A TYPEFACE FOR THE ADULT DYSLEXIC READER

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A TYPEFACE FOR THE ADULT DYSLEXIC READER

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Typographic specification

This thesis has been set in Times New Roman using Microsoft Office Word software.

Headline A:	24 pt Times New Roman bold. Upper and lowercase.
Headline B:	18 pt Times New Roman bold. Upper and lowercase.
Headline C:	14 pt Times New Roman bold. Upper and lowercase.
Headline D:	12 pt Times New Roman bold. Upper and lowercase.
Headline C:	10 pt Times New Roman bold. Upper and lowercase.
Main text:	10/15 pt Times New Roman. Upper and lowercase. Ranged left. Unjustified over a measure of 120 mm and 140 mm.
Captions:	7 pt Helvetica medium italics. Upper and lowercase. Centred.
Footers:	8 pt Times New Roman. Upper and lowercase.
Folios:	10 pt Times New Roman.
Dedication:	18pt Sylexiad Serif Thin. Upper and lowercase.
Chapter 19:	12/16 pt Serif Sylexiad. Upper and lowercase. Ranged left. Unjustified over a measure of 154 mm.

CD Rom

Anastacia Tohill constructed the CD Rom. The CD Rom was made in Director and can be accessed using the following system requirements:
PC Windows XP and Mac 0SX.

ANGLIA RUSKIN UNIVERSITY
ABSTRACT

FACULTY OF ARTS, LAW AND SOCIAL SCIENCE

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A TYPEFACE FOR THE ADULT DYSLEXIC READER

By ROBERT ALAN HILLIER

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The investigation concerns a series of typeface legibility and readability studies which have resulted in the creation of a number of new typefaces including Sylexiad. Sylexiad is grounded and informed from a dyslexic viewpoint and is a typeface for the adult dyslexic reader.

Sylexiad was developed by means of comparative typeface testing. This involved a series of formative and summative small-scale tests which accommodated two established word recognition models – word shape and parallel letter recognition. This novel method of measuring legibility and readability is called developmental typeface testing. The data was gathered by means of qualitative and quantitative techniques from dyslexic and non-dyslexic groups based at Norwich School of Art and Design and The University of East Anglia. These techniques included questionnaires, interviews and observations. The research was inductive and practice-based in approach.

The findings identify which typographic characteristics adult dyslexic and non-dyslexic readers preferred and why. For the majority of non-dyslexic readers tested it was the combination of serif-style, lowercase forms, large x-heights, medium weight, variable strokes and normal inter-word spacing that was preferred. The non-dyslexic readers also favoured the form of Times New Roman. Conversely, for the majority of dyslexic readers tested it was the combination of handwritten style, uppercase forms, long ascenders and descenders, light weight, uniform strokes, perpendicular design and generous inter-word spacing that was preferred. The dyslexic readers also favoured the form of Serif Sylexiad.

The conclusions have raised issues that confirm and contradict current typographic principles of legibility. In particular, from a dyslexic perspective, the word shape model has been challenged. The outcomes and issues that have been identified as a result of developmental typeface testing have therefore contributed to new knowledge within the field of dyslexia typographic research.

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1. The research – an introduction and overview.

1.1 Background

This investigation began in January 2001. During that period there was a great interest within the Art and Design higher education sector concerning the condition of dyslexia. In 1999 Central St Martins College of Art and Design put forward the hypothesis that there would be "*more dyslexia among art and design students than non-art students*" (Padgett, 1999, p.11). It was estimated that the figure could be as high as 15% (Surrey Institute of Art and Design, 1999) compared to a national figure of 4% with severe characteristics and a further 6% with mild dyslexic characteristics (Smythe, 1999, p.1).

As a result of this interest, I began to question the reasons for my own reading difficulties, especially my frequent mis-reading of texts. Therefore, as part of the pre-research process, I was psychologically assessed for dyslexia by Ruth Smallwood, an educational psychologist. The assessment indicated the presence of specific learning difficulties (dyslexia) due to "*slow speed of visual processing, and a slight weakness with working memory*" (Smallwood, 2000, p.3).

At the time the recommendation by dyslexia organisations was that preferred dyslexia typefaces should be exclusively for sans-serif fonts, particularly Arial (British Dyslexia Association, 2000, p.1) and Sassoon Primary (Dyslexic.com, 2000, p.1 and British Dyslexia Association, 2000, p.1). The only recommendation for serif fonts was sixteen years earlier by Bevé Hornsby of the International Dyslexia Centre, and that was for Times New Roman (Hornsby, 1984, p.71).

None of the typefaces recommended by these dyslexia organisations were ever designed specifically for the dyslexic reader. The design of Helvetica (on which Arial was profoundly based) and Times New Roman were developed when there was little or no mainstream understanding of the condition of dyslexia. Indeed, these typographic forms were exclusively developed by non-dyslexic designers for a non-dyslexic audience.

The typographic model for legible fonts was exclusively a non-dyslexic model, based on a theory of word shape which states that words are recognised as complete units by the outlines made by their shape (Cattell, 1886, p.9). According to McLean, and typical of mainstream typographic thinking, in order to provide good word shape the following aesthetic principles should be observed:

1. "*Sans-serif type is intrinsically less legible than seriffed type*" (McLean, 1980, p.44).

2. "*Well-designed roman upper and lowercase is easier to read than any of its variants, e.g. italic, bold, caps, expanded or condensed versions*" (McLean, 1980, p.44).

3. "*Words should be set close to each other (about as far apart as the width of the letter 'i'); and there should be more space between the lines than the words*" (McLean, 1980, p.45).

These recommendations (of which there are many) do not accommodate newer theories of word recognition from other fields. For example, the word shape model is no longer part of the dominant thinking within cognitive psychology (Watt, 2003). The model currently accepted as the most accurate is the parallel letter recognition model. This states that a word is recognised by the letters within the word – not by its shape (Larson, 2004, p.74). As a designer myself, with a particular interest in typography and as a dyslexic reader, I found the recommendations by both the typographic establishment and the dyslexia organisations to be too prescriptive and contradictory. My investigation was therefore prompted by the need to bridge the gap between the fields of typographic design and cognitive psychology in order to identify the most appropriate recognition model for the adult dyslexic reader and to allow for the possibility of developing new design paradigms. My research therefore involved the design, development and testing of five new typefaces that were specifically targeted at adult dyslexic readers.

Each typeface I designed was tested against those typefaces which at the time were recommended by dyslexia organisations. The outcomes from these tests, combined with reader comments, my own views as a dyslexic reader and my own views as a designer, helped to inform the development of each subsequent typeface design. The design/testing process that I originated involved a series of evaluative study tests which focus on individual characters, words, sentences and paragraphs in order to measure the legibility of typefaces. The model is linear and flexible in structure and will be referred to as "*developmental typeface testing*".

It is the developmental typeface testing of my typefaces Dine 1, Dine 2, Dine 3, Serif Sylexiad and Sylexiad Sans which formed the basis of this research.

1.2 Research procedure and aims

Research procedure

This practice based research involved an investigation into contemporary dyslexia typeface design and used dyslexic reader groups which represent the adult dyslexic reader. Although practice led, the research was theoretically informed by accommodating two established word recognition models. In doing so, links were made between the distinct fields of typographic design and psychology. The approach was also inductive rather than deductive involving fieldwork which led to evidence, propositions and conclusions (Strange and Trafford, 2005, p.5).

My literature review identified word recognition models including word shape and parallel letter. These models informed the typeface design of Dine and Sylexiad. They also informed the fieldwork which concerned a number of evaluative tests that resulted in the creation of a new typeface testing technique – developmental typeface testing. The evidence gathered as a result of these tests led to conceptual propositions which underpin the production of new typefaces and which contribute to new knowledge.

Research aims

Based on the outcomes of my developmental typeface testing model and my own views as a dyslexic designer and reader, the aims of the research was to:

1. Test existing typefaces (Arial, Sassoon Primary, Times New Roman and Tiresias InfoFont) in order to establish which of those fonts adult dyslexic readers prefer and why.

2. Test my own typeface designs (the Dine and Sylexiad fonts) in order to identify which typographic characteristics adult dyslexic readers prefer and why.

3. Contribute new knowledge to the field of contemporary dyslexia typeface design.

Based on these aims, the objective of the research was to provide answers to the following questions:

1. Is there a preferred typeface for the adult dyslexic reader?

2. Is it different from the control?

3. What are the typographic characteristics that adult dyslexic readers favour?

In answering these questions my objective was to design a typeface for the adult dyslexic reader and, in doing so, develop a new typeface testing model.

1.3 Preliminary stage

The preliminary stage of research involved a literature search and review, establishing a design process and providing a structure to the developmental typeface testing model. This stage also included an analysis of my own reading difficulties and a review of potential test typefaces (Chapters 2, 3, 4, and 5).

1.3.1 Literature review

A literature review was conducted in order to provide a context and framework for the research. The review targeted the subjects of dyslexia and typography within a narrow field. Specifically, the search topics included the following areas:

dyslexic typeface
dyslexia (with regards to ocular and oculo-motor problems)
dyslexia (with regards to phonological deficits)
dyslexia assessments
reading tests
legibility (typeface) tests

With the exception of the Olsen typeface designed by Morten Rostgaard Olsen in 2001 and the Read Regular typeface produced by Natascha Frensch in 2003 at the Royal College of Art, I found no evidence of current research involving typefaces specifically designed for the dyslexic reader. There was also very little information concerning both dyslexia and typography as a single topic. With regards to dyslexia, my focus was on the visual aspects of the condition – specifically the visual anomalies associated with the alphabet system. The typographic review was concerned with the areas of legibility and legibility testing, as well as those typefaces recommended by dyslexia organisations. The review also identified the two recognition models which are key to my investigation – the word shape model and the parallel letter recognition model. The parameters of the literature search was for books, journals and thesis material printed in English (Chapters 2 and 3).

1.3.2 The design process and developmental typeface testing

The literature review helped to inform the structure of the design process and my developmental typeface testing model. It also informed an inductive approach to my research. The design process was grounded within the visual (or what I term as alphonomic) aspects of dyslexia. During the pre-design, I began to compile a diary of all the words I was mis-reading. This resulted in an analysis of my own reading difficulties. These difficulties, coupled with those identified in other dyslexic readers, helped to progress my design/testing process. Developmental typeface testing is unique within the field of typographic design research in that it accommodates a formative *and* summative aspect to design, development and testing of fonts. It also accommodates the word shape and parallel letter recognition model (Chapter 4).

As part of the initial design process, in order to establish similiarities and differences between individual characters a visual analysis of Helvetica (representative of a typical sans serif font – the style approved by most dyslexia organisations) was made. This analysis (based on extreme word shape) was coupled with the features from a diagnostic dyslexia handwriting checklist. This in turn, helped to establish the design of Dine 1, the first experimental font to be used during the testing process (Chapter 4).

Developmental typeface testing consisted of 7 study tests involving 71 readers. It also comprised two distinct stages. The *formative stage* can be seen as experimental and exclusively dyslexic in terms of readership. The structure of this stage evolved as each subsequent study informed the next. The *summative stage* was more fixed and comparative. It involved both dyslexic *and* control groups (Chapter 4). The novel aspects of the formative and summative stages allow the design process to be developed in tandem with the testing process rather than being independent of it.

1.3.3 Test typefaces

All of the typefaces recommended by the various dyslexia organisations I investigated were analysed, as well as those typefaces which influenced me during the initial design development of Dine 1. Arial, Sassoon Primary and Times New Roman were chosen to be used throughout the developmental typeface testing process and were selected for two reasons. Firstly, they were considered to be dyslexia friendly fonts. Secondly, due to their distinct and differing forms, they enabled me to categorise them into *archetypal* or what I refer to as *standard* font types. Therefore, Arial (recommended by the British Dyslexia Association) was used as a "*standard sans-serif font*", Sassoon Primary (recommended by Dyslexic.com) was used as a "*standard handwritten-style font*" and Times New Roman (recommended by the International Dyslexia Centre) was used as a "*standard serif font*" (Chapter 5).

This simple classification of three key typographic styles seemed appropriate in providing the correct focus and continuity throughout the research. The use of more historical styles such as old style, transitional and modern serifs and grotesque, geometric and humanist sans-serifs within the testing process was rejected. Such inclusions would have over-complicated and unnecessarily broadened the investigation.

1.4 Phase one

The investigation can be summarised as four successive stages. Phase one of the research can be considered to be the formative stage of the developmental typeface testing process. A succession of dyslexic reader groups were established at Norwich School of Art and Design. These groups comprised participants from undergraduate courses, all having undergone a psychological assessment conducted by educational psychologists from the Norfolk Psychological Service.

The formative stage of developmental typeface testing consisted of three study tests. Each version of the Dine font was tested against the various dyslexia organisations' recommended fonts of Arial, Sassoon Primary and Times New Roman; and on two occasions Tiresias InfoFont, a typeface recommended by the Royal National Institute for the Blind.

The outcomes and reader feedback gathered from each of the tests, coupled with my own experiences and views as a dyslexic reader, helped to inform the design and development of subsequent versions of the Dine font. Each study test focused on the reading of text formations within four distinct areas. The areas of investigation concerned individual characters, individual words, individual sentences and individual paragraphs. Phase one of the research began in November 2001 and was completed in November 2003 (Chapter 4).

Phase one of the research resulted in the development of Dine 1, Dine 2 and Dine 3. The Dine fonts were produced from a series of evaluative studies. They are not typefaces for the adult dyslexic reader, rather theoretical fonts which have been informed by the process of developmental typeface testing (Chapter 6).

1.5 Phase two

Phase two of the research involved a detailed evaluation of the formative developmental typeface testing outcomes from all three study tests. This appraisal included matters concerning dyslexic issues, text formation issues, general typographic design issues as well as issues regarding the Dine fonts. The evaluation attempts to highlight the differences experienced when reading different texts and to identify the significant factors required to develop a preferred typeface for the adult dyslexic reader. Phase two began in December 2003 and was completed in April 2004 (Chapter 7).

1.6 Phase three

The outcomes of Phase two, coupled with my own experiences and views as a dyslexic reader, have informed the design and development of Sylexiad – the first variant of a typeface for the adult dyslexic reader. Sylexiad has two forms, a serif version (Serif Sylexiad) and a sans-serif (Sylexiad Sans)(Chapter 8).

Phase three of the research can be considered to be the summative stage of the developmental typeface testing process. In order to overcome any possible bias regarding the visual aspects of the typefaces tested (due to the groups being exclusively art-school based), it seemed appropriate to conduct both internal *and* external trials. The internal trial continued to be based at Norwich School of Art and Design whilst the external trial was at The University of East Anglia. Both internal and external trials comprised a dyslexic group and a control group (making a total of four reader groups, two dyslexic and two control). As in Phase one, all dyslexic participants have undergone a psychological assessment by educational psychologists.

