonological awareness tests and their role in identifying monolingual Arabic speaking dyslexic children.

There is a significant substantial correlation between non-word reading and spelling (**r = 0.538**) and non-word reading and phoneme deletion (**r = 0.689**). Both non-word reading and phoneme deletion are tests believed to measure phonological processing and as such a high correlation such as this one would indicate that there was a strong convergent validity between these two constructs. The correlation between non-word reading and spelling may indicate that the abilities underlying the non-word reading tasks seem to be also employed by monolingual Arabic speakers when performing their spelling tasks. This analysis seems to confirm one's initial expectation regarding the validity and importance of phonological awareness amongst Arabic children. It is anticipated that once groups are divided into high and low achievers, such a picture concerning the relationship between reading (accuracy and comprehension), spelling and phonological awareness will become clearer.

Backward digit span correlates, although with different degrees, with all literacy skills in ADATI; i.e., (**r = 0.319**) with spelling, (**r = 0.160**) with reading accuracy and (**r =**

0.203) with reading comprehension. The strongest correlation out of these three are, as one expects, the correlation between backward digit span and spelling. This correlations coincide with the general belief that spelling ability depends on short term verbal working memory of participants. In this context, it is therefore natural for the spelling test to correlate with the backward digit span one. However, one had expected a stronger correlation than the above (r = 0.319). Again, this is an important issue and one that will hopefully become clearer as the analysis of different groups unfold.

7.4.2 Group 2: High achievers in spelling

ADATI spelling test is out of 10 and it is decided that participants who only score the two top marks and the two bottom marks are used to account for high and low achievers respectively so long as these cut off points generate enough participants to be able to calculate a correlation coefficient and other statistical analysis and provided that participants are controlled for chronological age. These cut off points represent two extremes of ADATI participants' scores on spelling test. High achievers in spelling are those who scored 9 or 10 on the spelling test while low achievers are those who scored 0 or 1 and these cut off points represent the two opposite sides of the continuum of ADATI scores on spelling test. Table (13) below represents the correlation matrix for ADATI high achievers in spelling.

Measures	Spelling	RACCU	RCOMP
PMARS	-0.089	0.111	0.100
GD	-0.079	-0.121	-0.019
W& S Chain	0.012	0.290	0.061
NWR	0.219	-0.001	0.210
PD	-0.140	0.120	0.038
RD	-0.025	0.250	0.373
RN	-0.195	0.335	0.155
BDS	0.026	-0.187	0.016

(Table 13: ADATI high achievers in spelling correlation matrix)

Correlation coefficients between non-verbal deductive reasoning in the spelling high achievers and spelling (**r = -0.089**), reading accuracy (**r = 0.111**) and reading comprehension (**r = 0.100**) are weak. This indicates the lack of a linear relationship between them and that the non-verbal reasoning test can not be used to predict spelling.

There is a small correlation coefficient between reading accuracy and reading comprehension of the high achievers in spelling with ADATI non-verbal deductive reasoning correlation (**r = 0.111**) with reading accuracy and (**r = 0.100**) with reading comprehension. The correlation coefficient between reading accuracy and non-verbal reasoning in the spelling high achievers group is slightly lower than it was in the whole data cohort (**r = 0.111**) in the spelling high achievers while it is (**r = 0.160**) in the whole data set. The correlation coefficient between reading comprehension and non-verbal reasoning in the spelling high achievers group is significantly higher than the whole data cohort (**r = 0.160**) in the spelling high achievers group while it is (**r = 0.008**) for the whole data set.

The correlation coefficient between reading accuracy and rhyme detection in the spelling high achievers group is slightly less than the whole data cohort (**r = 0.250**) in the spelling high achievers while it is (**r = 0.281**) in the whole data set. The correlation coefficient between reading accuracy and rapid naming in the spelling high achievers group is slightly more than it was in the whole data cohort (**r = 0.335**) in the spelling high achievers group while it is (**r = 0.316**) for the whole data set.

7.4.3 Group 3: Low achievers in spelling

As mentioned in group 2 above, ADATI spelling test is out of 10 and the low achievers in spelling are those who scored 0 or 1 and the rationale behind using these cut off points is explained in group 2 above. The following table represents the correlation matrix of ADATI low achievers in spelling.

Measures	Spelling	RACCU	RCOMP
PMARS	0.177	0.169	-0.052
GD	-0.066	0.117	0.211
W& S Chain	0.036	0.250	**0.373**
NWR	0.047	0.137	0.066
PD	0.110	0.132	0.056
RD	0.158	**0.390**	0.161
RN	0.199	0.299	0.121
BDS	-0.053	-0.027	0.102

(Table 14: ADATI low achievers in spelling correlation matrix)

Correlation coefficients between the non-verbal deductive reasoning test in ADATI spelling low achievers and ADATI literacy tests are small; (**r = 0.177**) for spelling, (**r = 0.169**) for reading accuracy and (**r = -0.052**) for reading comprehension. Therefore, from groups 1, 2 and 3 above, one can conclude that the correlation figures in the whole data set, the spelling high achievers group and the spelling low achievers group do not seem to have any significant statistical difference and would indicate that the non-verbal deductive reasoning abilities of ADATI participants does not affect their spelling abilities.

Amongst the low achievers in spelling, there are substantial correlation coefficients between their word and sentence chain and both their reading accuracy (**r = 0.250**) and reading comprehension (**r = 0.373**). These figures, although not strong in themselves, are relevant when compared with their counterparts in the case of the high achievers in spelling (**r = 0.290**) with reading accuracy and (**r = 0.061**) with reading comprehension. Therefore, dividing monolingual Arabic children into high and low achievers depending on their scores on the spelling test results in increasing the correlation between word &

sentence chain and both reading accuracy and reading comprehension in the case of the low achievers in spelling group than in the good spellers group. Such a relationship, although not strong, indicates that monolingual Arabic children employed the same skills used when performing their word & sentence chain test (orthographic knowledge) when reading and that impairments in their orthographic knowledge seem to negatively affect their reading ability.

Correlation coefficients between reading accuracy and rhyme detection did not change much between the whole data set (**r = 0.281**) and the high achievers in spelling (**r = 0.250**). However, this correlation coefficient increased significantly amongst the low achievers in spelling group (**r = 0.390**). This indicates that skills measured by the rhyme detection task seem to affect the literacy skills amongst Arabic monolingual children and the relationship between the two tends to be stronger in the case of poor achievers. This indicates that Arabic poor spellers depend on the same skills employed when performing their rhyme detection task in their reading development and that deficits in their rhyme skills seem to negatively affect their reading and spelling abilities.

On the contrary, the correlation coefficients between rhyme detection and reading comprehension decreased in the case of the low achievers in spelling group (**r = 0.161**) than it was in the case of the whole data set (**r = 0.213**). This correlation coefficient has increased in the case of high achievers in spelling to (**r = 0.373**). It seems that high achievers in spelling tend to have a stronger correlation between their reading comprehension than their counterparts who are low achievers in spelling.

7.4.4 Group 4: High achievers in reading accuracy

ADATI reading accuracy test is out of 30. following the same rationale employed in identifying cut off points for spelling in the previous two groups, high achievers in reading accuracy are those who scored 29 or 30 in ADATI reading accuracy test. However, 0 and 1 scores on reading accuracy can not be used to refer to bad readers according to their reading accuracy scores because no participant scored 0 or 1. The minimum score of the reading accuracy in ADATI is in fact 5 and only one participant scored 5. Therefore, choosing those who scored 5 or less, 10 or less or even 15 or less does not generate enough participants to carry out the statistical analysis, the necessary comparisons between the two groups or enough participants to control for chronological age. In order to guarantee enough participants to carry out the required statistical analysis, a 20 or less score is used as a cut off point. Therefore, low achievers in reading accuracy are those who scored 20 or less. These cut off points are chosen because the number of participants who scored 20 or less on the reading accuracy test in ADATI are only 19 participants which made up 5% of the whole data set (382 participant). Table (15) below represents the correlation matrix of ADATI high achievers in reading accuracy.

Measures	Spelling	RACCU	RCOMP
PMARS	-0.056	0.157	-0.049
GD	0.085	-0.010	-0.046
W& S Chain	**0.507**	0.170	**0.414**
NWR	**0.469**	0.204	0.301
PD	0.316	0.175	0.160
RD	0.201	0.149	0.204
RN	0.249	0.064	0.203
BDS	0.283	0.078	0.144

(Table 15: ADATI high achievers in reading accuracy correlations)

Correlation coefficients between non-verbal deductive reasoning in the reading accuracy high achievers group and spelling (**r = -0.056**), reading accuracy (**r = 0.157**) and reading comprehension (**r = -0.049**) are weak. There seems to be no relationship between tests of attainment amongst the high achievers in reading comprehension and their non-verbal deductive reasoning when participants are grouped according to their high scores on the reading accuracy test.

Word & sentence chain scores correlate well with the spelling scores of high achievers in reading accuracy (**r = 0.507**) and reading comprehension (**r = 0.414**). These correlation coefficients are similar to those between word & sentence chain and spelling (**r = 0.497**) and reading comprehension (**r = 0.461**) in the whole data set. Although participants scores on the word & sentence chain do not correlate well with spelling (**r = 0.012**) nor reading comprehension (**r = 0.061**) in the case of the high achievers in spelling group, they correlate well with spelling (**r = 0.507**) and with reading comprehension (**r = 0.414**) in high achievers in reading accuracy group. These correlation coefficients prompt one to speculate that spelling and the reading comprehension of high achievers in reading accuracy depend to some extent on their orthographic processing skills; a task believed to be measured by the word & sentence chain test.

High achievers in reading accuracy test have a medium correlation between their spelling and reading comprehension and their orthographic processing. It is therefore hypothesised that orthographic processing skills of monolingual Arabic children affect their spelling and reading comprehension and that the more advanced orthographic skills monolingual Arabic children have the more advanced reading skills they tend to possess. This may become clearer with further analysis of the remaining groups into high and low achievers according to other variables. The spelling of reading accuracy high achievers has a medium linear relationship with their non-word reading (**r = 0.469**). There is a significant correlation between the spelling of the high achievers in reading accuracy group and their phoneme deletion (**r = 0.316**), rhyme detection (**r = 0.201**), rapid naming (**r = 0.249**) and backward digit span (**r = 283**), although these correlations are small.

7.4.5 Group 5: Low achievers in reading accuracy

Low achievers in reading accuracy are those who scored 20 or less on ADATI reading accuracy test. The reason of choosing this cut off point was explained in group 4 above. Table (16) below represents the correlation matrix of ADATI low achievers in reading accuracy.

Measures	Spelling	RACCU	RCOMP
PMARS	-0.094	0.230	-0.076
GD	0.225	**0.597**	**0.450**
W&S Chain	0.336	**0.500**	**0.402**
NWR	0.348	0.034	-0.023
PD	**0.484**	-0.019	-0.048
RD	0.265	0.312	0.002
RN	0.275	0.312	0.274
BDS	-0.051	-0.225	-0.056

(Table 16: ADATI low achievers in reading accuracy correlation matrix)

The correlation coefficients between non-verbal deductive reasoning in ADATI reading accuracy low achievers and ADATI literacy skills tests are weak; (**r = -0.094**) for spelling, (**r = 0.230**) for reading accuracy and (**r = -0.076**) for reading comprehension. It seems that dividing ADATI participants into high and low achievers on their reading accuracy scores does not show any significant correlation between their non-verbal deductive reasoning and their literacy skills.

On the contrary, word & sentence chain in this group has substantial correlation coefficients with spelling (**r = 0.336**), reading accuracy (**r = 0.500**) and reading comprehension (**r = 0.402**). This is particularly interesting as the correlation between word & sentence chain and reading accuracy in the reading accuracy high achievers (group 4 above) is (**r = 0.170**) while the same correlation in the case of reading accuracy low achievers (the current group) increased to (**r = 0.500**). This is an interesting finding and indicated that low achievers on reading accuracy seem to have a problem with word boundaries in Arabic, an underlying task believed to be measured by word & sentence chain test. Deficits in orthographic knowledge, an underlying ability believed to be measured by word & sentence chain test, seem to negatively affect monolingual Arabic speakers spelling, reading accuracy and reading comprehension performance. This conclusion is supported by the medium to high correlations between word & sentence chain and literacy skills in Arabic in the case of both high and low achievers in reading accuracy (apart from the correlation between word & sentence chain and reading accuracy in the case of high achievers which is (**r = 0.170**), the rest of the figures indicate medium to high linear relationship).

Therefore, dividing ADATI participants into groups of high and low achievers according to their reading accuracy scores shows that the low achieving group have a much higher correlation between their reading accuracy and their word & sentence chain than their high achieving counterparts. In other words, the poor achievers in ADATI monolingual Arabic children seem to depend on their orthographic knowledge much more than their high achieving counterparts. It will be interesting to note how early training on orthographic processing will benefit monolingual Arabic children's reading accuracy and it will also be interesting to note whether early orthographic processing deficits will predict later deficits in reading accuracy amongst monolingual Arabic children.

Grapheme discrimination of the low achievers on reading accuracy strongly correlates with their reading accuracy (**r = 0.597**), and substantially correlates with their spelling (**r = 0.225**) and their reading comprehension (**r = 0.450**). These correlation coefficients are very interesting, particularly after their significant increase from (**r = -0.010**) between grapheme discrimination and reading accuracy in the reading accuracy high achievers to (**r = 0.597**) between the same variables in the case of low achievers in reading accuracy.

Again, dividing ADATI participants into groups of high and low achievers according to their reading accuracy scores shows that the low achieving group have a much higher correlation between their grapheme discrimination and their reading accuracy than their high achieving counterparts. Consequently, the reading skills of ADATI low achievers in reading accuracy seem to be negatively affected by their visual discrimination ability, the underlying skill believed to be measured by the grapheme discrimination test.

The above is an important and relevant observation and it is hypothesized that low achieving monolingual Arabic readers employ a global visual strategy when reading. Monolingual Arabic low achievers seem to read each word as a continuous string of letters rather than decoding the word into its constituent letters. Due to the close visual similarity of Arabic graphemes and the high number of dots employed to differentiate between these graphemes, it is hypothesised that global visual strategy employed by monolingual Arabic low achieving readers on tests of reading accuracy impair their reading accuracy skills. These findings support conclusions of Talcott et. al (2002) who assert that

> When children first begin to learn to read, they may use holistic visual analysis to retrieve words from lexicon by sight rather than relying upon phonological decoding skills that are not yet fully developed
>
> (Talcott et. al 2002: 204-225)

Both grapheme discrimination and word & sentence chain tests correlate well with reading accuracy skills of poor monolingual Arabic readers as explained above. Both subtests are conducted silently and both depend on visual abilities of monolingual Arabic readers. If poor monolingual Arabic readers tend to employ global visual strategy while reading, then one will expect their scores on rhyme detection to also correlate with their reading accuracy. The rhyme detection task, although a well established measure of phonological processing, may have an additional dimension in Arabic which is particularly relevant to word boundaries and visual global strategy. After all, rhyme occurs at the end of words and it is possible that word boundaries in Arabic may also be challenging for disabled readers while performing on this test. Accordingly, one expects the visual global strategy to be used extensively by monolingual Arabic poor readers and that impairments in the visual discrimination skills of monolingual Arabic poor readers may manifest itself in tests of word & sentence chain, grapheme discrimination and rhyme detection.

It is hypothesised that impairments in orthographic knowledge of monolingual Arabic poor readers can occur over and above impairments in their phonological processing. This can be the result of a number of overlapping processes such as the nature of Arabic script, the confusions caused by inconsistencies in its word boundaries or the visual global strategy of reading elected by monolingual Arabic poor readers. As originally anticipated, phonological processing skills are relevant to reading and spelling skills of monolingual Arabic readers, although such impairments in phonological processing do not seem to be as high or as strong as is reported in the case of phonological processing impairments amongst English poor and/or dyslexic or poor readers.

7.4.6 Group 6: High Achievers in Reading Comprehension

The reading comprehension test in ADATI is out of 26 and the high achievers in reading comprehension are those who scored 24, 25 or 26, while the low achievers in reading comprehension are those who scored 10 and below. These cut off points are chosen because the number of participants who scored 10 or less on the reading comprehension test in ADATI are 33 participants which makes up 8.6 % of the whole data set, while the number of participants who scored 24, 25 or 26 on the reading comprehension test in ADATI are 34 participants which makes up 8.9 % of the whole data set. Had only those who scored the two top marks included as the high achievers, the number of participants would have been only 16. Therefore, it is decided to include participants who scored the highest top 3 marks (24, 25 and 26) to represent the high achieving group. Table (17) below represents the correlation matrix of ADATI high achievers in reading comprehension.

Measures	Spelling	RACCU	RCOMP
PMARS	-0.151	0.148	0.001
GD	0.025	-0.141	-0.134
W&S Chain	**0.512**	**0.518**	**0.481**
NWR	0.379	0.234	0.301
PD	-0.154	-0.038	-0.077
RD	**0.433**	0.058	0.032
RN	0.130	0.202	0.124
BDS	0.027	0.029	0.094

(Table 17: ADATI high achievers in reading comprehension correlation matrix)

The correlation coefficients between non-verbal deductive reasoning test in ADATI reading comprehension high achievers and ADATI literacy tests are small; (**r = -0.151**) for spelling, (**r = 0.148**) for reading accuracy and (**r = 0.001**) for reading comprehension.

The correlation coefficients between word & sentence chain and literacy attainment skills in Arabic in the whole data set are: (**r = 0.497**) for spelling, (**r = 0.360**) for reading accuracy and (**r = 0.461**) for reading comprehension. The same correlation in the case of the reading comprehension high achievers increases to (**r = 0.512**) for spelling, (**r = 0.518**) for reading accuracy and (**r = 0.481**) for reading comprehension. The same correlation stayed more or less the same in the case of low achievers in reading comprehension (**r = 0.481**) for spelling, (**r = 0.436**) for reading accuracy and (**r = 0.182**) for reading comprehension.

The above is an interesting finding and one that yields further evidence to analysis reported in group 4 above which all confirm that skills measured by the word & sentence chain test (orthographic knowledge) are relevant to the same skills required for reading and spelling development amongst monolingual Arabic children. It seems that the high achievers in reading comprehension in Arabic learn to identify individual words and are aware when individual words end and/or finish in Arabic.

Non-word reading has significant correlations with reading and spelling skills; (**r = 0.379**) in spelling, (**r = 0.234**) in reading accuracy and (**r = 0.301**) in reading comprehension in the case of ADATI reading comprehension high achievers. These correlation coefficients are lower than the original correlations reported in the case of the whole data set; (**r = 0.538**) in spelling, (**r = 0.379**) in reading accuracy and (**r = 0.282**) in reading comprehension. Non-word reading has a significant statistical relationship with the spelling of Arabic monolingual high and low achievers according to their scores on reading accuracy. It is therefore safe to generalize that non-word reading skills, so far, are relevant to reading and spelling skills amongst monolingual Arabic readers.

7.4.7 Group 7: Low achievers in reading comprehension

Low achievers in reading comprehension are those who scored 9 or below out of 26 on ADATI reading comprehension test. The rationale for using these cut off points is explained in group 6 above. Table (18) below represents the correlation matrix of ADATI reading comprehension low achievers.

Measures	**Spelling**	**RACCU**	**RCOMP**
PMARS	0.269	0.346	0.011
GD	0.232	0.395	0.124
W&S Chain	**0.481**	**0.436**	0.182
NWR	**0.441**	0.094	-0.038
PD	**0.480**	0.235	-0.030
RD	**0.413**	**0.573**	0.284
RN	**0.414**	**0.580**	0.377
BDS	**0.044**	-0.058	-0.108

(Table 18: ADATI low achievers in reading comprehension correlation matrix)

For the first time, one observes that the correlation between non-verbal deductive reasoning and both spelling and reading accuracy amongst the reading comprehension low achievers group actually increases. It seems that there is a linear relationship, albeit very small, between non-verbal reasoning and spelling and reading accuracy for participant who are low achievers according to their reading comprehension scores (**r = 0.249**) for spelling and non-verbal reasoning and (**r = 0.321**) for reading accuracy and non-verbal reasoning. Such a linear relationship is much smaller in the case of the whole data set as well as the high and low achieving groups according to both spelling and reading accuracy.

There are significant correlations between grapheme discrimination and literacy skills; (**r = 0.232**) for spelling, (**r = 0.395**) for reading accuracy and (**r = 0.124**) for reading comprehension amongst low achieving participants on the reading comprehension test, although such a linear relationship is weak. Again, the highest correlation coefficient out of these figures is between grapheme discrimination and reading accuracy. These correlation coefficients converge with similar findings reported earlier and further support the hypothesis proposed earlier that low achievers in reading comprehension as well as low achievers in reading accuracy seem to employ a global visual strategy when reading and scores on their reading accuracy (whether they have been originally divided into high and low achievers according to their reading accuracy or according to their reading comprehension scores) tend to correlate with their ability to visually discriminate between the graphical shapes of Arabic graphemes; a task believed to be required in order to perform accurately the grapheme discrimination test.

Word & sentence chain has substantial linear correlations with ADATI reading comprehension low achievers in spelling (**r = 0.481**) and reading accuracy (**r = 0.436**). Moreover, the spelling of reading comprehension low achievers has a substantial linear relationship with non-word reading (**r = 0.441**), phoneme deletion (**r = 0.480**), rhyme detection (**r = 0.413**) and rapid naming (**r = 0.414**).

Non-word reading, phoneme deletion and rhyme detection are all subtests believed to measure phonological awareness which, in this case, seem to correlate well with the spelling of low achievers on the reading comprehension test. This is another proof that phonological awareness based tests are relevant to reading and spelling abilities of monolingual Arabic readers. It seems that not being able to re-code spoken words into their corresponding written letters and words, one of the skills required to perform a spelling task, may negatively affect the spelling ability of monolingual Arabic reading comprehension low achievers. This indicates that phonological awareness skills are involved in the literacy skills of monolingual Arabic children.

Rhyme detection has a strong linear correlation with reading accuracy in ADATI low achievers in reading comprehension (**r = 0.573**). This is interesting as the correlation in rhyme detection and reading accuracy in case of reading comprehension high achievers is (**r = 0.058**) but has significantly increased amongst the reading accuracy low achievers (**r = 0.573**). This is an important finding and indicates that low achievers on reading comprehension has a problem with rhyme detection in Arabic which impairs their reading accuracy. This proves that phonological awareness is relevant to the acquisition and development of literacy skills amongst Arabic monolingual speakers.

It is hypothesized that the rhyme detection test (an underlying measure of phonological awareness) and word & sentence chain test (a measure of orthographic knowledge) are both required for accurate word recognition and in particular accurate word endings in Arabic. The cursive nature of Arabic script, the lack of capital letters in Arabic, the confusion caused by the six non-connecting letters and the various shapes Arabic letters assume when occurring in initial, medial, final and in isolated positions all require monolingual Arabic readers to be aware of word boundaries. It also hypothesised that monolingual Arabic poor readers are not able to identify word endings accurately in Arabic and tend to skip read without paying attention to word endings or employ a global visual strategy when reading. These hypotheses explain the high correlation coefficients between rhyme detection, word & sentence chain and their reading accuracy and spelling skills in Arabic low achieving groups either according to their spelling, reading accuracy or reading comprehension scores.

7.4.8 Group 8: High achievers in rhyme detection

High achievers in ADATI rhyme detection test are those participants who scored 9 or 10 out of 10, while the low achievers in rhyme detection are those who scored 0 or 1. These cut off points represent the two opposite ends of the continuum of rhyme detection scores and produce a sufficient number of participants in each group to enable a comparison and a statistical analysis of the two groups. Table (19) below represents the correlation matrix of ADATI high achievers in rhyme detection.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	-.004	1									
RD	.036	.015	1								
SP	-.031	.101	.167	1							
WSC	-.061	.073	.126	**.500**	1						
RACCU	.081	.070	.141	**.424**	**.410**	1					
RCOMP	-.141	.098	.059	**.488**	**.430**	.367	1				
NWR	.068	.017	.109	**.532**	.239	.305	.247	1			
PD	.075	-.045	.083	.331	.117	.157	.117	**.670**	1		
BDS	.141	.084	.073	.342	.202	.189	.190	.270	.209	1	
RN	.176	.006	.144	.291	.203	.227	.173	.293	.238	.071	1

(Table 19: ADATI high achievers in rhyme detection correlation matrix)

Table (19) above indicates that scores of high achievers in rhyme detection test seem to correlate with almost all of the other subtests in ADATI, although these correlations are small. Apart from the non-verbal deductive reasoning test, the correlation coefficients of spelling and almost the rest of ADATI subtests in the high achievers group on scores of rhyme detection are medium to strong. Spelling correlates particularly well with the word & sentence chain (**r = 0.500**) and the non-word reading (**r = 0.532**), whereas it has a medium linear relationship with reading accuracy (**r = 0.424**) and reading comprehension (**r = 0.488**).

The word & sentence chain of monolingual Arabic high achievers in rhyme detection group correlates well with the rest of their literacy skills; (**r = 0.500)** in spelling, (**r = 0.410)** in reading accuracy and (**r = 0.430)** in reading comprehension. The correlation coefficients of the word & sentence chain tests seem to be consistent with the rest of literacy skills amongst monolingual Arabic readers and notably those who are low achievers whether these groups are divided into high and low achievers according to their spelling, reading accuracy, reading comprehension or rhyme detection.

There is a convergent validity correlation coefficient between non-word reading and phoneme deletion of monolingual Arabic high achieving readers according to scores on their rhyme detection test. Since both non-word reading and phoneme deletion are believed to be two tests measuring the same construct, i.e., phonological awareness, these figures reinforce the reliability of ADATI test battery as well as reinforce the relevance of phonological awareness to spelling skills amongst Arabic readers; (**r = 0.532)** between non-word reading and spelling in the current group.

7.4.9 Group 9: Low achievers in rhyme detection

Low achievers in rhyme detection are those who scored 0 or 1 out of 10 on ADATI rhyme detection test. The reason of choosing these cut off points are explained in group 8 above. Table (20) below represents the correlation matrix of ADATI low achievers in rhyme detection.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.147	1									
RD	-.049	**.498**	1								
SP	**.458**	**.443**	.160	1							
WSC	.375	**.438**	.005	**.436**	1						
RACCU	.396	**.437**	**.452**	**.524**	**.465**	1					
RCOMP	-.001	**.497**	.350	.338	**.406**	.388	1				
NWR	**.410**	-.013	.046	**.649**	.125	**.478**	.072	1			
PD	**.525**	-.048	.030	**.662**	.257	**.413**	-.125	**.822**	1		
BDS	**.627**	.082	.028	.233	.155	.371	.140	**.614**	**.490**	1	
RN	**.522**	.091	.075	**.528**	.233	**.492**	.084	**.498**	**.588**	.341	1

(Table 20: ADATI low achievers in rhyme detection correlation matrix)

The non-verbal deductive reasoning scores of ADATI monolingual Arabic low achievers according to their rhyme detection scores correlate well with 7 subtests out of the 11 variables reported in Table (20) above. Some of the correlation coefficients are medium such as (**r = 0.458**) with spelling, (**r = 0.375**) with word & sentence chain and (**r = 0.396**) with reading accuracy, while other correlation coefficients are strong like (**r = 0.525**) with phoneme deletion, (**r = 0.627**) with backward digit span and (**r = 0.522**) with rapid naming.

There are substantial significant correlations between the rhyme detection of ADATI low achievers on rhyme detection group and their reading accuracy (**r = 0.452**). This is particularly interesting as the correlation in the case of the high achievers rhyme detection group and their reading accuracy is (**r = 0.141**) which has significantly increased in the case of the rhyme detection low achievers to (**r = 0.452**). This finding converges with earlier findings above which all indicate that low achievers on rhyme detection have a problem that impair their reading accuracy skill. This, in turn, further supports to the belief that phonological awareness is an important and relevant skill that affects the reading development of monolingual Arabic children. Grapheme discrimination also significantly correlates with the three literacy skills; (**r = 0.443)** with spelling, (**r = 0.437)** with reading accuracy and (**r = 0.497)** with reading comprehension amongst ADATI rhyme detection low achievers. In addition, grapheme discrimination has a significant correlation with word & sentence chain (**r = 0.438**). This is another significant correlation in a series of relevant ones discussed earlier which seem to reinforce the relevance of grapheme discrimination skills to reading and spelling skills amongst monolingual Arabic children.

7.4.10 Group 10: High achievers in non-word reading

High Achievers in ADATI non-word reading test are those participants who scored 9 or 10 out of 10, while low achievers are those who scored 0 or 1. These cut off points represent the top two marks and the bottom two marks for high achievers and low achievers respectively on the non-word reading test. Table (21) below represents the correlation matrix of ADATI non-word reading high achievers.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.039	1									
RD	.105	.035	1								
SP	-.088	.073	.136	1							
WSC	-.078	-.031	.118	.365	1						
RACCU	.138	.006	.201	.342	.271	1					
RCOMP	-.014	-.084	.176	**.441**	**.400**	**.408**	1				
NWR	-.058	.113	.124	.203	.054	-.039	.113	1			
PD	-.040	.066	.207	.036	.071	.038	.073	.220	1		
BDS	.048	.117	.054	.254	.094	-.012	.068	.089	.087	1	
RN	.110	.030	.224	.286	.185	.356	.326	.062	.104	-.034	1

(Table 21: ADATI high achievers in non-word reading correlation matrix)

There are significant, but small, correlations between scores of high achievers in ADATI non-word reading test and their scores on the rest of the subtests. There are significant correlations between spelling and reading accuracy (**r = 0.342**) and reading comprehension (**r = 0.441**) amongst non-word reading high achievers. There is also a significant correlation coefficient between spelling and word & sentence chain (**r = 0.365**). The reading comprehension of ADATI non-word reading high achievers correlate with spelling (**r = 0.441**), word & sentence chain (**r = 0.400**) and reading accuracy (**r = 0.408**). The rapid naming had a significant correlation with the both reading accuracy (**r = 0.356**), reading comprehension (**r = 0.326**) and spelling (**r = 0.286**) skills amongst monolingual non-word reading Arabic high achievers.

7.4.11 Group 11: Low achievers in non-word reading

Low achievers in non-word reading are those who scored 0 or 1 out of 10 on ADATI non-word reading test. The reason for choosing these cut off points are explained in group 10 above. Table (22) below represents the correlation matrix of ADATI low achievers in non-word reading.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.238	1									
RD	.228	-.156	1								
SP	.259	.011	-.327	1							
WSC	.302	**.467**	-.271	.069	1						
RACCU	.304	-.194	.342	.272	-.119	1					
RCOMP	.053	**.470**	-.085	-.410	.345	-.281	1				
NWR	.267	.228	.046	.367	-.023	**.473**	-.146	1			
PD	.200	.129	-.011	**.627**	.078	.116	**-.430**	.367	1		
BDS	**.668**	.394	.163	.189	.044	.042	.228	.228	.288	1	
RN	.369	-.049	-.023	.371	-.047	.134	.049	.054	.027	.188	1

(Table 22: ADATI low achievers in non-word reading correlation matrix)

The non-verbal deductive reasoning test of the low achievers in non-word reading group has a number of significant correlations with almost all the rest of ADATI variables except with reading comprehension. The highest correlation coefficient out of all these is the strong correlation coefficient between the non-verbal deductive reasoning and the backward digit span (**r = 0.668**). This is a significant correlation coefficient particularly if it as compared with the same correlation in the case of the high achievers in non-word reading group above (**r = 0.048**).

There is a significant correlation coefficient between low achievers in non-word reading and their non-verbal deductive reasoning (**r = 0.267**). This is an interesting finding as the correlation between non-verbal reasoning and non-word reading in the whole data set is (**r = 0.134**). This correlation has decreased significantly to (**r = -0.040**) in the case of high achievers in non-word reading only to raise again to (**r = 0.267**) in the case of low achievers in non-word reading.

There are also significant correlations between the non-word reading of ADATI low achievers in non-word reading and their spelling (**r = 0.367**), reading accuracy (**r = 0.473**) and phoneme deletion (**r = 0.367**) skills. It seems that Arabic monolingual children who are low achievers in non-word reading have a problem which negatively affected their spelling, reading accuracy and phoneme deletion abilities. Although the correlation coefficient (**r = 0.473**) is not in itself a strong correlation, it becomes significant when compared with the same correlation in the case of the whole data set and the high achievers group; (**r = -0.039**) in non-word reading high achievers and reading accuracy, while (**r = 0.473**) in non-word reading low achievers and reading accuracy. These correlation coefficients indicate that non-word reading; a measure of phonological decoding, is indeed relevant to the development of reading accuracy skills amongst monolingual Arabic readers.

7.4.12 Group 12: High achievers in phoneme deletion

High achievers in ADATI phoneme deletion test are those participants who scored 8 or 9 out of 9, while low achievers are those who scored 0 or 1. These cut off points represented the top two marks and the bottom two marks for high achievers and low achievers respectively on the phoneme deletion test. Table (23) below represents the correlation matrix of ADATI high achievers in phoneme deletion.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.022	1									
RD	.147	.016	1								
SP	.040	.151	.101	1							
WSC	-.008	.102	.065	**.422**	1						
RACCU	.161	.069	.125	**.438**	.379	1					
RCOMP	.008	.079	.158	**.427**	**.421**	.365	1				
NWR	.062	.070	.081	**.403**	.220	.251	.243	1			
PD	.011	.072	.122	.097	.046	.077	.111	.267	1		
BDS	.103	.110	.085	.273	.160	.063	.132	.164	.053	1	
RN	.181	.043	.147	.248	.242	.301	.244	.176	.150	-.014	1

(Table 23: ADATI high achievers in phoneme deletion correlation matrix)

There are significant correlations between scores of high achievers in phoneme deletion test in ADATI and their scores on the rest of the subtests, although such correlations are generally small. The spelling of high achievers in phoneme deletion group has a significant correlation with word & sentence chain (**r = 0.422**), reading accuracy (**r = 0.438**), reading comprehension (**r = 0.427**), non-word reading (**r = 0.403**) as well as backward digit span (**r = 0.273**) and rapid naming (**r = 0.248**).

Reading accuracy of the high achievers in phoneme deletion group correlates with spelling (**r = 0.438**) and word & sentence chain (**r = 0.379**). The reading comprehension of the high achievers in phoneme deletion group also correlates with spelling (**r = 0.427**) and word & sentence chain (**r = 0.421**). These correlation coefficients seem consistent with similar correlation coefficients reported in various groups above which all suggest that word & sentence chain test is relevant to reading and spelling skills amongst monolingual Arabic children. The various groups discussed above all support the view that orthographic knowledge can be shown to have a linear relationship, the degree of which will vary, with spelling and reading (accuracy and comprehension) amongst high and low achieving monolingual Arabic readers.

7.4.13 Group 13: Low achievers in phoneme deletion

As mentioned above, low achievers in phoneme deletion are those who scored 0 or 1 out of 9 on ADATI phoneme deletion test. The reason of choosing such cut off points is explained in group 12 above. Table (24) below represents the correlation matrix of ADATI low achievers in phoneme deletion.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	-.388	1									
RD	**.534**	-.117	1								
SP	**.462**	.271	.289	1							
WSC	.362	.106	**.507**	**.781**	1						
RACCU	**.434**	-.158	.341	**.546**	**.785**	1					
RCOMP	**-.524**	**.588**	-.112	.402	.392	.184	1				
NWR	.369	.350	.324	**.971**	**.761**	**.552**	**.444**	1			
PD	-.005	.217	-.135	.071	.273	.352	.052	.069	1		
BDS	**.617**	-.150	.373	.709	.346	.331	.008	**.715**	-.142	1	
RN	**.538**	.257	**.429**	**.467**	.361	.534	.022	**.506**	-.109	.357	1

(Table 24: ADATI low achievers in phoneme deletion correlation matrix)

The above table represents the highest correlation matrix so far and includes some very high and strong correlations which yield evidence in support of some of the most important issues discussed throughout the current study. There are substantial correlation coefficients amongst the non-verbal deductive reasoning test in ADATI low achievers in phoneme deletion group and 10 out of the 11 other variables. Non-verbal deductive reasoning skills of the low achievers in phoneme deletion group has particularly strong linear relationships with the rhyme detection (**r = 0.534**), reading comprehension (**r = -0.524**), backward digit span (**r = 0.617**) and rapid naming (**r = 0.538**). This indicates that although the non-verbal reasoning test in ADATI does not, in the whole data cohort, correlate with the reading nor the spelling skills of monolingual Arabic children, it does so when participants are divided into groups of high and low achievers according to their various scores on the different variables which make up ADATI test battery. This in turn supports the first hypothesis of the study in that non-verbal deductive reasoning does not seem to have a linear relationship with the spelling or the reading (accuracy or comprehension) of monolingual Arabic readers, although the non-verbal deductive reasoning test becomes useful when participants are grouped according to their scores on various tests into high and low achievers.

The spelling of the phoneme deletion low achievers group has also some of the highest correlation coefficients obtained so far. In this group, spelling has a very strong linear relationship with non-word reading (**r = 0.971**). Spelling also has a very strong linear relationship with word & sentence chain (**r = 0.781**) and backward digit span (**r = 0.709**). These strong correlation coefficients are in addition to other medium correlation coefficients spelling has with reading accuracy (**r = 0.546**), reading comprehension (**r = 0.402**) and rapid naming (**r = 0.467**).

The word & sentence chain of the low achievers in phoneme deletion group has some of the strongest linear relationships so far specially with spelling (**r = 0.781**), reading accuracy (**0.785**) and non-word reading (**r = 0.761**). These figures further support the relevance and importance of word & sentence chain in the identification of poor readers amongst monolingual Arabic children.

Non-word reading of the low achievers in phoneme deletion group has also some strong correlation coefficients. It has very strong linear relationships with spelling (**r = 0.971**) and strong relationships with both word & sentence chain (**r = 0.761**) and backward digit span (**r = 0.715**). Non-word reading, as argued earlier, is believed to be a measure of phonological processing and one that has proved to be very important and indeed discriminant when assessing the cognitive profiles of high and low achievers amongst monolingual Arabic children. The fact that the correlation coefficient between non-word reading and spelling amongst low achievers in phoneme deletion group indicates that low and/or poor readers depend on phonological processing when spelling; i.e., poor monolingual Arabic spellers seem to have an impairment in their phonological processing which in turn negatively affect their spelling as well as their reading accuracy and reading comprehension skills.