The summative stage of developmental typeface testing consisted of four study tests. Each version of Sylexiad was tested against Arial, Sassoon Primary and Times New Roman.

Each study test continued to focus on the reading of text formations within four distinct areas. The areas of investigation concerned individual characters, individual words, individual sentences and individual paragraphs. Phase three of research began in April 2004 and was completed in June 2005 (Chapter 4).

1.7 Phase four

Phase four began in April 2005 and was concluded in December 2005, and marked the final stage of research. It involved a further evaluation of the data produced from both the internal and external trials. As with the formative evaluation of outcomes the appraisal included matters concerning dyslexic issues, text formation issues and typographic issues. The evidence gathered resulted in a comparative analysis between the dyslexic and control groups (Chapter 9). Finally, the legibility and typographic preferences between the adult dyslexic readers and the non-dyslexic readers were analysed. The analysis focussed on issues concerning typographic styles, typographic form and typographic variables; these have resulted in a contribution to new knowledge within the field of dyslexia typographic design.

1.8 CD Rom

The appendices are contained within the accompanying CD Rom and comprise 5 sections (A to E). Appendices A to D shows examples of all the materials used during the developmental typeface testing procedure. Appendix A, includes individual characters; Appendix B, individual words; Appendix C, individual sentences and Appendix D, individual paragraphs. Appendix E shows examples of all the test questionnaires. The appendices are purposefully comprehensive in that they provide evidence of the design practice element of my research.

1.9 Ethics

The research complies with the rules and regulations as set out in the Anglia Polytechnic University document "*Ethics Committee Procedures for the Conduct of Research*". An application for ethics approval was granted in 2001. All data generated from the research is protected by the Data Protection Act 1988, therefore consent was given by all participants before the data was used. Only relevant and necessary data was collected, and the data that is held is accurate, confidential and secure. The tests were not administered on children and all participants were over the age of 18.

2. Dyslexia contexts. A review of literature.

2.1 Theoretical context

The psychological aspects of dyslexia and the characteristics that influence legibility in typographic design occupy two very different and distinct research fields. There is little or no correlation between the two areas. For example, evidence from the last twenty years of work within cognitive psychology indicate that it is the letters within a word that leads to the recognition of that word (Larson, 2004, p.74). This model is called parallel letter recognition which I will discuss in this chapter. Conversely, the majority of typographic designers would agree that words are recognised by their shape and that lowercase letterforms are easier to read than uppercase forms (McLean, 1980, p.44). This model is referred to as word shape which I will address in Chapter 3. As we shall see, there is a clear dichotomy between the word shape model favoured by typographic designers and the letter recognition model favoured by cognitive psychologists. It is this dichotomy which provides a basic premise and theoretical context of my investigation.

There has been no study conducted which bridges the gap between the two models. Indeed, until this investigation, no one had been particularly interested in bringing the two fields together. This view is exemplified by David Jury the editor of TypoGraphic. When discussing the numerous psychological legibility studies undertaken over the last 100 years, (particularly the work of Burt, Tinker and Ovink which I will examine in Chapter 3), he stated that "*these studies provided little that was not already known by practising typographers*" (Jury, 2002, p.56). He went on to suggest that the studies conducted by Herbert Spencer (which are also examined in Chapter 3) "*are all the more accessible for being informed by design (rather than psychological) considerations*" (Jury, 2002, p.56). Jury argued that the "*degree to which a typeface is legible is entirely dependent upon the designer of a typeface (and legibility is not, in every case the most important criterion)*" (Jury, 2002, p.56).

My research challenges these notions. I believe that it is the psychological model of parallel letter recognition rather than the typographic model of word shape that influences legibility. Psychological study certainly can provide new knowledge to practising designers and the legibility of a typeface should not be exclusively dependent on the designer but also on the reader. Consequently, my research enables and encourages the reader to make a direct contribution to the design process.

The literature review therefore has two distinct elements – dyslexia contexts and typographic contexts. In an attempt to make connections and bring the two areas together the focus of the review has been on the visual factors which influence the ability to decode and encode language. For the analysis of dyslexia contexts in this chapter I have concentrated on the aspects of the condition with particular reference to the alphabet and reading issues, whilst the analysis of typographic contexts in Chapter 3 focuses exclusively on legibility and reading issues. As well as informing my design practice, these analyses

coupled with my own experiences as a dyslexic reader have helped to contribute to a potential new field of research which connects typographic design with cognitive psychology.

2.2 Introduction

This chapter is the first section of the literature review. There is great interest in the field of dyslexia from many different viewpoints. Much of the research centres on the psychological and educative aspects of this complex condition but not, however, from a design perspective. In order to address this discrepancy and progress my own design research as well as providing structure to initial stages of my investigation it was important to establish a working definition of dyslexia. The review therefore includes a discourse about what dyslexia is. The review also includes factors which, according to leading experts, concern the science of reading and an investigation into the relationship between reading and dyslexia. The review finally identifies the issues which will provide the framework for my own developmental typeface testing model.

In order to focus and locate the search of literature within the appropriate parameters of my own research, which is to identify the typographic characteristics which will inform the design of a typeface for the adult dyslexic reader, only texts concerned with the visual aspects of dyslexia within the alphabet system were considered. The core of this section of the search therefore involves the exploration of the relationship between reading and dyslexia.

As a designer, the psychology of dyslexia is an area which is well outside of my own field of expertise. The majority of the texts that have been selected are all relatively recent and are useful in that they help to inform my developmental typeface testing model. The texts are all written by recognised experts, most of whom were research active within the dyslexia field during the duration of this investigation.

2.3 What is dyslexia?

The term dyslexia is derived from the Greek “dys” (difficulty) and “lexis” (words). The Collins Concise English Dictionary stated that dyslexia is an “*impaired ability to read, not caused by low intelligence*” (Makins, 1993, p.402).

This is a misnomer. It is much more than an impaired ability to read. The condition covers as many difficulties with the spoken and written word as it does definitions. The Concise Oxford Dictionary offered the more expansive description of “*a disorder involving difficulty in learning to read or interpret words, letters, and other symbols*” (Concise Oxford Dictionary Thesaurus and Spellchecker, 2000).

Dyslexia is a disability which has been recognised by the British Government since the implementation in the 1970's of the Chronically Sick and Disabled Persons Act (Cottrell, 2000, p.59). It is estimated that 4% of the population in the United Kingdom is affected by dyslexia and a further 6% show some dyslexic characteristics (Smythe, 1999). The figure within the higher education art and design sector could be as high as 15% (Surrey Institute of Art and Design, 1999). The Royal College of Art dyslexia coordinator, Qona Rankin, suggested that "*It is now recognised that the incidence of dyslexia in art and design education is far higher than within other subject areas. Nearly a quarter of students at the RCA, for example, have some level of dyslexia*" (Myerson, 2003, p.29).

Serious study of the condition of dyslexia has only been undertaken comparatively recently, and the understanding of the condition has changed as research has developed. The World Federation of Neurology in 1968 stated that "*dyslexia is a disorder in children who, despite conventional classroom experience, fail to attain the language skills of reading, writing and spelling commensurate with their intellectual ability*" (Cottrell, 2000, p.59). It is interesting to note that the condition was exclusively associated with children, rather than people in general.

The Dyslexia Institute in 1989 suggested a broader definition, "*specific learning difficulties are defined as organising or learning difficulties which restrict the student's competency in information processing, in motor skills and working memory, so causing limitations in some or all of the skills of speech, reading, spelling, writing, essay writing, numeracy and behaviour*" (Cottrell, 2000, p.60). Information processing and motor skills have been included in what appears to be a more complex condition than the version offered by the World Federation of Neurology. The term 'dyslexia' has been replaced by 'specific learning difficulties', which suggests the condition is more than simply a difficulty or failure to attain various language skills.

A hybrid term, known as "specific developmental dyslexia", describes a condition in children which is evidenced by "*a difficulty in learning to read and erratic spelling which affects written rather than spoken language*" (Gregory, 1998, p.205). Neurologists suggest the condition could be a result of a neurological delay in development. Some individual cases of specific developmental dyslexia "*have clear difficulties when attempting to associate spatially ordered visual patterns (letters which combine to form words, which in turn form sentences, etc.) and temporarily ordered auditory patterns (the sound of phonemes and spoken words). It could be said that the association between printed and spoken words is never completely regular and uniform in the English language, but visual/auditory association difficulties in pupils said to be suffering from specific developmental dyslexia are reported in countries (such as Italy) where spelling and letter sounding are completely regular*" (Gregory, 1998, p.206).

This definition though only refers to the condition in children. Ian Smythe, of the World Dyslexia Network Foundation in an attempt to provide a framework for assessment and remediation of the condition, proposed the following definition which has been adopted by the Adult Dyslexia Organisation:

"*Dyslexia is a specific difficulty in the acquisition of reading, writing and spelling skills and may be caused by a combination of phonological, visual and auditory processing deficits. Word retrieval and speed of processing difficulties may also be present. A number of possible underlying biological causes of these cognitive deficits have been identified, and it is probable that in any one individual there may be several causes*" (Smythe, 2001).

Within this evolving context of definition and re-definition of dyslexia, Professor Julian Elliott an educational psychologist from the University of Durham has questioned the scientific status of dyslexia. He has suggested that the condition is largely "*an emotional rather than scientific function*" (Elliott, 2005, p.1). He has indicated that there is no consensus about how the condition is defined and has questioned the diagnostic criteria currently used to recognise the condition. He stated that the characteristics associated with dyslexia are "*commonly found in people without reading difficulties, and in poor readers not considered to be dyslexic*" (Elliott, 2005, p.1).

Elliott's thesis is at odds with professional dyslexia opinion and indeed my own findings. As Margaret Snowling, a Professor of Psychology at the University of York argued, "*There is strong scientific evidence concerning the nature, causes and consequences of dyslexia. Thus dyslexia can be readily identified by educated professionals and its potentially negative effects can be ameliorated*" (Snowling, 2005, p.2). The Adult Dyslexia Association suggested that Elliott's questioning of diagnostic criteria "*does not negate the existence of the problem but highlights the shortcomings of the professionals charged with the identification of those difficulties*" (Schloss, 2005, p.1).

Elliott's controversial thesis was a key tenet of the Channel 4 documentary *Dispatches : The Dyslexia Myth* which was broadcast in September 2005. Other important features of the programme included popular misconceptions of the condition (such as the connection between literacy problems and physical co-ordination difficulties) and the distinction of dyslexic readers from other poor readers. Most contentiously, however, the documentary also suggested that "*dyslexia is not a visual problem*" (Dispatches, 2005). This notion is an oversimplification and ignores "*over 500 scientific publications in the last 10 years that show the importance of visual factors in dyslexia*" (Dyslexia Research Trust, 2005, p.1). The evidence gathered throughout my investigation indicates that visual problems most certainly do impact on dyslexia, and indeed it is those very visual problems associated with dyslexia which underpin this thesis.

Although the *Dispatches* programme was confused and often ill-informed investigation, it did however raise some interesting points. It certainly put the definition of dyslexia under scrutiny once again which will result in yet further re-definitions of the condition in the near future. Nonetheless, for the purpose of this investigation, I submit that dyslexia can be seen as *a phonological deficit that influences an individual's ability to decode and encode language.*

Dyslexia is also a syndrome (Cottrell, 2000, p.60); its symptoms can be broken into further categories, which include dysgraphia (difficulty with writing), dyspraxia (difficulty with co-ordinating movement) and dyscalculia (difficulty with numbers).

In the London Institute research project, "Visual Spatial Ability and Dyslexia", Ian Padgett proposed that, "*the condition covers a spectrum, from severe to mild individual cognitive differences in language spoken and written*" (Padgett, 1999, p.2). These difficulties can include the following characteristics:

1. a weakness in working memory
2. hearing anomalies
3. visual anomalies
4. directional difficulties
5. sequential difficulties
6. organisational difficulties
7. slow initial learning
8. attentional difficulties
9. automacity difficulties and problems in combining tasks
10. poor motor co-ordination
11. difficulties in making sense of detail without a concrete context.

The visual anomalies (number three in the aforementioned characteristics list) include factors such as the sequencing, distortion and tracking of words when reading text. As cited by Padgett, Dr Margaret Newton submitted "*the term dyslexic is used to describe a constitutional development pattern of learning which does not favour an easy acquisition of fluency in symbolic materials (such as the Alphabet System)*" (Padgett, 1999, p.2).

Alphonomic

The New Oxford Dictionary of English defined the words 'alphabet' (noun) as "*a set of letters or symbols in a fixed order used to represent the basic set of speech sounds of a language, especially the set of letters from A-Z*" (Pearsall, 1998); and 'anomaly' (noun) as "*something that deviates from what is standard, normal or expected*". When discussing the meaning of dyslexia, the expression "dyslexic reader" may appear to be too broad a term in the context of this research which is primarily located within the areas of visual anomalies and the alphabet. Therefore, the combination of the words 'alphabet' and 'anomaly' to create the more focussed neologism "*alphanomic*" (rather than dyslexia) *may* be more

appropriate. Nevertheless, in the interests of familiarity, I will continue to use the expression "dyslexia" throughout this thesis.*

For the purpose of my investigation I will, nonetheless, focus on alphonomic difficulties – the visual anomalies associated with the alphabet system which influence an individual's ability to decode and encode language – the visual perception and processing of spatial information. "*Visuo/spatial processing involves both feature detection and pattern activation – or in other words categorical encoding and coordinated encoding (the what and where of visual enquiry)*" (Padgett, 1999, p.2). Visual anomalies appeared to provide the most promising and appropriate focus within the context of developing and designing a typeface for the adult dyslexic reader.

2.3.1 Decode and encode

If, as I proposed earlier (2.3), dyslexia can be seen as a phonological deficit then Watson and Hill offer a useful definition concerning an individual's ability to decode and encode language. They stated that: "*Messages are both composed and interpreted in the light of certain rules and codes which are often taken for granted. The sender utilises certain language and communication skills in constructing a message: writing, speaking, and gesturing etc. These skills enable the sender to organise and marshal thoughts and communicate them to others: to encode them. Further in the process of encoding, certain assumptions and values will also affect the way in which the message is constructed. Thus to make sense of the message, to decode it, the receiver requires not just an understanding of the words, gestures and images used but also the values and assumptions which underpin their construction into that particular message, their syntax*" (Watson and Hill, 1996). This explanation has been useful in providing a phonological context for my investigation, particularly concerning issues of readability and legibility (3.2).

2.3.2 Meares-Irlen Syndrome

Meares-Irlen Syndrome may or may not be part of the dyslexic syndrome. It is a visual perceptual distortion problem for people with sensitivity to light (or scotopic sensitivity). The syndrome implies an undue sensitivity on the rod receptors in the eye and overlaps with the condition of photophobia; it also involves many conditions of visual discomfort (Wilkins, 1993, p.447). The term is sometimes used to refer to the collection of symptoms associated with visual fatigue when reading extended texts. Other terms include Irlen Syndrome or Scotopic Sensitivity Syndrome, however, there is no universal agreement on its name.