However, it is hypothesised that poor monolingual Arabic spellers seem to also have an orthographic knowledge impairment over and above their phonological processing impairment as the high correlation between spelling and word & sentence chain (**r = 0.781**) indicated.

Correlation coefficients for the backward digit span of the low achievers in phoneme deletion group are also amongst the strongest so far, notably in relation to the non-verbal reasoning test (**r = 0.617**), spelling (**r = 0.709**) and non-word reading (**r = 0.715**). It is hypothesized that in addition to the double deficits in phonological processing and orthographic processing of monolingual Arabic poor readers proposed above, spelling also depends on the short term verbal working memory as the strong linear relationship between backward digit span and spelling (**r = 0.709**) seems to indicate.

7.4.14 Group 14: High achievers in word & sentence chain

High achievers in ADATI word & sentence chain test are those participants who scored 24 or 25 out of 25, while the low achievers are those who scored 0, 1 or 2. Those who scored 2 are included here in order to generate more participants since choosing only those who scored 0 or 1 as is the case in almost all the tests above will only generated 3 participants in the low achievers group. These cut off points represent the top two marks and the bottom three marks for high achievers and low achievers respectively on the word & sentence chain test. Table (25) below represents the correlation matrix of ADATI high achievers in word & sentence chain.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	-.125	1									
RD	**-.458**	**.424**	1								
SP	-.120	-.281	-.124	1							
WSC	**-.438**	**.516**	.078	-.161	1						
RACCU	-.069	-.206	.340	-.268	-.376	1					
RCOMP	.155	-.316	-.049	.252	**-.470**	.342	1				
NWR	.048	-.159	.081	.079	**-.515**	**.758**	**.727**	1			
PD	.285	.249	-.093	.000	-.167	.338	**.706**	**.727**	1		
BDS	**.445**	.146	-.083	-.227	-.220	-.106	.295	.060	**.423**	1	
RN	.040	.097	-.060	.041	-.236	**.511**	**.658**	**.831**	**.881**	.188	1

(Table 25: ADATI high achievers in word & sentence chain correlation matrix)

Table (25) above represents another important and interesting correlation matrix which contains a number of relevant correlation coefficients. Non-verbal deductive reasoning test significantly correlates with rhyme detection (**r = - 0.458**), word & sentence chain (**r = -0.438**) and backward digit span (**r = 0.445**) amongst the high achievers in word & sentence chain group.

The non-word reading scores of the high achievers in word & sentence chain test group strongly correlate with 5 other variables in ADATI subtests which are: (**r = - 0.515**) with word & sentence chain, (**r = 0.758**) with reading accuracy, (**r = 0.727**) with reading comprehension, (**r = 0.727**) with phoneme deletion and (**r = 0.831**) with rapid naming.

Phoneme deletion scores of the high achievers in word & sentence chain test group has a strong linear relationship with reading comprehension (**r = 0.706**), non-word reading (**r = 0.727**) and rapid naming (**r = 0.881**). The rapid naming scores of the high achievers in word & sentence chain test group strongly correlates with reading accuracy (**r = 0.511**), reading comprehension (**r = 0.658**) and phoneme deletion (**r = 0.881**). These correlation coefficients are very important and confirm the relevance of word & sentence chain test and in turn orthographic knowledge for the reading and spelling development of monolingual Arabic children. Dividing participants' scores on the word & sentence chain test into high and low achievers produces some very interesting and relevant correlations which is a further proof that word & sentence chain test and in particular orthographic knowledge is relevant when identifying poor monolingual Arabic readers.

7.4.15 Group 15: Low achievers in word & sentence chain

As mentioned above, low achievers in word & sentence chain are those who scored 0, 1 or 2 out of 25 on ADATI word & sentence chain test. The reason for choosing these cut off points is explained in group 14 above. Table (26) below represents the correlation matrix of ADATI low achievers in word & sentence chain.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	**.505**	1									
RD	.262	**.530**	1								
SP	**.623**	**.452**	**.547**	1							
WSC	-.122	**.423**	**.506**	.188	1						
RACCU	**.478**	.399	**.730**	**.741**	**.509**	1					
RCOMP	.070	**.408**	**.564**	.386	.214	.268	1				
NWR	**.434**	**.773**	.027	**.466**	.242	.115	.242	1			
PD	-.247	**.451**	.242	.245	.272	-.076	**.549**	**.572**	1		
BDS	-.122	**.404**	-.340	-.123	.113	**-.412**	-.092	**.729**	**.657**	1	
RN	.305	.109	**.710**	**.429**	.030	**.433**	**.637**	-.197	.085	**-.502**	1

(Table 26: ADATI low achievers in word & sentence chain correlation matrix)

Table (26) above is an important correlation matrix which contains significant correlation coefficients. Non-verbal deductive reasoning strongly correlates with grapheme discrimination (**r = 0.505**) and spelling (**r = 0.623**) amongst word & sentence chain low achievers. Non-verbal deductive reasoning also significantly correlates with reading accuracy (**r = 0.478**), non-word reading (**r = 0.434**) and rapid naming (**r = 0.305**) amongst the low achievers in word & sentence chain group.

Grapheme discrimination scores of the low achievers in word & sentence chain test group has significant correlations with the non-verbal reasoning (**r = 0.505**), rhyme detection (**r = 0.530**), spelling (**r = 0.452**), word & sentence chain (**r = 0.423**), reading accuracy (**r = 0.399**), reading comprehension (**r = 0.408**), phoneme deletion (**r = 0.451**) and backward digit span (**r = 0.404**). Grapheme discrimination has a strong linear relationship in the low achievers in word & sentence chain test group with non-word reading as indicated by the strong correlation coefficient (**r = 0.773**). Reading accuracy of the low achievers in word & sentence chain test group has strong correlations with rhyme detection (**r = 0.730**), spelling (**r = 0.741**) and word & sentence chain (**r = 0.509**). The non-word reading of low achievers in word & sentence chain test group also has significant correlations with grapheme discrimination (**r = 0.773**), phoneme deletion (**r = 0.752**), and backward digit span (**r = 0.729**).

Both backward digit span and rapid naming scores of the low achievers in word & sentence chain test group have significant correlations. Backward digit span in this group strongly correlates with non-word reading (**r = 0.729**), phoneme deletion (**r = 0.657**) and rapid naming (**r = -0.502**). The rapid naming scores of this group also strongly correlates with rhyme detection (**r = 0.710**) and reading comprehension (**r = 0.637**).

7.4.16 Group 16: High Achievers in rapid naming test

Rapid naming test final score is out of 78 and as such choosing the minimum two scores and the maximum two scores like earlier tests is not recommended as a cut off point, particularly that the number of participants needed to carry out the statistical analysis and the necessary comparisons would not have been possible. Table (27) below lists the frequency scores of the rapid naming test.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	.3	.3	.3
	11	1	.3	.3	.5
	13	1	.3	.3	.8
	16	2	.5	.5	1.3
	20	1	.3	.3	1.6
	23	1	.3	.3	1.8
	31	1	.3	.3	2.1
	33	2	.5	.5	2.6
	34	1	.3	.3	2.9
	35	3	.8	.8	3.7
	36	3	.8	.8	4.5
	37	1	.3	.3	4.7
	38	3	.8	.8	5.5
	39	2	.5	.5	6.0
	40	4	1.0	1.0	7.1
	41	1	.3	.3	7.3
	42	3	.8	.8	8.1
	43	7	1.8	1.8	9.9
	44	3	.8	.8	10.7
	45	6	1.6	1.6	12.3
	46	4	1.0	1.0	13.4
	47	2	.5	.5	13.9
	48	3	.8	.8	14.7
	49	5	1.3	1.3	16.0
	50	7	1.8	1.8	17.8
	51	6	1.6	1.6	19.4
	52	5	1.3	1.3	20.7
	53	12	3.1	3.1	23.8
	54	6	1.6	1.6	25.4
	55	17	4.5	4.5	29.8
	56	8	2.1	2.1	31.9
	57	11	2.9	2.9	34.8
	58	13	3.4	3.4	38.2
	59	21	5.5	5.5	43.7
	60	20	5.2	5.2	49.0
	61	14	3.7	3.7	52.6
	62	8	2.1	2.1	54.7
	63	21	5.5	5.5	60.2
	64	11	2.9	2.9	63.1
	65	15	3.9	3.9	67.0
	66	18	4.7	4.7	71.7

	67	8	2.1	2.1	73.8
	68	26	6.8	6.8	80.6
	69	8	2.1	2.1	82.7
	70	16	4.2	4.2	86.9
	71	7	1.8	1.8	88.7
	72	8	2.1	2.1	90.8
	73	10	2.6	2.6	93.5
	74	8	2.1	2.1	95.5
	75	5	1.3	1.3	96.9
	76	6	1.6	1.6	98.4
	77	4	1.0	1.0	99.5
	78	2	.5	.5	100.0
	Total	382	100.0	100.0	

(Table 27 ADATI rapid naming frequency scores)

Because of the number of participants scoring the low and high marks on the rapid naming test listed in Table (27 above, it is decided to divide participants' scores on the ADATI rapid naming test into three equal groups as per the following table:

ADATI Rapid Naming Statistics

RN

N	Valid	382
	Missing	0
Percentiles	33.33333333	57.00
	66.66666667	65.00

(Table 28 ADATI rapid naming statistics)

Both the 33.33 % and the 66.66 % percentiles are chosen as cut off points and participants who scored below 57 (33%) are regarded as low achievers while those who scored above 65 are regarded as high achievers in ADATI rapid naming test. Table (29) below represents the correlation matrix of ADATI high achievers in rapid naming.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.056	1									
RD	.052	.091	1								
SP	-.080	.057	.157	1							
WSC	-.084	.107	.097	**.474**	1						
RACCU	.019	.070	.283	**.515**	.215	1					
RCOMP	.023	.067	.147	**.477**	**.410**	.278	1				
NWR	-.116	.049	.206	**.586**	.312	**.455**	.255	1			
PD	-.022	.022	.189	.354	.177	.344	.204	**.547**	1		
BDS	.105	.085	-.060	.371	.301	.200	.344	.166	.032	1	
RN	-.034	.078	.125	.207	.150	.190	.141	.229	.169	.017	1

(Table 29: ADATI high achievers in rapid naming correlation matrix)

There is a weak correlation amongst the high achievers in rapid naming test group between their non-verbal reasoning scores and almost all the rest of the subtests. There are significant correlations between spelling and almost all the rest of the subtests and there are particularly two strong correlation coefficients between spelling and reading accuracy (**r = 0.515**) and non-word reading (**r = 0.586**). There are also significant correlations between the non-word reading in this group and tests of spelling (**r = 0.586**), reading accuracy (**r = 0.455**) and phoneme deletion (**r = 0.547**).

7.4.17 Group 17: Low achievers in rapid naming test

As mentioned above, participants who scored less than 57 out of 78 are regarded as low achievers in rapid naming test. The reason for choosing these cut off points is explained group 16 above. Table (30) below represents the correlation matrix of ADATI low achievers in rapid naming test.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	-.029	1									
RD	.208	.152	1								
SP	.080	.236	.160	1							
WSC	-.075	.373	.076	**.486**	1						
RACCU	.146	.268	.340	**.418**	**.431**	1					
RCOMP	-.084	.268	.222	**.414**	**.485**	.414	1				
NWR	.245	.086	.139	**.471**	.189	.331	.213	1			
PD	.154	.064	.212	**.417**	.173	.259	.205	**.707**	1		
BDS	.175	.189	.095	.323	.246	.083	.133	.378	.390	1	
RN	.341	.001	.102	.241	.232	.307	.165	.138	.169	.105	1

(Table 30: ADATI low achievers in rapid naming correlation matrix)

The spelling of low achievers in rapid naming test group has the most statistical significance in its correlation coefficients. Spelling in this group significantly correlates with word & sentence chain (**r = 0.486**), reading accuracy (**r = 0.418**), reading comprehension (**r = 0.414**), non-word reading (**r = 0.471**) and phoneme deletion (**r = 0.417**). The reading comprehension of the low achievers in rapid naming test group also correlates with spelling (**r = 0.414**), word & sentence chain (**r = 0.485**) and reading accuracy (**r = 0.414**). On the other hand, the reading accuracy of the low achievers in rapid naming group has a number of significant correlation coefficients with spelling (**r = 0.418**), word & sentence chain (**r = 0.431**) and reading comprehension (**r = 0.414**).

The strongest correlation coefficient amongst the low achievers in rapid naming test group is the linear relationship between phoneme deletion and non-word reading (**r = 0.707**). This correlation coefficient can also be used as an additional support of a divergent validity since both tests; phoneme deletion and non-word reading, are tests believed to be measuring the same construct "phonological awareness" and as such having such a strong correlation coefficient indicates that these two subtests are valid measures of phonological awareness skills amongst monolingual Arabic children.

7.4.18 Group 18: High achievers in backward digit span test

High achievers in ADATI backward digit span are those participants who scored 9 or 10 out of 10, while low achievers are those who scored 0, or 1. These cut off points represent the top two marks and the bottom two marks for high achievers and low achievers respectively on the backward digit span test. Table (31) below represents the correlation matrix of ADATI high achievers in the backward digit span test.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.027	1									
RD	.213	-.316	1								
SP	-.035	-.266	.270	1							
WSC	-.010	-.207	.199	**.761**	1						
RACCU	**.417**	-.083	**.443**	**.557**	**.676**	1					
RCOMP	.330	-.192	**.466**	**.561**	**.761**	**.780**	1				
NWR	-.145	-.196	.155	**.483**	.075	-.158	.134	1			
PD	-.128	-.226	**.633**	.289	.058	-.135	.065	**.532**	1		
BDS	**-.419**	.032	-.148	-.215	**-.446**	-.365	**-.482**	.055	.178	1	
RN	**.431**	-.094	.350	.329	**.440**	**.729**	**.679**	-.094	-.189	-.148	1

(Table 31: ADATI high achievers in backward digit span correlations)

There are some significant correlation coefficients between the non-verbal deductive reasoning test in the high achievers in backward digit span group and the rest of ADATI subtests notably reading accuracy (**r = 0.417**) and backward digit span (**r = 0.419**). The spelling of the high achievers in backward digit span group strongly correlates with word & sentence chain (**r = 0.761**), reading accuracy (**r = 0.557**), and reading comprehension (**r = 0.561**).

The word & sentence chain of the high achievers in backward digit span test group strongly correlates with spelling (**r = 0.761**), reading accuracy (**r = 0.676**), and reading comprehension (**r = 0.761**). In additions, the rapid naming of the high achievers in backward digit span also strongly correlates with their reading skills; i.e., (**r = 0.729**) in reading accuracy and (**r = 0.679**) in reading comprehension. These high correlation coefficients between rapid naming and reading skills (both reading accuracy and reading comprehension) amongst the low achievers in backward digit span group suggest that rapid naming is important and relevant when identifying poor monolingual Arabic readers and/or specific reading disabled. These figures are particularly relevant when compared with the same correlation between the whole data set; i.e., rapid naming with reading accuracy is (**r = 0.316**) while it doubled in the high achievers in backward digit span test group to (**r = 0.729**). The same happens with the rapid naming and the reading comprehension which was (**r = 0.224**) but is now (**r = 0. 679**) in the current group. The backward digit span of high achievers in backward digit span test group also significantly correlated with almost all the subtests of ADATI, notably with reading comprehension (**r = -0.482**), reading accuracy (**r = -0.365**) and word & sentence chain (**r = -0.446**). The phoneme deletion of the high achievers in backward digit span test group strongly correlates with rhyme detection (**r = 0.633**).

7.4.19 Group 19: Low achievers in backward digit span test

As mentioned in group 18 above, those who scored 0 or 1 out of 10 are regarded as low achievers in the backward digit span test. The reason of choosing these cut off points is explained in group 18 above. Table (32) below represents the correlation matrix of ADATI low achievers in backward digit span.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.387	1									
RD	-.250	**-.402**	1								
SP	-.315	.195	-.386	1							
WSC	-.103	**.698**	.262	.246	1						
RACCU	-.080	-.229	.388	.177	.024	1					
RCOMP	-.131	.331	**.598**	.139	**.795**	**.503**	1				
NWR	-.239	.047	-.010	**.520**	.151	**.531**	**.504**	1			
PD	-.234	-.042	-.211	**.549**	-.080	**.509**	.256	**.957**	1		
BDS	.398	-.046	**.411**	**-.483**	.019	-.084	.303	.194	.038	1	
RN	**.553**	.203	.140	.235	.243	.358	.270	-.104	-.179	.004	1

(Table 32: ADATI low achievers in backward digit span correlations)

There is a substantial correlation coefficient between backward digit span low achievers and their spelling (**r =- 0.483**). This correlation is particularly interesting because in the whole data set group, the correlation was (**r = 0.319**), but has slightly decreased in the backward digit span high achievers group (**r = -0.215**) only to increase significantly again in the low achievers group. This correlation coefficient indicates that low achievers in backward digit span test have a problem with their verbal short term working memory that may impair their spelling skills. Spelling in Arabic, as in other alphabetic scripts, draws upon the ability to decode words being heard and/or dictated into their constituents sounds and re-encode these into their corresponding graphemes in Arabic. This task draws heavily upon two factors, verbal short term working memory and phonological awareness (the ease with which dictated words are de-coded and re-encoded again). The significant linear relationship between spelling and backward digit span of low achievers in the backward digit span test group indicates that verbal short term memory was indeed relevant to the identification of poor monolingual Arabic readers and/or specific disabled readers. The highest correlation co-efficient ever in this correlation matrix is between phoneme deletion and non-word reading (**r = 0.957**). The reading comprehension of the low achievers in the backward digit span test group has strong linear relationships with rhyme detection (**r = 0.598**), word & sentence chain test (**r = 0.795**), reading accuracy (**r = 0.503**) and non-word reading (**r = 0.504**). The phoneme deletion of the low achievers in backward digit span group had significant correlation coefficients with spelling (**r = 0.549**), reading accuracy (**r = 0.509**) and non-word reading (**r = 0.957**). Phoneme deletion, a test of phonological awareness as argued earlier, is indeed very relevant to the reading and spelling skills of monolingual Arabic readers.

7.4.20 Group 20: High achievers in non-verbal reasoning test

Non-verbal deductive reasoning test final score is out of 60 and choosing the minimum two scores and the maximum two scores like earlier tests are not recommended as cut off points particularly as the number of participants needed to carry out the statistical analysis and the necessary comparisons would not have been possible. Following the same rationale employed in groups 16 and 17 above, the scores of participants on the non-verbal deductive reasoning test is divided into three equal groups as per the following table:

ADATI Non-verbal Reasoning Statistics

PMARS

N	Valid	382
	Missing	0
Percentiles	33.33333333	20.00
	66.66666667	28.00

(Table 33: ADATI non-verbal reasoning statistics)

The 33.33 % and 66.66 % percentiles are adopted as cut off pints and those who scored less than 20 out of 60 are regarded as low achievers while those who scored more than 28 are regarded as high achievers. The following table represents the correlation matrix of ADATI high achievers in non-verbal deductive reasoning test.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.054	1									
RD	.169	.030	1								
SP	.183	.157	.162	1							
WSC	.050	.061	.021	**.475**	1						
RACCU	.112	.202	.213	**.493**	.279	1					
RCOMP	.099	.164	.033	**.480**	.377	**.436**	1				
NWR	.094	.086	.054	**.512**	.253	.300	.231	1			
PD	.039	.056	.149	**.481**	.318	.278	.254	**.675**	1		
BDS	.272	.094	.078	.370	.260	.237	.248	.181	.166	1	
RN	-.021	.047	.162	.272	.210	.179	.333	.218	.363	.096	1

(Table 34: ADATI high achievers in non-verbal reasoning correlations)

The spelling of ADATI high achievers in the non-verbal deductive reasoning correlations test group significantly correlates with word and sentence chain (**r = 0.475**), reading accuracy (**r = 0.493**), reading comprehension (**r = 0.480**), non-word reading (**r = 0.512**) and phoneme deletion (**r = 0.481**). In addition, the reading accuracy of the high achievers in non-verbal reasoning test strongly correlates with their spelling (**r = 0. 493**). The phoneme deletion of the current group also strongly correlates with the participants non-word reading scores (**r = 0.675**).

7.4.21 Group 21: Low achievers in non-verbal reasoning test

As explained in group 20 above, those who scored less than 20 out of 60 are regarded as low achievers. Table (35) below represents the correlation matrix scores of ADATI low achievers in non-verbal reasoning.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.046	1									
RD	.045	.117	1								
SP	.130	.182	.249	1							
WSC	-.004	.180	.161	**.523**	1						
RACCU	.061	.136	.384	**.483**	**.490**	1					
RCOMP	-.053	.125	.333	.383	**.477**	**.454**	1				
NWR	.141	.122	.203	**.572**	.291	.351	.267	1			
PD	.160	.085	.270	**.411**	.200	.268	.207	**.741**	1		
BDS	.207	.128	.068	.358	.208	.095	.078	**.433**	.394	1	
RN	.261	.084	.228	.380	.296	.360	.310	**.421**	.309	.199	1

(Table 35: ADATI low achievers in non-verbal reasoning correlations)

There are significant correlation coefficients between spelling in the low achievers in non-verbal reasoning test group and almost all the rest of the subtests particularly with rhyme detection (**r = 0.249**), word & sentence chain test (**r = 0.523**), reading accuracy (**r = 0.483**), reading comprehension (**r = 0.383**), non-word reading (**r = 0.572**), phoneme deletion (**r = 0.411**), backward digit span (**r = 0.358**) and rapid naming (**r = 0.228**). The strongest correlation coefficients out of all these though are the ones with word & sentence chain and with their non-word reading. Word & sentence chain is believed to be a test of orthographic knowledge while non-word reading is believed to be a test of phonological processing. These two high correlations reinforce the view proposed earlier that both phonological processing and orthographic processing affect the reading and spelling skills of monolingual Arabic children and that deficits in these two cognitive abilities impair the reading and spelling abilities of monolingual Arabic poor readers.

Another important observation in the correlation matrix presented in Table (36) above is that correlation coefficients on phonological awareness based tests such as non-word reading, phoneme deletion and rhyme detection and scores on spelling and reading skills (both reading accuracy and reading comprehension) when compared in the case of high and low achievers non-verbal reasoning test scores have produced a mixed bag of figures. On the one hand, the non-word reading and phoneme deletion scores of both high and low achievers according to their non-verbal reasoning test and their spelling and reading skills do not differ much. On the other hand, the rhyme detection correlation of both high and low achievers according to their non-verbal reasoning test differ significantly. Moreover, rhyme detection and reading comprehension group of ADATI high achievers in non-verbal reasoning test group is (**$r = 0.033$**), but has significantly increased to (**$r = 0.333$**) in the case of the low achievers group. This indicates that dividing ADATI participants into high and low achievers non-verbal reasoning test, apart from very few exceptions, generally does not result in any significant differences between high and low achieving monolingual Arabic children. This is a further proof to support the initial hypothesis of the study that, generally, there is a weak correlation between non-verbal deductive reasoning test and reading (reading accuracy and reading comprehension) and spelling amongst monolingual Arabic children. Such a weak relationship does not support the use of non-verbal deductive reasoning test and reading achievement discrepancy for the identification of dyslexics amongst monolingual Arabic children.

7.5 Dyslexia in Arabic

7.5.1 Group 22: Dyslexic group

The above results, either specifically in groups 20 and 21, or generally in the rest of the groups (group 1 to 19), represent the case for the irrelevance of IQ-reading achievement discrepancy in the identification of dyslexia amongst monolingual Arabic children. Having examined the case of IQ-reading achievement discrepancy in detail, and having shown that non-verbal deductive reasoning test employed in ADATI does not seem to have any strong linear relationships with any of the literacy skills (spelling, reading accuracy and reading comprehension in ADATI), it is useful, for a complete examination of the underlying causes of developmental dyslexia in Arabic, that an attempt is made towards specifying participants in ADATI who seem to be poor readers first and then compare these with their scores in the non-verbal reasoning test. This is attempted "to ensure that difficulties in the given cognitive tasks are not due to general deficits in cognitive processing and this is the reason for excluding children with low non-verbal reasoning abilities" (Landerl 2001: 193). The IQ test can also be extremely useful as both a general indicator of cognitive abilities and for its role in providing a profile of abilities (Reid & Kirk 2001).

Conducting such an analysis has a number of very useful purposes. First: one can then rule out those poor readers who may be having global deficiencies or may have low current cognitive abilities and therefore stressing and showing the *specificity* of the nature of dyslexia and ultimately differentiating it from garden variety poor readers. Second: one can then proceed to try and discover the occurrence of dyslexia and quantify dyslexics amongst monolingual Arabic children.

Since the scores of reading accuracy obtained in ADATI are high and close to ceiling and its variance is relatively lower than one expected, it is preferred to use both the reading comprehension and spelling tests as the current measure of literacy achievement amongst ADATI participants. Poor spellers (according to their spelling test scores) and poor readers (according to their reading comprehension test scores) are selected according to the same cut off criteria previously reported in groups 2, 3, 6 and 7. These cut off points are:

- Participants who scored 0 or 1 in the spelling test. (Poor spellers)
- Participants who scored 10 or below in the reading comprehension test. (Poor readers according to their reading comprehension scores).
- Participants who scored more than 20 on the non-verbal deductive reasoning test. (Global deficiency is therefore controlled for and ruled out).

Arabic dyslexics are only those who meet these strict selection criteria. These selection criteria is based on both theoretical understanding of the definitional issues and challenges of developmental dyslexia discussed in detail in the first chapter of the current study. These selection criteria also ensure that only those participants who are poor in spelling and poor in reading comprehension while at the same time average or above average according to their non-verbal reasoning scores are selected. Participants who meet this criteria in ADATI are 11 which makes up 2.8 % of the original data sample (382 participants) and therefore, the percentage of dyslexics amongst ADATI participants was 2.8%. Appendix (8) is the table of monolingual Arabic dyslexics amongst ADATI data sample showing their various scores on ADATI subtests. The number of dyslexic males are 9 while the number of dyslexic females are 2. This ratio (4.5 : 1) converges with Miles (1999) reported ratio of dyslexics boys to girls in which he asserts that if dyslexia is defined simply on the basis of underachievement at reading, the ratio of boys to girls was found to be not far from 1:1 (a ratio that has also been found by Shaywitz et al. (1999), "whereas if spelling and the supplementary items were also taken into account, the ratio came out as 4.5 : 1" (Miles & Miles 1999: 27).

Examining closely the table of dyslexics in Appendix (8), one notes that out of the 11 children in this dyslexia group, all but two scored less than 10 out of 25 on the word & sentence chain test. Although the selection criteria is only carried out according to spelling, reading comprehension and non-verbal deductive reasoning test, it seems that word & sentence chain, as previously anticipated, is also a very strong indicator of dyslexia type behaviour amongst monolingual Arabic children. This finding supports initial expectations and one of the research hypotheses that due to the specific nature of the Arabic orthography, orthographic processing and/or knowledge seem to be very relevant to the development of spelling and reading skills amongst monolingual Arabic readers and that impairments in orthographic knowledge negatively affect spelling and reading skills amongst monolingual Arabic dyslexia children.

Scores of dyslexics on the reading accuracy test are high and close to ceiling and further supports the choice of substituting the reading accuracy with the reading comprehension as a selection criteria to identify dyslexics. Two dyslexics participants scored 29, three scored 28, two scored 26, one scored 24, one scored 22, one scored 18 and one scored 15 out of the final score of 30. These are high scores for dyslexics and would indicate that the nature of the Arabic language, discussed in chapter 3 in detail, makes it easier even for dyslexics to develop phonemic awareness at a much finer level (the level of the phoneme) than their English counterparts which are reported to develop their phonemic awareness at a much thicker chunks (the level of onsite and rime), simply because the phoneme grapheme relationship is unambiguously represented by the Arabic orthography. These results converge with Mutter's (2003) conclusions that children learning to read in highly transparent orthographies such as Arabic tend to develop phoneme-grapheme recoding skills much easier and quicker than those learning to read in opaque orthographies (Mutter 2003). That is why even Arabic dyslexics attain high grades in their reading accuracy test. However, the same dyslexic individuals attain a much lower grades in their reading comprehension and/or spelling which are also measures of their literacy skills.

The number of dyslexics who scored 5 or less on the non-word reading test are 7 out of 11 participants. The number of participants who scored 5 or less on the phoneme deletion test are 5 out of 11 and the number of participants who scored 5 or less on the rhyme detection test are 4 out of 11. These low scores indicate that non-word reading, phoneme deletion and rhyme detection are indeed relevant to spelling and reading skills amongst poor monolingual Arabic readers, however, it seems that almost half the dyslexic group has achieved above 50 % of the scores on the above three tests which all proves that phonological processing is relevant when identifying monolingual Arabic dyslexics although the degree of its importance and severity is not as high or as critical as it is reported in the case of monolingual English speakers.

The number of participants who scored less than 5 (no one scored 5) on the Backward Digit span test are 7 out of 11. These scores indicate that backward digit span is a good indicator when identifying monolingual Arabic dyslexics, which also indicates that impairments in verbal short term memory, an underlying skill believed to be measured by the backward digit span test, negatively affects the spelling and reading skills of specific reading disabled monolingual Arabic children

Table (36) below contains the correlation matrix of ADATI dyslexic group.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	-.343	1									
RD	.270	**.466**	1								
SP	.338	.137	**.716**	1							
WSC	-.315	-.005	.020	-.296	1						
RACCU	**-0.611**	**0.453**	.289	.242	-.017	1					
RCOMP	-0.264	0.313	**.534**	.181	.115	**.713**	1				
NWR	-.193	.071	.201	.165	.222	-.093	-.040	1			
PD	-.160	**-.400**	.161	.297	.206	.160	.085	**.530**	1		
BDS	-.270	-.091	.145	.113	-.049	**.565**	**.445**	**-.400**	.271	1	
RN	-.149	.209	.121	-.015	.008	.295	-.082	-.292	.117	**.610**	1

(Table 36: ADATI dyslexics correlation Matrix)

The correlation matrix of ADATI dyslexic group in Table (36) above contains some relevant and important correlation coefficients. The non-verbal deductive reasoning scores of the monolingual Arabic dyslexic group correlates with all the rest of ADATI subtests and the highest correlation coefficients concerning the non-verbal reasoning test is with the reading accuracy (**r = 0.611**). This correlation is very significant if compared with the same correlation amongst the whole data set which was (**r = 0.160**).

The spelling of ADATI dyslexic group has a strong correlation with their rhyme detection (**r = 0.716**). Again, this is a very important and significant statistical difference when compared with the same correlation in the case of the whole data set which was (**r = 0.207**). It therefore seems that impairments in rhyme detection skills has negative impact on the spelling skills of dyslexic monolingual Arabic children. The rhyme detection scores of ADATI dyslexic group strong correlates with their grapheme discrimination (**r = 0.466**), their spelling (**r = 0.716**) and their reading comprehension (**r = 0.534**). These correlation coefficients yield further evidence in support of the relevance of rhyme detection skills amongst monolingual Arabic readers. These results converge with Goswami and Bryant (1990) who conclude that there is a significant relationship between children's ability to make rhyme analogies while reading and rhyme judgments and that children might have employed similar analogies early in the development of their spelling.

The backward digit span scores of ADATI dyslexic group has substantial significant correlations with monolingual Arabic dyslexic scores on reading accuracy (**r = 0.565**), reading comprehension (**r = 0.445**), non-word reading (**r = -0.400**) and rapid naming (**r – 0.610**). These strong correlations stress the importance of backward digit span as a good predictor of dyslexia type behaviour when identifying dyslexia amongst monolingual Arabic readers. It also reflects the importance of verbal short term working memory on the spelling and reading skills of monolingual specific Arabic dyslexics and that impairments on their skills of verbal short term memory negatively affects their literacy skills in Arabic.

The correlations in word & sentence chain in the case of dyslexics group have decreased significantly with the rest of the tests except for the correlation between word & sentence chain and the non-verbal reasoning test which has increased from (**r = -0.020**) in the whole data set to (**r = -0.315**).

The correlations between reading accuracy amongst the dyslexic group and the rest of the tests have increased significantly. The correlation between reading accuracy and non-verbal reasoning test is (**r = 0.160**) in the whole data set which has more or less stayed the same in the high achievers in reading accuracy group (**r = 0.172**). The same correlation increased slightly in the case of the low achievers in the reading accuracy group (**r = 0.230**), but has increased significantly again in the case of the dyslexic group (**r = -0.611**).

The correlation coefficient between reading accuracy and reading comprehension in the dyslexic group has also increased from (**r = 0.376**) in the whole data set to (**r =**

0.713). The correlation between reading accuracy and backward digit span has increased significantly in the dyslexic group (**r = 0.565**) to almost the double of the correlation formerly found amongst the whole data set (**r = 0.203**). Backward digit span is a test believed to measure verbal short term working memory and deficits in verbal short term memory seem to be a core indicator of dyslexia amongst monolingual Arabic children.

The increase in correlations between backward digit span and both reading accuracy and reading comprehension amongst the dyslexic group further stress the importance of backward digit span when identifying dyslexics. The correlation between non-word reading amongst the dyslexic group has decreased with the rest of the subtests in ADATI, although it has significantly maintained its strength with the phoneme deletion test (**r = 0.530**). The correlation between backward digit span has significantly increased with rapid naming amongst ADATI dyslexic group; (**r = 0.105)** in the whole data set but (**r = 0.610)** in the dyslexic group. This indicates that monolingual Arabic dyslexics have significant problems in both rapid naming and backward digit span. Such a correlation is significant enough to warrant rapid naming and backward digit span as core (positive) indicators of dyslexia amongst monolingual Arabic dyslexics.

7.5.2 Group 23: Specific reading disabled Control group

In order to be able to compare the scores and correlation coefficients of ADATI dyslexic participants, a controlled group is selected according to the following selection criteria:

1. Participants who are closely matched for chronological age.
2. Participants who scored 2 or above in the spelling test.
3. Participants who scored more than 10 in reading comprehension test.
4. Participants who scored more than 20 in non-verbal deductive reasoning test.

Arabic specific reading disabled control group are only those who met the above selection criteria. These selection criteria guarantee that balanced statistical analysis and relationships are investigated while controlling for other intervening variables such as chronological age. Appendix (9) shows the table of ADATI control group. Table (37) below shows the correlation matrix of ADATI control group.

Measures	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
PMARS	1										
GD	.232	1									
RD	-.230	.128	1								
SP	.089	-.272	-.144	1							
WSC	-.065	-.244	-.239	**.460**	1						
RACCU	.003	-.072	-.236	**.509**	.375	1					
RCOMP	.098	-.236	-.096	**.417**	**.451**	.280	1				
NWR	**.412**	.029	-.151	.232	.024	.052	.216	1			
PD	-.117	.039	.143	.045	.207	-.076	.214	.212	1		
BDS	.087	.050	.022	.258	-.279	.143	.136	.069	.151	1	
RN	-.073	-.061	.076	.257	.113	**.413**	.290	.175	**.422**	.023	1

(Table 37: ADATI control group correlation matrix)

Table (37) above represents the correlation matrix of ADATI control group. Comparing the correlation matrix of the control group and the dyslexic group, one observes that, apart from the correlation between non-word reading and non-verbal deductive reasoning test, all the rest of the correlations in the case of the control group are much smaller than their counterparts in the dyslexic group. These correlation coefficients among ADATI subtests and the non-verbal deductive reasoning test in the case of the dyslexic group are all interesting (as high as **r = 0.611** in the reading accuracy and non-verbal reasoning correlation) and confirm one's approach that using the non-verbal deductive reasoning test not as a measure of discrepancy with reading skills but as a differentiating tool to control for global deficient participants is indeed useful and that scores of dyslexic and normal readers closely matched for age are statistically different when employing the non-verbal reasoning test to rule out global deficiency.

Correlation coefficients of Arabic dyslexic participants on the grapheme discrimination test and other subtests of ADATI are higher than their equivalents in the case of the control group. While grapheme discrimination correlation coefficients in the case of the control group are (**r = 0.128**) with rhyme detection, (**r = -0.272**) with spelling, (**r = -0.072**) with reading accuracy and (**r = -0.236**) with reading comprehension, the same correlation coefficients in the case of the dyslexic group are (**r = 0.466**) with rhyme detection, (**r = 0.137**) with spelling, (**r = 0.453**) with reading accuracy and (**r = 0.313**) with reading comprehension. The same correlation coefficients between grapheme discrimination and tests of rhyme detection, reading accuracy and reading comprehension in the case of the whole data cohort are also lower than the correlation coefficients in the case of the dyslexic group.

These statistical differences in correlation coefficients in the case of grapheme discrimination scores amongst dyslexics and control group and amongst dyslexics and the whole data cohort provides further support to the relevance and importance of utilizing grapheme discrimination tests when identifying specific reading disabled Arabic children. Grapheme discrimination test measures the visual discrimination of Arabic grapheme skills amongst monolingual Arabic readers. It is hypothesized that such a skill is relevant to reading skills in Arabic due to the similar visual nature of Arabic letters as well as the high dependence on dots in Arabic to differentiate between some 15 graphemes out of a 28 letter alphabet. Such a specific nature of Arabic orthography may increase demands on the visual discrimination skills of Arabic children.

Correlation coefficients of specific reading disabled Arabic participants on the rhyme detection test and other subtests of ADATI are higher than their equivalents in the case of the control group (expect for the word & sentence chain test). The rhyme detection correlation coefficients in the case of the control group with non-verbal reasoning (**r = -0.230**), grapheme discrimination (**r = 0.128**), spelling (**r = -0.144**), reading accuracy (**r = -0.236**) and reading comprehension (**r = -0.096**) are all significantly lower than their respective correlation coefficients in the case of the dyslexic group which are (**r = 0.270**) with non-verbal deductive reasoning test, (**r = 0.466**) with grapheme discrimination, (**r = 0.716**) with spelling, (**r = 0.289**) with reading accuracy and (**r = 0.534**) with reading comprehension. These statistical differences in the scores of dyslexic and normal readers further support the view that rhyme detection is both relevant and important when identifying monolingual dyslexic Arabic children. It also supports the conclusion that phonological awareness is a relevant skill which contributes to literacy abilities amongst monolingual Arabic readers and that impairments in phonemic awareness seem to negatively affect spelling and reading skills of monolingual dyslexia Arabic children.