The symptoms of Meares-Irlen Syndrome were first described by Olive Meares and have been listed by Helen Irlen, (Irlen Centres, 2001) as follows:

*My own alphonomic difficulties have, however, been described in 4.3.2.

1. glare from the page
2. headaches when reading
3. sore eyes when reading
4. movement/blurring of print

It has been found that coloured overlays or tinted glasses can increase the speed and comfort of reading. If the text is closely spaced, the benefit of the colour is more immediate (Irlen Centers, 2001).

Meares-Irlen Syndrome affects people of all ages and *can* relate directly to specific learning difficulties or dyslexia. Dyslexic individuals, however, may have difficulties with visual perception, but they also may have difficulties of a linguistic nature, which need to be addressed separately (Irlen Centers, 2001).

My research will examine the condition of the movement and blurring of print when reading texts. It will investigate problems associated with the contrast between text and paper, the "jumping" of letterforms, and the distortion of words on the printed page – all symptoms of scotopic sensitivity. However, the use of coloured tints and overlays in order to alleviate these difficulties, which has already been well-researched and documented (Irlen, 1991; Pumfrey and Reason, 1991; Wilkins, et al, 2000 and Evans, 2004) will not be part of the research process.

2.4 How we read

What is reading? The Collins Concise English Dictionary stated that reading is "*to comprehend the meaning of (something written or printed) by looking at and interpreting the written or printed characters*" (Makins, 1993, p.1112). It is getting meaning from print rather than simply decoding print into spoken word.

"*There are two routes to reading*" (Stein, 2003.b). Both start with a visual analysis of the word and finish with a semantic analysis resulting in meaning; however, each route has a different intermediate stage. The first route involves a phonological analysis of the word, and the second route a direct visual analysis of the word. This view is widely supported by psychologists. In terms of connecting cognitive psychological research with typographic design research (especially with regards to notions of readability and legibility which are described in Chapter 3) John Everatt a Senior Lecturer within the Department of Psychology at the University of Surrey framed a definition which is helpful. "*The act of reading can be thought of as comprising of two basic processes: (i) decoding of the written form; and (ii) comprehension of the message presented by the written form. It could therefore be argued that reading is word decoding plus language comprehension*" (Everatt, et al, 1999, p.1).

2.4.1 Eye movement

Within the context of my research it was important to investigate the physiology of reading and the visual process. Of particular importance was the study of eye movement which helps to explain reading behaviour and more importantly (from a dyslexic viewpoint) reading difficulties. Reading involves a series of eye movements of *fixations* and *saccades* from one word to the next. The looking at a point (or word) on a page is called a fixation which lasts for one third of a second (Stein, 2003.b) and the eye's movement to another point (or word) is called a saccade.

The perception and comprehension of the content of the text happens during fixations. The frequency of fixations is dependent on the difficulty of text being read (Wickens, 1992). During fixations the identification of letters occurs in an area of the retina called the *fovea*, where visual activity is at a maximum. Connolly stated that the fovea "*allows identification of about 10 letters, depending on the size of the print. In the parafoveal region, more global information such as word boundaries are extracted*" (Connolly, 1998, pp.1-4).

The information from the fovea and parafovea is used to determine the location of the next saccade. The eye travels from one word to the next but the smaller words are not always fixated and are often skipped over when they can be identified by their context and size. Watt called this task "*navigational*" (Watt, 2001, p.20) and it is dependent on the position of lines and words within the page. In scanning the visual environment (the words and lines of the text), saccades provide the visual brain with the information required to build up the image of a page (Tchalenko, 2001, p.38).

The early stages of the human visual system have two parallel streams (Watt, 2003). The first is the magnocellular system responsible for spatial vision, which facilitates timing and motion (movement/dynamic stimuli); and the second is the parvocellular system responsible for detailed vision, which facilitates colour and fine detail (static/fixed point stimuli). An important function of the magnocellular system is to help the control of eye movements – the fixations and saccades.

"*The magnocellular system is small in dyslexics*" (Stein. 2003.b), and in some cases, eye fixations have been found to be destabilised (Stein. 2000). This destabilisation may account for texts to take on various visual manifestations or "*effects*" (Irlen, 1991, pp.34-46). These appearances include a wash-out effect, a river effect and a swirl effect (Irlen, 1991, pp.34-46). All these effects cause the text to blur and jump, which results in visual confusion for the dyslexic reader. It has been estimated that up to 75% of people with specific reading difficulties have a deficit of the magnocellular visual system (Evans, 2004, p.15).

The evidence from saccadic eye movement research and a correlation to dyslexia is, however, inconclusive. The general consensus is that saccadic dysfunction is not a major cause of dyslexia (Evans, 2004, p.10). Eye movement literature in general has however provided a significant body of evidence, particularly the work of McConkie and Rayner

(1975, pp.578-586) and Rayner, McConkie and Zola (1980, pp.206-226) (2.4.3), which supports the parallel letter recognition model, a key tenet within my own developmental typeface testing model.

2.4.2 Word recognition models

This section will identify the three main word recognition models and, in particular, provide a detailed discussion of the parallel letter recognition model. The main source for the identification of the models I have highlighted has been taken from the paper "*The Science of Word Recognition*", first presented at the Atypl conference in Vancouver in 2003, by Kevin Larson a cognitive psychologist working for Microsoft. In this important paper, Larson argues that word shape is no longer an appropriate typographic recognition model. If he is correct, and my evidence (as we shall see) suggests he may well be, then the fundamental typographic premise of word shape is called into question.

There are three main types of word recognition. They are the word shape model, the serial letter recognition model and the parallel letter recognition model. The word shape model states that words are recognised as complete units (Cattell, 1886, p.9). Hence texts set in lowercase forms are considered by typographers to be more legible than those in uppercase forms (Figure 14). A lowercase word is seen as a complete pattern rather than the sum of its letter parts. A more detailed discussion of this model can be located in Chapter 3 (3.3.1). The serial letter recognition model states that the reader identifies words and letters sequentially (Duncan, 1987, pp.39-81). Information passes through one stage of processing at a time (Giles, 2005, p.168). The first letter is read first, then the second, then the third and so on until the word has been recognised. According to Larson, this model has been largely discarded by psychologists (Larson, 2004, p.74). Roger Watt, Professor of Psychology at the University of Stirling and vision expert agrees and suggests that the word shape and serial letter models are not dominant in terms of contemporary psychological thinking (Watt, 2003). The parallel letter recognition model, however, is.

2.4.3 Parallel letter recognition model

The parallel letter recognition model is based on contemporary eye movement research. It states that the letters within a word are recognised simultaneously. The letter information is then used to recognise the word. This is parallel processing, a type of cognition where information is processed in several different ways at once (Giles, 2005, p.168).

Eye movement studies using fast eye trackers and computers have indicated that there are three zones of visual identification. The first area is the recognition zone. It is closest to the fixation point and large enough to capture the word as well as other words to the right of the fixated word. The second area extends a few letters beyond the word recognition zone providing the reader with preliminary information about the next letters. The third area extends fourteen to fifteen letters past the fixation point where global information is extracted. This information is then used to locate the length of upcoming words and

identify the next fixation point (Larson, 2004, p.74). There are many studies within this active area of research, however, two studies in particular have helped psychologists understand fixation spans. They are the moving window study and the boundary study.

In the moving window study, (McConkie and Rayner, 1975, pp.578-589), the amount of text around a fixation was restricted. This restricted area was called a window. Other letters on the page or outside the window were replaced by the letter 'x'. The readers were then required to read the text. During each study the restrictions outside each window were increased incrementally either by letters or words.

The study showed that the more letter information within the window the faster the reading rates were. A window size containing only 3 letters resulted in slow rates whilst 9 letters resulted in moderately slow rates. However, when the size accommodated 15 letters the reading rate was as fast as if there was no moving window present, in other words, a normal rate (340 words per minute). This would indicate that at 15 letters there is a clear relationship between the letter number available to the reader and the normal speed of reading. Our perceptual span is therefore 15 letters, however the average saccade length is only 7 to 9 letters. This would suggest that although words are identified around the fovea, other information is used to guide the reader, which in turn, emphasises the importance of individual letters (rather than word shape) in reading (Larson, 2004, p.75).

In the boundary study (Rayner, McConkie and Zola, 1980, pp.206-226), eye trackers and computers were used to provide evidence concerning reader information inside the perceptual span of 15 letters, but outside the word that was fixated. In this study the reader performed ordinary reading tasks. As the reader fixated from one word to the next an invisible boundary triggered a change in text. The first word fixated was a real word but the following fixation point contained a non-word. Before the saccade was completed the non-word was changed to a real word. The outcomes showed that the reader always fixated on the correct word (Larson, 2004, p.75).

The readers were also shown real and non-words that had both similar and dissimilar word shapes. The outcomes indicated faster reading rates for the dissimilar words. This indicates that letter information is being collected within the fixation span even when the entire word was not recognised. Further studies were conducted using uppercase letters. In doing so, notions of word shape were eliminated because uppercase words are contained within the same regular rectangular shape (Figure 14). The fixation times were the same as those of the controls which demonstrates that the information retained by the reader from saccade to saccade was not due to word or letter shape but a more abstracted information concerning the next letters to be read (Larson, 2004, p.75). Both the boundary study and the moving window study provide compelling evidence in favour of the parallel letter recognition model.

Roger Watt suggested that, "*Each word can be correctly identified by a mixture of visual analysis creating internal descriptions of the image pattern, and informed guessing from the*

linguistic context. It is very probable that certain words are recognised only after their letters have been clearly seen, whereas other words can be recognised in context because their overall shape and size fits with what is expected" (Watt, 2001, p.20). This idea supports the notion of the parallel letter recognition model, and to a lesser extent, the word shape model. Most psychologists would, however, currently accept the parallel letter model as being the most accurate. The model is, as Larson argued contrary to current typographic thinking which favours the word shape model (3.3.1). "*Word shape is no longer a viable model of word recognition … the readability and legibility of a typeface should not be evaluated on its ability to generate a good word shape*" (Larson, p.77). In an attempt to bridge the gap between psychological and typographic thinking my investigation accommodated both models.

2.5 Reading and dyslexia

As with the literature search concerning eye movement, an investigation into neuroanatomy in order to understand the biology of how we read is important in the context of my research. This section will therefore look at the neuroanatomical regions responsible for the process of reading and the subsequent difficulties related to dyslexia. Many of the points raised within this area have been previously made by Jean Robertson (an independent psychologist who works primarily with dyslexic children and adults) in the Neuropsychology and Reading chapter from *Dyslexia and Reading. A Neuropsychological Approach* (Robertson, 2000, pp.1-41). This text is one of many recent texts which investigates contemporary ideas regarding the neurobiology of dyslexia. Others include *The Neurobiology of Dyslexia* (Knight and Hynd, 2003, pp.28-41) and *The Neurobiology of Dyslexia* (Beaton, 2004, pp.35-66). The text was chosen because it represents the current thinking within that particular field.

2.5.1 Neuroanatomy

Different parts of the brain facilitate different types of human behaviour. The various regions of the brain are located on the cortex. The cortex is divided into two hemispheres and contains four areas called lobes. Each lobe has a specific responsibility and function. The occipital lobe is located at the back of the brain and contains areas which facilitate visual processing; the parietal lobe is located at the top of the brain and facilitates movement, orientation, calculation and body senses; the temporal lobe is located around the ears and facilitates auditory perception and sound and speech comprehension; the frontal lobes are believed to be associated to higher order skills such as thinking, conceptualisation and planning. Situated at the base of the cortex, and partly fused to it, is the cerebellum which facilitates balance, movement and equilibrium (Robertson, 2000, pp.1-3).

The specific areas within the brain which are associated with dyslexia research, include: Broca's area (associated with speech production), Wernicke's area (associated with speech comprehension), the corpus callosum (associated with hemisphere information transferral),

the angular gyrus (associated with connecting the visual to sound-word recognition to the phonological system), the arcuate fasciculus (associated with language production and comprehension), the visual cortext (associated with visual processes), the cerebellum (associated with balance, co-ordination and language) and the insular cortex (associated with the activation of different brain areas) (Robertson, 2000, pp.3-4).

When light falls on the retina, in the eye, a chemical reaction is triggered within the cells which is converted into a nerve impulse. The route made by these nerve impulses (which run along the optic nerve) is called the visual pathway. Both right and left optic nerves meet at the optic chiasma, which is central to the visual perception process. The fibres from the optic nerves of each eye cross to the opposite side of the brain until they reach the visual area of the brain situated in the occipital cortex. The left optic nerve (or tract) deals with information from the outside half of the left eye and the inside of the right eye, and the right optic tract from the inside half of the left eye and outside half of the right eye (Robertson, 2000, p.8). This is referred to as a crossover of stimuli.

The temporal lobe deals with auditory perception. Sound projections are relayed to the planum temporale, where phonemes (a basic unit of spoken language) are mapped onto visual graphemes (the smallest meaningful unit in a writing system) – they are an arrangement of letters that can be decoded without being sounded out. As with the visual pathway, the auditory process also relies on a crossover of stimuli from one hemisphere to the other. Impulses travel along fibres which divide into two, some remaining on the same side of the brain, and others travelling to the other side.

Generally (although not exclusively), speech and language processes are largely performed in the left hemisphere of the brain (Young and Tyre, 1983, p.69). For non-dyslexic readers the left hemisphere can be seen as the verbal, logical and controlling side, while the right is the non-verbal, practical and intuitive side (Hornsby, 1984, p.126). In most cases, therefore, right-handed people interpret language in the left hemisphere and research has shown that the planum temporale for such people is usually larger in the left hemisphere. In cases of right-handed people, where the planum temporale is not larger in the left hemisphere, dyslexic traits have been identified manifested by exceptional development of visuospatial ability but poor phonological skills (Robertson, 2000, p.9).

Brain research with regards to reading and linguistic processes was advanced in the 1950's by the Canadian neurosurgeon Wilder Penfield who noted that when a patient's Broca area was stimulated, difficulties occurred with word retrieval and the ability to perform phonemic discrimination tasks were identified. Some patients experienced problems with letter reversals and had difficulty in decoding words such as "pig" and "big" when asked if the words began with the same letter (Robertson, 2000, p.11). Other studies made by Ojemann and Mateer (1979) suggested that stimulation of the speech zones in the vicinity of Broca's area as well as affecting speech also impacted on short-term memory and reading. Later studies made by Van Patten and Rheinfelder (1995) highlighted processing

differences between environmental sounds and speech-like sounds, and single words and connected text (Robertson, 2000, pp.11–12). The latest evidence from neuroscientific research reveals that the different regions of the brain do not however function in isolation. The regions are much more integrated than previous studies have suggested as one part of the brain can often influence other parts far removed (Beaton, 2004, p.65). The evidence gathered from neuroscientific research in relationship to reading and dyslexia would appear to be in a state of flux. Studies within this field are very much at an early stage and are limited and far from conclusive. Therefore, although the ideas I have highlighted are interesting and provide a context for my own investigations they have not been incorporated directly into my theoretical model of developmental typeface testing.