There are also some significant statistical differences between correlation coefficients of backward digit span and other ADATI subtests in both the dyslexic and the control group. The correlation coefficient between backward digit span and reading accuracy is (**r = 0.143**) in the control group while the same correlation coefficient in the dyslexic group is (**r = 0.565**). Further, the correlation coefficient between backward digit span and reading comprehension is (**r = 0.136**) in the control group while the same correlation coefficient in the dyslexic group is (**r = 0.445**). The same correlation between backward digit span and reading accuracy in the case of the whole data set is (**r = 0.160**) and between backward digit span and reading comprehension is (**r = 0.203**). It seems therefore that backward digit span scores in the case of the dyslexic group have a higher correlation with both reading accuracy and reading comprehension than in the case of the control group and in the case of the whole data set. This indicates that deficits in backward digit span negatively affects the dyslexic group's performance in reading accuracy and reading comprehension, which in turn stresses the relevance and importance of backward digit span when identifying dyslexics amongst monolingual Arabic children.

7.6 Conclusion

The group by group analysis discussed throughout this chapter indicates some important findings regarding common features of developmental dyslexia as well as some specific characteristics of developmental dyslexia in Arabic. The importance and relevance of both reading comprehension and spelling when assessing educational achievement is a common feature of dyslexia assessment while the irrelevance of reading accuracy is a specific feature of dyslexia in Arabic. The importance of non-word reading, rhyme detection and phoneme deletion as components of a dyslexia diagnostic test is as relevant in Arabic as it is in other alphabetic scripts and as such is a common feature of dyslexia. However, the importance of word & sentence chain test is specific to dyslexia manifestation in Arabic which is due to the morphological density and the importance of orthographic processing for the acquisition of reading and spelling skills amongst monolingual Arabic speaking Egyptian children.

Most of the results explained in the group analysis above converge with similar findings in epidemiological studies of developmental dyslexia in other alphabetic scripts, notably studies of developmental dyslexia in transparent orthographies such as German, Italian, Maltese, Spanish and Greek. The statistical analysis presented above yield further evidence in support of the initial expectation that dyslexia manifests itself differently in Arabic; an assumption that has initially been based on the specific nature of the Arabic language discussed in chapter three of the study. The following chapter discusses in more detail the statistical analysis presented throughout this chapter in light of the research questions and the research hypothesis. The discussion of ADATI results in the coming chapter is conducted according to the main topics raised throughout the whole research; i.e., the interpretation of the data results as it impacts our understanding of dyslexia generally and its specific manifestation amongst monolingual Arabic speaking Egyptian children.

The discussion presented in the next chapter draws upon issues related to dyslexia definition, dyslexia theories, dyslexia assessment and the specific nature of dyslexia manifestation in Arabic. It is felt that discussing the results in this manner would sum up the whole issues discussed throughout the study and as such assists in representing the results and concluding the research at the same time.

Chapter Eight: Results and conclusions

8.1 The IQ-Reading discrepancy in ADATI

The correlation tables reported in groups 1 to 7 in the previous chapter shed light on the use of non-verbal deductive reasoning test in ADATI. Correlation coefficients reported in these groups do not indicate any significant relationship between non-verbal deductive reasoning test and spelling, reading accuracy and reading comprehension amongst participants of the sample. The following table shows only the correlation figures between non-verbal reasoning in different groups and each of the literacy skills in Arabic

Non-verbal Reasoning	Spelling	RACCU	RCOMP
Whole data set	0.032	0.160	0.008
High Achievers in Spelling	-0.089	0.111	0.100
Low Achievers in Spelling	0.177	0.169	-0.052
High Achievers in RACCU	-0.056	0.157	-0.049
Low Achievers in RACCU	-0.094	0.230	-0.076
High Achievers in RCOMP	-0.151	0.148	0.001
Low Achievers in RCOMP	0.269	0.346	-0.011

(Table 38: ADATI non-verbal reasoning and literacy skills correlations)

According to figures in Table (38) above, one observes that the highest correlations are between non-verbal reasoning and reading comprehension in the low achievers in reading comprehension group (**r = 0.346**) and between non-verbal reasoning and reading accuracy in the low achievers in reading accuracy group (**r = 0.230**). However, these two figures are small at best and do not seem to have any statistical or practical significance and as such can not be indicate a conclusive strong relationship between non-verbal deductive reasoning test and literacy skills in ADATI. Had non-verbal deductive reasoning ability correlate with literacy skills in ADATI (spelling, reading accuracy and reading comprehension), one would have expected to witness a stronger correlation between high achievers in literacy skills and non-verbal reasoning and a stronger correlation between low achievers in literacy skills and non-verbal reasoning than the figures shown above.

The above figures corresponded with correlation figures reported by Stanovich while making up his case against the use of IQ in dyslexia identification. Stanovich listed numerous studies where researchers found very low correlations between IQ and reading which include: Tunmer et al. (1988) (**r = 0.10**), Lundberg, Olfsson and Wall (1980) (**r = 0.19**), Tonneus (1984) (**r = 0.24**), Stanovich et al. (1984) (**r = 0.25**), Zifcak (1981) (**r = 0.27**), Jule et al. (1986) (**r = 0.34**), Vellutino & Scanlon (1987) (**r = 0.34**), Helfgott (1976) (**r = 0.41**), Share et al. (1984) (**r = 0.47**) and Bryant et al. (1989) (**r = 0.66**). These findings yield further support to Lyon's argument that the IQ-reading discrepancy criteria is inappropriate because of the body of research which shows that, on measures assessing decoding, word recognition and phonological skills, high-IQ readers do not differ from reading disabled children with lowers IQs (cited in Reid 1998). These findings also converge with the findings of the British Psychological Society Working Party Report (1999), which states that the validity of identifying dyslexia in terms of statistically unexpected contrasts between actual literacy attainments and those predicted on the grounds of IQ scores is not supported by the body of evidence which shows that the children of different IQs perform similarly on a variety of measures in reading and spelling.

The above figures also reflect the debate which has been on-going regarding the relationship between IQ, reading ability and the reading process and which has been extensively covered in the literature (e.g. Stanovich 1991, 1996, Turner 1997, British Psychological Society Report 1999). It has been suggested that the relationship between intelligence and reading is "complex and more likely to be multi-faceted rather than linear" (Reid & Kirk 2001: 28).

It is therefore safe to conclude that there is no significant correlation between scores of high achievers monolingual Arabic readers on tests of non-verbal reasoning and reading (accuracy and comprehension) and scores of their disabled monolingual Arabic readers (low achievers) closely matched for age and as such, it is not possible to use high achievers and low achievers monolingual Arabic children's scores on non-verbal reasoning and literacy skills (spelling, reading accuracy and reading comprehension) as a discrepancy basis for the identification of monolingual Arabic dyslexics.

Non-verbal reasoning in ADATI can not predict literacy attainment as the relationship between non-verbal reasoning in ADATI and literacy attainment skills (spelling, reading accuracy and reading comprehension) is not unidirectional. This conclusion supports the first hypothesis of the study and converges with other well-documented studies which argued for the irrelevance of IQ measures in the identification of dyslexics (e.g., Siegel 1989, Stanovich 1991 & 1994, Aaron 1994, Flowers et. al 2000, Berninger 2001, Dickman 2001, Samuelson 2002, Lyon 2003).

The non-verbal reasoning test in ADATI, similar to all other non-verbal reasoning tests, is intended to measure participants' current general cognitive abilities at deductive reasoning without having to use verbal clues. However, Vellutino (1979) noted that if the theory of dyslexia was that children were characterized by basic deficiency in visual-spatial orientation, then it might be counterproductive to employ, for selection criteria, an IQ test highly saturated with demands for spatial reasoning and visual orientation. Therefore, it may be still counterproductive to use the non-verbal reasoning test in

ADATI even so it is used merely because it does not include any linguistic elements so as not to be biased against dyslexics. The same view is also expressed by Stanovich (1992) who argues that the notion of unlocked potential is misconceived, and that the use of certain types of IQ tests, particularly non-verbal or performance measures, "will make it difficult empirically to differentiate dyslexic children from other poor readers" (Stanovich 1992: 136).

The above findings also converge with the results of the report of the American National Institute of Child Health & Human Development (NICHD), in which Lyon asserts that distinguishing between disabled readers with an IQ-reading achievement discrepancy and those without a discrepancy reflects an invalid practice at the beginning stages of reading. Specifically, children with and without a discrepancy do not differ in the information processing skills (phonological and orthographic coding) that are necessary for the accurate and rapid reading of single words" (National Centre for Learning Disabilities: 2003).

Having presented the case for the absence of a linear relationship between non-verbal deductive reasoning test and literacy skills in ADATI, it is interesting to note that the non-verbal reasoning test has been indeed useful in assessing the current cognitive abilities of ADATI participants. The correlation matrix of ADATI dyslexic group (Table 37) shows that the non-verbal deductive reasoning scores of the monolingual Arabic dyslexic group in ADATI correlates with all the rest of ADATI subtests and that the highest correlation coefficient concerning the non-verbal reasoning test is with reading accuracy (**r = -0.611**). This correlation is significant when compared with the same correlation in the case of the whole data set which is (**r = 0.160**).

When comparing the above correlation coefficients with the same correlation coefficients amongst the non-verbal deductive reasoning test and literacy skills in the control group, one starts to realise that scores of dyslexic and control group (normal readers) closely matched for chronological age are statistically different when employing the non-verbal reasoning test to rule out global deficiency. This confirms that the approach of utilizing the non-verbal deductive reasoning test not as a measure of discrepancy with reading skills but as a differentiating tool to control for globally deficient participants can still be useful and can result in some statistically significant differences between groups of poor readers and as such dyslexics can be differentiated from garden variety poor readers.

8.2 ADATI and the use of attainment tests

8.2.1 ADATI and the Spelling test

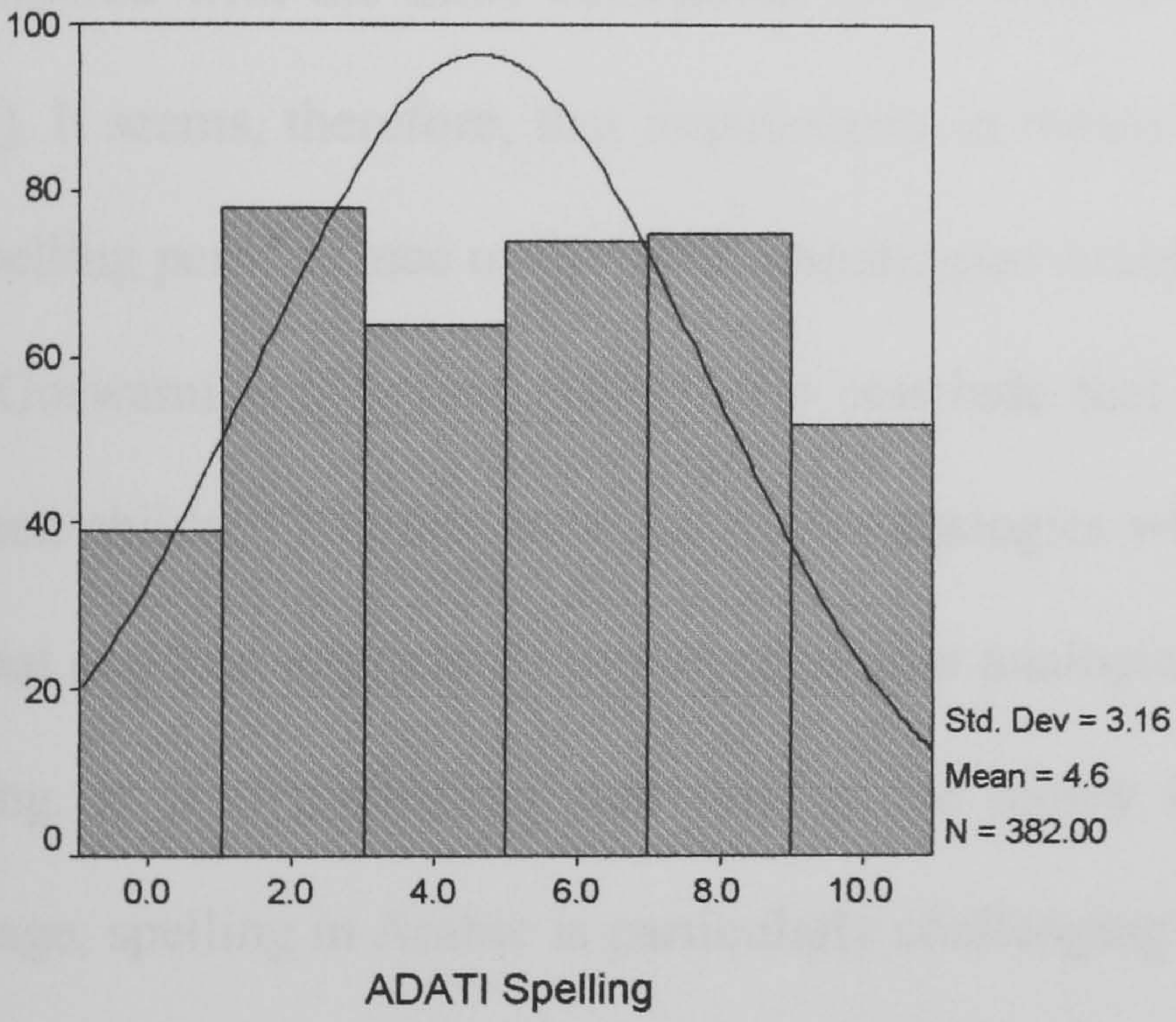
The results of ADATI spelling test converge with similar well documented results of the importance of spelling in dyslexia assessment tests (e.g., Miles 1994, Nikolopoulos, Gloulandris & Snowling 2003). ADATI scores in spelling also confirm the practical reliance on the results of spelling tests when identifying dyslexics. Spelling, can be considered a universal identifier of dyslexia regardless of the language used. Preliminary results of the spelling test in ADATI do not show the results of spelling as close to ceiling as the rest of the phonological awareness based tests (phoneme deletion, non-word reading and rhyme detection) which are discussed in the phonological awareness section below. Both Table (39) and Figure (9) below represent the general statistics of ADATI spelling as well as the distribution of its scores.

ADATI Spelling Statistics

Spelling

N	Valid	382
	Missing	0
Mean		4.62
Std. Error of Mean		.162
Median		5.00
Mode		5
Std. Deviation		3.157
Variance		9.968
Range		10
Minimum		0
Maximum		10
Sum		1766

(Table 39: ADATI spelling scores)



(Figure 9: ADATI spelling graph)

Throughout the data analysis reported in the previous chapter, spelling has produced some interesting and expected correlation coefficients. In the whole data set, spelling has substantial linear relationships with word & sentence chain (**r = 0.497**), non-word reading (**r = 0.538**), reading accuracy (**r = 0.452**), reading comprehension (**r = 0.464**) and phoneme deletion(**r = 0.395**). In the case of the high achievers in phoneme deletion, their spelling has significant correlations with word & sentence chain (**r = 0.422**), reading accuracy (**r = 0.438**), reading comprehension (**r = 0.427**), non-word reading (**r = 0.403**) as well as backward digit span (**r = 0.273**) and rapid naming (**r = 0.248**). In the case of the low achievers in phoneme deletion, their spelling has some very strong correlation coefficients such as the correlation coefficients of selling with non-word reading (**r = 0.971**), spelling with word & sentence chain (**r = 0.781**) and spelling with backward digit span (**r = 0.709**). These strong correlation coefficients are in addition to other medium correlation coefficients spelling has with reading accuracy (**r = 0.546**), reading comprehension (**r = 0.402**) and rapid naming (**r = 0.467**) in the same group.

In the case of the dyslexic group, spelling has a strong correlation with their rhyme detection (**r = 0.716**). This is a particularly important and significant statistical difference if compared with the same correlation in the case of the whole data set which is (**r = 0.207**). It seems, therefore, that impairments in rhyme detection skills negatively impact the spelling performance of dyslexic monolingual Arabic children. These results converge with Goswami and Bryant (1990) who conclude that there is a significant relationship between children's ability to make rhyme analogies while reading and rhyme judgments and that children might have employed similar analogies early in the development of their spelling. It is hypothesised that due to the highly inflectional nature of the Arabic language, spelling in Arabic is particularly challenging for dyslexic children. To spell the MSA correctly, it is necessary for ADATI participants to have an extensive knowledge of the grammatical rules in place to regulate the inflections of nouns and adjectives as well as the conjugations of verbs. This is, of course, in addition to the required knowledge of correct spelling of the root morphemes of Arabic words.

8.2.2 ADATI and Reading Accuracy & Reading Comprehension

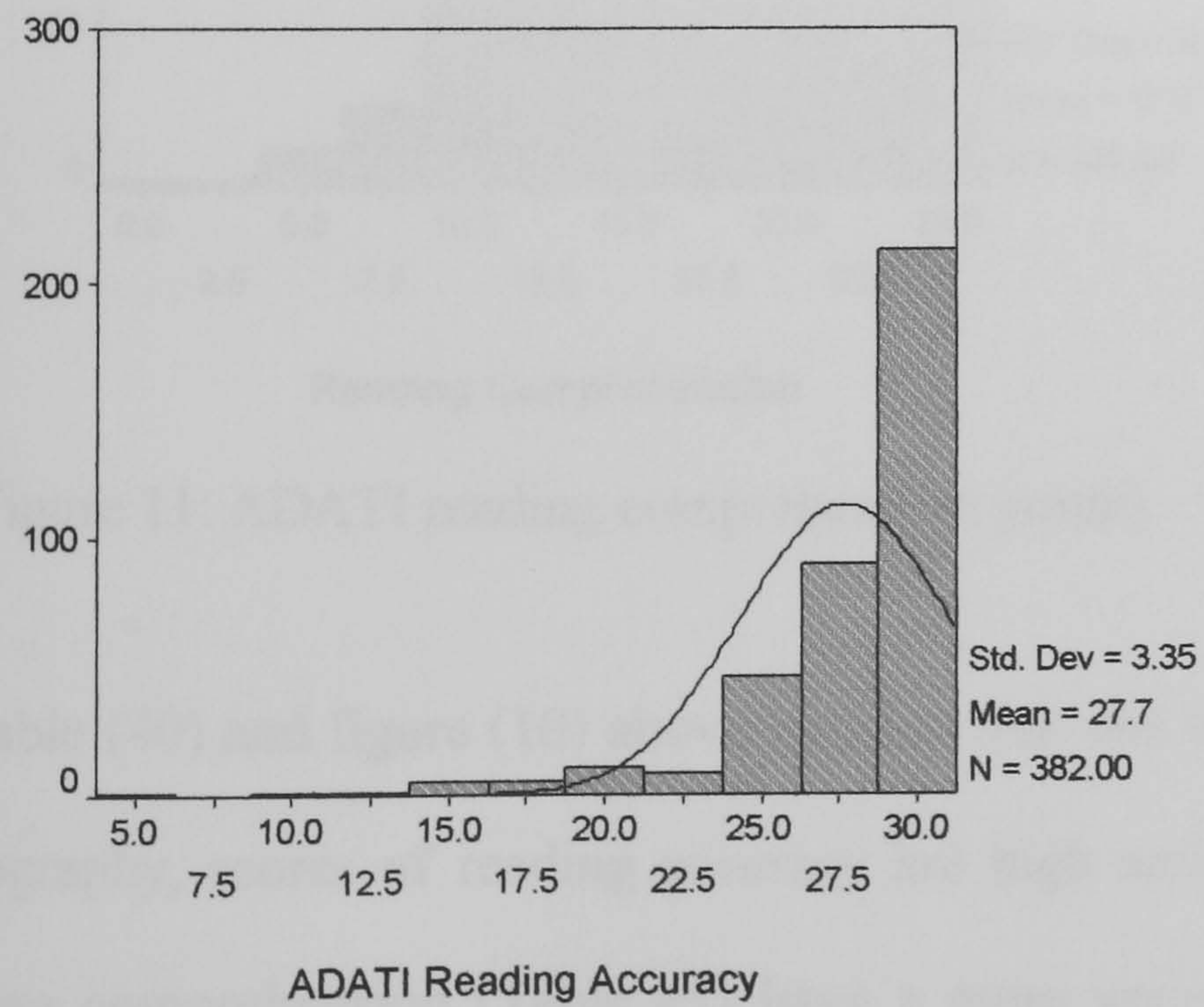
An important observation in ADATI scores in tests of attainments is the significant differences in participants' scores in the reading accuracy test and the reading comprehension test. The following two tables and two graphs represent these significant differences.

ADATI Reading Accuracy Statistics

Reading Accuracy

N	Valid	382
	Missing	0
Mean		27.66
Std. Error of Mean		.172
Median		29.00
Mode		30
Std. Deviation		3.352
Variance		11.238
Range		25
Minimum		5
Maximum		30
Sum		10566

(Table 40: ADATI reading accuracy scores)



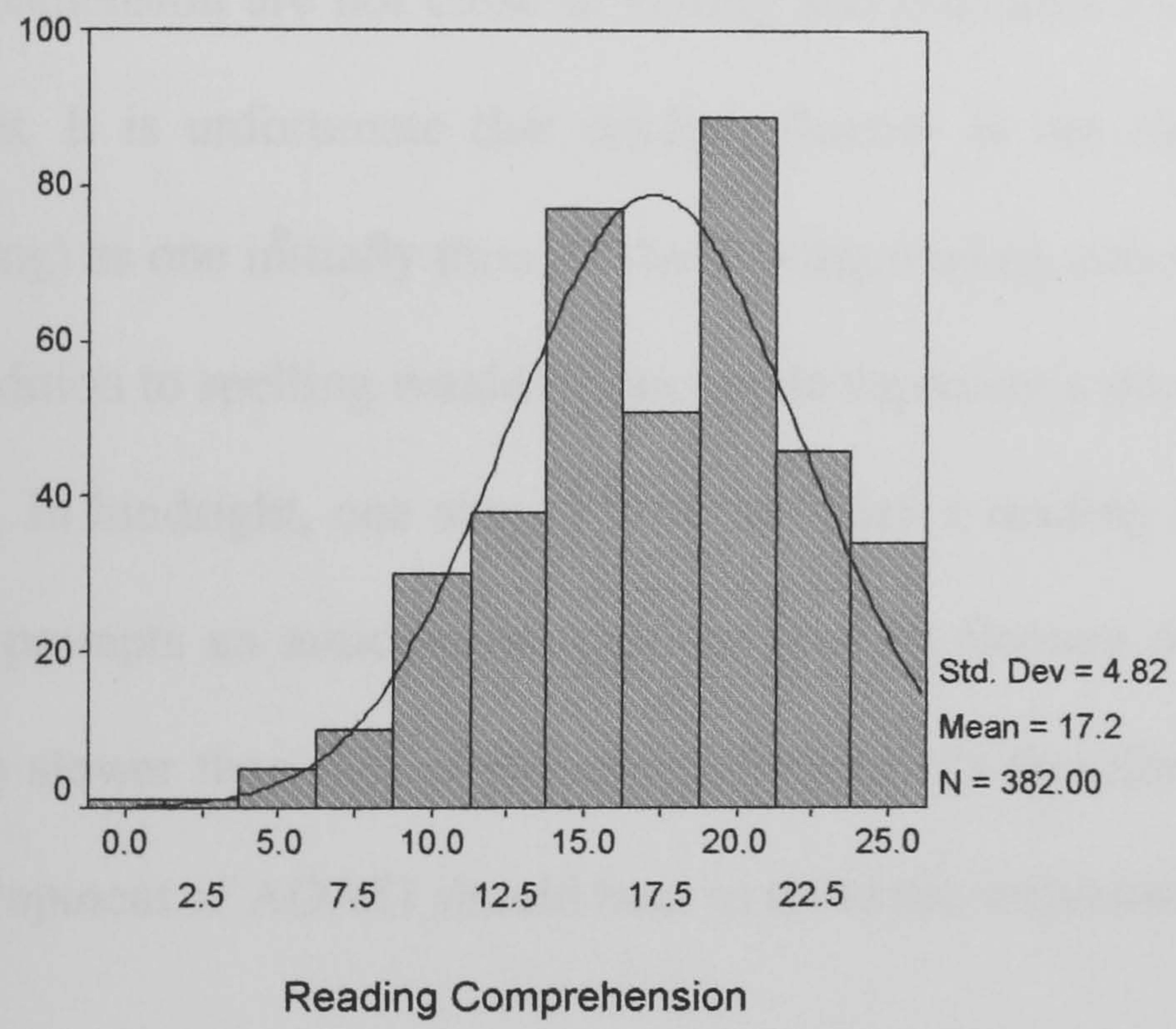
(Figure 10: ADATI reading accuracy graph)

ADATI Reading Comprehension Statistics

Reading Comprehension

N	Valid	382
	Missing	0
Mean		17.23
Std. Error of Mean		.247
Median		18.00
Mode		20
Std. Deviation		4.822
Variance		23.249
Range		26
Minimum		0
Maximum		26
Sum		6582

(Table 41: ADATI reading comprehension scores)



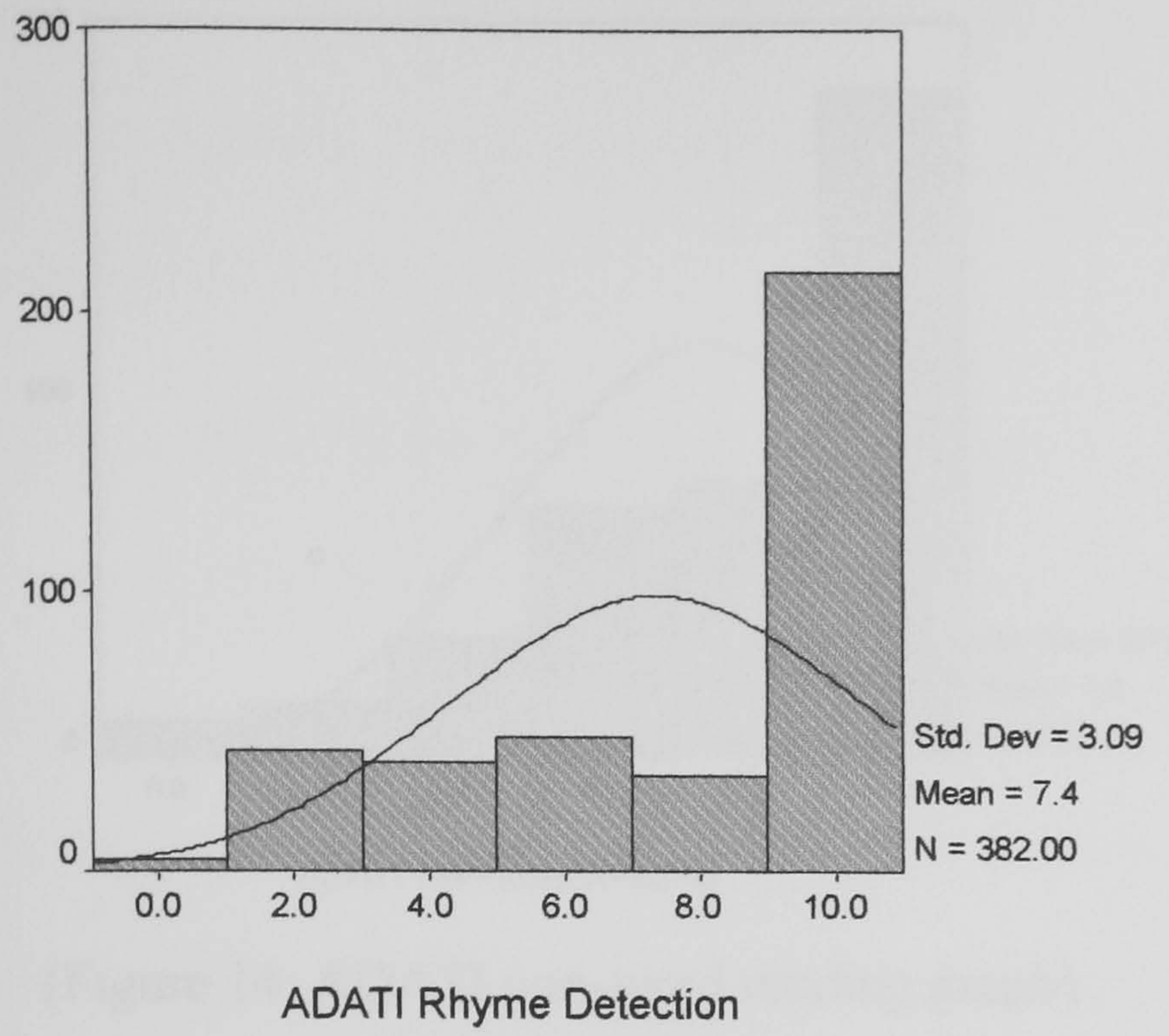
(Figure 11: ADATI reading comprehension graph)

Table (40) and figure (10) above indicate that due to the transparent nature of Arabic orthography, scores of reading accuracy are high and close to ceiling, while scores of reading comprehension (Table 41) have a more varied distribution as indicated by its distribution curve (figure 11). These findings converge with relevant studies of dyslexia in other alphabetic scripts such as German and in particular Landerl (2003) study. German dyslexic children in Landerl's (2003) study "show surprisingly high reading accuracy for both words and non-words" which had prompted Landerl to conclude that "orthographic consistency does have an important influence on dyslexic children's reading performance" (Landerl 2003: 20). These findings also correspond with the same findings by Goswami (2002) who concludes that "evidence for a phonemic deficit in terms of accuracy of performance is difficult to find in dyslexic children learning to read consistent orthographies" (Goswami 2002: 151).

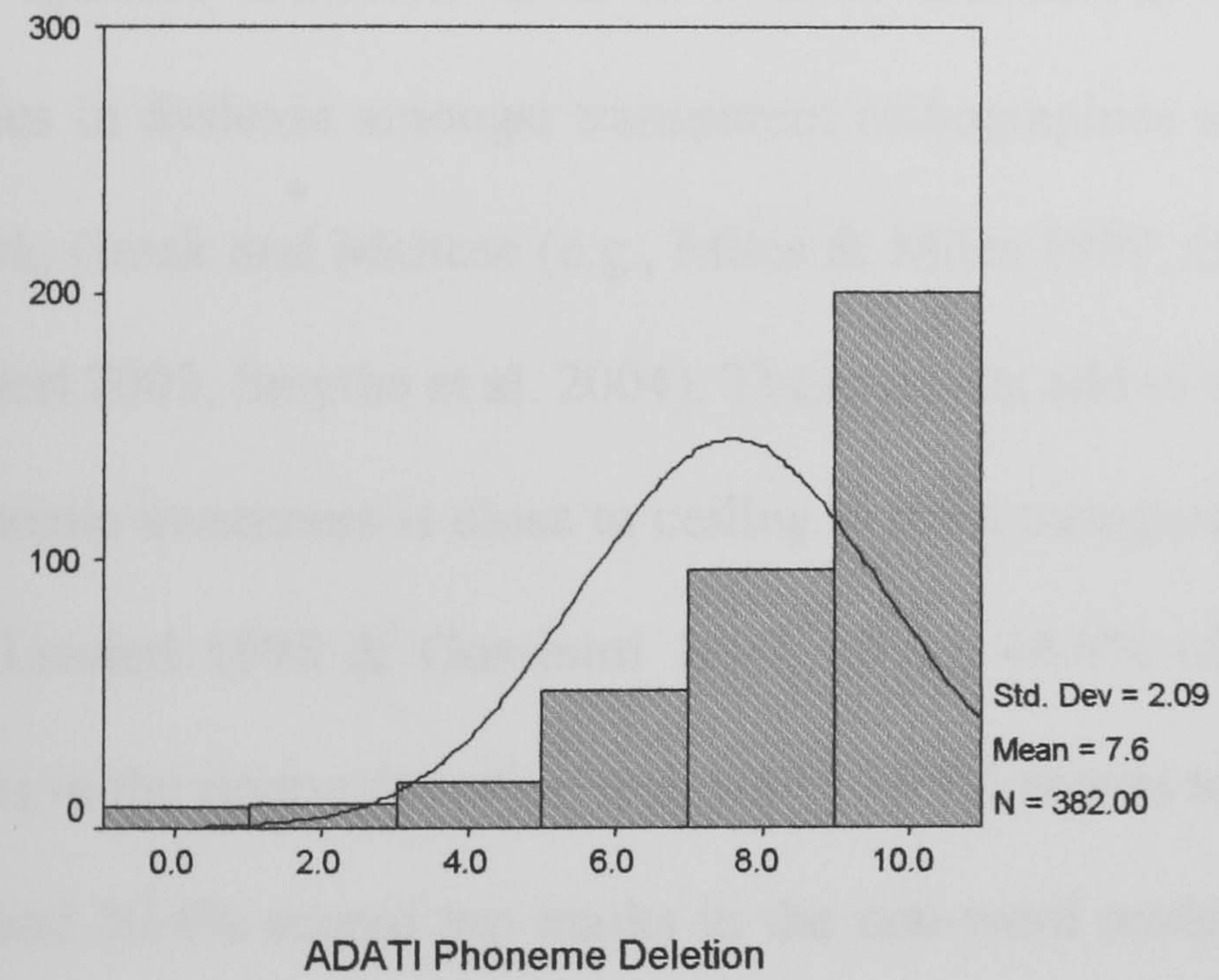
As indicated above, although the reading accuracy of ADATI participants are high and close to ceiling, a fact that is attributed to the shallow Arabic orthography which enables its readers to acquire orthographic representations at the phoneme level, their reading comprehension are not close to ceiling and indicates a much more wider distribution in scores. It is unfortunate that reading fluency is not measured in ADATI (the rate of reading) as one initially thought that having reading accuracy and reading comprehension in addition to spelling would be enough to represent a good picture of participants reading level. In hindsight, one should have included a reading fluency test as one's experience now prompts an anticipation that the reading fluency of dyslexics in Arabic would be much slower than that of the control group. It's therefore recommended that any future development of ADATI should bear in mind the inclusion of a reading fluency test.

8.3 ADATI and the phonological Deficit Hypothesis:

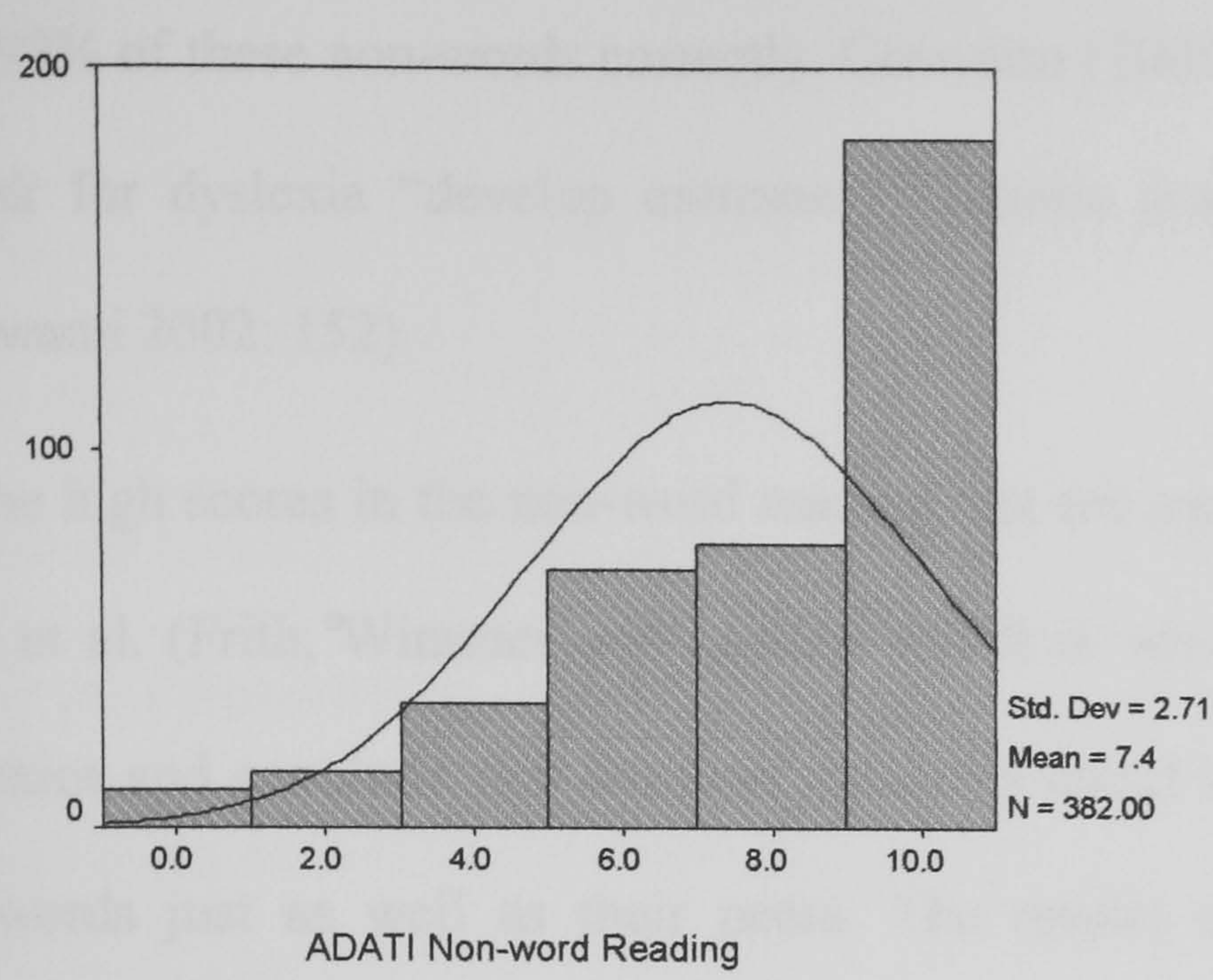
The following three graphs represent the scores of ADATI participants on the three phonological awareness tasks, which are rhyme detection, phoneme deletion and non-word reading.



(Figure 12: ADATI rhyme detection graph)



(Figure 13: ADATI phoneme deletion graph)



(Figure 14: ADATI non-word reading graph)

Figures (12), (13) and (14) above are very indicative and enrich our understanding of how dyslexia manifests itself in Arabic. The scores are consistent with other similar studies in dyslexia amongst transparent orthographies such as German, Italian, Spanish, Czech, Greek and Maltese (e.g., Miles & Miles 1999, Goswami 2002, Gloulandris 2003, Landerl 2003, Smythe et al. 2004). These results add to the growing body of evidence that phonemic awareness is close to ceiling in most transparent orthographies (Frith, Wimmer and Landerl 1998 & Goswami 1997, 2002). 44.6% of ADATI participants scored top marks in the rhyme detection test, while 53.5% scored top marks in the phoneme deletion test and 30.4% scored top marks in the non-word reading test. These scores support the notion that children learning to read in highly transparent orthographies such as Arabic tend to develop phoneme-grapheme recoding skills much easier and quicker than those learning to read in opaque orthographies (Mutter 2003). As a direct result of this easier access to phoneme-grapheme recoding skills for children learning to read transparent orthographies, they tend to acquire literacy quicker and easier than their counterparts learning to read opaque orthographies.

The high scores in the non-word reading task also converge with a study conducted by Propodas (cited in Goswami 2002: 152) in which he found that Greek dyslexic children read 93% of these non-words correctly. Goswami (2002) concludes that even the children at risk for dyslexia "develop extremely accurate grapheme-phoneme recoding skills" (Goswami 2002: 152).

The high scores in the non-word reading test are consistent with studies conducted by Frith et al. (Frith, Wimmer and Landerl 1998) in which they studied German-speaking dyslexics and conclude that German dyslexics could in fact read unfamiliar words and non-words just as well as their peers. The results of the non-word reading test are consistent with observations of Frith who notes that non-word reading tests seem to be specific to English orthography, and that in "Italian and German, irregular words are rare, and non-word reading is far less of a problem than it is in English" (Frith 2002: 52).

The results of the non-word reading test also converge with the conclusion of a similar study by (Nikolopoulos & Gloulandris & Snowling 2003) who compared Greek and English dyslexics' scores on non-word reading test and concluded that "non-word reading accuracy deficit was not necessarily a characteristic of developmental dyslexia in the context of regular orthographies" (Ibid: 57). The orthographic transparency of the Arabic writing system enables monolingual Arabic children to acquire the alphabetic competency early on, which in turn help to assist them in attaining high levels of reading accuracy. This orthographic transparency enables monolingual Arabic speaking Egyptian children to acquire orthographic representations at a much finer level "level of the phoneme" than their counterparts learning an opaque orthography.

Based on the correlation matrices presented in the previous chapter, the following three tables further investigate the correlations between tests of phonological awareness employed in ADATI (rhyme detection, phoneme deletion and non-word reading) and tests of literacy skills(spelling, reading accuracy and reading comprehension).

8.3.1 Rhyme Detection:

Test	Whole Data Set RD	Dyslexic RD	Control RD
Spelling	0.207	**0.716**	-0.144
Reading Accuracy	0.281	0.289	-0.236
Reading Comprehension	0.213	**0.534**	-0.096

(Table 42: ADATI rhyme detection correlations)

The above correlation coefficients indicate that there are statistically significant differences between scores of dyslexic and normal readers on rhyme detection test in ADATI. Statistical analysis of the various groups of ADATI high and low achievers as well as the dyslexia and the control group has also produced some relevant and important correlations between rhyme detection and the rest of ADATI tests. The correlation coefficient between reading accuracy and rhyme detection in the case of the whole data set was (**r = 0.281**). The same correlation in the case of spelling high achievers was (**r = 0.250**). This correlation coefficient, however, has increased significantly in the case of the low achievers in spelling group to (**r = 0.390**). Rhyme detection has a strong linear correlation with reading accuracy in the case of ADATI low achievers in reading comprehension (**r = 0.573**). This is particularly interesting as the correlation in rhyme detection and reading accuracy in the case of reading comprehension high achievers is (**r = 0.058**) which has significantly increased in the case of the reading accuracy low achievers group to (**r = 0.573**).

There is also a substantial significant correlation between the rhyme detection of ADATI low achievers on rhyme detection group and their reading accuracy (**r = 0.452**). This is particularly interesting as the correlation in the case of the high achievers rhyme detection group and their reading accuracy is (**r = 0.141**) which has increased in the case of the rhyme detection low achievers to (**r = 0.452**).

The above results represent important and relevant findings. ADATI low achievers on rhyme detection seem to have a problem which impairs their reading accuracy skills. Low achievers on reading comprehension also seem to have a problem with rhyme detection in Arabic that impair their reading accuracy performance. Such findings yield further support to the belief that phonological awareness is an important and relevant skill which affects the reading development of monolingual Arabic children. As expected, phonological awareness is relevant to the development of literacy skills amongst monolingual Arabic children.

It is hypothesized that the rhyme detection test; a underlying measure of phonological awareness, and word & sentence chain test; a measure of orthographic knowledge, are both required for accurate word recognition and in particular accurate word endings in Arabic. The cursive nature of the Arabic script, the lack of capital letters in Arabic, the confusion caused by the six non-connecting letters in Arabic and the various shapes Arabic letters assume when occurring in initial, medial, final and in isolated positions all require monolingual Arabic readers to be aware of word boundaries. It is this specific nature of Arabic orthography which makes rhyme detection relevant to word boundaries, in addition to its underlying phonological processing role.

The above findings confirm that skills measured by the rhyme detection task affect the literacy performance of monolingual Arabic children and that, generally, the relationship between rhyme detection and literacy skills amongst monolingual Arabic children tend to be stronger in the case of poor achievers. It is hypothesised that Arabic poor spellers depend on the same skills employed when performing their rhyme detection task in their reading development and that deficits in their rhyme skills seem to negatively affect their reading and spelling abilities. It is, therefore, safe to conclude that rhyme detection is a relevant measure of dyslexia type behaviour amongst monolingual Arabic children and that phonological awareness is indeed a relevant skill amongst monolingual Arabic children. Deficits in phonological processing negatively affects the development of reading and spelling development amongst monolingual Arabic children.

8.3.2 Phoneme Deletion:

Tests	Whole Data	High Achievers	Low Achievers	Dyslexics	Control
Spelling	0.395	0.011	-0.258	0.297	0.045
RACCU	0.293	0.077	0.267	0.160	-0.076
RCOMP	0.197	0.111	**-0.425**	0.085	0.214

(Table 43: ADATI phoneme deletion correlations)

Table (43) above represents some significant differences between high & low achieving groups in the phoneme deletion test as well as dyslexic and control groups in relation to their spelling, reading accuracy and reading comprehension. High achievers in phoneme deletion do not depend on their phoneme deletion skills to develop their spelling, reading accuracy and reading comprehension skills; hence the low correlation. On the other hand, scores of low achievers in phoneme deletion seem to correlate with their scores on spelling, reading accuracy and reading comprehension. Moreover, the phoneme deletion of the low achievers in backward digit span group has strong significant correlation coefficients with spelling (**$r = 0.549$**), reading accuracy (**$r = 0.509$**) and non-word reading (**$r = 0.957$**). It is, therefore, safe to conclude that phoneme deletion, a test of phonological awareness, is relevant to reading and spelling skills of monolingual

Arabic children and that deficits in phoneme deletion abilities seem to negatively affect the spelling and reading skills of monolingual Arabic children.

8.3.3 Non-word Reading

Tests	Whole Data Set	High Achievers	Low Achievers	Dyslexics	Control
Spelling	**0.538**	0.203	0.273	0.165	0.232
RACCU	0.379	-0.039	0.398	-0.093	0.052
RCOMP	0.282	0.113	-0.096	-0.040	0.216

(Table 44: ADATI non-word reading correlations)

Although Table (44) above does not indicate a significant statistical difference between dyslexic and control group when considering the correlations between non-word reading and literacy skills in ADATI, the various correlation coefficients noted throughout the rest of the statistical analysis when groups of high and low achievers were compared indicate the importance of the non-word reading and its relevance to dyslexia. In the whole data set, there is a significant substantial correlation between non-word reading and spelling (**r = 0.538**) as well as non-word reading and phoneme deletion (**r = 0.689**). The correlation between non-word reading and spelling indicates that the abilities underlying the non-word reading tasks are also employed by monolingual Arabic speakers when performing their spelling tasks.

There are also significant correlations between non-word reading of ADATI low achievers in non-word reading and their spelling (**r = 0.367**), reading accuracy (**r = 0.473**) and phoneme deletion (**r = 0.367**) skills. It seems that those who are low achievers in non-word reading have a problem which negatively affects their spelling, reading accuracy and phoneme deletion skills. Although the (**r = 0.473)** is not in itself a strong correlation, it becomes significant when compared with the same correlation in the case of the whole data set and the high achievers group; (**r = -0.039)** in non-word reading high achievers and reading accuracy, while (**r = 0.473)** in non-word reading low achievers and reading accuracy.

Moreover, the non-word reading scores of the high achievers in word & sentence chain test group strongly correlate with 5 other variables in ADATI subtests which are: (**r = -0.515**) with word & sentence chain, (**r = 0.758**) with reading accuracy, (**r = 0.727**) with reading comprehension, (**r = 0.727**) with phoneme deletion and (**r = 0.831**) with rapid naming. The non-word reading of the low achievers in phoneme deletion group has some strong correlation coefficients. It has a very strong linear relationship with spelling (**r = 0.971**) and strong relationships with both word & sentence chain (**r = 0.761**) and backward digit span (**r = 0.715**). The fact that the correlation coefficient between non-word reading and spelling amongst low achievers in phoneme deletion group indicates that low and/or poor readers depend on phonological processing when spelling; i.e., monolingual Arabic poor spellers have an impairment in their phonological processing that negatively affects their spelling as well as their reading accuracy and reading comprehension performance.

The above findings confirm one of the hypotheses of the current study which anticipated relevant statistical difference between high & low achievers on phonological awareness based tasks (rhyme detection, phoneme deletion and non-word reading) and their literacy skills (spelling, reading accuracy and reading comprehension). These findings converge with Abu Rabia (2004) in which he also found dyslexic readers of Arabic showed poor phonological decoding abilities on the pseudowords and phonological choice test when compared with their chronological age readers and with their reading level readers.

8.4 ADATI and Orthographic & Morphological Knowledge

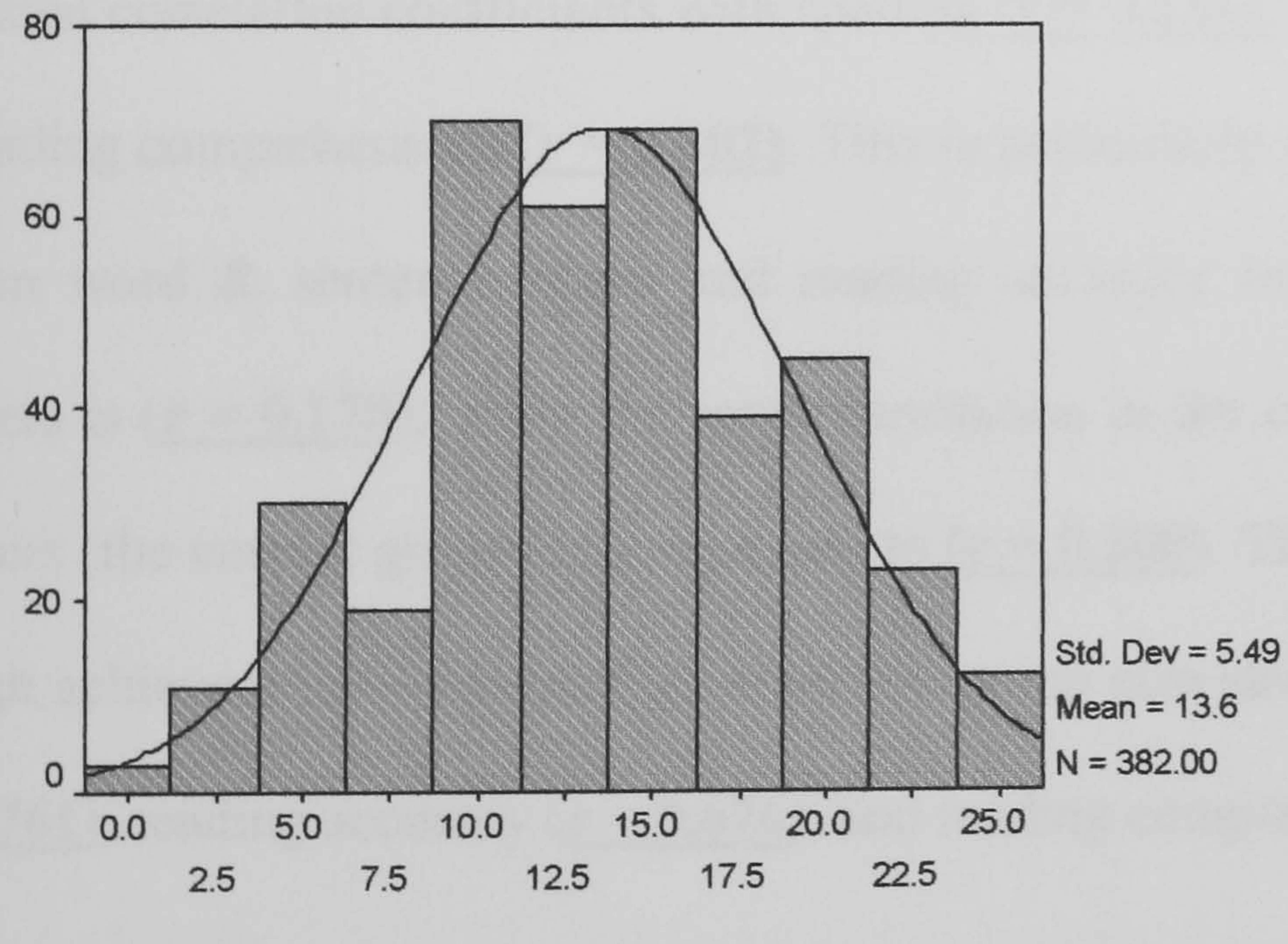
The following table and graph represent ADATI participants' scores on the Word & Sentence Chain test.

ADATI Word & Sentence Chain Statistics

Word & Sentence Chain

N	Valid	382
	Missing	0
Mean		13.60
Std. Error of Mean		.281
Median		13.00
Mode		13
Std. Deviation		5.492
Variance		30.163
Range		25
Minimum		0
Maximum		25
Sum		5194

(Table 45: ADATI word & sentence chain scores)



(Figure 15: ADATI word & sentence chain graph)

Word and sentence chain test is believed to be a test of orthographic and morphological processing in Arabic (Miller Guron 1999). Throughout the data analysis of the various groups, the word & sentence chain test produced some consistent and strong correlation coefficients with the rest of ADATI subtests and would therefore strongly indicate the importance and relevance of such a test in identifying Arabic dyslexic children. In the whole data set, the word & sentence chain test has a substantial linear correlation with all literacy skills in ADATI; i.e., (**r = 0.497**) in spelling, (**r = 0.360**) in reading accuracy and (**r = 0.461**) in reading comprehension. The word & sentence chain of the low achievers in phoneme deletion group also has some of the strongest linear relationships with spelling (**r = 0.781**), reading accuracy (**0.785**) and non-word reading (**r = 0.761**). The word & sentence chain scores correlate well with the spelling scores of ADATI high achievers in reading accuracy (**r = 0.507**) and in reading comprehension (**r = 0.414**). These correlation coefficients are more or less the same correlation coefficients between word & sentence chain and both spelling (**r = 0.497**) and reading comprehension (**r = 0.461**) in the whole data set.

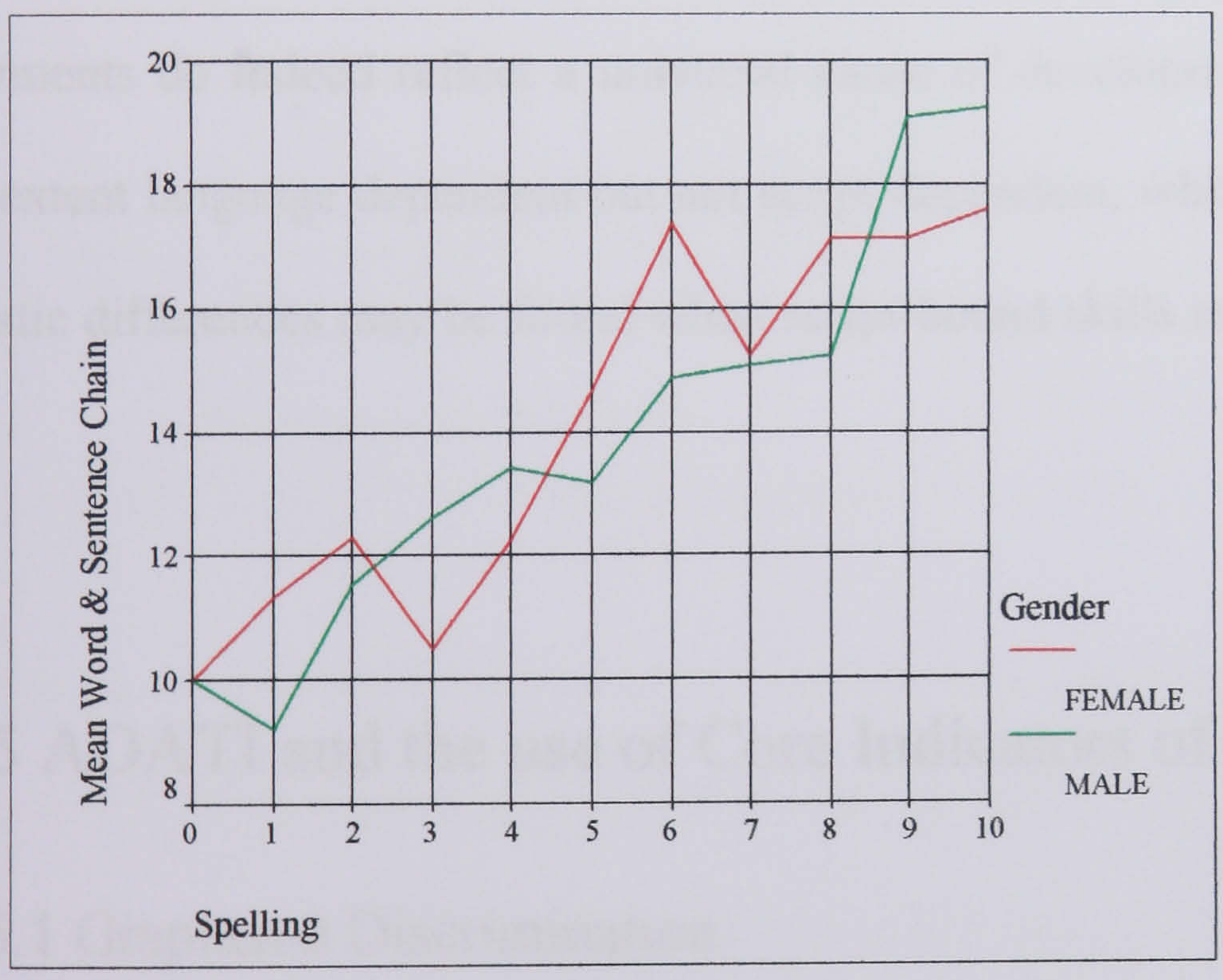
The word & sentence chain of the low achievers in reading accuracy group have substantial correlation coefficients with spelling (**r = 0.336**), reading accuracy (**r = 0.500**) and reading comprehension (**r = 0.402**). This is particularly interesting as the correlation between word & sentence chain and reading accuracy in the reading accuracy high achievers is (**r = 0.170**), while the same correlation in the case of reading accuracy low achievers (the current group) has increased to (**r = 0.500**). The word & sentence chain of the high achievers in backward digit span test group also strongly correlate with spelling (**r = 0.761**), reading accuracy (**r = 0.676**), and reading comprehension (**r = 0.761**).

The above figures support the relevance and importance of word & sentence chain in the identification of poor readers and/or dyslexics amongst monolingual Arabic children. It seems that the reading deficit in languages that have transparent orthographies (such as Arabic) can be more obviously observed in achievement measures which place a high demand on orthographic processing such as the word and sentence chain. These conclusions converge with a relevant study by Goswami (1997) where orthographic representations were assessed in more transparent orthographies. In this study, Goswami (op. cit) proposes that the performance of children learning to read highly transparent orthographies will be better than children learning to read more opaque orthographies since the former would develop orthographic representations which gave priority to the phoneme (more refined level), while the latter would develop orthographic representations which gave priority to onset-rime (coarse chunks rather than phonemes). As such, children learning to read highly transparent orthographies will decode nonsense words quicker and easier than those learning to read more opaque orthographies.

It is hypothesised that one of the main deficits involved in orthographic processing in Arabic is word boundaries. The agglutinative nature of Arabic orthography makes such inconsistencies in word boundaries the more challenging for dyslexic as well as poor readers. The agglutinative nature of Arabic places extra demands on Arabic readers to differentiate not only syllables but also whole words expressing different functions. Such inconsistencies are found in other transparent orthographies such as Maltese (highly similar to Arabic) and in even less transparent orthographies such as Welsh. These findings converge with similar reports of word boundaries problems in both Welsh and Maltese by Miles (2000). These findings converge with similar findings on studies of dyslexia in other Semitic scripts such as Hebrew (Share 2003). Champion (1997) lists a number of studies by Carlisle 1987, 1988; Fischer, Shankweiler, and Liberman 1985; Rubin 1987; Templeton and Scarborough-Franks 1985 which all point to a link between morphological knowledge and spelling abrlity (all cited in Champion 1997: 34).

Hultquist (1997) argues that just as there is a relationship between "phonological processing and reading development, there is also a relationship between orthographic processing and reading development" (Hultquist 1997: 902) and he lists various studies by Murphy & Pollatsek (1994), Manis et al. (1988) and Olson et. al (1989) (all cited in

Hultquist 1997: 91) which confirm the importance of orthographic processing towards reading acquisition and development. Share (personal communication) "have always considered the word chains test a measure of orthographic knowledge. To the extent that subjects have well-unitised and well-integrated orthographic representations for printed words, speed and accuracy in this task should be better". Similar studies have also demonstrated the importance of orthographic knowledge in reading over and above phonological decoding (Cunningham & Stanovich 1990). In order to establish the relationship between word & sentence chain test which seem to tap into monolingual Arabic speakers' orthographic processing and morphological knowledge and their spelling scores, the following figure shows that there is indeed a linear relationship between the two variables



(Figure 16: Word & sentence chain and spelling relationship in ADATI)

The above figure indicates that there is a positive correlation between participants' scores on tests of spelling and word & sentence chain. Higher scores in the word & sentence chain test correspond with higher scores on the spelling test as explained by the linear relationship in the graph above.

The results are consistent with the proposal that the relationship between phonological awareness and problems in reading and spelling "may differ depending on the phonology of the language that is being learned and the orthographic units that this phonology makes salient" (Goswami 1997: 141). The above results also agree with Wimmer, Mayringer & Landerl's (1998) argument that children learning a transparent orthography with a predisposition towards dyslexia tend to do relatively well on tasks of phonological segmentation and nonsense word reading while their difficulties may be evident on measure of verbal short term memory (Mutter 2003).

It may be assumed, based on the above investigation of the roles of both phonological processing and orthographic processing to reading (accuracy and comprehension) and spelling of monolingual Arabic speaking Egyptian children, that phonological impairments do indeed reflect a universal cause of developmental dyslexia which is to some extent language dependent but not script dependent, while at the same time "cross-linguistic differences may be found when script-bound skills are needed" (Der Leij 2004: 59).

8.5 ADATI and the use of Core Indicators of dyslexia

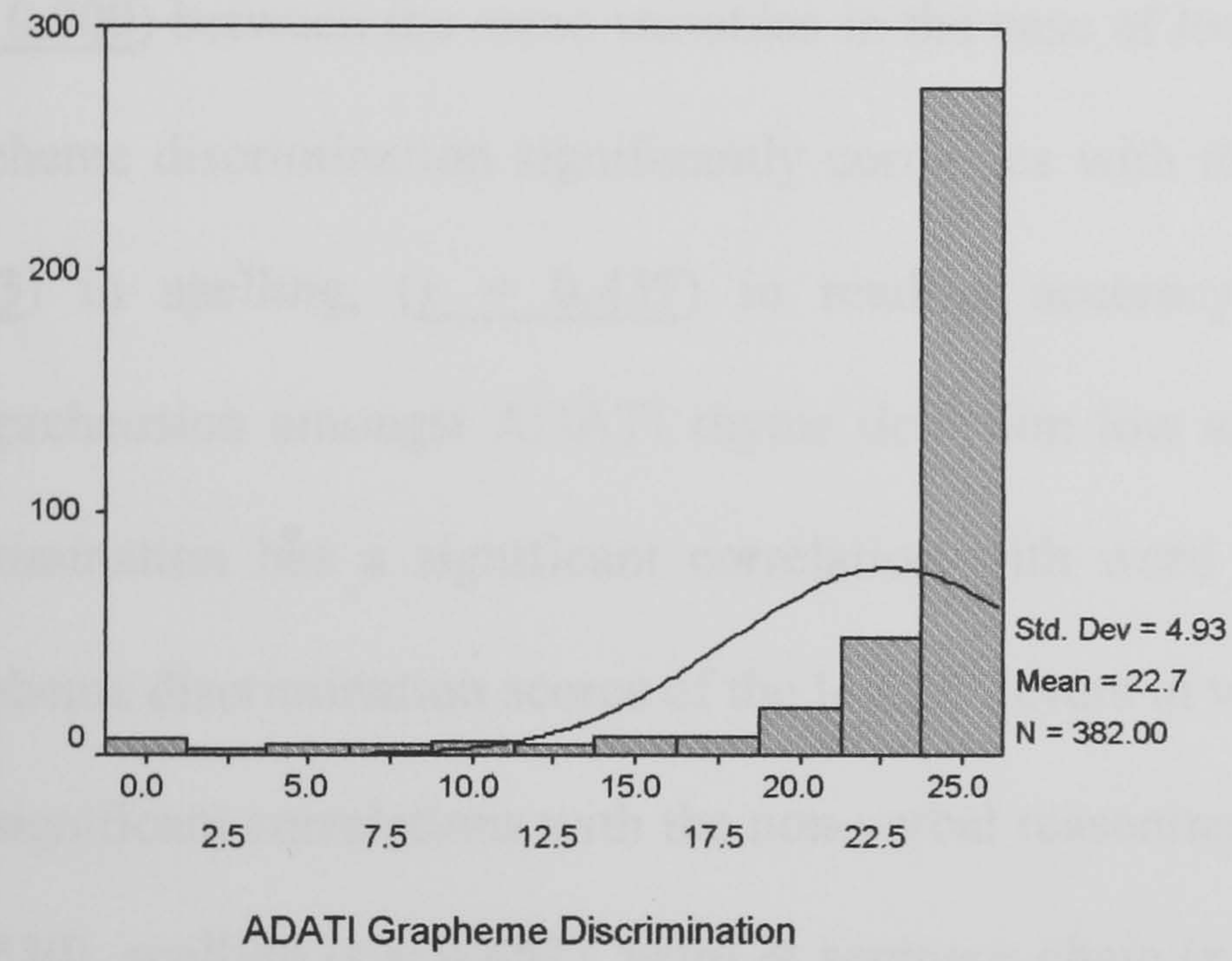
8.5.1 Grapheme Discrimination

The following table and graph represent the scores of ADATI grapheme discrimination test.

Descriptive Statistics

	N	Range	Minimu	Maxim	Sum	Mean		Std.	Varian
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
GD	382	25	0	25	8678	22.72	.25	4.928	24.282
Valid N (listwise)	382								

(Table 46: ADATI Grapheme Discrimination descriptive statistics)



(Figure 17: ADATI Grapheme Discrimination graph)

There is a significant statistical correlation between grapheme discrimination test amongst ADATI dyslexics and the rest of the subtests. There is a substantial statistical difference between ADATI dyslexics and the whole data set on grapheme discrimination test when it correlates with:

1. The non-verbal reasoning test; i.e., (**r = -0.343**) in dyslexics while (**r = 0.024**) in the whole data set,
2. The rhyme detection test; i.e., (**r = 0.466**) in dyslexics while (**r = 0.137**) in the whole data set, and

3. Reading accuracy; i.e., (**r = 0.453**) in dyslexics while (**r = 0.163**) in the whole data set).

The grapheme discrimination of the low achievers on reading accuracy strongly correlates with their reading accuracy (**r = 0.597**), and substantially correlates with their spelling (**r = 0.225**) and their reading comprehension (**r = 0.450**). These correlation coefficients are relevant, particularly after their increase from (**r = -0.010**) between grapheme discrimination and reading accuracy in the reading accuracy high achievers to (**r = 0.500**) between the same variables in the case of low achievers in reading accuracy. Grapheme discrimination significantly correlates with the three literacy skills; i.e., (**r = 0.443**) in spelling, (**r = 0.437**) in reading accuracy and (**r = 0.497**) in reading comprehension amongst ADATI rhyme detection low achievers. In addition, grapheme discrimination has a significant correlation with word & sentence chain (**r = 0.438**). Grapheme discrimination scores of the low achievers in word & sentence chain test group has significant correlations with the non-verbal reasoning (**r = 0.505**), rhyme detection (**r = 0.530**), spelling (**r = 0.452**), word & sentence chain (**r = 0.423**), reading accuracy (**r = 0.399**), reading comprehension (**r = 0.408**), phoneme deletion (**r = 0.451**) and backward digit span (**r = 0.404**). Grapheme discrimination also has a strong linear relationship in the low achievers in word & sentence chain test group with non-word reading as indicated by the strong correlation coefficient (**r = 0.773**).

Due to the visual similarity of Arabic graphemes and the high number of dots employed to differentiate between these graphemes, global visual strategy employed by monolingual Arabic low achieving readers on tests of reading accuracy may impair their reading accuracy skills. These findings support conclusions of Talcott et. al (2002) who assert that when children first begin to learn to read, they may use holistic visual analysis to retrieve words from lexicon by sight rather than relying upon phonological decoding skills that are not yet fully developed (Talcott et. al 2002: 204-225).

8.5.2 Backward Digit Span

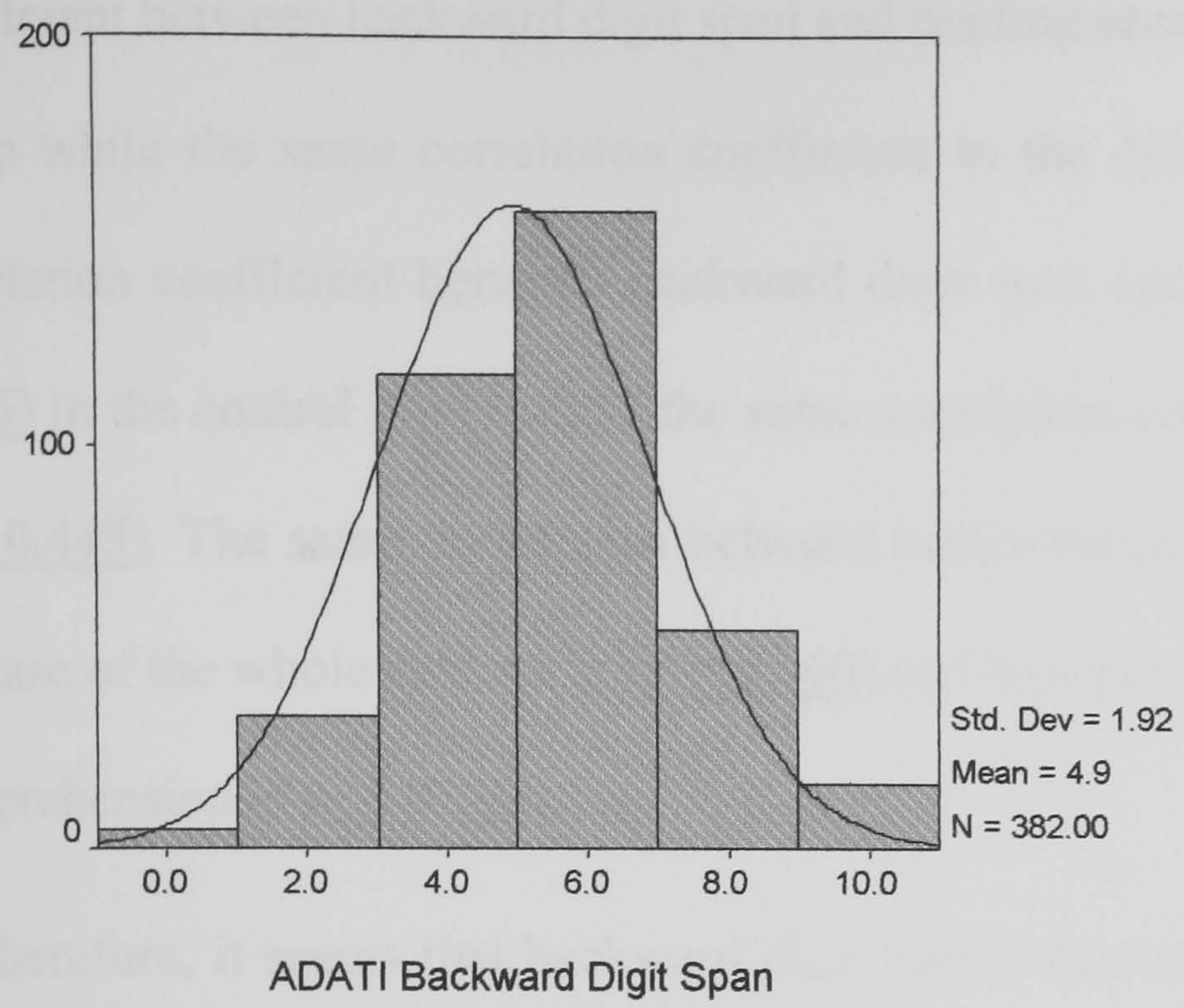
Results obtained from the backward digit span test and the apparent generally low scores converge with existing empirical studies which all indicate that the digit span of dyslexic individuals, regardless of their age, is always well below average" (Aaron 1994). The following table and graph represent the general statistics of ADATI participants on the backward digit span test.

ADATI Backward Digit Span Statistics

Backward Digit Span

N	Valid	382
	Missing	0
Mean		4.94
Std. Error of Mean		.098
Median		5.00
Mode		5
Std. Deviation		1.917
Variance		3.676
Range		10
Minimum		0
Maximum		10
Sum		1888

(Table 47: ADATI backward digit span scores)



(Figure 18: ADATI backward digit span graph)

The high correlations between backward digit span and the rest of ADATI subtests reinforce the relevance and importance of such a tool when identifying dyslexics and poor readers amongst monolingual Arabic children. There are strong correlation coefficients between backward digit span of the low achievers in phoneme deletion group and their non-verbal reasoning test (**r = 0.617**), spelling (**r = 0.709**) and non-word reading (**r = 0.715**). The increase in correlations between backward digit span and both reading accuracy and reading comprehension amongst the dyslexic group further stress the importance and relevance of backward digit span when identifying dyslexia.

The correlation between backward digit span has also significantly increased with rapid naming amongst ADATI dyslexic group; i.e., (**r = 0.105)** in the case of the whole data set but (**r = 0.610)** in the dyslexic group. This indicates that monolingual Arabic dyslexics have significant problems in both rapid naming and backward digit span. Such a correlation is significant enough to warrant rapid naming and backward digit span as core indicators of dyslexia amongst monolingual Arabic dyslexics. There are also some significant statistical differences between correlation coefficients of backward digit span and other ADATI subtests in both the dyslexic and the control group. The correlation coefficient between backward digit span and reading accuracy is (**r = 0.143**) in the control group while the same correlation coefficient in the dyslexic group is (**r = 0.565**). The correlation coefficient between backward digit span and reading comprehension is (**r = 0.136**) in the control group while the same correlation coefficient in the dyslexic group is (**r = 0.445**). The same correlation between backward digit span and reading accuracy in the case of the whole data set is (**r = 0.160**) and between backward digit span and reading comprehension is (**r = 0.203**).

Therefore, it seems that backward digit span scores in the case of the dyslexic group have a higher correlation with both reading accuracy and reading comprehension than in the case of the control group and in the case of the whole data set. This indicates that deficits in backward digit span may negatively affect the dyslexic group's performance in reading accuracy and reading comprehension, which in turn stresses the relevance and importance of backward digit span when identifying dyslexics amongst monolingual Arabic children.

8.5.3 Rapid naming

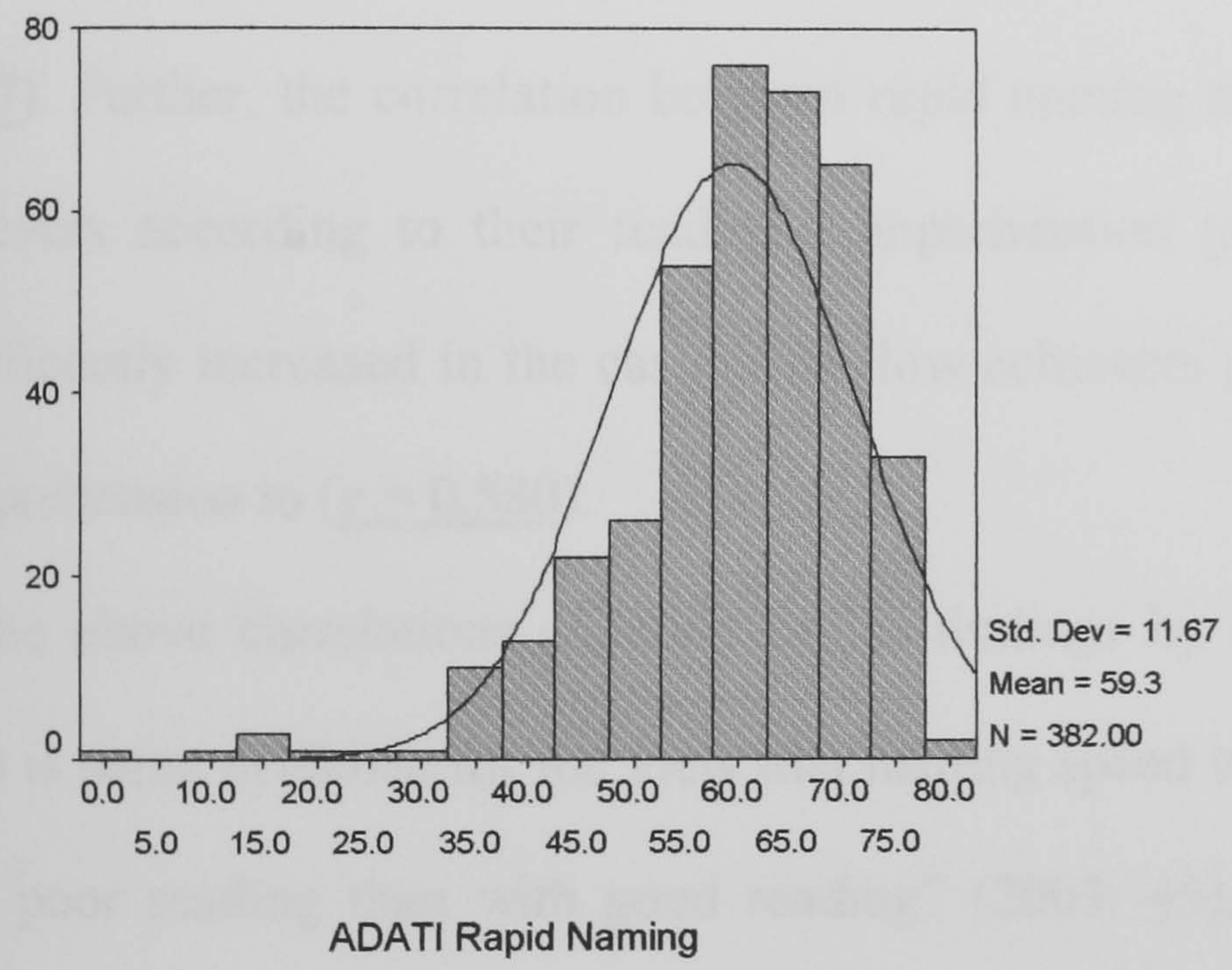
The following graph and table represent participants' scores on the Rapid Naming test.