2.5.2 A developmental stage model of reading

Tunmer (1994) states that reading relies (as does speech) on phonological processing, and that two views have emerged over the last four decades with regards to reading ability. The first view put forward by Goodman and Goodman (1979), Goodman and Attwerger (1981) and Harste, Burke and Woodward (1982) suggests that reading is a natural and spontaneous experience which evolves in the same way that speech develops (Hulme and Snowling (Eds), 1994, p.167). In other words, a subject learns to read by reading. They argue that poor reading skills are a result of poor methods of instruction that conflict with a natural progression. The opposite view, however, put forward by Gough and Hillinger (1980) claimed that reading in an "*unnatural act*" (Hulme and Snowling (Eds), 1994, p.168). Sassoon agreed and considered the use of spoken language forms to be a natural attribute, but reading and associated problems with visual processing as "*not natural*" (Sassoon, 2001). Joyce stated "*one of the logical reasons for dyslexics to have trouble with reading and writing, is because it is not a natural process by itself*" (Frensch, 2003, p.13). This is a view which is currently supported by most reading experts, and one to which I subscribe. Whether a natural or unnatural attribute, the ability to read is an acquired skill (Young and Tyre, 1983, p.33), which has distinct developmental stages.

A useful model of literacy that has had a considerable influence on the study of dyslexia was put forward by Frith (1985, pp.301-330), who proposed three stages of literacy development: logographic, alphabetic and orthographic (Goulandris, 1997, p.78). In this model the reader starts with a visual or whole-word strategy using word recognition as simple letter cues. This is called the logographic. The reader then progresses to learning grapheme-phoneme (letter-sound) correspondences, which is called the alphabetic (Robertson, 2000, p.35). The final stage relies on the use of morphological spelling patterns (a morpheme being the smallest unit of language which carries meaning) which transcend simple grapheme-phoneme correspondences; this is called the orthographic (Snowling, 2000, p.65). The orthographic stage includes an understanding of prefixes, suffixes and letter strings and enables the subject to read fluently (Robertson, 2000, p.36).

Although this model is helpful it has its limitations. Snowling argued that the stages proposed by Frith were poorly specified and each stage transaction unclear. She also

questioned the sequential nature of the model pointing to empirical data indicating that reading development is not universal for all subjects (Snowling, 2000, p.66).

However ill-defined Frith's development stage model is, it would appear that different skills, and therefore different brain areas, are utilised when reading which involve both cerebral hemispheres. Problems with reading performance, such as dyslexia, may be a result of difficulties within one or all of the developmental stages. Conversely, as Snowling suggested, individual differences in reading might reflect processing preferences rather than abnormalities of development (Snowling, 2000, p.66). Although Frith's model of literacy relates to children rather than adults, I have nonetheless incorporated its structure loosely within my own developmental typeface testing model. The study tests concerning individual characters can be seen as the logographic stage, the tests concerning individual words as the alphabetic stage and the tests concerning individual sentences as the orthographic stage.

2.5.3 Phonological difficulties

Most alphabetic writing systems can be traced to the system invented by the Phoenicians in around 1000 B.C. (Smitshuijzen Abi Farès, 2001, p.13). However, difficulties associated with literacy such as reading problems are a comparatively new phenomenon. Descriptions of reading difficulties were first identified as (relatively) recently as 1896 by Morgan and 1917 by Hinselwood (Miles and Miles, 2000, p.1). These difficulties were initially considered to be as a result of physical anomalies. Contemporary evidence, however, from the field of cognitive psychology indicates that this is not the case and that most dyslexics have difficulty at the phonological level (Miles and Miles, 1992, p.2).

The language system has a distinct hierarchical structure. The highest order skill (in terms of reading) is metacognition. Readers automatically and knowingly make inferences from letters and words, and bring prior knowledge to bear in order to understand the text. As Stothard (1994) stated, the comprehension of text is far more dependent upon metacognitive awareness than word recognition and decoding (Hulme and Snowling (Eds), 1994, pp.201-205). The units within the language system, required for the metacognition of text include a semantic component (word meaning and vocabulary), a syntax component (grammatical structure) and a discourse component (connected sentences). At the lowest level of the language system is a phonological component which facilitates the processing of the sound elements that constitute language.

A phoneme is defined as one of the set of speech sounds in any given language that serve to distinguish one word from another (Makins, 1993, p.1005). It is the smallest meaningful unit of language and is the fundamental element of the language system. For example, the language system distinguishes three phonemes embedded in the word "bat"; they are "buh", "aah" and "tuh". The pronunciation of these sounds in the English language is indicated by linguists as b, æ and t. Before words can be coded and decoded by any of the semantic, syntax and discourse components higher up the language system hierarchy, they must be

broken down (or parsed) into phonetic units by the phonological component within the language system of the brain.

A deficit in phonological processing impairs decoding and therefore the correct identification of a word. This failure within a low order language function blocks access to higher order functions such as the semantic, syntax and discourse components which help facilitate megacognition and meaning from a text. Although the actual language processes involved in gauging comprehension and meaning remain intact, they cannot be utilised because they can only be accessed after a word has been identified (Shaywitz, 1996, p.3). This theory concerning phonological processing difficulties which characterises the view that dyslexia is a language disorder is now widely accepted by most experts.

My developmental typeface testing model, which allows for the testing of individual characters, words, sentences and paragraphs, enabled my investigation to include aspects of phonological processing research identified as a result of this search. For example, Hatcher and Snowling and Høien highlighted particular phonological testing tasks which have directly impacted on my own testing methods. They include non-word reading and oral response (Høien, 2002, pp.57-59) and rhyme recognition and letter knowledge (Hatcher and Snowling, 2003, pp.75-77). One of the many indicators of dyslexia is manifested in the phenomenon of reversed letters and words such as b/d, p/q and saw/was (British Dyslexia Association, 2001, p.1). This occurrence will be tested as letter reversals are an important feature of my developmental typeface testing model. The structure of my paragraph tests will also allow for aspects of metacognition skills and their associated semantic, syntax and discourse components to be investigated.

2.6 Conclusion

As a result of investigating the changing definitions of dyslexia, I established my own very basic working definition. Dyslexia can be seen to be a phonological deficit that influences an individual's ability to decode and encode language. Although this definition does not contribute to new dyslexia knowledge, it is, nonetheless, a useful working tool in context of my research. However, despite this, even the expression "dyslexic reader" may be too broad a term. The main focus of my exploration was on the visual anomalies associated with the alphabet system. Therefore, a more focussed term such as "alphonomic reader" could be more appropriate than "dyslexic reader". In the interests of familiarity, however, I will continue to use the term "dyslexic reader" throughout this thesis.

Many of the visual anomalies (or alphonomic difficulties) experienced by readers can include aspects of Meares-Irlen Syndrome (or Scotopic Sensitivity Syndrome). There has been extensive research undertaken in order to alleviate scotopic sensitivity by the practice of printing text on tinted paper rather than white paper or by the use of tinted overlays. For this research however, the texts were only printed on white paper in order to focus purely on

typographic design and form considerations, rather than replicating existing research, which would have resulted in second order issues concerning preferred paper and tint colour being raised.

The review of eye movement literature identified three distinct models of word recognition. The first, favoured by typographic designers was the word shape model which is described in detail in Chapter 3. The second was the serial letter recognition model largely discarded by psychologists. The third was the parallel letter recognition model favoured by cognitive psychologists. Individual characters are recognised by the reader simultaneously and this information is used to recognise the word. My developmental typeface testing process as well as including the word shape model, also accommodated the parallel letter recognition model in that exclusively uppercase texts (which have less intrinsic word shape than lowercase texts) were tested – particularly as extended paragraphs.

The investigation into the neurobiology of dyslexia was interesting but less significant in terms of my own research. Due to a combination of inconclusive findings and my own lack of expertise within the field (and indeed lack of resources) the evidence from this particular area of study was not directly incorporated within my own testing model.

As a result of the review of dyslexic contexts, the design and implementation of the developmental typeface testing process has loosely incorporated elements of Frith's literacy development model. The study tests concerning individual characters can be seen as the logographic stage, the tests concerning individual words as the alphabetic stage and the tests concerning individual sentences as the orthographic stage. This model will therefore facilitate the investigation with aspects of metacognition, recognition and decoding. Phonological assessment tasks have been incorporated into my developmental typeface testing process and includes aspects of non-word reading, oral response, rhyme recognition and letter knowledge. The phenomenon of letter reversals has also been included as a significant aspect of the testing process. All of the texts I have used during this review of dyslexia literature were the most useful to my investigation and they either directly or indirectly support my research.

3. Typographic contexts. A review of literature.

3.1 Introduction

This chapter is the second section of the literature review. In comparison to cognitive psychology, typographic practice is a relatively narrow field concerned with a combination of aesthetics, technology and fashion. The development and design of letterforms have always been inextricably linked to their reproduction on either a page or screen. For example, the vogue for short ascenders and descenders arose in the 1930's from the newspaper industry need to accommodate as many lines on a page as possible. This is a fashion that is still popular amongst typographic designers today, and typefaces which contain long ascenders and descenders are considered to be "*old fashioned*" (Downes, 2005).

The field of typographic design is profoundly connected to reading and many rules have been established by practitioners in order to facilitate the maximum legibility of texts. These rules have been developed since the first typographic studies were conducted in the mid nineteenth-century. Indeed most rules have been underpinned by the word shape model first proposed by the psychologist James Cattell (Cattell, 1886, p.9). This model has been largely rejected by cognitive science in favour of a serial letter recognition model and more recently a parallel letter recognition model. However, most typographers still accept the word shape model. Because typographic legibility rules were therefore established before the condition of dyslexia was understood it seems reasonable to argue that these rules were developed by literate designers for literate readers. They were certainly not created for readers with reading difficulties.

In an attempt to bridge the gap between the fields of cognitive psychology and typographic design within the parameters of my own research, which is to identify the typographic characteristics that will inform a typeface for the adult dyslexic reader, the focus of the literature search within this section has therefore been on typographic legibility research.

3.2 Readability and legibility

In order to establish an appropriate framework for my own developmental typeface testing model it was important to investigate the notions of readability and legibility. This section will therefore survey the conceptual development of the terms, identify their differences and in doing so provide my research with a working definition.

The Concise Oxford Dictionary defined the words as:

readable. Capable of being read with pleasure or interest; legible; hence ~ ABILITY,

legible. (Of handwriting or print) clear, capable of being read; hence ~ IBILITY n.,

The important distinction between the two definitions are: "*with pleasure or interest*" suggesting an inherent understanding of the linguistic and semantic aspects of the text, and therefore implying notions of literacy (readability); and "(*of handwriting or print*)" suggesting an understanding of the physicality of the text, its appearance and its visuality, the perception of the letters (legibility).

Very little scientific research on reading had been conducted before 1900 and the use of the word legibility had been used as a catch-all term with regards to factors that influence the ease and efficiency of reading.

Robert Bridges, the nineteenth-century poet, when commenting on handwriting suggested: "*Legibility depends very much on what one is used to reading. When a person writes so badly that others cannot read the writing or only with great difficulty, he may not quite understand why he is being criticized, for he, himself is used to his own writing and is therefore likely to be able to read it*" (Fairbank, 1970, p.76).

With regards to the printed word, R.L. Pyke (1926) in the medical research report "*The Legibility of Print*", attempted to frame a definition. "*Legibility refers to (1) letters, (2) words, and (3) continuous texts. Its essential and sufficient conditions are that it should be possible; (1) with letters, for the eye to define clearly the shape of a letter; (2) with words, the collective shape of a word; and (3) with continuous texts, to read a type both accurately and fast*" (Ovink, 1938, p.8). As G.W. Ovink, a psychologist at the University of Utrecht observed, Pyke's attempted definition is more an enumeration of essential criteria. The problem of the term has to be found in the multitude of its significances. "*It can be used to indicate a quality of a type or a piece of print, and then it means the ease, with which the subject can read that type or printed matter. The ease is a property not of the type etc. but of the subject*" (Ovink, 1938, p.8). In other words, it refers to the visuality and physicality of the printed word *and* the reading ability of the reader.

A more focussed and helpful definition was formulated in 1940. As Professor Miles Tinker, the Professor Emeritus at the University of Minnesota and internationally recognised authority on the legibility of print noted: "'*readability' came to be regarded as a more descriptive and meaningful word than 'legibility', and it was commonly adopted. However, with the advent of 'readability formulas', devised to measure the difficulty of reading material, an entirely different meaning developed for readability. To avoid confusion, it seems best to employ 'legibility of print' to designate the effects of typographical factors on the ease and efficiency of perception in reading*" (Tinker, 1965, p.115). Tinker suggested that a practical definition of legibility should include the "*relative perceptibility of the letters in the alphabet to measuring speed of reading continuous meaningful text*" (Tinker, 1965, p.115). In the introduction to *Legibility of Print*, he stated that legibility deals with "*the coordination of those typographical factors inherent in letters and other symbols, words, and connected textual material which affect ease and speed of reading*" (Tinker, 1963, p.8).

Sir Cyril Burt, the Professor of Psychological Emeritus at the University of London, suggested that legibility is concerned with the visible appearance of printed matter and those factors which affect the communication of the content of the text (Burt, 1959, p.ix). Stanley Morison, the designer of Times New Roman in his introduction to Burt's study summarised that the term is determined by "*the size and substance of the letters; the space between them and the words they constitute; and the distance between the successive lines. Other important factors are the texture and colour of the paper, the quality of the impression and the density of the ink*" (Morison, 1959, p.ix). Herbert Spencer, a Senior Research Fellow at the Royal College of Art and editor of *The Penrose Annual*, offered a more succinct definition suggesting that legibility is concerned with the "*efficiency of the printed word*" (Spencer, 1968, p.6).

For the purpose of my research, factors which affect and influence legibility will include typographic characteristics and the physical characteristics linking the reader to the printed text. Typographic characteristics include factors such as the font, the font size, the font weight, kerning (character and word spacing), leading (interline spacing) and the contrast of print and paper types. The physical characteristics linking reader to print include factors such as the illumination of the printed text and the angle and distance from which the text is read.