ADATI Rapid Naming Statistics

Rapid Naming

N	Valid	382
	Missing	0
Mean		59.31
Std. Error of Mean		.597
Median		61.00
Mode		68
Std. Deviation		11.673
Variance		136.266
Range		77
Minimum		1
Maximum		78
Sum		22655

(Table 48: ADATI rapid naming scores)



(Figure 19: ADATI rapid naming graph)

There is a significant statistical difference between high and low achievers in rapid naming and their reading accuracy; (<u>**r = 0.190**</u>) in case of high achievers in rapid naming and reading accuracy and (<u>**r = 0.311**</u>) in case of low achievers in rapid naming and reading accuracy. These figures converge with Davis & Knopik & Olson & Wadsworth & DeFries's (2001) conclusion that rapid naming may correlate more highly with measures of reading performance in "samples of children with reading difficulties than in samples without evidence of reading problems" (Davis et. al 2001: 233). McBride-Chang and

Manis (1996, cited in Davis et. al 2001) report that rapid naming tasks are significantly associated with word reading in a sample of poor readers (**r = - 0.32** to **– 0.52**) but not significantly associated with word reading for good readers (**r = 0.16** to **– 0.11**). (Davis et. al 2001: 233). Studies with the same conclusion by Meyer, Wood, Hart and Felton (1998) and Scarborough (1998) are also reported in Davis et. al (2001: 233-234). The correlation between rapid naming and reading accuracy in the case of high achievers in reading accuracy is (**r = 0.064**) while the same correlation in the case of low achievers in reading accuracy is (**r = 0.312**). The correlation between rapid naming and reading comprehension in the case of high achievers in reading comprehension is (**r = 0.124**) while the same correlation in the case of low achievers in reading comprehension is (**r = 0.377**). Further, the correlation between rapid naming and reading accuracy in the high achievers according to their reading comprehension group is (**r = 0.202**) which has significantly increased in the case of the low achievers group according to their reading comprehension to (**r = 0.580**).

The above correlations support similar findings by Mutter (2003) who asserts that there is some evidence for the view that naming speed may have "a stronger association with poor reading than with good reading" (2003: 45). Therefore, it seems that skills involved in the rapid naming affect monolingual Arabic speakers' reading accuracy performance particularly in the case of low achievers in rapid naming who also seem to have a problem with their naming speed and speed of access to phonological memory, which in turn seem to negatively affect their reading accuracy, thus making it much slower than their high achievers rapid naming counterparts closely matched for chronological age. These findings converge with similar studies which all conclude that dyslexic children tend to name visually presented items, including numbers, colours, pictures of common objects and letters "more slowly than normally achieving readers" (Davis et. al: 2001: 232).

8.6 Conclusion

The statistical analysis presented in the previous chapter and the in depth analysis of the results presented above all highlight a number of main findings concerning the current research which are:

First: the irrelevance of non-verbal deductive reasoning test in the identification of monolingual Arabic dyslexic participants in ADATI when such an identification is based on discrepancy between the IQ-reading scores. The lack of strong linear relationship between non-verbal reasoning test and literacy skills (reading accuracy, reading comprehension and spelling) in ADATI confirms previous findings that the relationship between non-verbal reasoning and literacy skills are not unidirectional and as such a non-verbal deductive reasoning and reading discrepancy is not valid for the identification of dyslexia amongst monolingual Arabic children (Siegel 1989, Stanovich 1991, 1994, Aaron 1994, Berninger 2001, Samuelson 2002, Smythe at al. 2004). This lack of IQ-reading discrepancy should not be understood to indicate the absence of a problem. Alternatively, this may indicate that either dyslexia identification by IQ-reading discrepancy is better substituted by other methods or that the IQ-reading discrepancy should be substituted by another discrepancy. An alternative to the search for a discrepancy is the identification of a pattern of difficulty that is generally observed and reported amongst dyslexics and perhaps the operationalisation of this pattern to further identify dyslexic individuals.

Second: the importance of phonological processing in the identification of monolingual Arabic dyslexic children. The correlation coefficients presented in the various groups and particularly low achievers in rhyme detection, non-word reading and phoneme deletion indicate that there is a linear relationship between these tasks and literacy performance in Arabic. It is therefore important to include tests of phonological processing when identifying Arabic monolingual dyslexic speakers, although the statistical figures presented earlier have shown that the degree of such deficits are smaller than deficits in monolingual English dyslexics. It was also interesting to note that although deficits in phonological decoding was not as strongly reported amongst the Arabic speaking dyslexic children as it is amongst their English speaking counterparts (Goswami & Bryant 1990, Goswami 1997, 2002, Snowling 2000, Goulandris 2003) deficits in phonemic awareness were clearly observed as the differences in scores and statistical correlations in rhyme detection and phoneme deletion tests between low and high achievers as well as dyslexic and chronologically age matched normal readers indicate. These findings replicate earlier conclusions by Wimmer 1993, Miles 1994, Frith 2002, Goswami 2002, Landerl 2003, Muter 2003, Nikolopoulos, Goulandris & Snowling 2003.

Third: the importance of orthographic and morphological processing in the identification of Arabic speaking Egyptian dyslexic children. Deficits in orthographic and morphological processing are important when identifying monolingual Arabic dyslexic children because of the specific linguistic features of Arabic. The highly agglutinative and inflected nature of Arabic morphology, its cursive script and the inconsistencies of its word boundaries pose an additional challenge in orthographic and morphological processing for Arabic speaking Egyptian dyslexic children. Measuring their orthographic and morphological skills are therefore good predictors of subsequent literacy acquisition and early problems in such abilities may indicate later dyslexia type problems amongst Arabic speaking Egyptian dyslexic children (Carlisle 2002, Share 2003, Bryant & Nunes 2004)

Fourth: the importance of current widely used core indicators of developmental dyslexia when identifying the condition. Tables of correlations and subsequent statistical analysis discussed above all indicate the relevance of some of the core indicators in identifying dyslexia and statistical difference between high and low achievers on both rapid naming and backward digit span tests. The underlying cognitive skills measured by these two tests seem to be universal markers of dyslexia regardless of the language of instruction. Speed of information processing, speed of access to phonological representations in the long-term memory and verbal short-term working memory are all skills that are relevant to the identification of dyslexia amongst Arabic speaking Egyptian dyslexic children.

Fifth: the irrelevance of measuring reading accuracy when trying to identify Arabic speaking dyslexic children. The close and consistent relationship between Arabic phonemes and graphemes and the ease with which spoken Arabic map onto written Arabic seem to enable even dyslexic Arabic speaking children with the necessary tool to develop their decoding skills at a finer level (the level of the phoneme) and which in turn give even Arabic speaking dyslexic children a head start when learning to read Arabic than their English speaking counterparts who are reported to develop such a skill at a much coarser level (the level of the onset and rime) (e.g., Goswami & Bryant 1990, Goswami 1997, 2002, Snowling, Goulandris 2003, Muter 2003).

Sixth: the global visual strategy which seem to be employed by both dyslexia and low achieving Arabic speaking Egyptian children when reading Arabic. Both dyslexic and low achievers seem to read words as a string of letters instead of decoding each word into its constituent sounds. Such a global visual strategy, although beneficial at a later stage because of its impact on the speed of sight word reading, seem to negatively impact the accuracy of reading, and reading comprehension indirectly, and spelling (Goswami & Bryant 1990, Talcott et. al 2002). Knowing such a technique is used by dyslexic and poor readers may prompt teachers and/or curriculum designers to account for this and develop some resources which take into account the impaired phonological processing abilities amongst the dyslexic and poor readers.

The data results discussed in the previous section represent evidence in support of the similarity in the cognitive profiles of Arabic and English dyslexic readers and yield further support to various theories that consider developmental dyslexia as a universal phenomenon with varying manifestations and characteristics depending on the nature of the language and orthography as well as the cultural and educational practices which are generally regarded as part of the environmental factors (e.g., Snowling 2000, Smythe & Everatt 2000, Nikolopoulos et al. 2003, Smythe et. al 2004). Findings reviewed earlier indicate general similarity in the incidence and causes of dyslexia in Arabic and elsewhere amongst transparent orthographies. The transparent nature of Arabic orthography makes the acquisition of reading accuracy much easier than in the case of English orthography.

A priori, it seems that unlike their English counterparts, monolingual Arabic speaking Egyptian children do not in fact come to a halt at the logographic stage of their literacy development as per Frith's (1997) theory while describing English speaking dyslexics, but proceed to acquire the alphabetic principle with ease and establish a sound knowledge of the phoneme-grapheme relationship. The close and consistent phoneme-grapheme relationship in Arabic and the transparent nature of its orthography enable monolingual Arabic speakers to acquire the alphabetic principle more easily than their English counterparts. This conclusion supports the growing evidence that persistent difficulties with phonological decoding associated with dyslexia are not a universal phenomenon. "Rather they appear to be specific to children learning to read in irregular or 'deep' orthographies, such as English" (Hatcher & Snowling 2002: 71) and it seems that dyslexia in a consistent orthography such as Arabic, is mainly a problem with learning orthographic skill; i.e., "making word recognition automatic and producing spellings that are orthographically legal" (Szczerbinski 2003: 76).

The above findings seems to further support the well established notion that a deficit in phonemic awareness *per se* can not be considered a causal factor in developmental dyslexia in Arabic and that it seems that any deficits in phonemic awareness "are products of the pre-existing poorer phonological skills of dyslexic children" (Goswami 2002: 154). However, from the statistical analysis presented earlier, it seems that monolingual dyslexia Arabic speaking Egyptian children may have impairment in their orthographic processing (specific feature of dyslexia which is influenced by the specific linguistic features of the Arabic script) over and above impairment in their phonological processing (a common feature of developmental dyslexia across alphabetic scripts).

The following section lists some recommendations for further studies and future developments of the diagnostic test devised in the current research which are based on the discussion of various points and issues raised throughout the study.

8.7 Recommendations

8.7.1 Implications for dyslexia research

Reid & Fawcett (2004) stress the interesting times dyslexia research is currently witnessing particularly in that the complexity of the condition of dyslexia has now been widely recognized. "There is a solid output of research articles and steady progress in the understanding of dyslexia theory, practice and policy" (Nicolson 2002: 56). Diversity in both research and researchers should be viewed as an element of strength towards the progress of dyslexia research and not an element of confusion. It has become clear that problems experienced by dyslexics are far wider than just reading difficulties. The realization that the manifestations of dyslexia can be studied at different levels and that various theories proposed to explain the condition are not incompatible have, no doubt, some very positive effects on dyslexia research and practice.

It is therefore recommended that researchers from different backgrounds should collaborate in research so as to investigate the underlying causes of developmental dyslexia. The same underlying recommendation has been more clearly expressed by Nicolson (2002) while trying to explain what he calls the dyslexia ecosystem (Nicolson 2002: 55-66), and by the British Psychological Society Working Party's report (1999). An example of such a view towards the dyslexia research is the model proposed by Frith (1997) in which biological, cognitive and behavioural basis of dyslexia all interact with the many environmental factors in order to affect the manifestation of dyslexia.

The current study has confirmed that the practice of IQ-reading discrepancy is invalid when identifying dyslexic individuals. It is therefore recommended that such practice is dropped and other avenues are explored in order to identify dyslexics without biasing or neglecting other poor readers. The current study has also showed how cross linguistic studies of dyslexia in other scripts can enrich our understanding of dyslexia and of its manifestations. While the current study has confirmed that phonological decoding may not be the underlying cognitive deficits of dyslexics in Arabic, it has nevertheless, confirmed that phonemic awareness in Arabic is impaired in the case of both dyslexic and poor Arabic speaking Egyptian children. The study has also confirmed the importance of orthographic and morphological processing when identifying dyslexics.

8.7.2 Implications for dyslexia assessment in Arabic

The current study is a modest building block towards the study of learning difficulties in general and developmental dyslexia in particular in Egypt. Systematic study and investigation of learning difficulties and dyslexia are critically needed in Egypt as indeed in the rest of the Arab world. More research and awareness of the condition must be encouraged and published to the wider public across the Arab world. It is hoped that the investigation undertaken by the current study will generate a degree of informed enthusiasm for a particularly challenging and important area of work; learning difficulties. It is also hoped that the battery of tests (ADATI) developed in the current study will benefit the corresponding Arabic literature on matters related to learning difficulties generally and dyslexia in particular. This battery of tests is intended to be used as an open diagnostic tool. Eventually, and after due modifications, ADATI can be used by special education teachers in Egypt. It is hoped that such an easy-to-use battery can potentially be made available to aid special education teachers in Egypt. It is also hoped that such a battery, can fill in the existing gap of such cognitive diagnostic tests and answer a need for a variety and availability of such easy to use quick tools in Arabic. The availability of such an easy to use diagnostic tools may encourage continuous assessment which is the "heart of all good classroom practice, enabling the teacher to identify learners in need of additional support" (Broomfield & Combley 2003: 47).

In order to maximize the reliability and validity of recommended tasks and tests, it is considered best to keep only the tests that show substantial differences between dyslexics and non-dyslexics. It also recommended that new tests, an in particular, a timed reading test be included. Results of reading accuracy in ADATI have shown that due to the transparency of the Arabic orthography, monolingual Arabic readers seem to be able to decode words much more accurately than their English counterparts. What ADATI does not show is whether dyslexic Arabic monolingual readers read slower than their normal readers or not. It is anticipated that a timed reading test will shed further light on the fluency problems in Arabic word reading and that statistical differences between high and low achievers on reading fluency will be much more indicative than high and low achievers on reading accuracy.

It is recommended that IQ-achievement discrepancy criteria should be substituted with another criteria that could perhaps stress the age and grade discrepant weaknesses in some of the underlying cognitive processing abilities as well as basic literacy attainment skills (reading accuracy, reading comprehension, reading fluency and spelling) as the defining characteristics of dyslexia. IQ measures should therefore only be used to rule out global deficiency. IQ, one can not dispute, is useful when assessing an individual's profile of cognitive strengths and weaknesses but should not be used to decide on the allocation of services for reading disabled. Use of IQ-achievement discrepancy and the resulting discrepant and non-discrepant group and the eventual exclusion of the non-discrepant group on the basis of their low intellectual abilities is a biased practice which harm the poor readers who are non-discrepant.

8.7.3 Implications for the Educational System in Egypt

The need for appropriate resources to overcome learning difficulties generally and dyslexia in particular is critical in Egypt. There is a need for the availability of tutors who are trained in understanding and dealing with dyslexia. There is also a need for increased awareness of the nature and problems of dyslexia as well as a need for more effective identification procedures. There is an urgent need for support for students with dyslexia at all levels within the educational system in Egypt. Developing a programme of staff awareness for special education teachers, examinations officers, councillors and career advisers in Egypt is highly recommended.

There is a need for early identification and assessment for dyslexia in Egypt. "The use of computers for learners with literacy difficulties is an exciting and rapidly developing area" (Broomfield & Combley 2003: 41). Dyslexics benefit immensely from using computer and other forms of assistive technology which empower them with a tool to facilitate their written communication as well as developing their literacy skills. Miles (1992) recommends that in view of what can be achieved, at relatively modest cost, it would seem to be good policy to invest resources both "in the training of teachers able to specialise in these methods and in the provision of awareness courses for non specialists" Miles 1992: 151). Computer-based screening offers some good potential for quick and accurate screening of adults. Computer based screening can minimize "clinical judgement, is quick and easy to administer, requires little training, can be self administered and can provide useful informative feedback to individuals" (Reid & Kirk 2001: 34). These are all, of course, in addition to their cost-effective advantages, particularly in the longer term.

Establishing a policy of intervention for all schools in Egypt is highly desirable. Multi-sensory procedures are essential when working with children with dyslexia. It is therefore recommended that these are included and/or made available for dyslexic children in Egypt. Oral examinations must also be included and the current total dependency on written examinations must consider that children with dyslexia may be disadvantaged when expressing themselves in writing.

Early screening of children and in particular the screening that can be conducted prior to the onset of formal instruction is of extreme importance for it permits the desired long-term prevention of difficulties. It is therefore highly recommended that screening and diagnostic tools are made available for all monolingual Arabic speakers at all ages.

8.8 Further Research

Children's errors on spelling tasks can tell us a great deal about a particular child's knowledge of letter-sound correspondence and the kind of spelling strategies they use: i.e., either phonic in trying to cue the words to the symbols or trying to remember the letters as a sequence in what is generally called global strategy. It is therefore recommended that further studies and analysis are conducted in order to further investigate the types of mistakes monolingual Arabic dyslexic children make while spelling so that a more effective remedial programme can be identified.

Morphological and orthographic processing are two very important areas of research that needs to be investigated in detail amongst Arabic speaking dyslexic and poor readers. Due to the specific linguistic features of Arabic and its Semitic origins, Arabic readers' knowledge of root and patterns and word structure are likely to positively affect their reading ability as well as their spelling performance. It is therefore highly recommended that further research investigate the critical role of morphological and orthographic processing abilities amongst Arabic speaking individuals.

Arabic short vowels are not always represented in the script, save from elementary teaching books or the Qur'an. It would therefore be interesting to investigate the influence of reading without such short vowels; i.e., reading unpointed texts and find out the differences in reading pointed vs. unpointed texts. In addition, the diaglossic situation in Egypt; i.e, between the Egyptian Colloquial Arabic spoken at home and in everyday life activities as opposed to the Modern Standard Arabic as the written language of educational materials and academic books, should be investigated in detail so that the issues of confusion that are due to such a diaglossic situation may be dealt with. The impact of phonemic and lexical distance on the phonological analysis of Arabic speaking Egyptian children is an area of research that has not been addressed before.

It is also highly recommended that further research is carried out in order to develop screening and diagnostic tools for dyslexia in Arabic. It would be greatly useful if norms are collected across the Arab World and age matched scores and percentiles are developed. Such norms and standardized tests and screening tools make any future research studies easier and more effective.

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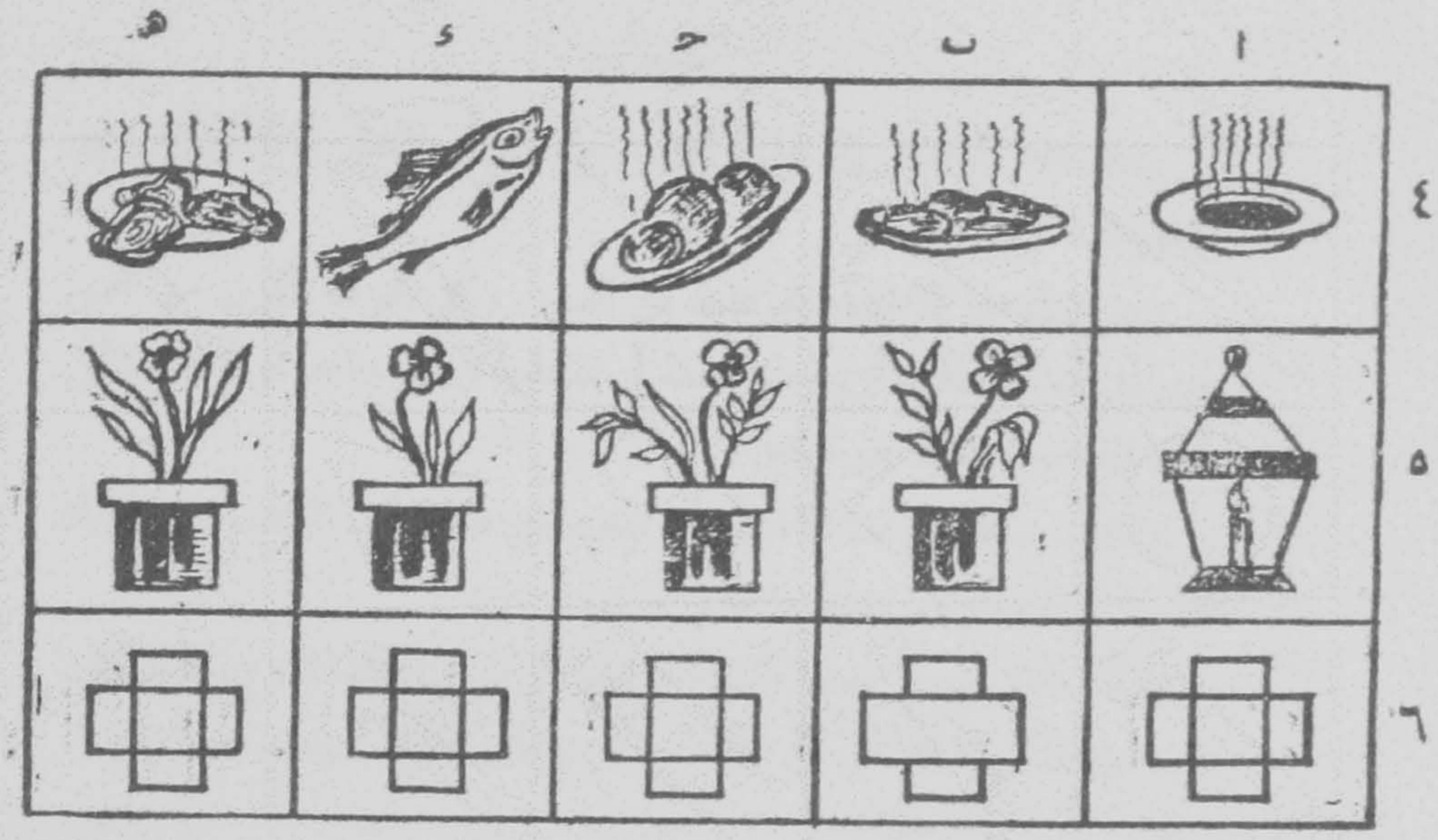
Appendix 1: Non-verbal Reasoning (Pictorial Non-verbal Mental Abilities) Test

والآن أجب عن الأسئلة التالية بنفسك وحينما تنتهى منها ضع القلم .



الإجابة الصحيحة فى المثال رقم (٤) هى (ء) لماذا ؟
والإجابة الصحيحة فى المثال رقم (٥) هى (ا) لماذا ؟
والإجابة الصحيحة فى المثال رقم (٦) هى (ب) لماذا ؟

والآن قد فهمت هذا النوع من المشاكل . المطلوب منك الآن أن تعمل بسرعة ودقة كى لاترتكب أخطاء . لا تضيع وقتاً طويلا فى سؤال واحد . ستعطى عشر دقائق فقط للاجابة عن الأسئلة فى هذه الكراسة وهى ستون سؤالا .

ليس من المفروض أن تحل كل الأسئلة . لاتضيع وقتاً طويلا فى سؤال واحد . حالما تعطى تعليمات بالإجابة أبدأ وأستمر فى الإجابة عن أسئلة الاختبار حتى يطلب منك أن تضع القلم .

لاتقلب هذه الصفحة قبل أن يؤذن لك .

ولا تسأل أسئلة كى لاتضيع وقتاً .

Appendix 2: Non-verbal Reasoning (Pictorial Non-verbal Mental Abilities) Test

تعليمات

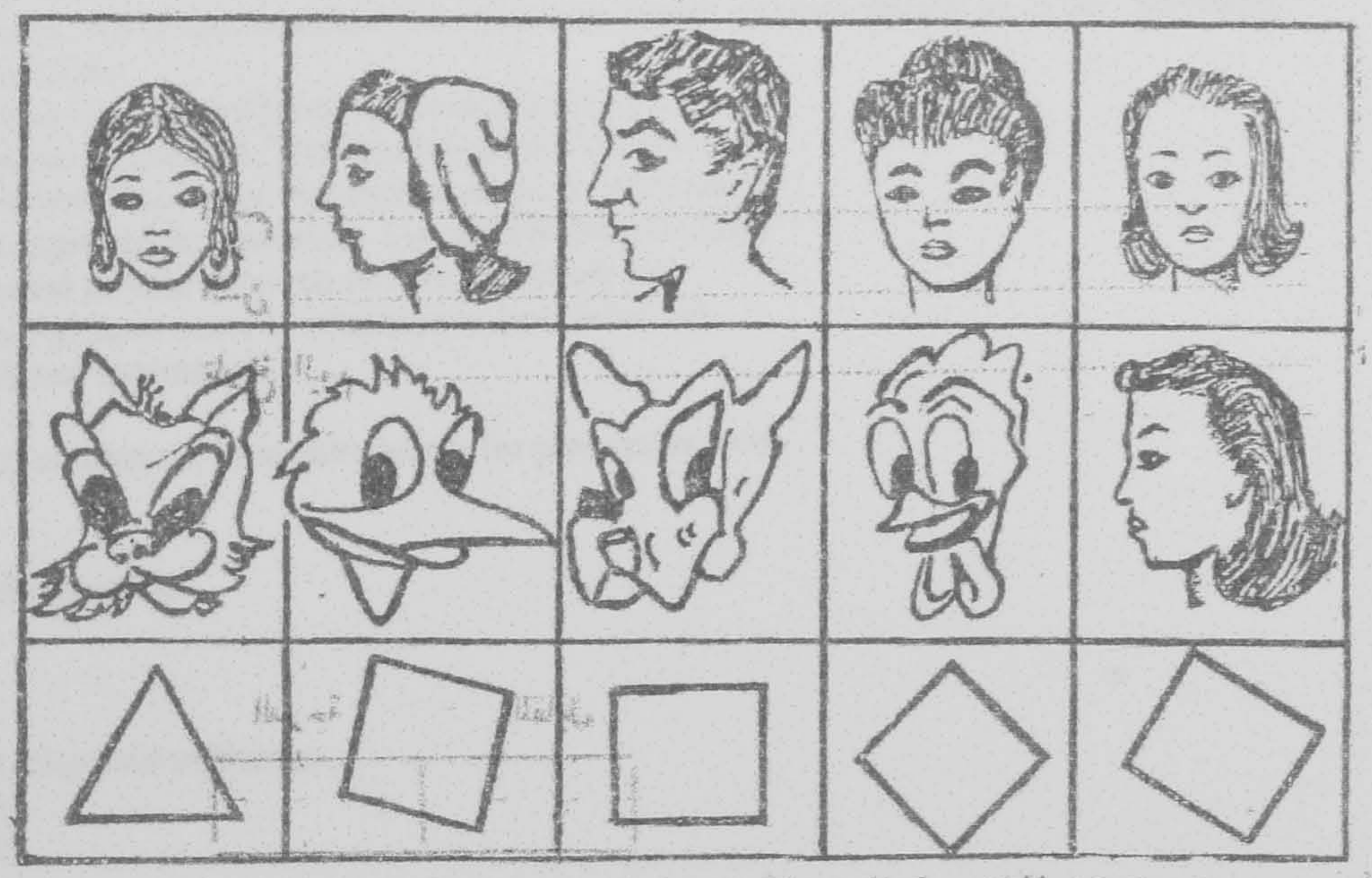
يهدف هذا الاختبار إلى قياس القدرة على إدراك التشابه والاختلاف بين الموضوعات والأشياء .

ويوجد فى هذا الاختبار مجموعات من الصور ، كل مجموعة تتكون من خمس صور أو خمسة أشكال ، أربعة منها متفقة أو متشابهة فى أمر واحد أو أكثر وشكل واحد فقط هو المختلف عن الباقين .

والمطلوب منك فى هذا الاختبار أن تبحث عن هذا الشكل المختلف بين أفراد المجموعة الواحدة وتضع عليه علامة (×) .

والآن فلنتدرب على بعض الأمثلة حتى نتأكد من فهمنا لهذا النوع من المشاكل: ابحث عن الشكل المخالف فى كل مجموعة من المجموعات الآتية ، وضع عليه (×) .

ا ب ح ء ه



١ ٢ ٣

ماهو الشكل المخالف فى المجموعة رقم (١) ؟

لاحظ أن كل الصور تعبر عن صورة « بنت » أو « سيدة » ماعدا الصورة (ح) فهى تعبر عن رجل . ولذلك يجب أن تضع عليها علامة (×) .

أما فى المثال رقم (٢) فإن الشكل المخالف هو (ا) ، لماذا ؟

وفى المثال رقم (٣) فإن الشكل المخالف هو (ه) ، لماذا ؟

Appendix 3: Permission from the Psychological Corporation to use Rapid Naming and Backward Digit Span tests

Gad.Elbeheri

Subject: FW: FW: Permission Request to use RN in DST

From: "McKeown, Paul (TPC-International)" <Paul.McKeown@tpc-international.com>
To: "'gad elbeheri'" <gad1318@hotmail.com>; "McKeown, Paul (TPC-International)" <Paul.McKeown@tpc-international.com>
Cc: "Munro, Lesley (TPC-International)" <Lesley.Munro@tpc-international.com>
Sent: Tuesday, March 18, 2003 10:27 AM
Subject: RE: FW: Permission Request to use RN in DST

> >Apologies for the delay.
> >Permission is subject to the following conditions:
> >* We give you 'research only' permission to use the current version
> >of the materials.
> >* You will have permission to use the materials ONLY in the research you describe below.
> >* You should not reproduce the materials for any other purposes.
> >* For subsequent publications from the research you will need to have additional permission to reproduce any of the materials. We normally do not give permission to reproduce test items beyond one or two from each test or permission to publish correct responses. Under no circumstances do we give permission to reproduce norm tables from our tests.

> >You will need to buy at least one copy of full DST. You do have Permission to reproduce enough copies of these materials for your research. All of the materials you reproduce for the research should have the following
> >copyright line on the cover:
> > Dyslexia Screening Test. Reproduced with permission by The
> >Psychological Corporation Limited. The Psychological Corporation,
> >1996. All rights reserved. Once your research is complete you should
> >destroy any unused copies of the materials. I would ask that you keep
> >Prof Nicolson informed of your research and we would ask for
> >permission to (possibly) have some to reference to (and detail of)
> >your research in a future test manual
> >
> >As far as payment is concerned, I am quite happy for permission to be
> >gratis.
> >
> >Good luck with your research.
> >
> >Paul McKeown
> >Director
> >The Psychological Corporation Europe
> >32 Jamestown Road
> >London NW1 7BY
> >United Kingdom
> >
> >Tel: + 44 (0)20 7424 4458
> >Fax: + 44 (0)20 7424 4457
> >www.tpc-international.com <www.tpc-international.com>
> >
> >Please note new email address from 20/01/03
> >paul.mckeown@tpc-international.com
> ><paul.mckeown@tpc-international.com>

Appendix 4: Permission from Louise Miller-Guron to use Word Chain test

Gad.Elbeheri

Subject: FW: Wordchains Permission Request

From: Louise Miller Guron
To: Gad Elbeheri
Sent: Friday, September 26, 2003 8:53 PM
Subject: Re: Wordchains Permission Request

Dear Gad,

The work you have done with Arabic wordchains sounds very interesting. There is no problem whatsoever with the development of wordchains in Arabic or any other language. Whenever copyright of the Wordchains Test is discussed, it is within the framework of each language version published. The first Wordchains Test that we know of was developed and published in Swedish by Christer Jacobson. In Sweden sentence chains have also been used. Since 1996 I have developed the test in English and Torleiv Höien in Norwegian and I have heard that a Welsh version has been written in collaboration with Ian Smythe. I have also heard interest from researchers in France, Holland and Denmark.

NFER-Nelson own copyright on the standardisation of my English Wordchains Test and I have copyright on the English version that they published. NFER-Nelson cannot object to any other language version of this test and they should be straight about that. I recommend you go ahead with your Arabic version and don't get too concerned with any further enquiries. If you can publish a research paper using Arabic wordchains it would be of great interest to researchers looking at cross-orthographic studies of word decoding efficiency. I wish you all the best with this project and look forward to hearing of any results you may have.