With reference to reading, the typographer Walter Tracy stated that there is little agreement on an accepted definition. "*One view is that writing is an encoding process, the action of representing language by symbols called letters; therefore reading is the process of decoding such symbols and converting them into language. A person performing that decoding process has learnt the alphabet and can recognise word formations. But is that reading? Is that person literate? Many psychologists think not, and insist that an adequate definition of reading and literacy must include comprehension of what has been read*" (Tracy, 1988, p.72). Psychological reading research therefore often includes tests designed to measure both decoding ability *and* comprehension. These tests also include an examination of the typographic factors that affect the outcomes. The studies are often referred to as legibility studies even though they include investigations into "*the readability of continuous text as well as the legibility of individual letters*" (Tracy, 1988, p.73).

Spencer noted that legibility is concerned with the efficiency, recognition and perception of the printed alphabet (Spencer, 1968, p.6), in other words, the recognition of the *visual*. Masaro and Cohen also suggested that it is the *visual* that is the primary source of information for reading (Masaro and Cohen, 1994, pp.1107-1129). In this sense, the notion of legibility (the recognition of the *visual*) can be considered to be the precursor to the notion of readability (the meaning of the text). Text that is legible may not necessarily be comprehensible or readable. Readable text, however, is inextricably linked to the comprehension and meaning of that text. Readability (or understanding) of a text can therefore be considered to be the successor to the legibility (or recognition) of that text.

The valuable distinction between readability and legibility is important in terms of my investigation. From a practical point of view, however, the act of reading is dependent on the readability and legibility of texts. Both terms implicitly inform my testing process and we can conclude, therefore, that for the purpose of developmental typeface testing the notion of *legibility* concerns the visual and typographic elements of a text and that *readability* concerns the meaning and understanding of that text.

3.3 Testing for legibility

Since Johann Gutenburg invented his revolutionary system of moveable type in 1450 (Steinberg, 1974, p.18), there have been innumerable typographic developments, both in terms of design and technological advancement.

The vast majority of new typefaces have been designed during and since the latter part of the twentieth-century. The introduction and development of digital software programmes such as Font Lab and Font Studio, Adobe Photoshop, Adobe Illustrator and QuarkXpress has had a profound effect on the proliferation of typefaces. Digitisation has made contemporary typeface design quicker and easier.

Meta Plus Book Roman for example, is one of those new typefaces. It is a sans-serif font designed by Erik Speakerman and has similarities to the News and Trade Gothic typefaces. The font forms part of a family that offers an exceptionally wide range of weights and it has an elegant and clear appearance on the printed page. Other recent fonts include Trebuchet and Georgia which have been designed for easy screen readability. Trebuchet designed by Vincent Connaire is a sans-serif humanist font and was inspired by the sans-serifs of the 1930s which typically had large x-heights and round features for readability on signs. Georgia designed by Matthew Carter as a serif web face was originally part of True Type's core fonts.

It is worth noting that all of these fonts have specific functions and all are considered to be good examples of legible typefaces (Berlow, 1999). However, my literature search has not identified any evidence to suggest that any of these typefaces have ever been formally tested for legibility. Most typographic design is an intuitive process which relies on the combination of aesthetics, technology and fashion. Notions of legibility are important to the designer, but they are not particularly embedded within the initial design process. Very few typefaces are ever actually tested for legibility and of those which are, none are tested either during or indeed before the design process. The area of legibility is clearly important in relationship to my research. During this section I will therefore identify those texts which have impacted most on my own theoretical model.

In the chapter *Investigating Legibility*, which forms part of the *Visible Word*, Spencer described a series of important typographic legibility tests. Although the tests mentioned do

not relate specifically to the dyslexic reader they are important to my research as they help to connect the fields of cognitive psychology and typographic design. One of the earliest comparative typographic tests was conducted in Paris by Anisson, head of Imprimerie Nationale, during the 1790's. The test compared Didot's modern Roman face with Garamond and found that Garamond "*was readable several stages after Didot's characters had become indistinguishable*" (Spencer, 1968, p.13). This technique pioneered by Anisson is a key principle that underpins my own theoretical framework. The comparative typographic tests within my own model have however been expanded to accommodate 5 rather than 2 typefaces.

In 1825 and 1827, a series of typographic studies were produced by Hansard and Babbage respectively. With regards to dyslexia and reading, it is relevant to note it was Babbage in 1834 who first identified that a tinted paper '*one of an amber colour*' (Spencer, 1968, p.13) was less fatiguing to the eye. This idea precedes theories of scotopic sensitivity or Meares-Irlen Syndrome by 146 years. It is also interesting to note that Babbage found that characters of uniform height were more legible than those with ascenders or descenders. This finding supports the theory of the parallel letter recognition model which is currently accepted by most cognitive psychologists. The model indicates that we use the letters within a word in order to recognise that word (Larson, 2004, p.74). The parallel letter recognition model will be incorporated into my theoretical model in that texts set exclusively in uppercase forms will be tested.

The ophthalmologist Professor Emile Javel of the University of Paris in 1878, made investigations into letter legibility based on distance and light variables. He also made important studies into eye movements when reading. Like Babbage, he agreed that tinted paper was preferable to white. He also suggested that spatial quality was an important factor when reading text – condemning an excessive use of white space. Javel was also the first to identify that the upper half of a line of text is more easily read than the lower half (Spencer, 1968, p.14 and Huot-Marchand, 2004, p.47).

Javel's discovery about the primacy of the upper half of a word was supported by studies made by Messmer in 1903. It is now widely accepted that the upper section of a word is more dominant than the lower part. This principle was initially explored during the experimental formative design stage of my research. The ascenders of the precursor font Dine 1 were designed to be more dominant than the descenders. However, in terms of overall word legibility, most typographers would argue that it is not the primacy of the ascenders or the upper section of a word that is important, rather the whole word shape where *both* ascenders and descenders are of equal importance (Sassoon, 2005).

Throughout the twentieth-century the research into typographic legibility was broad, and employed many techniques by which to measure legibility. It is interesting to note that this work was conducted by psychologists rather than typographic designers. Work produced by Ovink (1938), Burt (1959), Tinker (1963) and Zachrisson (1965) provide detailed

descriptions of some of the principal techniques which include: distance measurement, perception timing, eye movement measurement, blink rate, visual fatigue, peripheral vision, visibility and reading rate. Of the legibility methodologies that I have investigated not all are relevant to my research; those which have directly or indirectly impacted on my research include the following:

1. visibility rates
2. ocular preference
3. aesthetic preference
4. reading rates

A visibility method was used by Matthew Luckiesh and Frank Moss of the Lighting Research Laboratory at General Electric (Luckiesh and Moss, 1942) which measured the brightness and contrast between the printed image and the paper. Although this technique has not been adopted in my research, the relationship to dyslexia and in particular scotopic sensitivity is evident.

Bror Zachrisson, an internationally recognised expert on legibility and Director of the Graphic Institute in Stockholm, used a haploscope to determine ocular preference between serif and sans-serif typefaces (Zachrisson, 1965, p.168). This technique has not been employed for my own research, however, my developmental typeface testing model accommodated tests designed to establish reader preference between serif and sans-serif typefaces as well as handwritten style fonts and lightweight and bold fonts.

Burt noted that his subjects read faster those texts set in typefaces they found more aesthetically pleasing (Burt, 1959, p.18). This correlation was not accepted by Tinker who argued that "*habit, experience, and the subjective ease of perceiving the text is one thing, performance seems to be another*" (Spencer, 1968, p.23). My own view is that the aesthetic preference, when used in conjunction with other methodologies is absolutely relevant. As I have previously stated, in order to provide good word shape, certain typographic aesthetic principles need to be adhered to (1.1). Consistent text tonality, regular spatial quality and appropriate ascender and descender lengths are all important aesthetic concerns within the field of typographic research. With this in mind, aesthetic preference has therefore been included within my developmental typeface testing model in order to compare typographic aesthetic concerns with those of the readers.

The reading rate has been used by many researchers including Pyke, Paterson and Tinker, Ovink, Burt and Wilkins. The technique is a popular quantitative method by which to measure the legibility of text and it involves some timed element (either by setting a time limit, or measuring the time taken to read a given text). There have, however, been concerns expressed about this method. Spencer pointed out that "*since comprehension is the objective of all reading, the results obtained by measuring speed of reading are of value only if the factor of comprehension is adequately controlled*" (Spencer, 1968, p.23).

Paterson and Tinker used the Chapman-Cook Speed of Reading Test (Paterson and Tinker, 1940, p.15 and pp.161-162). Each text had a word which altered the meaning of the copy. In order to check comprehension, the reader had to identify the correct word. This method has been criticised. Zachrisson suggested that those people who skip read may be disadvantaged (Zachrisson, 1965, p.46), and Poulton considered the technique insensitive because it demands only a minimum level of comprehension (Spencer, 1968, p.24). Despite these criticisms, a quantitative method of measuring the readability of texts is important to my research. The most useful in developing my own model was the Wilkins Rate of Reading Test© (Wilkins, Jeanes, Pumfrey and Laskier, 1996), which has provided my research with a key technique in which to measure the legibility of extended texts.

3.3.1 Word shape model

The notion of words being recognised as whole units is known as the word shape model and was proposed by James Cattell in 1886. It is the oldest model in psychological literature and it argues that we read whole words as individual patterns more effectively and accurately than individual letters. As Cattell stated, "*The perception time is only slightly longer for a word than for a single letter; we do not therefore perceive separately the letters of which a words is composed, but the word as a whole*" (Cattell, 1886, p.9).

Cattell's model was also supported by early studies by Erdmann and Dodge (1898), Pillsbury (1897) and Huey (1908) . Pillsbury's work, reported in 1897, suggested that the reader often disregards detail such as the identification of incorrect or missing letters within a word (Spencer, 1968, p.18). In presenting letter and word stimuli to readers for a brief period of time (between five to ten milliseconds) Cattell showed that the eye recognised a whole word as accurately as a single letter. This finding is called the Word Superiority Effect and Cattell concluded that words are recognised more effectively by their shape rather than by individual letters (Cattell, 1886, p.9).

Additional evidence to support word shape can be located in a series of proof reading studies conducted by Haber and Schindler (Haber and Schindler, 1981 pp.573-579). The texts contained misspellings consistent with word shape and some that were inconsistent. The findings reported that readers were twice as likely to fail to notice a misspelling that was consistent with word shape (Larson, 2004, p.74). The final evidence to support the model is that it has been shown that lowercase texts are read faster than uppercase texts. Indeed, on average people read lowercase text 5 to 10% faster than uppercase text (Smith, 1969, pp.261-262 and Fisher, 1975, pp.188-196).

Texts set in lowercase letters have a more distinctive and unique pattern shape due to the ascenders and descenders being an intrinsic element of their design. Uppercase texts, however, do not contain ascenders and descenders which results in a more rectilinear and uniform form (Figure 14). Most typographers accept this old model and consider that the readability and legibility of a text has a direct relationship to good word shape.

Although the Word Superiority Effect showed that letters can be more accurately recognised in the context of a word rather than in isolation, this conclusion was based on real word studies. McLelland and Johnson showed that non-words such as 'mave' and 'rint' also show a Word Superiority Effect (McLelland and Johnson, 1977, pp.249-261). In this instance, while both non-words have a similar phonetic regularity, they do not share the same word shape. Therefore, it could be argued that the Word Superiority Effect rather than being dependent on word shape is more reliant on regular letter combinations (Larson, 2004, p.76).

Other evidence against word shape can be located in the moving window study (McConkie and Rayner, 1975) discussed in Chapter 2 (2.4.2). In this instance, a prediction was made that reading would be significantly improved if information on the whole word shape (rather than individual letters) were retained. This turned out to be false (Larson, 2004, p.74).

It could also be argued that evidence against word shape may also be due, as Licko argued to a practise effect (Unger, 1992, pp.100-101). Most people read texts in lowercase, however, when readers are forced to read uppercase texts their speeds *eventually* increase to the same rates as lowercase texts (Larson, 2004, p.76). This supports Babbage's early finding that characters of uniform height were more legible than those with ascenders or descenders (Spencer, 1968, p.14).

Based on the evidence I have highlighted, I would agree with Larson that the case for the word shape model is not strong. However, word shape is still accepted today by typographic designers as a viable model. In order to connect the fields of typographic design and cognitive science my research accommodated both the word shape model and the parallel letter recognition model currently accepted by cognitive psychologists. My developmental typeface testing model therefore included tests for uppercase texts as well as lowercase texts.

3.3.2 Typographic legibility

As David Jury the editor of TypoGraphic pointed out, the methodologies I have described (often developed and conducted by psychologists) provided little that was not already known by practising typographers. These studies did, however, help to reinforce good typographic practice in terms of legibility (Jury, 2002, p.56), and this view persisted as typographic research during the 1970's and 1980's became more sustained. Surveys issued in 1969 and 1980 when taken together included references to nearly 900 legibility studies (Tracey, 1988, p.73).

So what is good typographic practice in relationship to legibility? Linda Reynolds who was a Senior Research Fellow at the Royal College of Art has extensively investigated the legibility of type. She described her findings in the *Baseline* article "*Legibility of Type*" which can be summarised as follows:

Typographic style

1. Sans-serif typefaces are considered to be intrinsically less legible than seriffed typefaces because seriffed letter shapes have more individuality and are therefore more easily distinguished from one another than sans-serif letters.
2. Italic letterforms have been shown to be less legible than roman letters when set as continuous text. This may be because italic letters are less easily distinguished from one another (Reynolds, 1988, p.27).

Typographic form

1. Text set in uppercase letterforms is less legible than text set in lowercase letterforms. This is because lowercase letters with their ascenders and descenders create more distinctive word shapes. Uppercase letterforms also accommodate more space than lowercase forms so more fixations are needed to perceive the same number of words which results in slower reading times.

2. Good legible typefaces should have a relatively large x-height in relation to the capital letter height, and large, open counters with a relatively generous set width. These characteristics allow readers to recognise whole words by their outline and internal shape rather than reading letter by letter (Reynolds, 1988, pp.26-27).

Typographic variables

1. Bold type is likely to reduce legibility when used as continuous text. Dense black type can create after-images.

2. The space between words must also be greater than the space between letters within a word. The spacing must not however be so great that the horizontal emphasis of the line is destroyed (Reynolds, 1988, pp.27-28).

Although Reynold's findings are almost 16 years old they typically echo earlier findings by Spencer (1968), McLean (1980) and Tracey (1986) and later findings by Jury (2002). The findings are a typical reflection of the typographic status quo and are still accepted today as good typographic practice. These basic rules of legibility are clearly embedded within the word shape model. However, during the 1990s and with the advent of digital technology there was a move away from notions of legibility. Typographic aesthetics and fashion changed, away from formality and notions of legibility to a more layered and unstructured postmodern view typical of the work of David Carson and the early editions of the magazine *Émigré*.

Rational typography was rejected and ugly design was seen as a "*conscious attempt to create and define alternative standards*" (Heller, 1994, p.156). It was out of this climate

that my research was born. Indeed my precursor or experimental typeface Dine 1 was grounded in the ugly and illegible aesthetics of the period. This can be seen as being somewhat ironic as it was designed to be a legible font with maximum word shape.

3.3.3 Legibility and dyslexia

All of the studies outlined in this chapter have been summative and retrospective rather than particular and formative with regards to typeface testing. The typefaces used for all of the research I have documented existed *before* any tests were devised. With the exception of Sassoon Primary, designed by Sassoon in 1984 as a text face to be read by children (and subsequently adopted by certain dyslexia organisations as a dyslexia-friendly typeface), there has been little or no research to gauge the legibility of typefaces either formatively or during the design process.

As for the needs of the dyslexic reader there has been, until very recently, no *specific typeface* legibility testing at all. This trend was reversed in 2001 when Morten Rostgaard Olsen designed the Olsen typeface for people with reading difficulties including difficulties associated with dyslexia. Olsen's design objective was to "*create a typeface, so legible in every aspect of the shaping of its individual letters, that word recognition improves to a maximum*" (Gyllan, 2002, p.48). Particular emphasis was placed on reversed reading issues of letters such as b, d, p and q. Unfortunately *not* every aspect of the alphabet's counters, strokes and serifs have been sufficiently developed which has resulted in the Olsen typeface failing to meet its objectives with regards to maximum word recognition.

In 2003 Natascha Frensch designed Read Regular exclusively for the dyslexic reader. It was developed as an "*exercise to find optical pleasure*" (Frensch, 2003, p.28) and in doing so, provide dyslexics with a "*new tool of discovery, breaking conventional rules and conventions*" (Frensch, 2003, p.53). This approach is laudable, however my literature review provided no evidence to suggest any such typographic rule breaking. As Maag suggested, "*Commendable as the idea of Natascha Frensch's typeface is, it is nothing new to the serious type designer. Her assertions are what type designers have known for decades, if not centuries*" (Maag, 2005, p.12). The development of Read Regular was based on the designer's own experience of dyslexia and supported by anecdotal evidence. The research associated with the typeface was disappointing and can be seen as a missed opportunity. This is because there was no comparative testing of either fonts or typographic characteristics which would facilitate the measurement of readability and legibility of the typeface. The claim, therefore, that Read Regular is "*visually more effective for reading with dyslexia*" (Frensch, 2003, p.45) is, I would contend, not strong.

Burt observed that results obtained from research often depend on the experimental procedure used (Burt, 1959, p.4). Read Regular conforms to this observation insofar that Frensch's research has resulted in a clean and legible sans-serif typeface. I would argue, however, that it is not necessarily a *dyslexic* font because the experimental procedure was not targeted on an exclusively dyslexic audience. Burt's view regarding experimental

procedure seems obvious. Tinker, for example, compared the results of four studies which used different experimental methodologies by which to establish an order of typeface legibility. His analysis ranked different typefaces according to the different methods used (Spencer, 1968, p.24). For this research, I adopted a similar approach to that of Tinker and used four core studies by which to measure legibility. The experimental procedure was profoundly grounded in the dyslexic experience which offered new insights into dyslexia and legibility, and typographic form.

3.4 Conclusion

Dyslexia and typography do not sit comfortably together. Typography is inextricably linked to reading and dyslexic readers (and indeed dyslexic designers) do not like reading. The aim of this literature review was to attempt to bring the two fields together in order to establish appropriate methodologies for my own research.

Within the typographic contexts of my investigation the focus of my search was on legibility. In order to construct a framework it was important to establish the difference between notions of legibility and readability. For the purposes of this research, I propose that readability is synonymous with the comprehension and understanding of a text, whereas legibility is concerned with the typographic characteristics which make a text recognisable. The legibility of a text can therefore be seen to be the precursor to the readability of a text. The developmental typeface testing model therefore accommodates both aspects of reading within its structure.

A search into previous legibility research and associated methodologies was also undertaken. I discovered that these tests were conducted exclusively by psychologists and very rarely in tandem with typographic designers. With the exception of studies made by Sassoon in the development of Sassoon Primary, there was little other evidence to indicate that research was being undertaken either before or during the design process. All the tests were summative and retrospective. There was also no evidence to suggest that any of the studies were directly targeted at a dyslexic audience.

Nonetheless, the search enabled the identification of important research that helped to connect typography with dyslexia. Ideas from Anisson's comparative typographic tests, Babbage's notion of the primacy of uniform letters, Javel's notion of the primacy of the upper half of a word, Zachrisson's testing of serif and sans-serif forms, Burt's notion of aesthetic preference and Wilkin's Rate of Reading Test have all impacted either directly or indirectly on my developmental typeface testing model.

The review identified and described in detail the word shape model currently favoured by typographic designers. The search also identified the rules of typographic legibility and established the principles of good typographic practice. This practice is firmly embedded

within the word shape model which is the oldest word recognition model in psychological literature. My research framework will therefore include the word shape model in the testing of lowercase texts as well as the parallel letter recognition model currently favoured by cognitive psychologists in the testing of uppercase texts. In combining the two models within my own developmental typeface testing model, the fields of typographic research and cognitive science can be bridged.

As a result of the review of typographic contexts, the design and implementation of the developmental typeface testing process will therefore include new methodological approaches to the testing for legibility. These approaches will include the following:

1. A testing process that will accommodate aspects of typographic and cognitive psychological research by incorporating the two distinct word recognition models favoured by both fields within one single model.

2. A testing process that has been designed, developed and conducted by a typographic designer rather than a psychologist.

3. A testing process that will specifically focus on a dyslexic reader audience which has previously been untargeted.

4. A testing process that includes a unique formative and summative element to the design of letterforms.

4. The design process and developmental typeface testing.

4.1 Introduction

This chapter will explain how the literature review of dyslexia and typographic contexts, as well as my own experiences as a dyslexic reader have influenced the design of the study, in particular my developmental typeface testing model and my research process. It will also explain the initial design process. The chapter includes a diary of misread words and an analysis of how my reading difficulties have impacted on this investigation. It also re-visits the key word recognition models most helpful to my research and explains how the structure of previous legibility tests have informed my own theoretical model. There is also a description concerning the influences, rationale and starting points for the initial design of the experimental precursor font Dine 1. Finally the chapter will explain how the developmental typeface testing model was established and how it developed and evolved.

4.2 Design of the study

4.2.1 Developmental typeface testing

The developmental typeface testing model I have established involves a series of evaluative studies which measures legibility and informs subsequent design and testing procedures. The model has been grounded in the visual (alphonomic) aspects of dyslexia and as we have seen in the previous two chapters, has incorporated ideas concerning comparative typeface testing (Anisson), the primacy of uniform letters (Babbage), the primacy of the upper half of a word (Javel), the testing of serif and sans-serif forms (Zachrisson) aesthetic preference (Burt) and reading rates (Wilkins). The theoretical model also combines elements of Frith's literacy developmental stage model and Tinker's methodological approach to measuring legibility. Developmental typeface testing therefore includes clear stages which allow for the testing of individual characters, individual words, individual sentences and individual paragraphs.

As well as integrating psychological and typographic concepts, it also incorporates my own experiences as a dyslexic reader and designer. The developmental typeface testing model therefore accommodates my own alphonomic difficulties when reading, specifically issues concerning word/letter shape and context, letter inversions and letter inclusions. It also incorporates difficulties associated with dyslexia that I do not experience such as letter reversals and visual stress. As such, two word recognition models have been incorporated into the framework. These are the word shape model favoured by typographers and the parallel letter recognition model favoured by psychologists. Word shape was accommodated by the testing of lowercase letterforms and parallel letter recognition by the testing of uppercase forms.

The developmental typeface testing model also (and most crucially) facilitates both formative *and* summative legibility testing. This idea has been indirectly influenced by Rosemary Sassoon's design of the Sassoon family of fonts. During the development of Sassoon Primary she discovered that no research had previously been undertaken to find out what kind of letters children themselves found easiest to read (Club Type, 2001, p.1). This simple yet unique discovery indicates a clear formative aspect to the development of the Sassoon fonts. The formative stage of my investigation, however, is more comparative concerning the testing of the Dine fonts against the other test fonts, whilst the summative stage (not explored by Sassoon) concerns the testing of the Sylexiad fonts against the other test fonts.

The formative and summative aspects of measuring legibility forms a key central research tenet and makes my developmental typeface testing model both distinctive and unique. Previous models have only been exclusively summative. The thread that interweaves the formative and summative stages is the design process. The initial formative design stage was underpinned only by the word shape model. The design concept of the monocase Dine 1 typeface was therefore based on the provision of maximum word shape. Subsequent phases however included both models. The parallel letter recognition model became more influential with the design of the Sylexiad fonts.

4.2.2 Research process

As we have seen, the inquiry has been informed by two word recognition models – word shape and parallel letter. These theoretical models have underpinned and driven my practice based research. Due to the nature of the data and the manner of its collection the investigation combines elements of action research, ethnographic (ethnogenic) research and surveys (Bell, 1993, pp.6-10, Cohen and Manion, 1995, p.186 and Walliman, 2005, p.121). The data was gathered by means of qualitative and quantitative techniques from 71 respondents based at Norwich School of Art and Design and the University of East Anglia. These techniques form the basis of my developmental typeface testing model and included small-group evaluative tests, interviews, questionnaires, diary records and my own impressionistic observations as a dyslexic reader and designer (Bell, 1993 and Walliman, 2005). The research was narrow (rather than broad) in scope due to the relatively small sample sizes which allowed for a more in-depth investigation (Cohen and Manion, 1995).

The analytical process was based on the content analysis of data produced as a result of the seven developmental typeface study tests (Robson, 1993). Trends and commonalities were identified and categorised into four main areas: dyslexic issues; text formation issues; typographic design issues and Dine/Sylexiad design issues (Robson, 1993).

The fieldwork was conducted by myself and Jane Key an expert within the field of dyslexia screening and a member of The University of East Anglia Learning Support Centre. As a result of this fieldwork evidence has been gathered which has informed theory. The investigation has, as a result, established propositions which underpin the production of new

typefaces that can be tested by others (Bulmer, 1969). The research therefore contributes to new knowledge through an inductive approach (Strange and Trafford, 2005, p.5). The post-doctoral aim, however, will be towards the eventual testing of a hypothesis and therefore a more deductive conclusion.

4.3 Pre-design

The initial design process was grounded on the cognitive aspects of dyslexia, particularly with regards to phonological difficulty and specifically those areas concerning readability and legibility of texts. The focus was on the visual (alphonomic) anomalies associated with the alphabet system which influence a dyslexic reader's ability to decode and encode language (2.3).

As a result of my own alphonomic problems when reading texts, all the reading errors I experienced throughout this project were recorded. Many of these misreads were included in the initial pilot study test. The majority of my misreads were either headlines or sentences from newspaper articles, or words from road signage systems. The misreads have been documented in the form in which they appeared, for example the word MAR which was misread as WAR appeared in uppercase letters only. The recordings form my own personal diary of misread words.

4.3.1 Misread words 2002-2005

"*Special Events*" misread as "*Special Effects*" (5th August 2002)

"*CLASS WAR*" misread as "*GLASS WAR*" (7th August 2002)

"*Amnesiac*" misread as "*Asthmatic*" (11th August 2002)

"*Village of Parkside*" misread as "*Village of Paradise*" (16th August 2002)

"*MAR*" misread as "*WAR*" (18th August 2002)

"*Boating*" misread as "*Botanic*" (18th August 2002)

"*Felt-tip pens*" misread as "*penis*" (28th August 2002)

"*deaf signers*" misread as "*deaf singers*" (26th October 2002)

"*Win an incredible boarding holiday*" misread as "*Win an incredible boring holiday*" (5th November 2002)

"*Emily Bearn*" misread as "*Emily Beam*" (24th November 2002)

"*Scudamore bullish over TV rights*" misread as "*Scudamore bull shit over TV rights*" (26th November 2002)

"*Bug Buster*" misread as "*Bag Burster*" (22nd January 2003)

"*Fiat father dies*" misread as "*Flat father dies"* (25th January 2003)

"*The Liberty*" misread as "*The Library*" (24th February 2003)

"*Phil Spencer*" misread as "*Phil Spector*" (25th February 2003)

"*WILLARD BEOPPLE*" misread as "*WILLARD PEOPLE*" (15th March 2003)

"*SHADY LITES*" misread as "*LADY SHITES*" (9th April 2003)

"*Handy Andy*" misread as "*Hardy Andy*" (18th June 2003)

"*Catalonia bans children from bullfights*" misread as "*Cantona bans children from bullfights*" (27th June 2003)

"*Split trust mis-selling probe is extended*" misread as "*Split trust mis-spelling probe is extended*" (18th July 2003)

"*SUPPORTING ACTS*" misread as "*SPORTING ACTS*" (18th August 2003)

"*Norwich Bravery Awards*" misread as "*Norwich Brewery Awards*" (26th August 2003)

"*HERO OF THE NORTH*" misread as "*NERD OF THE NORTH*" (3rd September 2003)

"*Sasakawa*" misread as "*Swastika*" (19th September 2003)

"*FACULTIES*" misread as "*F.A. CUP TIES*" (13th September 2003)

"*Mobiles 'make you senile'*" misread as "*Mobiles 'make you smile'*" (14th September 2003)

"*genteel London*" misread as "*rented London*" (7th October 2003)

"*Friea*" misread as "*Frida*" (11th February 2004)

"*How fair do you consider the unit assessment?*" misread as "*How far do you consider the unit assessment?*" (11th March 2004)

"*Travelling Around*" misread as "*Travelling Abroad*" (19th March 2004)

"*Dirty Work*" misread as "*Daily Mail*" (19th March 2004)

"*cocaine*" misread as "*codine*" (20th March 2004)

"*Spring city breaks*" misread as "*Sporting City breaks*" (22nd March 2004)

"*BBC will wreck quality title*" misread as "*BBC will wreck quality of life*" (29th March 2004)

"*resentful*" misread as "*restful*" (31st March 2004)

"*green*" misread as "*queen*" (2nd April 2004)

"*READJUSTMENT*" misread as "*READ JUSTMENT*" (16th June 2004)

"*'new sister product'*" misread as "*'new sinister product'*" (20th July 2004)

"*Heath art auction*" misread as "*Health art auction*" (9th August 2004)

"*Finding Mick Jagger*" misread as "*Featuring Mick Jagger*" (20th August 2004)

"*the less elegant*" misread as "*the less legal*" (15th September 2004)

"*CLONEX ROOTING HORMONE*" misread as "*CLONEX ROTTING COMPOST*" (29th September 2004)

"*tipster*" misread as "*lipster*" (10th January 2005)

"*Pakistani*" misread as "*Parkinson*" (5th March 2005)

"*The Art of Learning*" misread as "The Art of Lettering" (14th March 2005)

"*soft*" misread as "*80 ft*" (21st March 2005)

"*During the war*" misread as "*Doing the War*" (28th May 2005)

"*Windsor Chase*" misread as "*Windsor Cheese*" (31st May 2005)

"*Beaulieu Jazz Festival*" misread as "*Blackpool Jazz Festival*" (19th June 2005)

"*Buckfast*" misread as "*Breakfast*" (20th June 2005)

"*patients*" misread as "*parents*" (25th June 2005)

"*Carluccio's hampers*" misread as "*Cappuchino hamper*" (26th June 2005)

"*Macmillan Cancer charity*" misread as "*Manchester Cemetery*" (12th July 2005)

"*dormant*" misread as "*dormouse*" (21st July 2005)

4.3.2 Alphonomic difficulties

It appears that my own alphonomic difficulties (2.3) take three forms:

1. incorrect decoding of lowercase texts
2. letter inversions
3. letter inclusions.