Best wishes,
Louise Miller Guron

Appendix 5: ADATI Rhyme Detection Internal Consistency Statistics

Name	G	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Sum
Abanoub Maher Fawzi	F	1	1	1	1	1	1	1	1	1	1	10
Abdelmoeti Muhammad Abdelmoeti	M	1	0	1	0	1	1	1	1	1	0	7
Abdulaziz Ali Abdulaziz	M	1	1	1	1	1	1	1	1	1	1	10
Abdullah Ahmed Ahmed	M	1	1	1	1	1	1	1	1	1	1	10
Abdullah Essayed Ahmed	M	1	0	0	0	0	0	0	0	0	0	1
Abdullah Ibraheem Edosooqi	M	1	1	1	1	1	1	1	0	0	0	7
Abdurrahman Mahmoud Abdurrahman	M	1	1	1	1	1	1	1	1	1	1	10
Abdurrahman Shaban Abdulkhaliq	M	1	1	1	1	1	1	1	1	1	0	9
Adel Ibraheem Mahrous	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Adel Abdulmonaeim	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Adel Eed Omar	M	0	0	0	0	0	0	0	0	0	0	0
Ahmed Adel Muhammad	M	1	1	1	1	1	1	0	1	1	1	9
Ahmed Ali Abdulaleem	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Ali Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Ashraf Abdelhameed	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Essayed Abdullah	M	1	0	0	0	0	0	0	0	0	0	1
Ahmed Essayed Ibraheem	M	1	0	1	0	1	1	1	0	0	1	6
Ahmed Ezzat Adbulatti	M	1	1	1	1	1	0	1	0	1	0	7
Ahmed Fathi Abdulaziz	M	0	1	0	0	0	1	0	0	0	0	2
Ahmed Gaber Essayed Ahmed	M	1	1	1	1	1	1	0	1	1	1	9
Ahmed Hassan Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Hassan Ahmed Ali	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Hilmi Abdullah	M	1	1	1	0	1	1	1	1	1	1	9
Ahmed Hisham Ahmed	M	0	0	0	1	0	0	0	0	0	0	1
Ahmed Hosam Edeen Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Hussein Abduldayem	M	1	0	1	1	1	0	0	1	0	0	5
Ahmed Ibraheem Abdulaziz	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Mahmoud Ahmed	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Mahmoud Ali	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Mahmoud Muhammad	M	1	1	1	1	1	0	1	1	1	1	9

Ahmed Muhammad Abdrabbou	M	1	1	1	1	1	1	1	1	1		9
Ahmed Muhammad Abdulaziz	M	1	1	0	1	1	1	1	1	1	1	9
Ahmed Muhammad Abdulsamee Abdulrasheed	M	1	1	1	1	1	1	0	1	0	0	7
Ahmed Muhammad Abou Elyazeed	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Muhammad Ahmed	M	1	1	1	1	1	0	1	1	1	1	9
Ahmed Muhammad Ali	M	1	1	1	1	0	1	0	1	0	1	7
Ahmed Muhammad Fathi	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Muhammad Hafiz	M	1	1	1	1	1	1	0	1	1	1	9
Ahmed Muhammad Abdou	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Muhammad Awad	M	1	1	0	1	0	1	1	1	1	1	8
Ahmed Muhammad Mahmoud	M	1	0	0	0	0	0	0	0	0	0	1
Ahmed Mustafa Ali	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Mustafa Essayed	M	0	0	1	0	0	0	1	0	0	0	2
Ahmed Mustafa Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Ramadan Ahmed Ali	M	0	0	0	0	0	0	0	0	0	0	0
Ahmed Ramadan Noubi	M	0	0	0	1	0	0	1	0	0	0	2
Ahmed Saad Abdelhameed	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Sameh Taha	M	1	1	1	1	0	0	0	0	0	0	4
Ahmed Sayed Ahmed Sayed	M	1	1	0	0	0	0	0	0	1	1	4
Ahmed Shaban Ali	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Tariq Said	M	1	1	1	1	1	1	1	1	1	1	10
Ahmed Yousef Muhammad	M	1	0	1	1	1	1	1	1	1	1	9
Ahmed Yousri Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Aidi Ashraf Shehata Shaban	M	1	1	0	0	0	0	0	1	0	1	4
Aiya Ahmed Abdulgawad	F	1	1	0	0	0	1	0	1	0	0	4
Aiya Ahmed Ali Qutub	F	1	1	0	1	0	0	0	0	0	0	3
Aiya Ahmed Amin	F	1	1	1	1	1	1	1	1	1	1	10
Aiya Ali Hassan	F	1	0	1	1	1	1	1	1	1	1	9
Aiya Ali Mabrook	F	1	0	1	0	0	0	0	0	0	0	2
Aiya Defi Abdulaziz	F	1	1	1	0	0	0	0	0	0	0	3
Aiya Ehab Abdulsalam	F	1	0	0	1	1	0	0	0	0	0	3
Aiya Ibraheem Badr Ibraheem	F	1	1	1	1	1	1	1	1	1	1	10
Aiya Mahmoud Taher	F	1	1	1	1	1	0	0	0	0	0	5

Aiya Muhammad Ahmed	F	1	0	0	1	1	0	0	0	0	0	3
Aiya Sami Ramadan	F	1	0	0	0	0	1	1	1	0	1	5
Alaa Adel Saad	M	1	0	1	1	1	1	0	1	0	0	6
Alaa Edeen Essayed Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Alaa Muhammad Mahmoud	M	1	1	1	1	1	1	1	1	1	1	10
Ali Abdelmoeti Bakr	M	0	0	1	0	0	1	0	0	1	0	3
Ali Gameel Ali Ahmed	M	1	1	1	1	1	1	1	1	1	1	10
Ali Muhammad Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Amal Eshafie Ahmed	F	1	1	1	1	0	1	0	1	0	1	7
Aminah Muhammad Masoud	F	1	1	1	1	1	1	1	0	1	1	9
Aminah Mustafa Ahmed	F	1	1	1	1	1	1	1	0	0	1	8
Amirah Ezzat Mahmoud	F	1	0	1	1	1	1	1	1	1	1	9
Amirah Abdelhafeez Ahmed	F	1	1	1	1	1	1	1	1	1	1	10
Amirah Anwar Marouf	F	1	1	1	1	1	1	1	1	1	1	10
Amirah Muhammad Basyouni	F	1	1	1	1	1	1	1	1	1	1	10
Amirah Muhammad Mustafa	F	1	1	1	1	1	1	1	1	1	1	10
Amr Mosa Ahmed	M	1	1	1	1	1	1	1	1	1	1	10
Amr Ramadan Mahmoud	M	1	1	1	1	1	1	1	1	1	1	10
Amr Waheed Hamid	M	1	0	1	0	1	1	1	0	0	0	5
Amr Mahmoud Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Amr Muhammad Ali	M	0	0	1	1	0	1	1	1	1	1	7
Annan Alaa Edeen Khamees	M	1	1	1	1	1	1	1	1	1	1	10
Asmaa Abdulbari Muhammad	F	1	0	1	0	0	0	1	1	0	0	4
Asmaa Abdulnabi Abdullah	F	1	1	1	1	1	1	1	1	1	1	10
Asmaa Adel Muhammad	F	1	1	0	0	1	0	0	1	0	0	4
Asmaa Ahmed Bekheet	F	1	1	1	1	1	1	1	1	1	1	10
Asmaa Ali Muhammad	F	1	1	0	1	1	1	0	1	0	1	7
Asmaa Alian Muhammad	F	1	1	1	0	1	1	0	0	0	1	6
Asmaa Essayed Ismail	F	1	0	1	1	1	1	1	1	1	1	9
Asmaa Essayed Zaki	F	1	1	0	1	0	0	0	1	1	1	6
Asmaa Fikri Ismail	F	1	1	1	1	1	1	0	1	0	1	8
Asmaa Fouad Ibraheem	F	1	0	0	1	1	1	0	1	1	1	7
Asmaa Gamal Muhammad	F	1	0	1	1	1	1	1	1	1	1	9

Asmaa Ibraheem Abdulgawad	F	1	0	1	1	1	1	0	0	0	0	5
Asmaa Mahmoud Mohammed	F	1	0	1	1	0	0	0	1	0	0	4
Asmaa Mustafa Ali Mustafa	F	1	1	1	1	1	1	1	1	1	1	10
Asmaa Mustafa Essayed	F	1	0	1	1	1	1	1	1	1	1	9
Asmaa Othman Muhammad	F	1	1	1	1	1	1	1	1	1	1	10
Atiyah Ahmed Atiyah Hassan	M	1	1	1	1	1	0	1	1	1	1	9
Ayah Muhammad Abdulazeem	F	1	1	1	1	1	1	1	1	1	1	10
Ayman Farag Abdulaal	M	1	0	0	0	0	1	1	0	0	0	3
Bahaa Edeen Muslim Kamel	M	1	1	0	0	0	1	0	0	0	1	4
Basant Ahmed Assem Ali	F	1	1	1	1	1	1	1	1	1	1	10
Basant Ashraf Hassan Khalil	F	1	0	1	1	1	1	1	1	1	0	8
Basant Ibraheem Darweesh	F	1	0	1	0	1	1	0	1	0	0	5
Basant Magdi Khamees	F	1	1	1	1	1	1	1	1	1	1	10
Basem Rami Ramadan Mosa	M	1	0	0	1	0	0	0	0	0	0	2
Basma Essayed Muhammad	F	1	1	1	1	1	1	0	0	0	1	7
Basma Gamal Abdulghani	F	1	1	1	1	1	1	1	1	1	1	10
Basma Gamal Abdelhameed	F	1	1	1	1	1	1	1	1	1	1	10
Basma Muhammad Saad	F	1	1	1	1	1	1	1	0	0	0	7
Basma Ramadan Abdulsalam	F	1	1	1	1	1	1	1	1	1	1	10
Basma Saad Hamoudah	F	1	1	1	1	1	1	1	1	1	1	10
Bassam Abdulhaleem Bekheet	M	1	0	0	0	0	0	0	0	0	0	1
Bodoor Ezzat Muhammad	F	1	1	0	1	1	1	1	1	1	1	9
Dimyanah Hanna Zaki Essa	F	1	1	0	0	0	1	0	1	1	0	5
Dina Hafiz Muhammad Hafiz	F	1	0	1	1	1	1	1	1	1	0	8
Dina Zechariah Ali Bekheet	F	1	1	1	1	1	1	1	1	1	0	9
Doaa Bayomi Muhammad	F	1	1	1	1	1	1	1	1	1	1	10
Doaa Ibraheem Muhammad	F	1	1	1	1	1	1	1	1	1	1	10
Doha Mustafa Essayed	F	1	0	0	1	1	1	0	0	1	0	5
Donia Muhammad Khalid	F	1	1	1	1	1	1	1	1	1	1	10
Emad Edeen Muslim Kamel	M	1	1	1	1	1	1	0	1	0	0	7
Essam Ali Rifat Ali	M	1	1	1	1	1	1	0	1	1	0	8
Essam Ibraheem Abdulssattar	M	1	0	1	1	1	1	1	1	1	0	8
Essayed Ali Abdurrahman	M	1	0	1	1	1	1	1	1	1	1	9

Essayed Mustafa Kamel	M	1	1	1	1	1	1	1	1	1	1	10
Fadi Wagdi Suleiman	M	1	1	1	1	1	0	1	1	1	1	9
Fatima Essayed Ahmed Ali	F	1	1	1	1	1	1	1	1	1	1	10
Fatima Ibraheem Muhammad	F	1	1	1	1	1	1	1	1	1	1	10
Galal Atiyah Zaki Essayed	M	1	1	1	1	0	1	1	1	1	1	9
Hadeer Ahmed Aboulfath	F	1	1	1	1	1	1	1	1	1	1	10
Hadeer Gaber Muhammad	F	1	1	1	0	0	0	1	0	0	0	4
Hadeer Hamdi Muhammad	F	1	1	1	1	1	1	1	1	1	1	10
Hadeer Hussein Muhammad	F	1	1	1	1	1	0	0	0	1	1	7
Hadeer Ismail Saad Ahmed	F	1	1	0	1	1	1	0	1	0	0	6
Hadeer Khamis Ibraheem	F	1	1	1	1	1	1	1	1	1	1	10
Hadeer Muhammad Salem	F	1	1	1	1	0	0	0	0	0	0	4
Hadeer Muhammad Mahmoud	F	1	1	1	1	1	1	1	1	1	1	10
Hadeer Samir Ahmed	F	0	0	0	1	0	1	0	1	0	1	4
Halah Mahmoud Kamel	F	1	1	1	1	1	1	1	1	1	1	10
Hamdi Mahmoud Mustafa	M	1	0	0	1	0	0	0	0	0	0	2
Hamid Muhammad Hamid	M	1	0	1	1	1	1	1	1	1	1	9
Hanan Essayed Salama	F	1	0	1	1	1	1	1	1	1	1	9
Hassan Said Gommaa Ali	M	1	1	1	1	1	1	1	1	1	1	10
Heba Hassan Essa	F	1	1	1	1	1	1	1	1	1	1	10
Heba Hifzi Abdulaal	F	0	0	0	0	0	0	1	0	1	1	3
Hosam Edeen Essam	M	1	1	1	1	1	1	1	1	1	1	10
Hosni Harbi Elbarbari	M	1	1	1	1	1	1	1	1	1	1	10
Hosni Muhammed Mahmoud	M	0	0	0	0	0	0	0	0	0	0	0
Iman Essayed Zaki	F	1	1	1	1	1	1	1	1	1	1	10
Islam Adel Hassan Saad	M	1	1	1	1	1	1	0	1	0	1	8
Islam Adel Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Islam Atif Othman	M	1	0	1	1	1	1	1	1	1	1	9
Islam Muhammad Abdulmonaeim	M	1	1	1	1	1	1	1	1	1	1	10
Islam Sayed Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Islam Seleem Saad	M	1	1	1	1	1	1	0	0	1	1	8
Israa Abdelhameed Mahmoud	F	1	1	1	1	1	1	1	1	1	1	10
Israa Hassan Essebai	F	1	1	1	1	1	1	1	1	1	1	10

Israa Muhammad Abdelhameed	F	1	0	1	1	1	1	1	0	0	0	6
Israa Muhammed Ibraheem	F	1	1	1	1	1	0	0	0	0	0	5
Kamal Shaker Morsi	F	1	0	0	1	0	0	0	0	0	0	2
Kareem Adel Muhammed	M	1	0	0	0	0	0	0	0	0	0	1
Kareem Hassan Essayed	M	1	1	1	1	1	1	1	1	1	1	10
Kareem Mahmoud Ali	M	0	0	0	0	0	0	1	0	0	0	1
Karimah Muhammed Ali	F	1	1	1	1	1	1	1	1	1	1	10
Khamees Hassan Ali Hamza	M	0	0	1	0	0	1	0	1	0	0	3
Kheristina Gameel Fikri	F	1	1	1	1	1	1	1	1	1	1	10
Kristina Radi Ayyad	F	1	1	1	1	1	1	1	1	1	1	10
Laila Khamees Zohair	F	1	1	1	1	1	1	1	1	1	1	10
Magdi Mustafa Muhammed	M	0	0	1	1	0	1	1	1	1	1	7
Mahmoud Abdullateef Muhammed	M	1	1	1	1	1	1	1	1	1	1	10
Mahmoud Abdulfattah Essawi	M	1	1	1	1	1	1	1	1	1	1	10
Mahmoud Abdulfattah Muhammed	M	1	0	1	1	1	1	1	1	1	1	9
Mahmoud Ahmed Hamdi	M	1	0	0	0	0	1	0	0	0	0	2
Mahmoud Ali Hassan Ali	M	1	1	1	1	1	1	1	1	1	1	10
Mahmoud Essayed Thabet	M	1	1	1	1	1	1	1	1	1	1	10
Mahmoud Muhammed Ali	M	1	1	1	1	1	1	1	1	1	1	10
Mahmoud Muhammad Ali	M	1	0	0	0	0	0	0	0	0	0	1
Mahmoud Rida Abdunnabi	M	1	0	1	1	1	1	1	1	1	1	9
Mahmoud Salim Muhammad	M	1	0	1	1	1	1	1	1	1	1	9
Mahmoud Shaaban Saleh	M	0	0	0	0	0	0	1	0	0	0	1
Marwa Shaaban Shihata	F	1	1	0	0	0	0	0	0	1	1	4
Marwah Essayed Khalil	F	1	1	1	1	1	1	1	1	1	1	10
Midhat Ramadan Essayed	M	1	0	0	0	0	0	0	0	0	0	1
Mina Nagi Nimatallah	M	1	1	1	1	1	1	1	1	1	1	10
Minatallah Abdulmawla Othman	F	1	0	0	1	0	0	0	0	0	0	2
Moataz Ibraheem Khamees	M	1	0	0	0	0	1	0	1	0	0	3
Moemin Alaa Edeen Abdulaziz	M	1	0	1	0	1	1	0	0	0	0	4
Moemin Hussein Ahmed	M	1	1	1	1	1	1	1	1	1	1	10
Moemin Mohammed Essayed	M	1	0	1	1	1	1	1	0	0	0	6
Mona Ali Kamal	F	1	1	1	1	1	1	1	1	1	1	10

Mona Magdi Mustafa	F	1	1	1	1	0	1	0	0	0	1	6
Mona Mahmoud Yousri	F	1	1	1	1	1	1	1	1	1	1	10
Mona Saad Zaki Salim	F	1	0	1	1	0	1	1	0	1	1	7
Motaz Billah Hashim	M	1	0	1	1	1	0	0	0	0	1	5
Muhammed Abdullah Abdelaal	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Abdunnabi Ahmed	M	1	1	0	0	1	1	0	0	0	1	5
Muhammed Abdunnabi Essafi	M	1	1	0	0	1	1	0	1	1	0	6
Muhammed Ahmed Abdulsamee	M	1	1	1	1	1	1	0	1	1	1	9
Muhammed Ahmed Abulwafaa	M	1	0	1	1	1	1	1	1	0	1	8
Muhammed Ahmed Ali	M	1	1	1	0	1	1	1	1	1	1	9
Muhammed Ali Ali Othman	M	1	0	1	1	1	1	1	1	1	1	9
Muhammed Ali Attyiah	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Ashraf Ahmed	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Dahi Mahmoud	M	0	0	0	0	0	0	0	0	1	0	1
Muhammed Essayed Thabet	M	1	1	0	1	0	1	1	0	1	0	6
Muhammed Fathi Ibraheem	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Gaber Abdurrahman	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Gaber Qoutoub	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Hassan Farag	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Hassan Fahmi	M	0	0	0	1	0	1	1	1	0	0	4
Muhammed Hassan Fathi	M	1	0	1	1	1	1	1	1	1	1	9
Muhammed Hisham Fouad	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Ibraheem Khalifah	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Mahmoud Ahmed	M	1	1	1	1	0	1	1	1	1	1	9
Muhammed Mahmoud Ali	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Muhammad Hussein	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Muhammad Mahmoud Essayed	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Mustafa Shehata	M	0	1	1	1	1	1	0	1	1	0	7
Muhammed Ragab Bakr	M	1	0	0	0	0	0	0	0	0	0	1
Muhammed Ramadan Bondoq	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Said Ahmed	M	1	1	1	1	1	1	0	0	0	0	6
Muhammed Said Seleem	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Sami Muhammad	M	1	1	1	1	1	1	1	1	1	1	10

Muhammed Shafeek Muhammad	M	1	1	1	1	1	1	1	1	1	1	10
Muhammed Youseif Essayed	M	1	1	1	1	1	0	1	1	1	1	9
Muhammed Yousri Ali	M	1	1	1	1	1	1	1	0	1	1	9
Muhammed Zinhom Ahmed	M	1	0	0	1	1	1	0	1	0	1	6
Mustafa Abdusalaam Abdelhameed	M	0	0	0	0	0	0	0	0	1	0	1
Mustafa Ahmed Rabee	M	1	0	1	1	1	1	1	1	1	1	9
Mustafa Ashour Yaseen	M	1	0	1	1	1	0	0	1	1	1	7
Mustafa Essam Mutwali	M	1	1	1	1	1	1	1	1	1	1	10
Mustafa Fathi Ibraheem	M	1	0	0	1	0	0	0	0	0	0	2
Mustafa Magdi Hamid	M	1	0	1	1	1	1	1	1	1	1	9
Mustafa Mahmoud Shaaban	M	1	1	1	1	1	1	1	1	1	1	10
Mustafa Muhammed Adam	M	1	1	0	1	0	0	0	1	0	0	4
Mustafa Muhammad Fathi	M	1	1	1	1	1	1	1	1	1	1	10
Nada Farag Ettohami	F	1	1	1	1	1	1	0	1	1	1	9
Nada Ramadan Ismail	F	1	1	1	1	1	1	1	0	1	1	9
Nader Galal Muhammed	M	1	1	1	1	1	1	1	1	1	1	10
Nadia Ahmed Muhammed	F	1	0	0	1	1	1	0	0	1	0	5
Naiema Othman Mosa	F	1	1	1	1	1	1	1	1	1	1	10
Nasser Ibraheem Ali Abdou	M	1	1	1	1	1	1	1	1	1	1	10
Nassir Abdulmageed	M	1	1	1	1	1	1	1	1	1	1	10
Nayerah Hamid Wahman	F	1	1	1	1	1	1	1	1	1	1	10
Nema Mahmoud Ali	F	0	0	0	0	0	1	0	0	0	0	1
Nema Salah Mukhtar	F	1	1	1	1	1	1	1	1	1	1	10
Nermeen Medhat Abdul Wahab	F	1	1	1	1	1	1	1	1	0	0	8
Nesma Essayed Muhammed	F	1	0	1	1	1	1	0	0	0	0	5
Nihal Shendi Ibraheem	F	1	0	1	1	1	1	1	1	0	1	8
Noha Shreef Ahmed	F	1	1	1	1	1	1	1	1	1	1	10
Noha Sobhi Muhammed	F	1	1	1	1	1	1	1	1	1	1	10
Nora Sobhi Michael	F	1	1	1	1	0	1	1	1	1	1	9
Norhan Ali Ahmed Ali	F	1	0	1	0	0	0	0	0	0	0	2
Norhan Mahmoud Muhammed	F	1	1	1	1	1	1	1	1	1	1	10
Norhan Muhammed Hanafi	F	1	0	0	0	1	1	0	0	0	1	4
Norhan Muhammed Sayed	F	1	0	0	0	0	0	0	1	0	0	2

Nouh Hussein Hassan	M	1	0	1	1	1	1	1	0	1	0	7
Nour Ali Mahmoud	F	1	1	1	1	1	1	1	1	1	1	10
Olla Oawni Fouad Ahmed	F	1	1	1	1	1	1	1	1	1	1	10
Rana Muhammed Abdurreheem	F	1	1	1	1	0	1	1	0	0	1	7
Rania Muhammed Salah	F	1	1	1	1	1	1	1	1	1	1	10
Rania Ramadan Mahmoud	F	1	1	1	1	1	1	1	1	1	1	10
Rasha Eed Abdulbaset	F	1	1	1	1	0	0	0	0	0	1	5
Reda Khamees Essayed	F	1	0	1	1	1	1	0	0	0	0	5
Riham Muhammed Zaki	F	1	1	1	0	1	1	0	0	0	0	5
Saad Abdulhaleem Saad	M	0	0	1	0	0	0	0	1	0	0	2
Saad Essayed Saad	M	1	0	1	1	1	1	1	1	1	1	9
Sabreen Mahmoud Salah	F	1	1	1	1	1	1	1	1	1	1	10
Safaa Ahmed Khalifah	F	1	1	0	1	1	1	1	1	1	1	9
Sahir Maher Nabeeh	M	1	1	1	1	1	1	1	1	1	1	10
Samah Hussein Hasan	F	1	0	0	1	1	1	1	1	1	0	7
Samar Ali Ibraheem Ahmed	F	0	0	0	0	0	0	0	0	0	0	0
Samar Muhammed Yaqoub	F	1	1	1	1	1	1	1	1	1	1	10
Sara Ali Hassan Mukhtar	F	1	1	1	0	0	1	0	0	0	1	5
Sara Hamdi Muhammad	F	1	0	1	1	1	1	1	1	1	1	9
Sarah Muhammed Abelaal	F	1	1	1	1	1	1	1	1	1	1	10
Shaima Magdi Abbas	F	1	1	1	1	1	1	1	1	1	1	10
Shaima Saad Edeen Zaki	F	1	1	1	1	1	1	1	1	1	1	10
Shaima Adel Ali Masoud	F	1	1	1	1	0	1	1	1	0	0	7
Shaimaa Ali Ali Khamees	F	1	1	1	1	1	1	1	1	1	1	10
Shorouk Salameh Ibraheem	F	1	1	1	1	1	1	1	1	1	1	10
Shourouk Magdi Abdulhameed	F	1	1	1	1	1	1	1	1	1	1	10
Sobhi Fikri Rasheed	M	1	1	1	1	1	1	1	1	1	1	10
Soha Mahmoud Essayed	F	1	1	1	1	1	1	1	1	1	1	10
Talaat Essayed Hassan	M	1	1	1	1	1	1	1	1	1	1	10
Taqi Hisham Fouad	M	1	1	1	1	1	1	1	1	1	1	10
Tariq Farag Abbas	M	1	1	1	1	1	1	1	1	1	1	10
Wael Ragab Abdulreheem	M	1	1	1	1	1	1	1	1	1	1	10
Wafaa Ali Hassan	F	1	1	1	1	1	1	1	1	1	1	10

Yasmeen Ashraf Hassan	F	1	1	1	1	1	1	0	0	0	1	7
Yasmeen Muhammad Ali	F	1	1	1	1	1	1	1	1	0	1	9
Yasmeen Yousri Abdulfattah	F	1	1	1	1	1	1	1	0	1	1	9
Zainab Mustafa Saad	F	1	1	1	1	1	1	0	1	1	1	9
Zobaidah Ibraheem Ali	F	1	1	1	1	1	1	1	1	1	1	10

N	299	299	299	299	299	299	299	299	299	298	299
Mn	0.93	0.70	0.80	0.82	0.77	0.81	0.70	0.74	0.70	0.71	7.67
SD	0.26	0.46	0.40	0.38	0.42	0.39	0.46	0.44	0.46	0.45	2.98
Sum	277	209	239	246	230	242	208	220	208	213	2292
P	0.93	0.70	0.80	0.82	0.77	0.81	0.70	0.74	0.70	0.71	
Q	0.07	0.30	0.20	0.18	0.23	0.19	0.30	0.26	0.30	0.29	
(p)(q)	0.07	0.21	0.16	0.15	0.18	0.15	0.21	0.19	0.21	0.20	1.74

Number of participants	299									
Number of items	10									
Test variance	8.9									
Sum of p x q products	1.74									
KR-20	**0.894**									
Ferguson's Delta										
Possible total	10									
Possible scores	1	2	3	4	5	6	7	8	9	10
Frequencies at each score	14	13	9	16	17	12	22	12	46	134
Squares of these	196	169	81	256	289	144	484	144	2116	17956
Sum of squares	21835									
Index of discrimination	**0.831**									

Appendix 6: ADATI Word & Sentence Chain Internal Consistency Statistics

Name	G.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Sum
Aala Muhammed Abulhamd	F	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Aamal Mahmoud Ibraheem	F	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	1	1	1	21
Abdullah Ahmed Ahmed	M	1	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	1	9
Abdullah Essayed Ahmed	M	1	0	1	0	0	0	1	1	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	14
Abdullah Ibraheem Edosooqi	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
Abdurrahman Aboubakr Ahmed	M	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	20
Abdurrahman Alaa Edeen Ramadan	M	1	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	13
Abdurrahman Mahmoud Abdurrahman	M	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	22
Abeer Ibraheem Yousef Ramadan	F	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
Adel Farag Muhammed Farag	M	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	8
Ahlam Ibraheem Abdulsalam	F	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	12
Ahmed Abdullah Azab	M	1	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	0	0	0	0	1	1	11
Ahmed Adel Eed Omar	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ahmed Ali Abdulaleem Mustafa	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Fouad Abdelhakam	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ahmed Gaber Essayed Ahmed	M	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	1	1	1	21
Ahmed Gamal Mosa	M	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	23
Ahmed Hisham Ahmed	M	1	1	0	0	0	0	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	16
Ahmed Ibraheem Abdulaziz	M	1	1	1	1	0	0	0	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Ahmed Ibraheem Essayed Ramadan	M	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0	1	1	10
Ahmed Mahmoud Ahmed Ali	M	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	0	0	0	1	1	1	1	11
Ahmed Muhammed Ali Muhammed	M	1	1	1	1	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	16
Ahmed Muhammed Amin Ibraheem	M	1	1	1	1	0	0	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	1	1	1	1	17
Ahmed Muhammed Mahmoud Awad	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
Ahmed Muhammed Muhammed Khalil	M	1	1	1	1	0	0	0	1	1	1	1	0	0	0	1	1	0	0	1	0	1	1	1	1	1	16
Ahmed Mustafa Ali Abdulbasset	M	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	12
Ahmed Mustafa Hamid	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	1	1	8
Ahmed Nasir Essayed	M	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	22
Ahmed Saad Abdulhameed	M	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	4

Ahmed Sami Essayed	M	1	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	14
Ahmed Yousri Muhammed Shihata	M	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	13
Aidi Ashraf Shihata Shaaban	M	1	0	0	1	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	13
Aiya Ali Hassan	F	1	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	0	0	0	1	0	0	1	10
Aiya Ali Mabrook Mossa	M	1	0	0	1	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	15
Aiya Defi Abdulaziz	F	1	1	1	1	0	0	0	1	1	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	14
Aiya Mahmoud Ahmed	F	1	1	0	1	0	1	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1	1	15
Aiya Mahmoud Taher Mahmoud	F	1	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	0	0	0	1	1	1	1	13
Aiya Muhammed Abdurrahman	F	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	3
Aiya Muhammed Heeb Heeb	F	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	12
Aiya Shawqi Sayed Ahmed	F	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0	0	0	1	1	17
Alaa Adel Saad	M	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	5
Alaa Edeen Essayed Lotfi	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	9
Alaa Edeen Muhammed Abdussalam	M	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Alaa Muhammed Mahmoud Hassan	M	1	1	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	20
Ali Ashraf Ahmed Muhammed	M	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	12
Ali Muhammed Muhammed Ali	M	1	1	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	16
Aminah Mahrous Essayed Abdulmageed	F	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Aminah Muhammed Masoud	F	1	1	1	1	1	1	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	19
Amira Muhammed Hassan AbdulMawla	F	1	1	1	1	0	0	0	0	1	1	0	0	0	1	1	1	0	1	1	0	0	1	1	1	1	15
Amirah Abdelhafeez Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Amirah Anwar Marouf	F	1	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	14
Amr Mosa Ahmed Essayed	M	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	19
Amro Mahmoud Muhammed	M	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	20
Annan Alaa Edeen Khamees	M	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	20
Asmaa Abdulnabi Abdalah	F	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	18
Asmaa Alian Muhammed Khalaf Allah	F	1	1	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	17
Asmaa Essayed Ahmed	F	1	0	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	12
Asmaa Essayed Zaki Muhammed	F	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	15
Asmaa Hosni Ahmed	F	1	0	0	0	0	0	0	1	1	1	1	1	0	0	1	1	0	1	0	0	0	1	1	1	1	13
Asmaa Mahmoud Ali Muhammed	F	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Asmaa Mansour Muhammed	F	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	15

Atiyah Ahmed Atiyah Hassan	M	1	1	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	17
Ayat Muhammed Abdulazeem Muhammed	F	1	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	1	9
Ayman Ahmed Ibraheem Muhammed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	23
Bahaa Edeen Esawi	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
Basant Ibraheem Ahmed Ramadan	F	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	1	12
Basant Magdi Khamees	F	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
Basma Essayed Muhammed Abdunnabi	F	1	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	17
Basma Gamal Abdulhameed	F	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	1	0	0	1	10
Basma Ramadan Abdussalaam Salim	F	1	1	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	18
Basma Saad Hamoudah Ismail	F	1	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	0	1	0	0	0	1	1	1	1	11
Bodoor Ezzat Muhammed Bakr	F	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	1	1	1	1	0	0	1	1	1	1	12
Boutrous Makram Shafeeq Saad	M	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	15
Dina Gaber Ahmed Abdulmawgood	F	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	20
Dinah Salah Abdulhameed	F	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	13
Doaa Abdelkhaliq Daood Muhammed	F	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	0	1	1	0	0	0	0	0	1	9
Doaa Abdelwahab Ibraheem	F	1	1	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	18
Doaa Bayomi Muhammed Bayomi	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Doaa Fawzi Hassan	F	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	0	0	1	0	0	1	1	1	1	13
Doaa Ibraheem Muhammed	F	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Doaa Masoud Abdulhameed Ibraheem	F	1	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	14
Dohaa Mahmoud Sayed Abdulaal	F	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	22
Donia Muhammed Khalid Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0	1	1	1	1	0	0	1	19
Enji Shreef Ahmed	F	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	0	1	0	0	1	1	1	1	13
Eshaymaa Hassan Muhammed Hassan	F	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	18
Essam Ali Rifat Ali	M	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	22
Essayed Ali Abdurrahman	M	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	1	13
Essayed Muhammed Essayed Tayel	M	1	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	15
Fadi Wagdi Toghian Suliman	M	1	1	1	1	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	1	1	1	1	1	18
Fatama Esayed Ahmed Ali	F	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	22
Faten Muhammed Attiah Hassan	F	1	0	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	0	0	0	1	1	1	1	14
Faten Muhammed Bayoumi Muhammed	F	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Gamal Nagah Abdusattar Abdulaziz	M	1	1	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	11

Gihad Hamdi Hussein	F	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	13
Hadeer Ismail Saad Ahmed	F	1	0	0	0	1	0	0	1	1	1	0	0	1	1	1	1	1	0	1	0	0	1	1	1	1	15
Hadeer Khamis Ibraheem Essafi	F	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	22
Hadeer Magdi Muhammed Algameel	F	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Hadeer Muhammed Addulzaher Salim	F	1	1	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	19
Hadeer Samir Ahmed Hassan	F	1	1	0	1	1	0	0	0	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	16
Halah Mahmoud Kamil Ali Muhammed	F	1	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	0	1	0	0	0	1	1	1	1	11
Hamdi Mahmoud Mustafa Ahmed	M	1	1	1	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	15
Hamid Muhammed Hamid Essayed	M	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	3
Hasan Ridah Farooq	M	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	22
Hassan Said Gomaa Ali	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Haytham Nasser Salim Muhammed	M	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	4
Hazim Muhammed Khalid	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Hebah Gaber Saleh Khalifah	F	1	1	1	1	1	1	0	0	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1		18
Hebah Hifzi Abdulaal Muhammed	F	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
Hind Adel Muhammed Abdulhameed	F	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	5
Hisham Fahmi Muhammed	M	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hoda Ali Essayed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	5
Hosam Nabeeh Salim Essayed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2
Hussein Hasan Hussein	M	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Ibraheem Khalid Muhammed Ali	M	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	22
Ibraheem Yasser Ibraheem Muhammed	M	1	0	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	0	0	0	1	1	1	1	14
Ihab Muhammed Ali Mahrous	M	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	7
Ihab Muhammed Khamees Ahmed	M	1	1	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	18
Iman Essayed Zaki Muhammed	F	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	12
Islam Adel Muhammed Essayed	M	1	1	1	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	16
Islam Hosni Othman Hassan	M	1	0	0	1	1	0	0	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	0	1	1	15
Islam Kamil Ali Muhammed	M	1	0	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	0	0	0	0	1	1	1	13
Islam Muhammed Muhammed Abdulmoniem	M	1	1	1	1	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	19
Islam Muhammed Muhammed Eshair	M	1	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	0	1	1	0	0	1	1	1	1	13
Islam Sayed Muhammed Ali	M	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	20
Islam Seleem Saad Saleem	M	1	1	1	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	22

Israa Abdulhameed Mahmoud Essayed	F	1	1	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
Israa Ali Salman Ali Salim	F	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	22
Israa Hamdi Essayed Ahmed	F	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	12
Israa Muhammed Abdulhameed Ahmed	F	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
Israa Muhammed Ibraheem Mustafa	F	1	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	18
Karam Elwatani Abulyousir	M	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	21
Kareem Ahmed Hussein Muhammed	M	1	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	0	9
Kareem Gamal Muhammed Ahmed	M	1	1	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1	1	19
Kareem Hassan Essayed Muhammed	M	1	1	0	0	0	1	0	0	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	16
Kareem Yehiya Muhammed	M	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	6
Khadiga Ezz Edeen Ibraheem	M	1	1	0	1	0	1	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	10
Khalid Mustafa Mahmoud Ahmed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	1	1	9
Khalid Saad Othamn	M	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22
Khamees Hassan Ali Hamza	M	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	8
Laila Khamees Zohair Khalifah	F	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	12
Laila Mahmoud Yaqoub	F	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	14
Lamiaa Muneer Abusaba Muhammed	F	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	17
Magdi Mustafa Muhammed	M	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Mahmoud Abdulfattah Essawi	M	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	23
Mahmoud Ahmed Abudrrahman	M	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	1	1	1	1	19
Mahmoud Ahmed Rabee Bahgat	M	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	8
Mahmoud Ali Abdulbaset	M	1	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	15
Mahmoud Essa Essayed Ahmed	M	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	18
Mahmoud Gaber Fareed Hamadi	M	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	0	1	1	0	0	1	1	1	1	14
Mahmoud Hassan Ali Muhammed	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	11
Mahmoud Ibraheem Mahmoud Haridi	M	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Mahmoud Muhammed Abdulmawgood	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	11
Mahmoud Muhammed Ali Hussein	M	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	12
Mahmoud Muhammed Mahmoud Ibraheem	M	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	0	0	0	1	0	1	1	11
Mahmoud Rida Abdunnabi Essayed	M	1	1	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	16
Mai Ahmed Abdulssattar	F	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	1	0	1	1	17
Mairaim Ibraheem Zaki Ibraheem	F	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	14

Marina Michael Youseif Fahmi	F	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	10
Marwa Essayed Abdussattar	F	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	17
Marwa Muhammed Ahmed Goma	F	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	18
Michael Magdi Mourkos Bolis	M	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	14
Mina Nagi Nimatallah Gad	M	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	0	0	1	1	1	0	0	0	0	0	13
Moataz Ibraheem Khamees	M	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	6
Moemin Alaa Edeen Abdulaziz	M	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0	1	0	0	1	1	1	1	20
Moemin Muhammed Essayed Abdussalam	M	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	9
Mona Ali Kamal Ali Muhammed	F	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	12
Mona Esayed Abdulazeem Esayed	F	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	8
Mona Mustafa Abdullah	F	1	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	17
Motaz Billah Qassim Abdulmobdi	M	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	6
Muhamed Adel Abdulqadir	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Muhammed Abdelshafee Muhammed	M	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	23
Muhammed Abdullah Ramadan	M	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	13
Muhammed Abdulqadir Mahmoud	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	12
Muhammed Adel Mansour	M	1	1	1	1	0	0	0	0	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	18
Muhammed Ahmed Ali Younis	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
Muhammed Ahmed Essayed Ibraheem	M	1	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	13
Muhammed Alaa Eddeen Ramadan	M	1	1	1	1	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	18
Muhammed Ali Ali Lokman	M	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	12
Muhammed Ali Attyiah Fathala	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	8
Muhammed Ali Hassan Shedeed	M	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	13
Muhammed Ashraf Ahmed Muhammed	M	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Muhammed Essa Muhammed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	4
Muhammed Essayed Abdulaal	M	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	5
Muhammed Essayed Farag Ali	M	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	21
Muhammed Essayed Thabet Abdulghani	M	1	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	0	0	0	1	1	1	1	12
Muhammed Fathi Ibraheem Ahmed	M	1	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	0	0	0	1	1	1	1	13
Muhammed Gaber Abdelseed	M	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	21
Muhammed Gaber Qoutoub	M	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	22
Muhammed Hamdi Ibraheem Shihata	M	1	1	1	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	0	0	1	14

Muhammed Hashim Fathi	M	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3
Muhammed Hassan Muhammed Fathi	M	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	1	6
Muhammed Ibraheem Hassan Ali	M	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0	1	1	1	0	0	0	0	0	1	1	12
Muhammed Ibraheem Muhammed Ibraheem Mahgoub	M	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	19
Muhammed Mahmoud Ahmed Gommaa	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	7
Muhammed Mahmoud Mahmoud Ahmed	M	1	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	15
Muhammed Mahmoud Muhammed Ali Hussein	M	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	21
Muhammed Muhammed Abdulkhaliq	M	1	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	14
Muhammed Mungid Abdulkadir	M	1	0	1	0	0	1	1	1	0	0	0	0	0	0	1	1	1	1	1	0	0	1	1	0	1	13
Muhammed Mustafa Shehata	M	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	6
Muhammed Said Ahmed Muhammed	M	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	20
Muhammed Sami Muhammed Hassan	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	1	0	1	1	1	1	1	10
Muhammed Shafeek Muhammed Elbahr	M	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Muhammed Yousri Muhammed Ali	M	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	14
Muhammed Yousri Salih	M	1	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	14
Muhammed Zakaria Shaaban Muhammed	M	1	0	0	1	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	14
Mustafa Abdusalaam Abdulhameed	M	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	0	0	0	1	1	1	1	12
Mustafa Ahmed Rabee Bahgat	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	3
Mustafa Essam Mutwali Sayed Ahmed	M	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	11
Mustafa Essayed Ali	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	12
Mustafa Fathi Ibraheem Ahmed	M	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	1	6
Mustafa Mahmoud Mustafa Muhammed Othman	M	1	1	1	0	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	17
Mustafa Mahmoud Shaaban Hassan	M	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	14
Mustafa Muhammed Adam Khalil	M	1	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	0	0	0	1	1	1	1	14
Nabeel Mosad Zaki Salim	M	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	6
Nada Ali Ismail Ali	F	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	17
Nada Muhammed Saleh Essharawi	F	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	0	9
Nadia Khalifa Abdella Ahmed	F	1	1	1	1	0	0	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	12
Nadia Nasr Abdelwahid Muhammed	F	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	1	1	12
Nasser Ibraheem Ali Abdou	M	1	1	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	17
Nema Ibraheem Abdrabennabi	F	1	1	0	0	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	19
Nermeen Medhat Abdul Wahab	F	1	1	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	18

Nermeen Saeed Abdulaziz	F	1	1	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	18
Nermeen Saeed Mustafa Muhammed	F	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	17
Nihad Saad Abulwafa Said	F	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	20
Nihal Kamal Qaoud	F	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	1	11
Nihal Shendi Ibraheem	F	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	10
Nora Sobhi Michael Salama	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	8
Norhan Mahmoud Muhammed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Norhan Muhammed Hanafi Mahmoud	F	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	8
Omar Ibraheem Abdulaziz Elokazi	M	1	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	17
Omniyah Hassanain Ahmed	F	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	16
Osama Adel Afifi Mustafa	M	1	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	13
Osama Wagdi Gaballah	M	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	11
Paula Dawood Radi	M	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	12
Radwan Muhammed Abdellateef Muhammed	M	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	6
Raghda Mustafa Muhammed	F	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	9
Rana Muhammed Abdulrheem	F	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	1	7
Rania Ahmed Muhammed Bayoumi	F	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	10
Rania Muhammed Muhammed Abdulghani	F	1	1	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	20
Rania Muhammed Salah Mukhtar	F	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	20
Raniya Muhammed Abdulsamee	F	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	12
Rasha Eed Abdulbasset	F	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	11
Riham Hisham Ahmed Muhammed	F	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1	13
Riham Muhammed Zaki Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	1	1	0	1	18
Saad Abdulhaleem Saad Muhammed	M	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	1	1	1	1	9
Saber Karim Saber Abluhasan	M	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	5
Saber Motwali Mahmoud Muhammed	M	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0	1	1	16
Safaa Ahmed Khalifa Khalifa	F	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	21
Sahar Gamal Edrees Badr	F	1	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	14
Salah Ashour Mahmoud	M	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	8
Samah Mohiedden Hassanain	F	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	14
Samar Ali Ibraheem Ahmed	F	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	1	1	1	1	9
Samar Gamal Ezzahir Ali	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Samar Ragab Abdurreheem	F	1	1	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	15
Samar Yaqoot Muhammed Salih	F	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	0	0	0	1	1	1	19
Samia Ahmed Ibraheem Ahmed	F	1	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	0	1	0	0	0	1	1	1	1	11
Sara Ahmed Essayed Ali	F	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	11
Sara Hassan Muhammed Hussein	F	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Sara Muhammed Ibraheem Hassan	F	1	1	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	22
Shaaban Fayez Mahmoud	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	4
Shadia Abdulfatah Ahmed Abdou	F	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	15
Shaima Ahmed Essayed Ali	F	1	0	0	0	1	0	0	1	1	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	11
Shaima Ghanim Abdussalaam Ghanim	F	1	1	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	16
Shaima Kilani Ahmed Kilani	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
Shaima Mahmoud Bershiway Muhammed	F	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	15
Shaima Muhammed Mahfouz	F	1	1	1	1	1	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	19
Shaima Muhammed Othman Mosa	F	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	9
Shaima Saad Edeen Zaki	F	1	0	0	0	1	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	16
Shaima Saad Ibraheem Ahmed Ali	F	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	12
Shaimaa Essayed Shaaban	F	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	14
Shaimaa Shihata Ahmed	F	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	5
Shereef Khalaf Muhammed Ahmed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	8
Shereen Muhammed Mahmoud Ali	F	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	9
Shihab Ibraheem Ali Ahmed	M	1	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	17
Shorouk Salamah Ibraheem Hassan	F	1	0	0	0	1	0	0	0	1	0	0	0	1	1	1	1	1	1	0	0	0	0	0	1	1	11
Shourouk Magdi Abdulhameed Bassouni	F	0	0	1	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	13
Soha Hassan Mahmoud Hassan	F	1	0	0	0	0	1	0	0	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	15
Soha Mahmoud Essayed	F	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	22
Somayah Farooq Saeed Ibraheem	F	1	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	14
Suliman Hassan Suliman	M	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	13
Talaat Essayed Hassan	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	6
Taqi Hisham Fouad	M	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	23
Wadee Samir Saber	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wafaa Ali Hassan Hassan	F	1	1	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	16
Walaa Magdi Muhammed	F	1	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	1	0	0	0	1	1	1	1	13

Waleed Mohsin Bastawisi	M	1	0	0	0	1	1	0	0	1	1	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1	15
Yaqoub Mahmoud Yaqoub	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	5
Yara Muhammed Mustafa	F	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	12
Yasmeen Muhammed Ali	F	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	0	0	1	0	0	1	10
Yasmeen Muhammed Ali Morsi	F	1	1	1	1	1	0	0	1	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	17
Yasmeen Ramadan Abdullah	F	1	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	0	0	1	1	13
Yasmeen Yousri Abdulfattah Suliman	F	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	17
Yehiya Ragab Ali Higazi	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0	1	0	1	1	9

N	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	292	293
Mn	0.84	0.40	0.28	0.29	0.24	0.24	0.26	0.62	0.83	0.53	0.32	0.12	0.22	0.48	0.81	0.93	0.81	0.85	0.71	0.37	0.33	0.70	0.73	0.81	0.89	13.[illegible]
SD	0.37	0.49	0.45	0.45	0.42	0.42	0.44	0.48	0.38	0.50	0.47	0.33	0.41	0.50	0.40	0.26	0.39	0.36	0.45	0.48	0.47	0.46	0.45	0.39	0.31	5.8[illegible]
Sum		245	117	82	85	69	69	76	183	243	156	95	36	63	140	236	272	237	249	209	107	98	206	213	238	261
p	0.84	0.40	0.28	0.29	0.24	0.24	0.26	0.62	0.83	0.53	0.32	0.12	0.22	0.48	0.81	0.93	0.81	0.85	0.71	0.37	0.33	0.70	0.73	0.81	0.89	
q	0.16	0.60	0.72	0.71	0.76	0.76	0.74	0.38	0.17	0.47	0.68	0.88	0.78	0.52	0.19	0.07	0.19	0.15	0.29	0.63	0.67	0.30	0.27	0.19	0.11	
(p)(q)		0.14	0.24	0.20	0.21	0.18	0.18	0.19	0.23	0.14	0.25	0.22	0.11	0.17	0.25	0.16	0.07	0.15	0.13	0.20	0.23	0.22	0.21	0.20	0.15	0.0[illegible]

Number of participants	294
Number of items	25
Test variance	34.4
Sum of p x q products	0.00

KR-20 **1.042**

Ferguson's Delta
Possible total 25
Possible scores 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Frequencies at each score 5 3 7 5 4 7 9 3 10 14 13 16 24 24 22 17 13 17 15 14 12 9 14 7 4 5
Squares of these 25 9 49 25 16 49 81 9 100 196 169256576 576 484 289 169 289 225 196 144 81 19649 16 25
Sum of squares 4299

Index of discrimination **0.988**

Appendix 7: ADATI Grapheme Discrimination Internal Consistency Statistics

Name	G	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Sum
Aaisha Adel Hussein	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Aala Muhammad Abulhamd	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Aamal Mahmoud Ibraheem	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Abanoub Maher Fawzi	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Abdelmoeti Muhammad Abdelmoeti	M	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	23
Abdulaziz Ali Abdulaziz	M	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	23
Abdullah Ahmed Ahmed	M	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	21
Abdullah Ibraheem Edosooqi	M	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	23
Ahmed Abdullah Azab	M	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	23
Ahmed Adel Abdulmonaeim	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Adel Eed Omar	M	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ahmed Ali Abdulaleem	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Ali Muhammad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Ashraf Abdelhameed	M	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Ahmed Fathi Abdulaziz	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Gaber Sayed Ahmed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Hassan Muhammad	M	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	17
Ahmed Hassan A. Ali	M	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Ahmed Hosam Edeen	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Ibraheem Abdulaziz	M	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Ahmed Ibraheem Essayed	M	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	23
Ahmed Kamal Abouzaid	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Muhammad Suleiman	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Muhammad Abdulsamee	M	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Ahmed Muhammad Ali	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ahmed Muhammad Hafiz	M	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Ahmed Muhammad Khalil	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	23
Ahmed Mustafa Essayed	M	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22
Ahmed Mustafa Muhammad	M	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Ahmed Nasir Essayed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	23
Ahmed Saad Abdelhameed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	24
Ahmed Sami Essayed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	24
Ahmed Yousri Muhammad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Aidi Ashraf Shehata	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Aiya Ahmed Amin	F	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	22
Aiya Ali Hassan	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Aiya Ashraf Ali	F	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24

Aiya Hassan Mahmoud	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	24
Aiya Ibraheem Badr	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Aiya Magdi Mosa	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	24
Aiya Mahmoud Taher	F	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Aiya Muhammad Heeb	F	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	23
Aiya Sami Ramadan	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Aiya Shawqi Sayed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Alaa Adel Saad	M	1	1	0	0	1	1	1	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	20
Ali Abdelmoeti	M	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Aminah Mustafa Ahmed	F	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Amirah Ezzat Mahmoud	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Amirah Anwar Marouf	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	23
Amr Mosa Ahmed	M	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22
Amr Muhammad Abdul	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Amr Ramadan Mahmoud	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Asmaa Abdulbari Muhammad	F	1	0	0	0	0	1	1	0	0	0	0	1	1	1	0	1	1	1	0	1	0	0	0	0	0	10
Asmaa Ahmed Bekheet	F	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
Asmaa Ali Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Asmaa Essayed Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	0	21
Asmaa Hosni Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Asmaa Saad Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Asmaa Salah Faheem	F	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Bahaa Edeen Muslim Kamel	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Basant Ibraheem Darweesh	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	23
Basem Rami Ramadan	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Basma Gamal Abdulghani	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Basma Gamal Abdelhameed	F	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Basma Muhammad Saad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Basma Ramadan Salim	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	23
Bodoor Ezzat Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Dina Adel Nasr	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Dina Hafiz Hafiz	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Dina Zachariah Ali	F	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Dinah Essayed Hafiz	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Doaa Abdulkhaliq Daood	F	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	0	0	0	0	1	1	18
Doaa Bayoumi Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Doaa Maher Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Doha Mustafa Essayed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Donia Muhammad Khalid	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Donia Osama Hassan	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Emad Edeen Kamel	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25

Enji Shreef Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Essam Ali Rifat Ali	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	24
Essam Ibraheem Abdulssattar	M	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	22
Essayed Ali Abdurrahman	M	0	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
Essayed Muhammad	M	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Essayed Mustafa Kamel	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Essayed Rafat Abdelmoeti	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Fadi Wagdi Suleiman	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Fatima Essayed Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Fatima Ibraheem Muhammad	F	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Fawziyah Muhammad Ali	F	1	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	21
Galal Atiyah Essayed	M	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Jihad Yaseen Thabet	F	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	20
Hadeer Ezzat Essayed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Hadeer Gaber Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Hadeer Hamdi Muhammad	F	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Hadeer Hassan Muhammad	F	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	23
Hadeer Ismail Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Hadeer Khamis Ibraheem	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Hadeer Abdulzahir Salim	F	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	23
Hadeer Samir Hassan	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Hadeer Yehiya Abbas	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Hadi Mahmoud Muhammad	M	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Hager Ahmed Salih	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Halah Mahmoud Kamel	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Hamdi Mahmoud Mustafa	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Hamid Muhammad Hamid	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Hanan Talaat Hassan	F	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	22
Hassan Ismail Salama	M	0	1	0	1	0	1	1	1	1	1	1	0	0	0	1	1	1	1	0	0	1	1	0	1	1	16
Hassan Said Gommaa	M	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Haytham Nasser Salim	M	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Hazim Muhammad Khalid	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Heba Abdulmonaeim Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Heba Hassan Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Heba Hifzi Abdulaal	F	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	22
Heba Muhammad Khalifah	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Hind Adel Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	23
Hisham Essayed Badawi	M	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	23
Hosam Edeen Essam Mustafa	M	0	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	21
Hosam Muhammad Omar	M	1	1	1	0	0	1	0	1	0	1	0	0	1	0	1	1	0	1	0	0	0	1	1	0	1	13
Hosam Nabeeh Salim Essayed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25

Hosni Harbi Elbarbari	M	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	1	10
Hosni Muhammad Mahmoud	M	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	23
Hussein Muhammad Hassan	M	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	23
Ibraheem Yasser Ibraheem	M	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Ehab Ali Mahrous	M	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Iman Muhammad Hassan	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Islam Othman Hassan	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Islam Ali Muhammad	M	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Islam Khalid Khamees	M	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	22
Israa Abulmagd Hassan	F	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Israa Ali Salman Salim	F	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Israa Hamdi Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Israa Hassan Essebai	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Israa Muhammad Ibraheem	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Israa Shaaban Muhammad	F	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Jihan Abdulgawad Marouf	F	1	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5
Kamal Shaker Morsi	F	1	1	1	1	0	1	0	1	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	20
Karam Elwatani Abulyousir	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Kareem Adel Muhammad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	24
Kareem Gamal Muhammad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Kareem Hassan Essayed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Kareem Mahmoud Ali	M	1	1	1	1	1	0	0	1	1	1	1	1	0	1	0	1	1	0	1	1	1	1	1	1	1	20
Khamees Hassan Hamza	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Christina Gameel Fikri	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Christina Radi Salama	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Laila Khamees Zohair	F	1	1	0	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Lamiaa Muneer Abusaba	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mahmoud Abdulghani Essayed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mahmoud Atif Fouad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mahmoud Essayed Thabet	M	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Mahmoud Fathi Abdulmajeed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mahmoud Gaber Fareed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mahmoud Hussein Gouda	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mahmoud Ibraheem Mahmoud	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	24
Mahmoud Muhammad Mahmoud	M	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	23
Mahmoud Muhammad Mahmoud	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	24
Mahmoud Muhammad Mahmoud	M	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Mahmoud Shaban Salih	M	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Mai Ahmed Abdulssattar	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Miriam Ibraheem Zaki	F	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Manal Essayed Abdulaziz	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25

Marian Victor Kamel	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Marwa Essayed Khalil	F	0	1	1	0	0	0	1	1	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	1	0	13
Midhat Ramadan Essayed	M	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	23
Mina Nagy Gad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	21
Mirvat Muhammad Abdulmawgood	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Moatz Ibraheem Khamees	M	0	1	0	1	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1	0	1	1	1	18
Moatz Billah Radwan	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Moemin Alaa Abdulaziz	M	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	22
Moemin Mohammed Essayed	M	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Mona Mahmoud Yousri	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mona Saad Zaki Salim	F	0	1	0	1	1	0	1	1	1	1	0	1	1	0	0	1	0	0	1	0	0	0	0	1	1	13
Moatz Billah Qassim	M	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Muhammad Ahmed Hassan	M	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	24
Muhammad Ali Lokman	M	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1	22
Muhammad Dahi Mahmoud	M	0	1	1	1	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	7
Muhammad Essayed Abdulaal	M	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22
Muhammad Essayed Thabet	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	23
Muhammad Gaber Abdelseed	M	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Mohammed Gaber Abdurrahman	M	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Muhammad Gaber Hassanain	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Muhammad Gaber Qutub	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Muhammad Hashim Fathi	M	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	1	1	1	0	0	0	17
Muhammad Hassan Fahmi	M	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	22
Muhammad Hassan Fathi	M	1	0	0	1	1	1	0	0	0	0	0	1	1	1	1	0	0	0	1	0	1	1	0	0	0	11
Muhammad Hussein Hassan	M	0	1	1	0	0	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	19
Muhammad Magdi Fouad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Muhammad Magdi Suleiman	M	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	1	1	1	0	0	19
Muhammad Mahmoud Ahmed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Muhammad Mahmoud Mahmoud	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Muhammad Muhammad Abdulmonaeim	M	1	0	0	1	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	7
Muhammad Muhammad Hussein	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Muhammad Muhammad Mahmoud	M	0	1	1	0	0	0	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	1	1	1	1	15
Muhammad Mungid Abdulkadir	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Muhammad Mustafa Shehata	M	0	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	22
Muhammad Ragab Bakr	M	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Muhammad Sami Muhammad	M	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Muhammad Samir Ramadan	M	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Muhammad Shafeek Muhammad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	24
Muhammad Yousri Ali	M	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	23
Muhammad Zinhom Ahmed	M	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	23
Mustafa Abdulsalam Abdelhameed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25

Mustafa Ahmed Hamid	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mustafa Ashour Ali	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mustafa Essam Mutwali	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Mustafa Fathi Ibraheem	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mustafa Magdi Ahmed	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	24
Mustafa Mahmoud Mustafa	M	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Mustafa Mahmoud Shaaban	M	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Mustafa Muhammad Adam	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Nada Farag Ettohami	F	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Nada Muhammad Salih	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Nada Ramadan Ismail	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	23
Nadia Abdusabour Mansoor	F	1	1	1	1	1	1	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	21
Nadia Ahmed Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	0	1	1	1	21
Nadia Khalifah Ahmed	F	1	1	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	21
Naiema Othman Mosa	F	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	1	0	0	1	1	1	1	1	10
Nasser Ibraheem Abdou	M	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	22
Nayerah Hamid Wahman	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Nema Mahmoud Ali	F	0	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	22
Nema Hamdi Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Nermeen Midhat Abdul	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Nesma Essayed Muhammad	F	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Nesma Muhammad Saad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Nesreen Essayed Riyad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Nidaa Hassan Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Nihal Shendi Ibraheem	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	24
Noha Shreef Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Nora Sobhi Salama	F	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Norhan Mahmoud Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Norhan Muhammad Hanafi	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	23
Nouh Hussein Nour	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Nour Ali Mahmoud	F	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Olla Fouad Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Omniyah Hassanain Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ramadan Muhammad Abdou	M	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Rana Fathi Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Rania Ahmed Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Rania Khamees Hassan	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Rania Muhammad Salah	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Rania Ramadan Mahmoud	F	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Rasha Fed Abdulbaset	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Rawan Mahmoud Saad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25

Reda Khamees Essayed	F	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Riham Hisham Ahmed	F	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Riham Muhammad Zaki	F	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Saad Abdulhaleem Saad	M	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Saad Essayed Saad	M	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Saber Karim Abulhasan	M	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Sabreen Mahmoud Salah	F	0	0	0	1	0	0	1	1	1	0	0	1	1	0	0	1	1	1	0	1	0	0	1	1	1	13
Safaa Ahmed Khalifah	F	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Safaa Muhammad Abdulmagd	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Sahar Muhammad Abdulmawgood	F	0	1	0	1	1	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	10
Sahir Maher Asaad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Samar Ali Ahmed	F	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	1	0	0	0	8
Samar Gamal Ali	F	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1	1	0	7
Samar Nasir Ahmed	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Samar Ragab Abdulreheem	F	0	1	1	0	0	0	1	1	1	1	1	0	0	0	1	1	1	1	0	1	0	0	1	1	1	15
Sara Adel Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Sara Ali Mukhtar	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Sara Hafiz Ahmed Hafiz	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Sara Hamdi Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Sara Mustafa Essayed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Sarah Muhammad Abelaal	F	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	23
Shaaban Fayez Mahmoud	M	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	24
Shaima Essayed Ali	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Shaima Ahmed Kilani	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shaima Mahmoud Bershiway	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Shaima Muhammed Mahfouz	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Shaima Saad Zaki	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Shaimaa Adel Masoud	F	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	22
Shaimaa Ali Khamees	F	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Shereef Khalaf Muhammad	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	24
Shereen Ezzat Abdulaziz	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Shereen Ibraheem Abdulazeem	F	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	23
Shereen Muhammad Mahmoud	F	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Shorouk Salameh Ibraheem	F	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Shourouk Magdi Abdulhameed	F	1	1	1	0	0	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	20
Soha Hassan Mahmoud	F	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Soha Mahmoud Essayed	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Talaat Essayed Hassan	M	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	1	0	0	1	1	1	11
Tariq Farag Abbas	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	24
Tasneem Mahmoud Saad	F	0	0	1	1	0	0	1	1	0	1	0	1	0	0	0	1	1	1	1	1	0	1	1	1	1	15
Wael Ragab Abdulreheem	M	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24

Walaa Magdi Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Waleed Mohsin Bastawisi	M	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Yasmeen Farooq Bateekh	F	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1	1	0	0	0	1	0	0	1	1	17
Yasmeen Mahmoud Muhammad	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Yasmeen Muhammad Ali	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Yasmeen Muhammad Ali	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	23
Yasmeen Yousri Abdul Fattah	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Yasser Ashraf Ali	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	24
Zainab Mustafa Saad	F	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Ziad Ibraheem Hanafi	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Zainab Muhammad Ali	F	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25

N 294 294 294 294 294 294 294 294 294 294 294 294 294 294 294 294 294 294 294 294 294 294
294 294 294 294

Mn 0.85034013 0.942 0.8911 0.914 0.8299 0.884 0.9455 0.952 0.9455 0.945 0.8979 0.833 0.8231 0.904 0.90810.9285 0.904
0.9047 0.911 0.9013 0.918 0.8945 0.921 0.9421 0.93877 22.64

SD 0.36 0.23 0.31 0.28 0.38 0.32 0.23 0.21 0.23 0.23 0.30 0.37 0.38 0.29 0.29 0.26 0.29 0.29 0.28 0.30 0.27 0.31
0.27 0.23 0.24 4.53

Sum 250 277 262 269 244 260 278 280 278 278 264 245 242 266 267 273 266 266 268 265 270
263 271 277 276 6655

p 0.85 0.94 0.89 0.91 0.83 0.88 0.95 0.95 0.95 0.95 0.90 0.83 0.82 0.90 0.91 0.93 0.90 0.90 0.91 0.90 0.92 0.89
0.92 0.94 0.94

q 0.15 0.06 0.11 0.09 0.17 0.12 0.05 0.05 0.05 0.05 0.10 0.17 0.18 0.10 0.09 0.07 0.10 0.10 0.09 0.10 0.08 0.11
0.08 0.06 0.06

(p)(q) 0.13 0.05 0.10 0.08 0.14 0.10 0.05 0.05 0.05 0.05 0.09 0.14 0.15 0.09 0.08 0.07 0.09 0.09 0.08 0.09 0.07
0.09 0.07 0.05 0.06 2.11

Number of participants	294
Number of items	25
Test variance	20.5
Sum of p x q products	2.11
KR-20	**0.935**

Ferguson's Delta

Possible total	25																									
Possible scores	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Frequencies at each score	2	2	0	0	0	1	0	4	1	0	4	2	0	4	0	3	1	3	2	3	5	9	15	40	71	

	122																							
Squares of these	4	4	0	0	0	1	0	16	1	0	16	4	0	16	0	9	1	9	4	9	25	81	225	1600
	5041	14884																						
Sum of squares	21950																							
Index of discrimination	**0.776**																							

Appendix 8: ADATI dyslexic[28] group

	NAME	G	DOB	AGE	PMARS	PMASS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD
1	Abdurrahman Alaa Edeen	M	29-Sep-1993	9.26	21	105	24	8	0	14	26	10	6	5
2	Ahmed Ibraheem Essayed	M	06-Jul-1990	12.49	22	94	23	4	0	9	28	9	2	3
3	Alaa Adel Saad	M	02-May-1992	10.67	23	100	20	6	0	5	29	9	5	7
4	Hisham Fahmi Muhammed	M	01-Sep-1991	11.33	33	116	25	9	1	1	22	6	5	2
5	Mahmoud Sobhi Essayed	M	01-Sep-1993	9.33	23	108	14	2	0	6	24	8	7	8
6	Nadir Galal Muhammed	M	01-Apr-1992	10.75	24	102	25	10	1	11	29	7	7	9
7	Nora Sobhi Michael Salama	F	27-Apr-1993	9.68	32	126	24	9	0	8	18	6	5	5
8	Saber Karim Saber	M	06-Jun-1991	11.57	21	95	24	10	1	5	28	8	6	9
9	Samar Ali Ibraheem Ahmed	F	09-Jan-1993	9.98	29	118	8	0	0	9	15	0	5	7
10	Shaaban Fayez Mahmoud	M	02-Apr-1991	11.75	22	96	24	2	0	4	28	5	3	4
11	Talaat Essayed Hassan	M	13-Feb-1993	9.88	34	130	11	10	1	6	26	10	3	8

[28] Those who scored 0 or 1 in the spelling test, 10 or below in the reading comprehension test and above 20 on the non-verbal reasoning test.

Appendix 9: ADATI control[29] group

	NAME	G	DOB	AGE	PMARS	GD	RD	SP	WSC	RACCU	RCOMP	NWR	PD	BDS	RN
1	Abdulaziz Ali Abdulaziz	M	02-May-1993	9.67	23	23	10	2	13	29	12	7	8	5	65
2	Ahmed Fathi Abdulaziz	M	02-May-1993	9.67	32	25	2	7	23	30	19	9	8	4	57
3	Ahmed Hussein Abduldayem	M	01-Sep-1993	9.33	26	23	5	4	20	30	19	9	9	3	50
4	Ahmed Muhammad Abdrabbou	M	09-Jan-1993	9.98	26	23	10	5	16	29	18	5	9	6	59
5	Ahmed Sameh Taha	M	28-Mar-1992	10.76	25	4	4	10	24	30	25	9	7	5	59
6	Aiya Hassan Mahmoud	F	01-Apr-1992	10.75	24	24	10	4	12	27	16	10	9	7	40
7	Asmaa Ahmed Bekheet	F	30-Sep-1993	9.25	22	19	10	3	13	26	13	7	9	2	70
8	Bassam Abdulhaleem Bekheet	M	02-May-1993	9.67	26	25	1	5	15	29	20	9	9	8	63
9	Dina Essayed Abdullah	F	08-Jan-1993	9.98	26	25	9	5	23	30	22	10	9	5	75
10	Doaa Ibraheem Muhammad	F	01-Sep-1993	9.33	33	25	10	5	2	26	14	10	9	6	63
11	Donia Muhammad Ahmed	F	02-May-1992	10.67	26	25	10	10	19	29	22	10	8	6	59
12	Faten Muhammad Bayoumi	F	01-Apr-1992	10.75	37	25	5	3	2	28	11	10	2	4	35
13	Hadeer Magdi Muhammad	F	02-May-1992	10.67	30	24	3	8	17	29	20	10	9	5	73
14	Hanan Essayed Salama	F	01-Oct-1993	9.25	22	25	9	2	2	28	18	8	9	6	53
15	Hassan Ismail Salama	M	27-Apr-1992	10.68	27	24	6	2	10	29	14	5	6	5	48
16	Islam Muhammad Muhammad	M	27-Sep-1993	9.26	41	25	10	7	19	30	21	10	9	7	61
17	Karimah Muhammad Ali	F	02-May-1993	9.67	28	25	10	3	13	25	15	9	9	4	35
18	Khadiga Ezz Edeen Ibraheem	M	02-May-1992	10.67	34	25	10	9	10	30	23	9	9	6	74
19	Mahmoud Essayed Thabet	M	01-Oct-1993	9.25	23	23	10	5	13	29	11	7	7	6	55
20	Muhammad Ahmed Gommaa	M	18-Feb-1993	9.87	34	24	5	2	19	26	17	9	9	3	58
21	Muhammad Gaber Qutub	M	31-Aug-1993	9.34	22	25	10	4	22	29	21	9	9	2	65
22	Muhammad Hussein Hassan	M	01-Sep-1993	9.33	22	19	10	7	14	29	14	10	9	6	63
23	Muhammad Said Ahmed	M	25-Apr-1993	9.69	32	25	6	7	20	29	19	8	6	5	52
24	Rami Sayed Ahmed Essayed	M	02-Apr-1991	11.75	23	25	10	8	25	29	16	6	6	3	45
25	Rawan Mahmoud Saad	F	25-Sep-1993	9.27	31	25	4	5	16	30	12	10	9	4	60
26	Rawan Nagah Abdulssattar	F	04-Sep-1993	9.33	23	25	10	4	8	30	19	9	6	4	78
27	Sahar Gamal Badr	F	28-Mar-1992	10.76	21	25	5	9	14	30	12	7	8	6	61
28	Salma Hassan Salim	F	02-May-1993	9.67	31	24	10	5	11	30	14	9	9	5	69
29	Yasmeen Muhammad Ali	F	02-Apr-1991	11.75	25	23	9	3	10	27	21	6	7	6	50

[29] Those who closely match the dyslexic group for chronological age, scored 2 or more on the spelling test and who also scored more then 10 on the reading comprehension test

Appendix 10: ADATI Sirs Ellayan Reading Accuracy Test

اختبار سرس الليان في القراءة الصامتة

القسم الأول

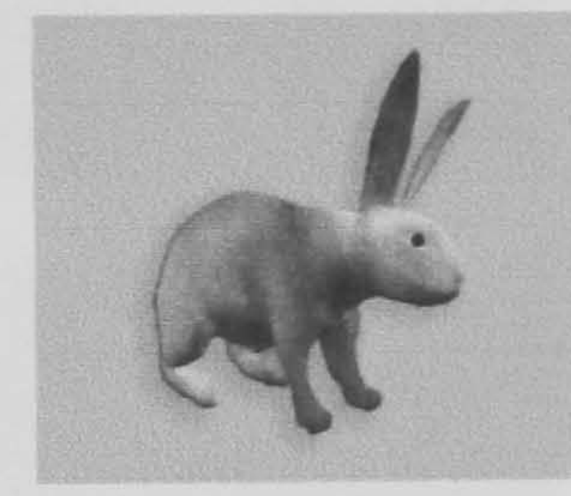
محمود رشدى خاطر

المدرسه :
الصف:
اسم التلميذ:
السن:
التاريخ:

نوع الاختبار	الدرجة
تعرف المفردات	
تعرف الجملة	
فهم الجملة	

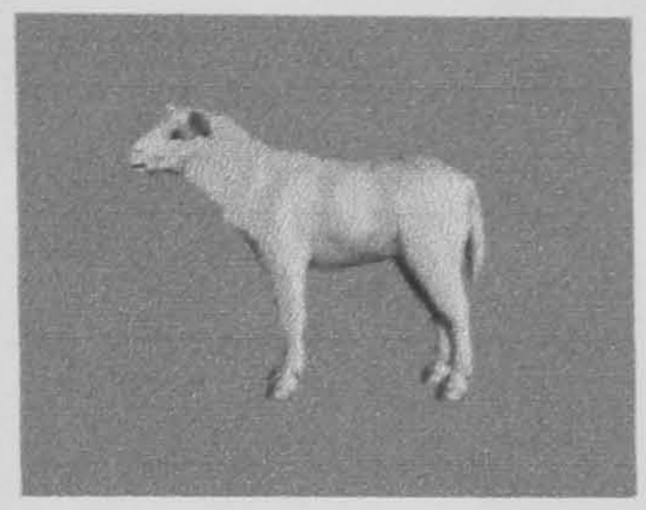
تعرف المفردات

١



ولد أرنب عنب أسد

٢

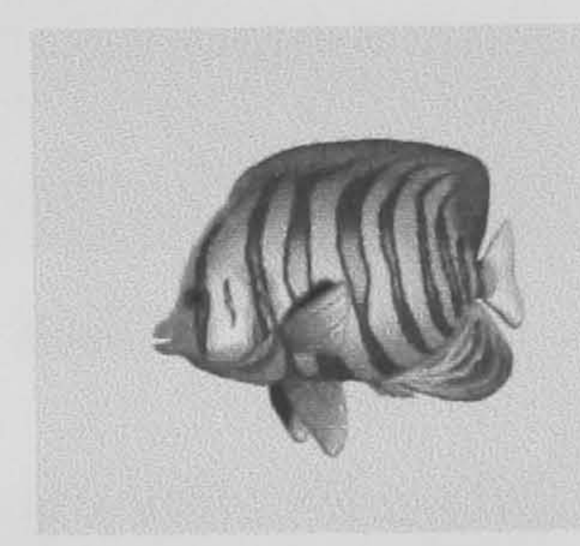


خشب مركب قفص خروف

٣

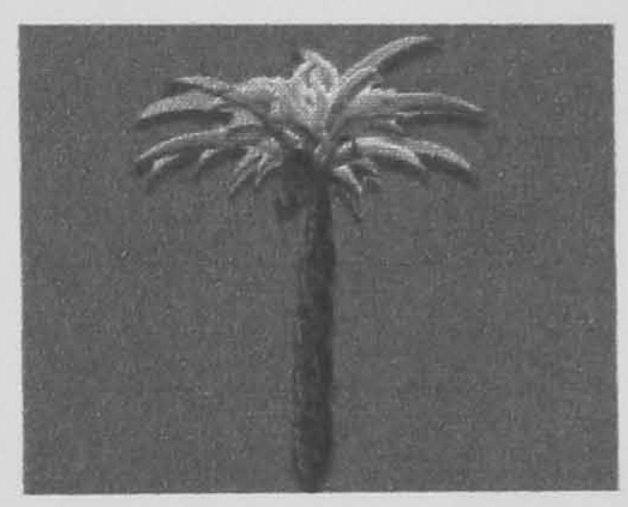
القرش الفول الديك المقص

٥



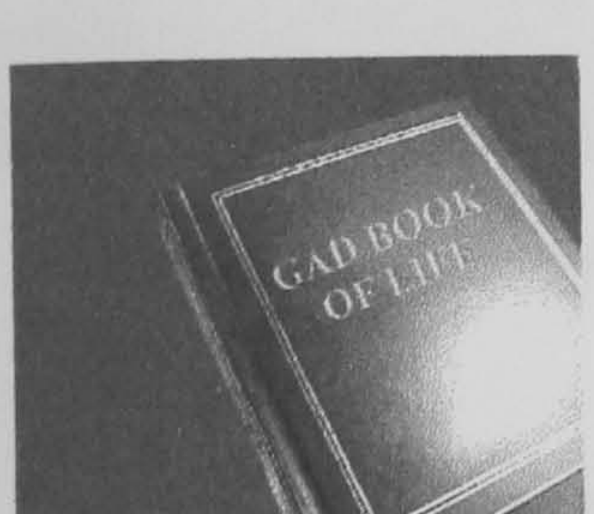
شجرة سمكة حمامة سلسلة

٤



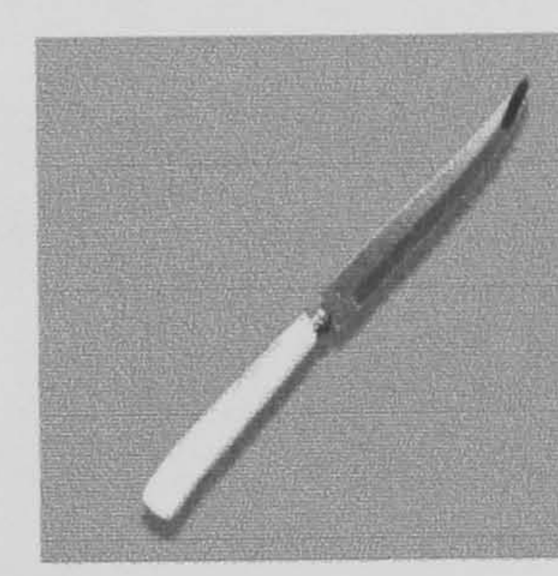
نخلة بقرة ساعة عجلة

٦



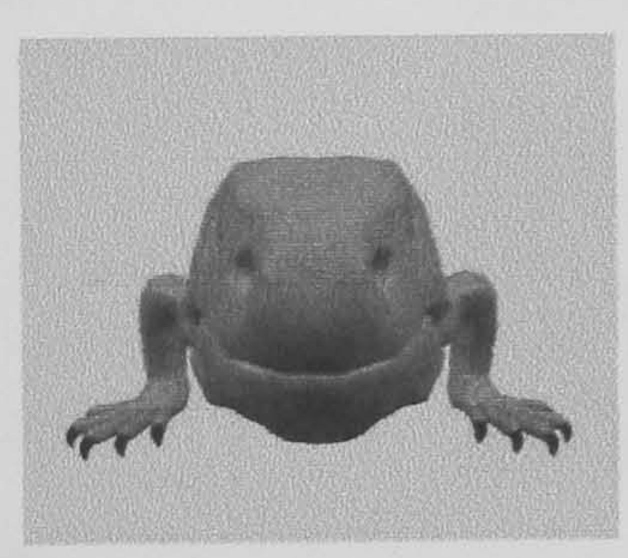
باب حصان قطار كتاب

٧



سكين عسكري قطن فأس

٨



قطة ورقة ضفدعة صفيحة

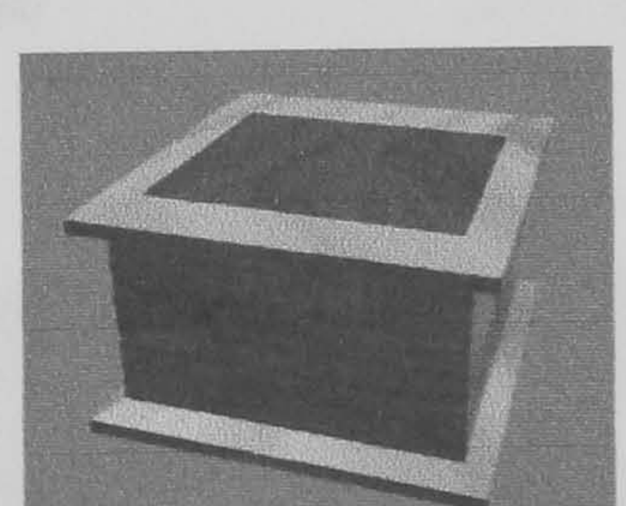
٩

باب حمار غراب مفتاح

١٠

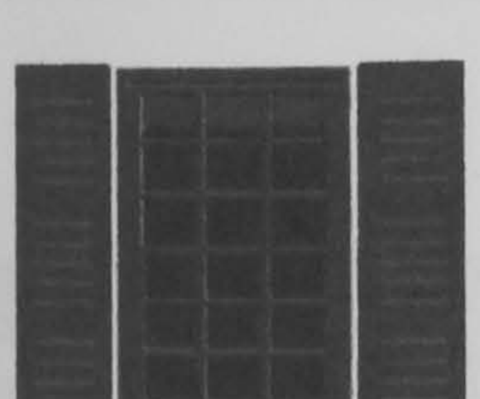
باب بنت عنب لبن

١١



ولد ابريق فانوس صندوق

١٢



بطاطس شاي سلم شب

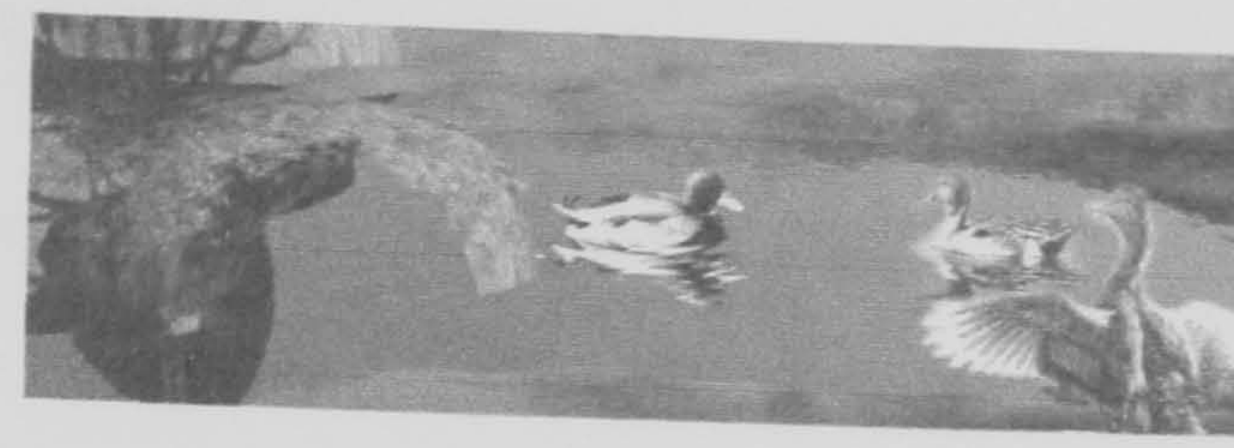
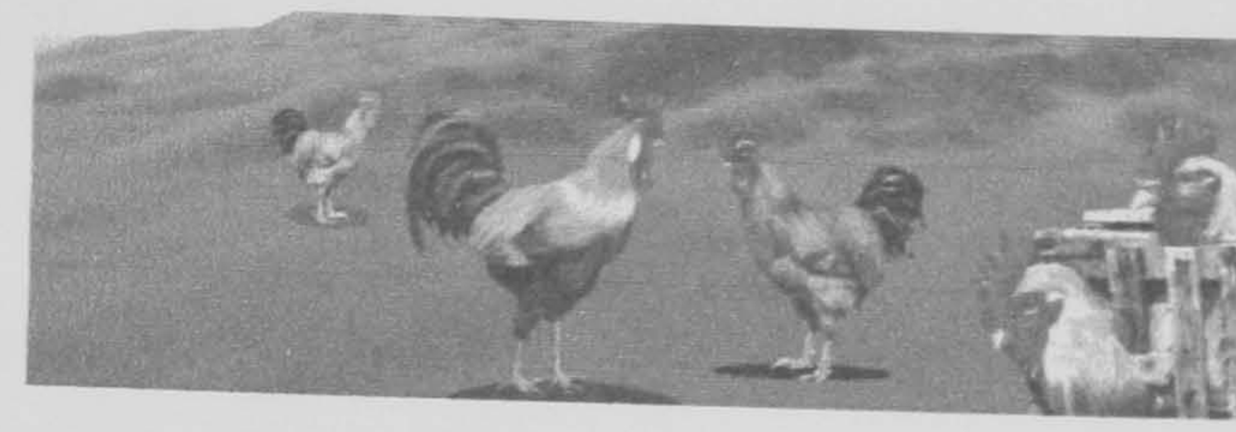
١٣