The first form concerns the decoding and encoding of specific lowercase word and letter shapes. The form of a word such as 'Liberty' resulted in the misread 'Library'. Both of these words share the same physical shape and length, which suggests that word shape plays an important role in word-recognition (or, with regards to the dyslexic reader, mis-recognition). It is interesting to note that most of my misreadings were not as single words but as double words or sentences. This may indicate that context is a factor in my decoding and encoding of words. For example, 'Special Events' was misread as 'Special Effects'; the word 'Special' in this instance may have been the trigger which prompted me to read the word 'Events' as 'Effects'.

The second form of alphonomic difficulty I experienced concerned individual letter inversions. An example of this concerned the inversion of the uppercase letter 'M' when the word 'MAR' was misread as 'WAR'. Most of my errors, however, were not in uppercase forms but in lowercase. This would support Babbage's early observation concerning the primacy of uniform letter legibility over lowercase forms (3.3), which in turn enforces the parallel letter recognition model (2.4.3). It is worth noting that the phenomenon of letter reversals (as opposed to letter inversions) experienced by dyslexic readers only occur in lowercase forms. My own experience, however, indicates no such difficulties with letter reversals such as b/d and p/q.

The third form of difficulty concerned the inclusion of letters from adjacent words in particular sentences. An example of this can be shown by my misreading of the words 'felt-tip pens'. The 'pi' element from the word 'tip' has been introduced into the word 'pens', resulting in the word being misread as '(p)penis'. This difficulty may also support the parallel word recognition model (2.4.3).

The three forms of alphonomic difficulty that I experienced whilst recording the diary of misread words were included in the initial design and developmental typeface testing process.

4.4 Word recognition and the design process

It is worth re-visiting the word recognition models I have identified from my literature review and attempt to relate them to my own reading difficulties, and in turn, to my own research. The three models I have identified are the word shape model, the serial letter recognition model and the parallel letter recognition model. Current trends indicate that many psychologists have moved away from word shape (favoured by most typographers) to a letter recognition model.

The word shape model states that words are recognised as complete units (3.3.1). It is the oldest model in psychological literature and as my literature review confirms is the model most favoured by typographic designers. The word shape model is supported by the fact that lowercase letters have ascenders and descenders which provide a more distinct word shape than uppercase letters, (Cattell, 1886, p.9) (Figure 14).

The serial letter recognition model states that the recognition of a word is analogous to looking a word up in a dictionary. The reader reads the word in a linear and sequential way until the word has been recognised (Gough, 1972). The model is based on tests concerning letter recognition speeds and word lengths. Outcomes indicated that letters are correctly recognised both sequentially and at a typical reading rate of 300 words per minute. Crucially, the model showed that words with fewer letters are recognised more quickly than words with many letters. This evidence was contrary to the word shape model which would expect longer words with more unique patterns to be easier to recognise (Larson, 2004, p.74). Because the model could not explain the words Superiority Effect (3.3.1) it was discarded, and for this reason, has not been incorporated within my own testing model.

The parallel letter recognition model is based on contemporary eye movement research. It states that the letters within a word are recognised simultaneously (2.4.3). A detailed description of the model can be found in Larson's paper "*The Science of Word Recognition*". It is this model that is currently accepted by psychologists as being the most accurate (Larson, 2004, pp.74-75).

It is significant to note that most typographers reject the parallel letter recognition model (or, more likely, are simply unaware of it) in favour of the word shape model. Larson argued that the strongest evidence for word shape shows "*that letters can be more accurately recognised in the context of a word than in isolation*" (Larson, 2004, p.76). He also proposed, however, that the weakest evidence for lowercase words being read faster than uppercase words is "*entirely due to a practise effect*" (Larson, 2004, p.76). This view is supported by one of the earliest legibility findings by Charles Babbage who in 1827 suggested that figures of uniform height were *more* legible than figures with ascenders and descenders (Spencer, 1968, p.13).

As a designer (and indeed a dyslexic designer) I have often found uppercase letterforms to be just as easy as lowercase forms to read, and indeed as my own reading difficulties show, I have misread more words in lowercase forms compared to those in uppercase forms. The view that uppercase forms are easy to read was also confirmed by comments made by dyslexic readers during this research.

My developmental typeface testing model has therefore incorporated both recognition models. The parallel letter recognition model allows for the testing of uppercase letterforms and the word shape model facilitates the testing of lowercase forms. During Study Test 1 however, the initial design process was firmly locked within the word shape model as no uppercase forms were tested. Indeed the model was initially taken to extremes during the design of the monocase Dine 1 which was developed in order to create maximum word shape. This idea ironically resulted in an almost illegible font design being tested. However, as the process progressed the parallel word recognition model was incorporated within the developmental typeface testing model in order to facilitate the testing of uppercase letterforms.

4.5 Legibility testing and its impact on the design process

Digital technological development and the introduction of the personal computer in the mid 1980's has revolutionised the typographic world. This has resulted in a profound increase in the number of typefaces available to people. In 1975, a typical typesetting company would (on average) offer around 100 typefaces to clients. This figure was increased to 1000 when Adobe launched its Type Library in 1986 (Müller, 2003, p.10).

Digitisation has made contemporary typeface design quicker and easier to develop than it had ever been. The democratisation and wide availability of fonts resulted in many of the basic rules and skills associated with good typographic practice being reconsidered and re-evaluated (Poyner, 1994, p.37). The re-evaluation of perceived typographic wisdoms during this period provided me with the trigger for a more experimental and radical approach to typographic design and enabled me to progress the precursor and experimental Dine fonts.

With the exception of studies undertaken by Sassoon in the mid 1980's, with the development of the Sassoon family of fonts (Sassoon, 1993c., pp.149-152) resulting in her advocation of long ascenders and descenders, there had been little or no research to gauge the legibility of typefaces either *formatively* or *during* the design process. The majority of legibility tests on typefaces were summative and retrospective rather than particular and formative. Indeed, most typographic design (irrespective of legibility testing) could be

regarded as being summative, dependent only on a combination of typographic rules, typographic skills and intuition.

The development of Dine (and subsequently Sylexiad) reverses this trend in that legibility and readability issues have been addressed formatively and during the design process. The outcomes of each study test (including reader comment and feedback) has subsequently informed each new typeface design. Crucially, the design process was grounded from a dyslexic viewpoint. The visual-spatial rather than the linear-sequential (Padgett, 1999, p.2 and Silverman, 2000). Developmental typeface testing targets the specific needs of the dyslexic reader (which at the start of this research in 2000 was ignored as a factor in the design and development of typefaces) and has resulted in a series of precursor fonts which have helped to inform the initial versions of a typeface for the adult dyslexic reader.

4.6 Influences on the design process

Sassoon's questioning of children during the formative aspect of the design of Sassoon Primary influenced the structure of my developmental typeface testing model (4.2.1). However, in terms of the design and development of Dine, there were two main influences which had a profound impact. They were: 1, Papazian's paradigm of modules and similars and 2, Silverman's diagnostic dyslexic handwriting checklist.

4.6.1 Papazian's paradigm of modules and similars

Hrant Papazian, an academic typographer at UCLA, has proposed a system of alphabet reform based on a word shape paradigm that aimed to increase letter readability by modifying those letters that appeared too similar. Papazian did this by grouping lowercase letters into modules and similars (Papazian, 1999). The modules comprised of *groups* of letters that contained similar components which contributed to word shape ambiguity. For example, all letters containing ascenders were grouped into modules. The similars are those *individual* letters that share distinct visual relationships. For example, within the ascender module, the lowercase b, d and h are similars, but not the lowercase l (Papazian, 2000, p.128). Using a modified version of Papazian's model, a typographic analysis was conducted in order to establish similarities and differences between different individual upper and lowercase characters.

The typeface selected for this analysis was the sans-serif font Helvetica for a number of reasons. Firstly, the majority of fonts recommended by dyslexia organisations tend to be sans-serif. (British Dyslexia Association, 2000.a., p.1 and Dyslexic.com 2004, p.1). Secondly, the British Dyslexia Association recommends Arial, a typeface based on the form and shape of Helvetica (Simonson, 2003, p.1) as the "*preferred*" dyslexia friendly font (British Dyslexia Association, 2000.a., p.1). Thirdly, it is a familiar and widely used font which is generally accepted to be legible for *all* readers.

The analysis was designed to establish the *essential* nature of each letter (McLean, 1980, p.51). It involved characters from the Helvetica alphabet to be grouped into three basic physical categories: 1, those letters which contained diagonal strokes (Figure 1) (13.1.1); 2, those letters which contained curved strokes (Figure 2) (13.1.2) and 3, those letters which contained right-angled strokes (Figure 3) (13.1.3).

These categories, in turn, were divided into sub-groups. For example, the characters containing diagonals were sub-divided into groups containing: 1, diagonals with horizontals; 2, diagonals with verticals and 3, diagonals only. These sub-groups were then, in turn, sub-divided further. For example, the diagonals with verticals category were sub-divided into: 1, diagonals with one vertical and 2, diagonals with two verticals. The category with diagonals containing two verticals involved the uppercase letters of M and N (Figure 1) (13.1.1).

In order to maximise the character contrast and therefore the shape potential of individual words, regarded as a key aspect of typographic legibility (Larson, 2004, p.74), the uppercase M and N from the aforementioned category had to appear as different from each other without compromising the meaning of the letter. One way of doing this was to render the M in its lowercase form (m) and the N in its uppercase form. It is this concept which has lead to the development of Dine 1 as a monocase font.

4.6.2 Silverman's diagnostic dyslexia handwriting checklist

Linda Silverman of The Gifted Development Centre (U.S.A.) said that "*visual spatial learners are pattern seekers, their minds are wired to seek patterns*" (Silverman, 2000). This would suggest that the dyslexic reader (in a general sense) is more visual, pattern-seeking and constructional than non-dyslexics. In typographic terms, this idea sits well with Papazian's notion of the "*maximisation of character contrast*" (Papazian, 1999) which contributes to heightened word shapes or "*boumas*" (Papazian, 2000, p.13).

In order to identify the condition of dyslexia, Silverman developed a diagnostic handwriting checklist (Silverman, 2000) which included the following:

- unusual spacing
- strange letter formations
- a combination of upper and lowercase letters
- a combination of cursive and manuscript letters
- cursive letters disconnected
- a lack of letter fluidity
- a reversal of letters or numbers

Dine 1 incorporates all the elements of this handwriting checklist to varying degrees. The design also attempts to evoke and highlight a strong sense of pattern in order for the reader to "*seek patterns*" (Silverman, 2000).

4.7 The design process and rationale for Dine 1

To summarise, the design process rational concerning the first version of the experimental precursor font Dine 1 was based on a word shape model. The process was also founded on a dyslexic viewpoint and was initially influenced by Papazian's paradigm of modules and similars and Silverman's diagnostic dyslexia handwriting checklist in order to provide maximum character contrast which would result in extreme word shape. For a more detailed account of the design development and evolution of all the precursor Dine fonts, please refer to Chapter 6.

4.8 Formative and summative testing

My developmental typeface testing process consisted of 7 study tests. Each was concerned with the reading and measurement of individual characters, words, sentences and paragraphs. There were two distinct stages using 71 readers. All the testing materials are in Appendices A – D which are located in the accompanying CD Rom.

4.8.1 Formative developmental typeface testing (Study Tests 1 – 3)

The formative stage of developmental typeface testing was based at Norwich School of Art and Design. It comprised of three study tests and can be seen as an experimental phase which provided structure for the summative stage. The studies facilitated the testing of the Dine fonts against other test fonts. The three studies comprised a total of 29 readers. All participants had undergone a psychological assessment and all were found to experience specific learning difficulties (dyslexia).

Study Test 1

Study Test 1 involved the comparative testing of Dine 1 (6.2) against the other test typefaces; Arial (5.2), Sassoon Primary (5.4), Times New Roman (5.3) and Tiresias InfoFont (5.5). Only lowercase forms of the fonts were used in this instance*****. The reader group comprised 8 dyslexic participants and involved 4 tests.

The character test was designed to gauge reader recognition and perception of each font set as specific individual characters. Using a rotational system, each reader was shown 10 individual characters set in 200 pt versions of each typeface and asked to identify them. The characters included letters, numbers and punctuation (Appendix A. 1.1).

*****The exception to this being the word pair example of 'PEDROS' and 'RECORDS' (Appendix 2.1) and the sentence example of HOUSE OF FRASER £25,000 FASHION GIVEAWAY' (Appendix 3.1) which were set in uppercase. This was the form in which they were originally misread.

The word test was designed to gauge reader recognition of each font set as specific word pairs. The pairs had both similar and dissimilar word shape and size. All of the examples were misread by myself. Using a rotational system, each reader was shown 8 word pairs set in 36 pt versions of each typeface and asked to read them out aloud (Appendix B. 2.1).

The sentence test was designed to gauge the readability and legibility of each font as a sentence. All of the examples used were misread by myself. Using a rotational system, each reader was shown 5 one line sentences set in 18 pt versions of each typeface and asked to read them out aloud (Appendix C. 3.1).

The paragraph test was designed to gauge the readability and legibility of each font as extended text. The texts were taken from the '*Dorling Kindersley Children's Illustrated Encyclopaedia*' (Kramer, 1998). Using a rotational system, each reader was shown 5 paragraphs containing similar word counts. The texts were set solid in 12 pt versions of each typeface across a measure of 31 picas (Appendix D. 4.1). Before reading, each participant was asked to describe the visual tone of the text. The reading speed was then timed using the Wilkins Rate of Reading Test (Wilkins, Jeanes, Pumfrey and Laskier, 1996). The readers were then asked if they re-read words and/or scan read words in the text. Finally they were asked to indicate their preferred typeface.

A summary of the significant comparative typeface data gathered from Study Test 1 can be located in Chapter 13 (Figures 16 – 26). This data has been incorporated with that gathered from the other formative tests and is discussed in detail in Chapter 7. The other testing issues that were also identified included aspects of recognition, hesitation, context, punctuation, space, numerals and repetition. These issues have also been incorporated within a set of generic formative testing issues which are also discussed in Chapter 7.