بندقية حقنة جنينة ورقة

١٤

عصفورة باذنجانة ذبابة برتقالة

تعرف الجملة

ا

ب

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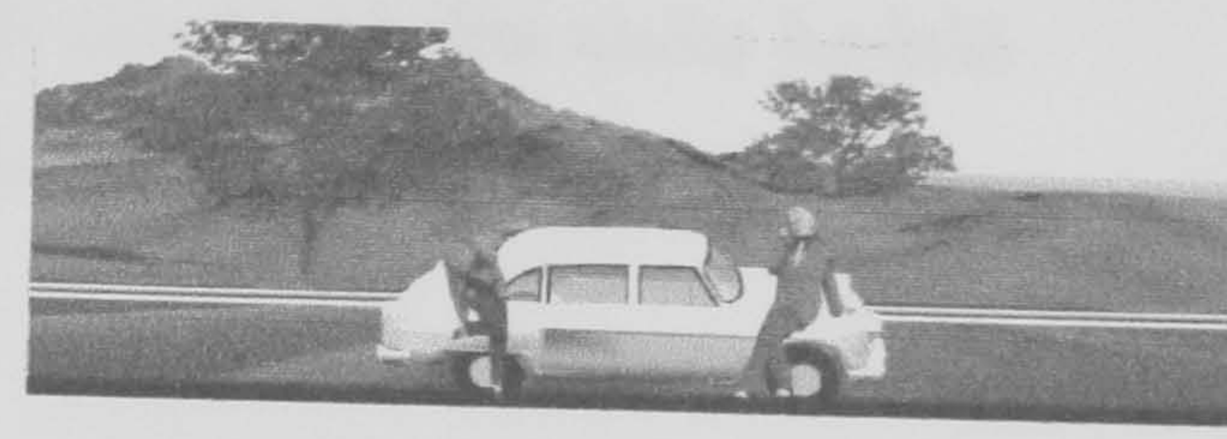


البط فى الماء

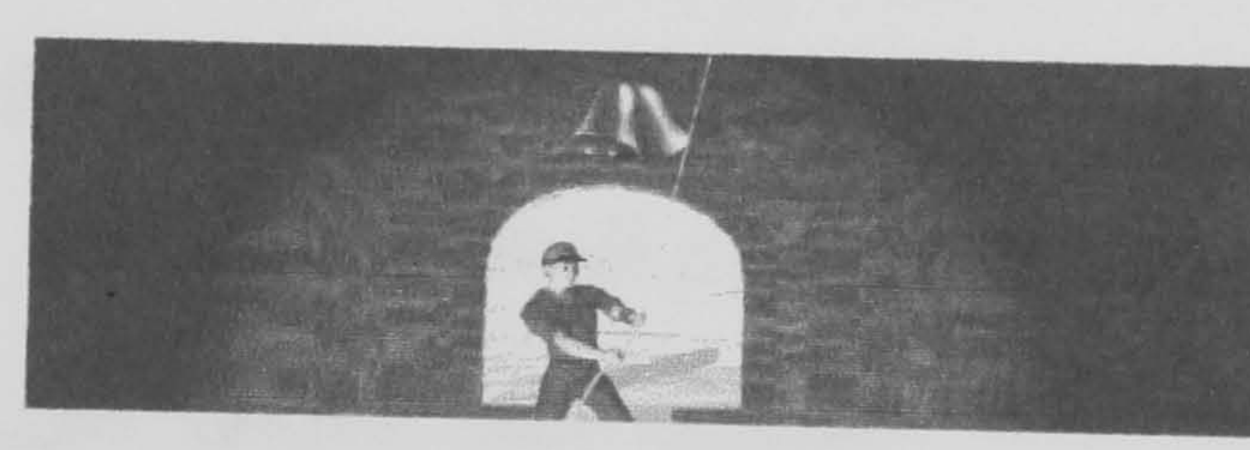
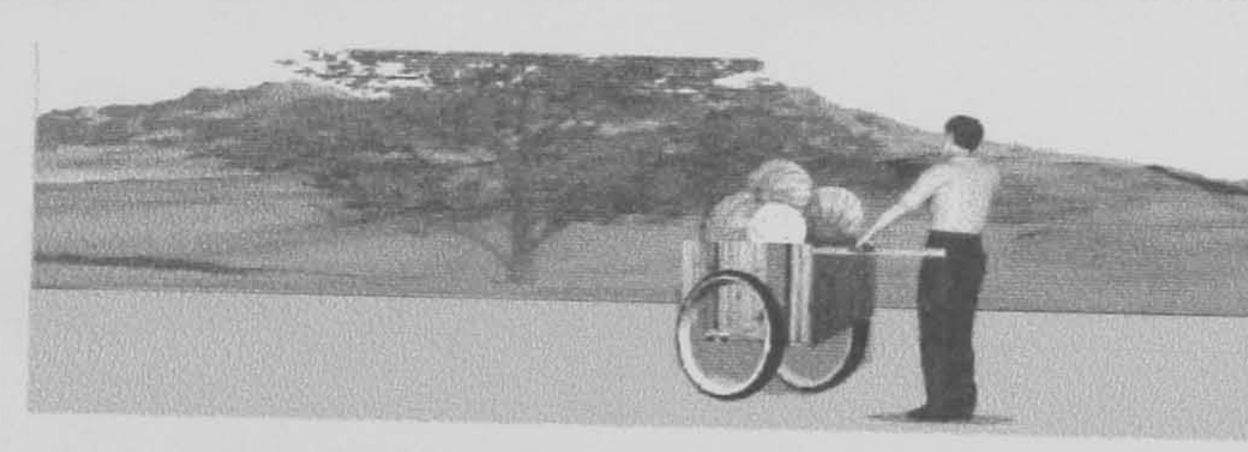
ا

ب

ج

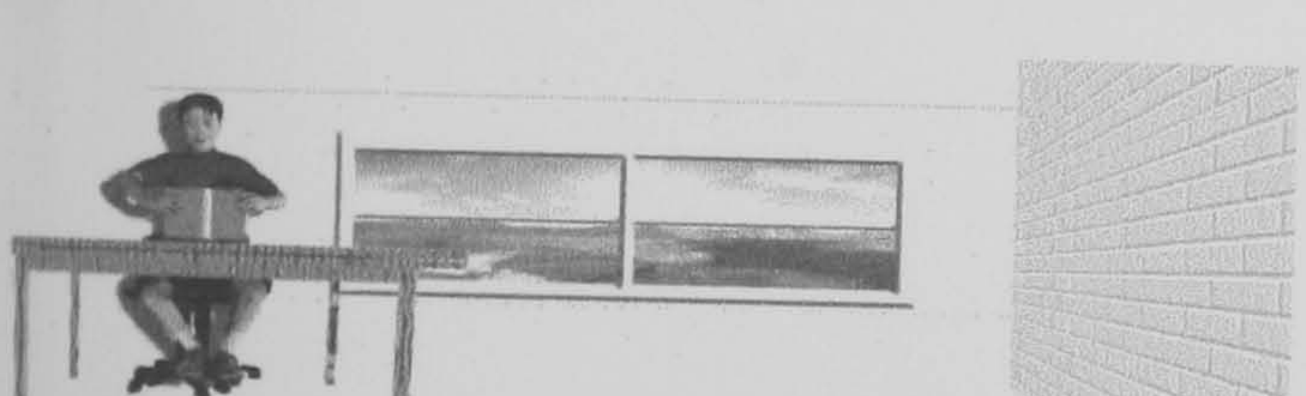

قطفت البنت الورد

ا

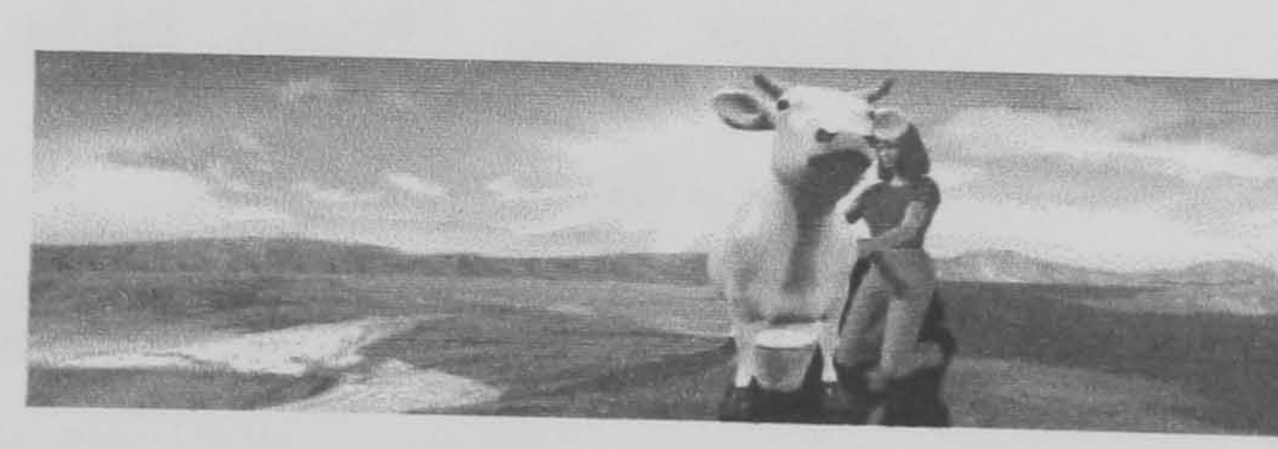
ب

ج


الولد يجري من الكلب

ا

ب

ج

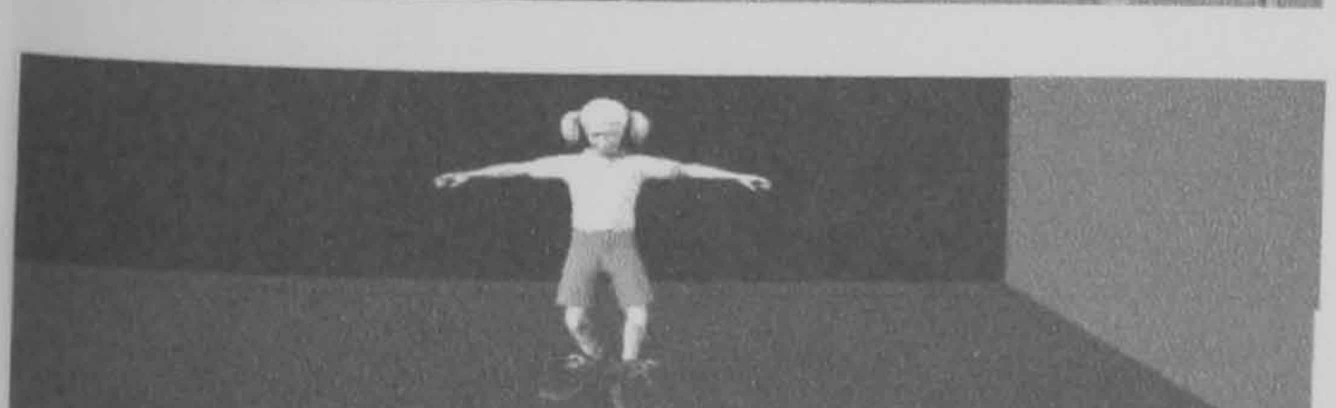

رمى الصياد الشبكة

ا

ب

ج


هذا الرجل وضع العصا على كتفه

ا

ب

ج


الحذاء الذى تلبسه البنت واسع

فهم الجملة

يقرأ التلميذ فى......

القلم   الكتاب   الكلب   الحبل

يزرع الفلاح الشجرة فى...........

الهواء   البحر   السماء   الأرض

أوراق الشجرة لونها..........

أرنب   أكبر   أطول   أخضر

فاطمة بنت نظيفة تغسل شعرها......

بالطين   بالنار   بالصابون   بالخشبة

❶ -الكلب يأكل.........

البرسيم   العظم   القمح   الفأر

❷-الجزار يبيع...........

اللبن   الصابون   اللحم   الورد

❸-يعوم البط فى.. ....

السرير   الماء   الأرض   الزرع

❹ - تمشط البنت شعرها........

بالسكين   بالمقص   بالماء   بالمشط

❺ - يصيد الصياد السمك من.....

السماء   الدار   السوق   البحر

❻ - تغرب الشمس فى آخر.......

الليل   النهار   الصباح   الظهر

❼ - عندنا حديقة واسعة زرعنا فيها........

الأشجار   الطيور   السمك   النحل

❽ - غسل الولد يديه ثم أكل......

الكتاب   الطعام   الحقيبة   القرش

❾ - مرض عبد العزيز فذهب إلى......

المستشفى   المدرسة   الحقل   الترعة

❿ - ذهب الفلاح الى الغيط وكان يحمل على كتفه....

فأرا   بيتا   جملا   فأسا

Appendix 11: ADATI Sirs Ellayan Reading Comprehension Test

اختبار سرس الليان في القراءة الصامتة

القسم الثاني

محمود رشدى خاطر

المدرسة :

الصف:

اسم التلميذ:

السن:

التاريخ:

القسم	نوع الاختبار	الدرجة
الأول	تعرف المفردات	
	تعرف الجملة	
	فهم الجملة	
الثاني	فهم الفقرة	
	المجموع:	

المستوى:

فهم الفقرة

الكلب لونه أسود.

البنت تغسل شعرها.

كانت البنت تلعب مع الكلب في الحديقة. فنطت الكرة وراء السور. و لكن الكلب نط و أحضرها.

ما لون الكلب ؟
- أ أبيض.
- ب أسود.
- ج أحمر.
- د أصفر.

ماذا تغسل البنت ؟
- أ عينيها.
- ب أسنانها.
- ج وجهها.
- د شعرها.

أين كان يلعب الكلب ؟
- أ في المنزل.
- ب وراء السور.
- ج في الحديقة.
- د وراء المدرسة.

بماذا كانت تلعب البنت ؟
- أ بالكلب.
- ب بالسور.
- ج بالحديقة.
- د بالكرة.

الولد يلعب بالكرة.

كسر الولد الزجاجة.

نحن نتغدى في الظهر.

لبس محمد ملابسه الجديدة يوم العيد الكبير.

١ بماذا يلعب الولد ؟
- أ بالقط.
- ب بالفأر.
- ج بالكلب.
- د بالكرة.

٢ ماذا كسر الولد ؟
- أ الزجاجة.
- ب الدجاجة
- ج القلة.
- د الابريق.

٣ ماذا نعمل في الظهر؟
- أ نتعشى.
- ب نتغدى.
- ج نفطر.
- د ننام.

٤ متى لبس محمد ملابسه الجديدة ؟
- أ يوم الجمعة الماضي
- ب يوم شم النسيم.
- ج يوم العيد الكبير.
- د يوم العيد الصغير.

أحمد له أخت تذهب معه كل يوم الى المدرسة.

الفلاحة تحلب البقرة، و تأخذ اللبن لتعمل منه الزبد و الجبن.

وقف القط على باب الشق ينتظر الفأر. و لكن الفأر عرف أن القط ينتظر فلم يخرج.

أراد الفلاح أن يشتري فأسا جديدة. فذهب الى دكان الحداد. و بعد أن أشترى الفأس رجع الى بلده.

٥ من يذهب مع أحمد الى المدرسة ؟
- أ أخوه.
- ب أخته.
- ج أبوه.
- د زميله

٦ من أي شيء تعمل الفلاحة الزبد ؟
- أ البيض.
- ب الجبن.
- ج البرسيم.
- د اللبن.

٧ أين وقف القط ؟
- أ على باب الشق.
- ب على باب المدرسة
- ج على باب النجار.
- د على باب الغيط.

٨ لماذا ذهب الفلاح الى دكان الحداد ؟
- أ ليسلم على الحداد.
- ب ليكتب جوابا.
- ج ليشتري فأسا.
- د ليشتري قطنا

ثريا طفلة صغيرة تقوم كل يوم من النوم مبكرة. فتغسل وجهها و يديها و تفطر ثم تحمل حقيبتها و تذهب الى المدرسة

٩ ماذا تفعل ثريا قبل أن تفطر ؟

أ تغسل وجهها و يديها.
ب. تفتح كتبها و تقرأ فيها
ج تلعب مع أخيها الصغير
د تحمل حقيبتها و تمشي.

١٠ أين تذهب ثريا بعد أن تحمل حقيبتها ؟

أ الى السوق
ب الى المنزل
ج الى الحقل
د الى المدرسة

طلب حامد من أبيه أن يشتري له طبلا صغيرا. فقال الأب: و لكني أخاف أن تزعجني بصوته. فقال له الأبن: لا تخف يا أبي، فلن أضربه إلا و أنت نائم.

١١ ماذا طلب حامد من أبيه ؟

أ أن يشتري له كتابا.
ب أن يشتري له بدلة.
ج أن يشتري له طبلا.
د أن يشتري له حذاء.

١٢ لماذا أراد حامد أن يضرب الطبل و أبوه نائم ؟

أ لكي يوقظ أباه من النوم.
ب لكي لا يسمع أبوه صوت الطبل.
ج لكي يملأ البيت بصوت الطبل.
د لكي يضحك على أبيه.

ديكا ظريف ، أحمر لطيف ، يقوم نشيطا مبكرا في الصباح. ويصيح كوكو كوكو. فيقوم الناس من نومهم ، و يذهبون الى اعمالهم ، انا أحبه لأنه نشيط.

١٣ ماذا يفعل الناس عندما يصيح الديك؟

أ يستريحون من عملهم.
ب ينامون في بيوتهم.
ج يقومون من نومهم.
د يذهبون الى دورهم.

سعاد كانت تربي أرنبا جميلا ، لونه أبيض ، و شعره ناعم و له يدان قصيرتان و رجلان طويلتان. و كان اذا سمع صوتا يجري بسرعة و يختفي في جحره

١٤ لماذا كان الأرنب يجري اذا سمع صوتا ؟

أ لأنه كان يخاف من الجحر.
ب. لأنه كان يخاف من الصوت.
ج لأنه كان يحب الجري.
د لأنه كان يحب الجحر.

كان لحداد كلب أسود. و كان من عادته أن يرقد ما دام الحداد عاملا فاذا انتهى العمل و قعد ليأكل استيقظ الكلب. فقال الحداد: هذا الكلب عجيب ! ينام على صوت المطارق و يستيقظ على صوت المضغ.

١٥ ماذا اعتاد الكلب أن يفعل ؟

أ أن ينام حينما يشتغل الحداد.
ب. أن ينام حينما يأكل الحداد.
ج أن يلعب حينما يشتغل الحداد.
د أن يلعب حينما يأكل الحداد.

١٦ ما الذي كان يوقظ الكلب ؟

أ الحداد.
ب. المطارق.
ج المضغ.
د الجوع.

كان لأم بنتان. أدخلت الكبيرة منهما في المدرسة. و بقيت الصغيرة في البيت. فتضايقت من وحدتها. و في يوم من الأيام قالت البنت الصغيرة لأمها: متى أذهب الى المدرسة يا أمي ؟ فقالت الأم : حينما تصبحين كبيرة. فقالت البنت: ألبسيني ثياب أختي فأصبح كبيرة.

١٧ أين كانت البنت الصغيرة تقضي وقتها ؟

أ في الحقل.
ب .في المنزل.
ج في المدرسة.
د في الشارع.

١٨ لماذا تضايقت البنت الصغيرة ؟

أ لأنها كانت في البيت وحدها.
ب لأنها كانت تذهب الى المدرسة.
ج لأنها كانت تحب أختها الصغيرة.
د لأنها كانت تحب الملابس الكبيرة.

١٩ متى تذهب البنت الص الى المدرسة ؟

أ حينما تلبس ثياب أختها
ب حينما تسكن قريبا من الم
ج حينما تصبح سنها كبير
د حينما تقرأ في الكتاب.

دخل لص دار رجل فقير ، و أخذ يبحث فيها عن شيء يسرقه. و كان صاحب الدار مستيقظا. فسمع اللص و هو يبحث في الدار و لا يجد شيئا. ضحك الفقير بأعلى صوته و قال للص: أيها المسكين اني أبحث في ضوء النهار الساطع فلا أجد شيئا. فماذا يمكن أن تجد أنت في ظلام الليل ؟ فخجل اللص و أنصرف.

٣٠ أين دخل اللص ؟

أ دكان تاجر كبير.
ب دكان تاجر مسكين.
ج دار رجل غني.
د دار رجل فقير.

٣١ لماذا ضحك صاحب الدار ؟

أ لأن اللص لم يجد ما يسرقه.
ب لأن اللص كان يبحث عنه.
ج لأن اللص هرب منه.
د لأن اللص خاف من ضوء النهار.

٣٢ كيف انصرف اللص ؟

أ فرحان.
ب غاضبا.
ج حزينا.
د خجلان.

اشترى أب لابنه فأسا صغيرا يلعب بها. فحملها و نزل الى الحديقة ، و قطع شجرة توت كان أبوه قد زرعها منذ أيام. و بعد يومين نزل الوالد الى الحديقة كعادته. فوجد الشجرة مقطوعة ، فحزن كثيرا ، و نادى ابنه و سأله: من الذي قطع الشجرة يا بني ؟ فقال الولد: أنا الذي قطعتها يا أبي ، واني آسف جدا. فعاتبه أبوه ، ثم صفح عنه.

٣٣ لماذا قطع الولد الشجرة ؟

أ لأنه أراد أن يزرع شجرة أخرى.
ب لأنه أراد أن يلعب بالفأس.
ج لأن أباه أمره أن يقطعها.
د لأن الشجرة كانت قد ماتت.

٣٤ لماذا صفح الأب عن ابنه ؟

أ لأنه هو الذي أشترى الفأس.
ب لأنه لا يريد الشجرة في الحديقة.
ج لأن ابنه لم يكذب عليه.
د لأن أمه طلبت منه ذلك.

وقف خادم على باب دكان ليشتري سمكا ، و كان ازدحام الناس شديدا ، فلم يلتفت اليه البائع و لما طال انتظاره أخذ السمكة و قربها من أنفه و كأنه يشمها. فاغتاظ البائع و قال له: أترك السمك ان لم يعجبك ، و رزقي على الله. فقال الخادم: انني لا أشم السمكة و لكنني كنت أسالها عن أخي الذي غرق في البحر منذ ثلاثة أيام. فقال البائع: و بماذا أجابت ؟ قال: انها لا تعرف عنه شيئا لأنها خرجت من البحر منذ ثلاثة أسابيع.

٣٥ لماذا وقف الخادم عند الدكان طويلا ؟

أ لأن السمك كان كثيرا.
ب لأن البائع كان مغتاظا.
ج لأن الازدحام كان شديدا.
د لأن الدكان كان بعيدا.

٣٦ ماذا فعل الخادم بالسمكة ؟

أ سألها عن أخيه.
ب شم رائحتها.
ج استمع الى كلامها.
د نظر الى ذيلها.

Appendix 12: ADATI Spelling Test

اختبار الإملاء

الاسم :

السن :

تاريخ اليوم :

المدرسة :

الفتاة الأمينة

بقينا نترقب القصة التي وعدنا بها جدي حتى أقبل علينا ذات يوم وجمعنا حوله وقال:

إليكم أيها الأبناء القصة التي وعدتكم بها فاسمعوا، لقد عرفتم أن أمير المؤمنين عمر بن الخطاب خليفة عادل يسهر على راحة الناس.

خرج ذات ليلة يطوف بالمدينة فسمع امرأة تقول لابنتها: قومي فاخلطي اللبن الذي نبيعه بالماء، فقالت البنت: (لقد نهانا الخليفة أن نخلط اللبن بالماء يا أمي)..

قالت الأم : (اخلطي اللبن بالماء، فان عمر لا يرانا الآن)..

فقالت الفتاة: (يا أماه، ان كان عمر لا يرانا فإن الله يرانا).

فسمعها عمر وأعجب بقولها وبإيمانها وأمانتها، واختارها زوجة لابنه عاصم وأصبحت هذه الفتاة الأمينة في بيت أمير المؤمنين زوجة عزيزة لابنه ثم جدة للخليفة الصالح عمر بن عبد العزيز.

Appendix 13: ADATI Non-word Reading Test

إختبار قراءة الكلمات التي ليس لها معنى

الإسم :

السن :

تاريخ اليوم :

المدرسة :

إجراءات الاختبار

يهدف هذا الاختبار إلى معرفة قدرة التلميذ على قراءة الكلمات التي ليس لها معني والتي تُعد مؤشراً جيدا للعسر القرائي. يَطلب الممتحن من التلميذ أن يَقرأ مجموعة من الكلمات (عشر كلمات) ليست لها معنى ويقوم الممتحن بتدوين عدد الأخطاء التي إرتكبها التلميذ. على الممتحن أن يُوضح للتلميذ أن هذه الكلمات ليست لها معنى وأنَ المطلوب من التلميذ هو أن يقرأها فقط وليس المطلوب منه أن يصححها.

الإختبار

الكلمات التي يطلب من التلميذ قراءتها هي:

1. ضحبوب
2. مكشب
3. دشكين
4. غدبين
5. تصاقم
6. ضبوش
7. ملاغس
8. خجوط
9. طبيق
10. أكخف

Appendix 14: ADATI Rhyme Detection Test

إِختبار إدراكُ التشابه والإختلاف بين أواخرِ الكلمات

الإسم :

السن :

تاريخ اليوم :

المدرسة :

إجراءات الاختبار

قم بإستخدام ورقة الإجابة الخاصة بإختبار إدراك التشابه والإختلاف بين أواخر الكلمات. الغرض من هذا الاختبار هو قِياس قُدرة التلميذ على إدراك التشابه والإختلاف بين أواخر الكلمات. يتكون هذا الاختبار من عشرة مجموعات من الكلمات: تحتوي كل مجموعة منها على خمس كلمات، أربعة منها تتشابه نهاياتها والكلمة الخامسة تختلف عن الباقين. المطلوب من التلميذ هو وضع دائرة حول الكلمة التي تختلف عن الباقين. على الممتحن أن يَقرأ كُل مجموعة من الكلمات بصوتٍ واضحٍ مسموع، ثم يَطلب من التلميذ أن يضع دائرة حول الكلمة المختلفة.

التمرين على الاختبار

تأكد من أن التلميذ قد فَهم المطلوب منه بالضبط. إستعمل مجموعة الكلمات التالية كمثال:

تاب	تليفزيون	شاب	جاب	باب

الإختبار

بعد الإنتهاء من التمرين على الاختبار والتأكد من أنَ التلميذ قد فَهِم المطلوب منه بالضبط، إبدأ في قراءة مجموعات الكلمات الموجودة في الاختبار. إقرأ الكلمات بصورةٍ واضحةٍ مسموعة.

1. مفتاح	كفاح	نجاح	صلاح	ضابط
2. كريم	عامل	شامل	كامل	خامل
3. عصفور	باب	صنبور	مشكور	مفتور
4. وليد	نشيد	شهيد	دولاب	مجيد
5. شباب	كتاب	محمد	ضباب	أصحاب
6. فارس	دارس	حارس	طالب	مارس
7. شنطة	كلب	قطة	بطة	محطة
8. شادي	وطن	هادي	فؤادي	بلادي
9. فؤاد	عباد	محسن	بلاد	ميلاد
10. حصير	سرير	فقير	علي	عبير

Appendix 15: ADATI Phoneme Deletion Test

إختبار القدرة اللغوية على حذف الأصوات وإعادة نطق الكلمة

الإسم :

السن :

تاريخ اليوم :

المدرسة :

يهدف هذا الإختبار إلى قياس قدرة الطالب على حذف الأصوات المكونة للكلمة (سواء في أول أو وسط أو آخر الكلمة) وإعادة نطقها بعد حذف الصوت المطلوب.

إجراءات الاختبار

قُم بقراءة مجموعة الكلمات المكونة لهذا لإختبار ثم إنطق كل كلمة للطالب وأطلب منه أن يَحذف صوت ما (حسب ما هو مطلوب في الإختبار) وأن يعيد نطق الكلمة بعد حذف الصوت المطلوب.

التمرين على الاختبار

تأكد من أن التلميذ يَسمعُك جيداً. حاول التدريب على الإختبار في ثلاث محاولات وتأكد من أن الطالب يعرف جيدا المطلوب منه.

1. شباك.................................انطق الكلمة مرة أخرى بدون (ش)
2. سمكة.................................انطق الكلمة مرة أخرى بدون (ة)
3. خاب.................................انطق الكلمة مرة أخرى بدون (ا)

الإختبار

إبدأ الاختبار بعد الإنتهاء من التمرين على الإختبار. لا تقل إذا كان الطالب صح أم خطأ. قم بتسجيل عدد مرات الأخطاء على كراسة التسجيل.

1. ضباب.................................انطق الكلمة مرة أخرى بدون (ض)
2. شباب.................................انطق الكلمة مرة أخرى بدون (ش)
3. شاب.................................انطق الكلمة مرة أخرى بدون (ش)
4. بحر.................................انطق الكلمة مرة أخرى بدون (ح)
5. بشر.................................انطق الكلمة مرة أخرى بدون ش)
6. فحل.................................انطق الكلمة مرة أخرى بدون (ح)
7. بيتي.................................انطق الكلمة مرة أخرى بدون (ي) الأخيرة
8. شجرة.................................انطق الكلمة مرة أخرى بدون (ة)
9. قطط.................................انطق الكلمة مرة أخرى بدون (ط) الأخيرة

Appendix 16: ADATI Backward Digit Span Test

إختبار تذكر الأرقام بطريقة عكسية

الإسم :

السن :

تاريخ اليوم :

المدرسة :

يهدف هذا الإختبار إلى إيجاد عدد الأرقام التي يتذكرها الطالب بطريقة عكسية بصورة صحيحة.

إجراءات الاختبار

قم بقراءة الأرقام بمعدل رقم لكل ثانية وإنتظر قليلا بعد كل محاولة. يجب على الطالب أن ينتظر حتى ينتهي الممتحن من الانتهاء من كل محاولة ثم عليه أن ينطق بالأرقام بطريقة عكسية.

التمرين على الاختبار

تأكد من أن التلميذ يسمعك جيدا وأنه يعرف جيدا المطلوب منه. حاول التدريب على الإختبار في ثلاث محاولات.

الإختبار

إبدأ الإختبار بعد الإنتهاء من التمرينات. لا تقل إذا أصاب الطالب أم أخطأ. قم بتسجيل عدد مرات الأخطاء في كراسة التسجيل. وقم بتوقف الإختبار إذا إرتكب الطالب خطأين متتالين في تذكر الأرقام.

حساب درجات الإختبار

الأرقام المستخدمة للتدريب هي:	9 2	الإجابة الصحيحة للطالب هي	2 9
	4 3 1	الإجابة الصحيحة للطالب هي	1 3 4
	7 6 5 1	الإجابة الصحيحة للطالب هي	1 5 6 7

الأرقام المستخدمة في الاختبار هي

2 4	الإجابة الصحيحة هي	4 2
6 9	الإجابة الصحيحة هي	9 6
8 3 5	الإجابة الصحيحة هي	5 3 8
1 7 6	الإجابة الصحيحة هي	6 7 1
6 9 3 4	الإجابة الصحيحة هي	4 3 9 6
3 8 1 7	الإجابة الصحيحة هي	7 1 8 3
4 1 6 2 3	الإجابة الصحيحة هي	3 2 6 1 4
2 7 4 6 8	الإجابة الصحيحة هي	8 6 4 7 2
8 7 1 5 6 9	الإجابة الصحيحة هي	9 6 5 1 7 8
4 1 5 2 7 8	الإجابة الصحيحة هي	8 7 2 5 1 4

Appendix 17: ADATI Rapid Naming Test

إختبار التسمية السريعة للأشياء

الإسم :

السن :

تاريخ اليوم :

المدرسة :

إجراءات الاختبار

قم بإستخدام الورقة الموجود بها مجموعة من الصور. تحتوي هذه الورقة على مجموعة من الصور (20 صورة) معادة مرتين. أسماء هذه الصور هي: سرير، شجرة، طائر، سفينة، يد، أوتوبيس، سمكة، قطة، فنجان، فأر، كلب، بنت، ورقة شجر، كتاب، ضفدع، قبعة، كرة، حصان، مائدة، حلويات. إقرأ هذه الصور للتلميذ بسرعة مشيرا إلى كل صورة وأنت تنطقها.

التمرين على الإختبار

تأكد من أن التلميذ قد فهم أن عليه أن يسمي الصور بالترتيب. قم بتثبيت إصبعك على الصورة الأولى ثم حرك إصبعك تدريجيا مع كل صورة ينطقها التلميذ حتى تصل إلى آخر كلمة في النصف العلوي. إذا إرتكب التلميذ خطأ أو تردد في الإجابة لثوان، قم بتصحيح الخطأ.

الإختبار

عندما ينتهي الطفل من التدريب قل: الآن ، أريدك أن تحاول تسمية هذه الصور بأقصى سرعة ممكنة. إبدأ من هنا (أول صورة) واستمر حتى نهاية الصفحة. إذا أردت، يمكنك إستخدام إصبعك ليساعدك ويذكرك أين توقفت.

إبدأ العد التنازلي عندما يبدأ التلميذ بتسمية الصور وتوقف عندما ينهي التلميذ الصفحة كاملاً (كلا الجزءين العلوي والسفلي). إذا فقد التلميذ مكانه وم يعرف أين توقف، صحِّح بالإشارة إلى المكان الذي توقف عنده التلميذ. لا تُنهي العد التنازلي بأي حال من الأحوال. قم بتسجيل جميع الأخطاء التي يقوم بها التلميذ. إذا قامَ التلميذ بتسمية الصور بكلمات أخرى محتملة (مثل مركب بدلا من سفينة ، أو كوب بدلا من فنجان) لا تحتسب هذا خطأ.

إنهاء الاختبار

لا تُنهي الإختبار بأي حالٍ من الأحوال. إذا توقف التلميذ عند صورة ما و لم يعرف تسميتها، إنطق الصورة للتلميذ بعد خمس ثوان.

حساب درجات الاختبار

أضف 5 ثوان لكل خطأ يقوم به التلميذ. قم بتسجيل الوقت (بالثواني) وعدد الأخطاء التي ارتكبها التلميذ. إذا قام التلميذ بتسمية صورة ولكن باستخدام أسم آخر غير المذكور عاليه (مركب بدلا من سفينة مثلا)، لا تحتسبها خطأ.

Appendix 18: ADATI Grapheme Discrimination Test

إختبار التمييز بين الحروف العربية بالشكل

الإسم :

السن :

تاريخ اليوم :

المدرسة :

أمامك خمسة وعشرون زوجا من الكلمات بعضها مختلف. المطلوب منك التعرف على الأزواج المتشابهة من المختلفة وبيان ذلك مقابل كل زوج:

مثال

حبل - حبل

مثل - مثل

الرقم	الكلمة الأولى	الكلمة الثانية	متشابه	مختلف
1	زجاجة	دجاجة		
2	حقول	حقول		
3	قطن	قطن		
4	شجرة	بقرة		
5	تفاحة	فتاحة		
6	عصفور	صنبور		
7	ورد	ورد		
8	سالم	سالم		
9	جمل	جمل		
10	ضياء	ضياء		
11	مذياع	مذياع		
12	تليفون	تليفزيون		
13	ألعاب	أتعاب		
14	هلال	ظلال		
15	فل	كل		
16	مدن	مدن		
17	أظافر	أظافر		
18	معارك	معارك		
19	أنهار	أنهار		
20	فصول	فصول		
21	طيور	نسور		
22	هدية	ندية		
23	نوادي	نوادي		
24	زواحف	زواحف		
25	روائع	روائع		

Appendix 19: ADATI Word & Sentence Chain Test

إختبار التعرف على سلسة الكلمات والجمل

الإسم :

السن :

تاريخ اليوم :

المدرسة :

إختبار التعرف على سلسة الكلمات و الجمل

أ. أنظر إلى مجموعة الحروف الآتية و حاول أن تقسم هذه الحروف إلى كلمات مفيدة ذات معنى واضح.
ضع علامة (/) لتفصل الكلمات المفيدة بعد نهاية كل كلمة مفيدة كما في المثال:
المثال: حبالهلالقليلجميلمدينةسفينة

الحل: حبال / هلال / قليل / جميل / مدينة / سفينة

والآن: إفصل الكمات المفيدة التالية بإستخدام
العلامة (/) كما موضح في المثال أعلاه:

كتابخطابشابسرابغريبضبابيطةقطةقلمعلمتلحبلجملمدرسة

ب. أنظر إلى مجموعة الكلمات الآتية وحاول أن تقسم هذه الكلمات إلى جملة مفيدة ذات معنى
ضع علامة (/) لتفصل الكلمات الآتية إلى جملة مفيدة كما في المثال

المثال: يذهبمحمدإلىمدرستهكليومسيراعلىالأقدام

الحل: يذهب/محمد/إلى/مدرسته/كل/يوم/سيرا/على/الأقدام

والآن: إفصل الكلمات الآتية إلى جملة مفيدة بإستخدام العلامة (/) كما هو موضح في المثال أعلاه:

محمودوصالحومنىطلابمجتهدونفيمدرسةالنجاحالقوميةالمشتركة