The design of Study Test 1 impacted on the design of Study Test 2 in a significant way. Most importantly, the testing of only lowercase letterforms was limiting in producing meaningful data and only embraced the word shape model. In order to include the parallel letter recognition model, all other studies included uppercase forms. In the word test, some readers were unfamiliar with the words in their isolated context, others had difficulty with pronunciation. For example, there was confusion concerning the pronunciation of the Spanish word 'PEDROS' that I had originally misread as 'RECORDS' (4.3.1). Some readers pronounced the 'S' in the word others didn't. Nonetheless both pronunciations were valid. In order to overcome this pronunciation issue and the issue of context, non-words identified by Rayner, McConkie and Zola (1980) (2.4.3) and McLelland and Johnson (1977) (3.3.1) were used in Study Test 2. The incorporation of my own reading errors in the sentence tests also resulted in some readers not being familiar with certain words resulting in pronunciation difficulties. In an attempt to overcome these pronunciation issues the sentence test in Study Test 2 only contained words from the *200 frequently used words*, (www.stenospeed.com, 2001, p.1). The design of the paragraph test was more successful in generating interesting outcomes. The quantitative and qualitative techniques, in particular,

were valuable in producing important data and have been included within the design of Study Tests 3 – 7.

Study Test 2

Study Test 2 involved the comparative testing of Dine 2 (6.3) against the other test typefaces; Arial (5.2), Sassoon Primary (5.4), Times New Roman (5.3) and Tiresias InfoFont (5.5). The reasons for the inclusion of Tiresias InfoFont are explained in Section 5.5. Both uppercase and lowercase forms were tested, thus enabling the word shape and parallel letter recognition model to be incorporated within my own developmental typeface testing model. The reader group comprised of 10 dyslexic participants and involved 4 tests.

The character test was an expanded version of Study Test 1 with the addition of uppercase forms making a total of 14 rather than 10 characters to be read (Appendix A. 1.1). The testing process was as in Study Test 1.

The word test was designed to gauge reader recognition of non-words in uppercase and lowercase forms. Using a rotational system, each reader was shown 10 non-words set in 36 pt versions of each typeface and asked to read them out aloud (Appendix B. 2.2).

The sentence test was designed to gauge the readability and legibility of each font as a sentence. Using a rotational system, each reader was shown 10 one line sentences set in 18 pt versions of each typeface. The readers were timed and asked to grade the readability of each typeface using a Likert Scale (Appendix C. 3.2).

The paragraph test was designed to measure the visual stress of each typeface as non-narrative extended texts. It was based on the Wilkins Rate of Reading Test, (Wilkins, Jeanes, Pumfrey and Laskier, 1996). Using a rotational system, each reader was shown 5 texts containing 150 words. Each text accommodated 10 lines within the same area of space. Before reading out aloud the reader was asked to describe the visual tone of the text. The reader was then timed in order to establish a reading rate. Finally, an order of preference was established based on each paragraph and also on all of the tests combined (Appendix D. 4.2).

A summary of the significant comparative typeface data gathered from Study Test 2 can be located in Chapter 13 (Figures 16 – 26). This data has been incorporated with that gathered from the other formative tests and is discussed in detail in Chapter 7. The other testing issues that were also identified included aspects of recognition and visual disturbance. These issues have been incorporated within a set of generic formative testing issues which are also discussed in Chapter 7.

The design of Study Test 2 impacted on Study Test 3. With regards to the character test, the use of isolated letterforms – particularly punctuation – was not helpful in producing meaningful data. Therefore a series of 7 letter character strings were used in Study Test 3

that contained similar letterform shape. The use of non-words in the word test produced some interesting outcomes. The word test in Study Test 3 was therefore expanded to include non-word pairs. During the sentence test, the use of the 200 most frequently used words was also considered to be limiting, therefore, the word range was increased. Lines from the poem *Night Mail (Commentary for a GPO Film*) by W.H. Auden were selected for Study Test 3 due to the strong rhythmic and repetitive nature of the stanzas. The repetition of words was not investigated in previous tests and their inclusion in Study Test 3 was to determine whether they are a factor in readability. The paragraph test in Study Test 2 was the only occasion throughout the entire testing process that readers were asked to read extended texts out aloud. This was in order to identify any misread words. Whilst the outcomes were interesting, the use of non-narrative texts coupled with reading aloud was considered to be problematic. Some readers found the process difficult and became physically fatigued after reading the tests. It was therefore decided to design subsequent paragraph tests to enable the subject to read silently, and in doing so, avoid a tiring and stressful experience. Because most reading is done using narrative rather than non-narrative texts, it was also decided to revert back to edited versions of the texts used in Study Test 1 for the paragraph test in Study Test 3

Study Test 3

Study Test 3 involved the comparative testing of Dine 3 (6.4) against Arial (5.2), Sassoon Primary (5.4), Times New Roman (5.3) and Dine 1 (6.2). During the previous tests some readers through a deductive process identified which typeface was the 'test' font. It was considered that such deductions may prejudice opinion and outcome. Therefore, the visually radical and unfamiliar Dine 1 was included in order to make the 'test' font, in this case Dine 3, less obvious. In order to accommodate Dine 1, Tiresias InfoFont, which was considered to be the previous group's least preferred typeface, was omitted. Both uppercase and lowercase forms were tested, thus enabling both recognition models to be incorporated within the testing process. The reader group comprised of 11 dyslexic participants and involved 4 tests.

The character test was designed to gauge reader recognition and perception of targeted characters identified as a result of recognition errors in previous tests. Using a rotational system, each reader was shown 10 seven-letter character strings set in 72 pt versions of each typeface. They were then asked to identify the middle letter, first letter, last letter, second letter and second last letter (Appendix A. 1.2).

The word test was designed to gauge reader recognition between non-word and real word pairings. The word pairs used contained letters which have either resulted in reader reversals or incorrect identifications in previous tests. Using a rotational system, each reader was shown 10 word pairs set in 36 pt versions of each typeface and asked to identify the real word (Appendix B. 2.3).

The sentence test was designed to gauge the readability and legibility of each typeface as multiple words within a sentence. The sentences contained strong rhythmic, rhyming and repetitive elements. Using a rotational system the group was shown 5 sentences set in 14 pt versions of each typeface. The readers were timed and asked to grade the readability of each typeface using a Likert Scale (Appendix C. 3.3).

The paragraph test was designed to gauge the readability and legibility of each typeface as extended text within a paragraph. It was a similar test to that used in Study Test 1. However, unlike Study Test 1 all of the paragraphs contained the same number of 150 words. Using a rotational system, each reader was shown 5 paragraphs. The lowercase paragraphs all accommodated a similar area of space, whereas the uppercase paragraphs were all set solid in 12 pt versions of each typeface. Before reading, each participant was asked to describe the visual tone of the text. The reader was then timed in order to establish a reading rate. Each paragraph contained a misspelt or non-word and the participant was invited to identify the 'wrong' word. The reader was also asked a series of questions about the meaning of the paragraph in order to gauge comprehension. Finally an order of preference was established based on each paragraph and also on all of the texts combined (Appendix D. 4.3).

A summary of the significant comparative typeface data gathered from Study Test 3 can be located in Chapter 13 (Figures 16 – 26). This data has been incorporated with that gathered from the other formative tests and is discussed in detail in Chapter 7. The other testing issues that were also identified included aspects of character confusion, hesitation, context and rhythm, rhyme and repetition. These issues have also been incorporated within a set of generic formation testing issues which are also discussed in Chapter 7.

The design of Study Test 3 impacted on the summative stage of developmental typeface testing in many positive ways. The word and sentence tests provided useful data. Therefore the tests were unmodified and incorporated into Study Tests 4 – 7. The character test, however, was slightly modified in that the letter string length was reduced from 7 to 4 letters. This was done in order to accommodate a more focussed set of character groups which had similar shape. Study Tests 4 – 7 therefore included character groups selected specifically because of their shape similarity. The paragraph test was also modified. In this instance, all texts were set in 12 pt versions of each typeface. Study Test 3 marked the end of formative developmental typeface testing.

4.8.2 Summative developmental typeface testing (Study Tests 4 – 7)

The summative stage of developmental typeface testing involved four study tests based on the design of Study Test 3. It allowed for the testing of the Sylexiad fonts against the other test typefaces. The key modification to this stage allowed for the inclusion of both internal and external dyslexic *and* control groups. During formative testing all the readers were art and design students based at Norwich School of Art and Design. Many of these readers may have had a propensity and possible bias towards the visual aspects of the typefaces

tested. It seemed appropriate, therefore, that future tests should include external readers outside the art school environment who may have a less pronounced interest in the visual elements of the fonts. With this in mind, the summative stage consisted of an internal trial at Norwich School of Art and Design and an external trial at the University of East Anglia. Both internal and external trials comprised of a dyslexic group and control group. The four studies comprised a total of 42 readers. The dyslexic group participants had all undergone a psychological assessment and all were found to experience specific learning difficulties (dyslexia). The control groups had no reading difficulties.

Study Tests 4 – 7

Study Tests 4 – 7 involved the comparative testing of Serif Sylexiad (8.6) and Sylexiad Sans (8.7) against the other test typefaces; Arial (5.2), Sassoon Primary (5.4) and Times New Roman (5.5). The reader groups comprised of 12 participants for Study Test 4 (internal dyslexic); 10 for Study Test 5 (internal control); 10 for Study Test 6 (external dyslexic) and 10 participants for Study Test 7 (external control).

The character test was designed to gauge reader recognition of targeted specific characters which have resulted in recognition errors (such as reversals) in previous tests. It was a smilar test to that in Study Test 3. However, unlike Study Test 3, 5 four letter character strings were set in 72 pt versions of each typeface (Appendix A. 1.3). The testing process was as in Study Test 3.

The word test (Appendix B. 2.3) and sentence test (Appendix C. 3.3) was unchanged from Study Test 3.

The paragraph test was designed to gauge the readability and legibility of each typeface as extended text. It was a similar test to that in Study Test 3. However, unlike Study Test 3 all texts were set in 12 pt test typefaces and used auto leading (Appendix D. 4.4). The testing process was as in Study Test 3.

A summary of the significant comparative typeface data gathered from Study Tests 4 – 7 is located in Chapter 13 (Figures 16 – 26). The summative data was gathered from each test and collated. Other issues raised as a result of these outcomes are also discussed in detail in Chapter 9. Study Tests 4 – 7 marked the end of the summative developmental typeface testing process.

4.8.3 Line spacing

One of the key principles of typographic legibility concerns line spacing or interlinear spacing. As McLean stated it "*is a vital factor in legibility, and can be stated as a rule of thumb that all continuous text matter is made easier to read by interlinear spacing*" (McLean, 1980, p.45). This view is supported by Reynolds (Reynolds, 1988, p.28), Carter, Day and Meggs (Carter et. al., 1993, p.91) and more recently Jury (Jury, 2002, p.94). As a dyslexic reader it is a view which I also subscribe to.

During the experimental formative stage of developmental typeface testing interlinear spacing was an important concern with regards to the testing of paragraphs. During Study Test 1 each paragraph was given the same equal leading. This resulted in texts being accommodated within unequal areas of space (Appendix D. 4.1). For example, the *Advertising* text set in Arial (Appendix 4.1.2) contained 182 words and accommodated 19 lines; whilst the *Music* text set in Times New Roman (Appendix 4.1.4) contained 152 words and was only 12 lines in depth. This discrepancy of 7 lines of space was considered to be a potential influencing factor on reader preference. There were also discrepancies in length within each generic paragraph. For example, the *Advertising* texts all had different depths ranging from 122 mm when set in Dine 1 (Appendix 4.1.1) to 81 mm when set in Times New Roman (Appendix 4.1.4).

Many dyslexic readers, myself included, consider long texts to be intimidating. After discussing this issue with Professor Roger Watt of the University of Stirling and Professor Arnold Wilkins of the University of Essex, both psychologists, a decision was made to accommodate subsequent *formative* test texts within a similar spatial area.

Therefore, for Study Test 2 the notion of equal leading was reversed. Each paragraph contained 10 lines and the same number of words. Non-narrative texts were justified within unequal interlinear space which ensured each text occupied the same equal area of space (Appendix 4.2). This more psychological, rather than typographic, approach to accommodating textual space was partly continued during Study Test 3. In this instance, the lowercase paragraphs had unequal leading and accommodated a *similar* area of space; whilst the uppercase paragraphs had equal leading and an unequal spatial area (Appendix 4.3). The experiment of mixing textual space values was, however, unhelpful in providing consistent outcomes.

The paragraphs used during the summative stage of testing therefore reverted back, as in Study Test 1, to auto leading. However, unlike Study Test 1, the paragraphs in Study Tests 4 – 7 all contained the same word count resulting in a depth disparity of only 2 lines (Appendix 4.4). The equal interlinear space between all of the summative test paragraphs ensured that no font was advantaged with greater leading and therefore greater readability.

4.9 Conclusion

The process of developmental typeface testing is unique within the field of typographic design research, and it formed the major practical component of my investigation. The testing for legibility is usually retrospective and summative in that typefaces are normally measured *after* they have been designed, never during or even before the design process. My developmental typeface testing model reverses this trend. By integrating both the design and testing processes, the typeface design can be modified *during* the testing procedure. This technique allows the design and testing of fonts to be a more flexible and

organic process. The main source of data gathering was through a series of evaluative studies, which therefore involved a formative *and* summative approach to the testing for legibility. The study tests incorporated two word recognition models. Firstly, the word shape model with regards to the testing of lowercase texts, and secondly, the parallel letter recognition model with regards to the testing of uppercase texts. These study tests resulted in the design and development of a series of unique typeface designs, which were tested on targeted dyslexic (and control) reader groups.

The initial design process was based on the visual anomalies (alphonomic difficulties) associated with the alphabet system which influence an dyslexic individual's ability to decode and encode language. This resulted in the design development and testing of the fonts Dine 1, Dine 2 and Dine 3 within the formative element of developmental typeface testing. The Dine fonts are what I term to be foundation, experimental or precursor fonts. They are *not* typefaces for the adult dyslexic reader, rather theoretical fonts whose development through a series of analytical, evaluative and modification processes have helped to inform the summative element, which was the design and development of Sylexiad. The design of Sylexiad by means of summative developmental typeface testing will help to inform contemporary attitudes to contemporary dyslexia typeface design. Sylexiad can be seen as the first variant of a typeface for the adult dyslexic reader.

5. Test typefaces and other typefaces.

5.1 Introduction

This chapter describes and provides a commentary on all the typefaces tested against the Dine and Sylexiad fonts as part of the developmental typeface testing procedure. It would be useful to repeat here a point made earlier in my Introduction (1.3.3) that Arial, Sassoon Primary and Times New Roman were used throughout the testing process. These fonts were selected because they were commended by dyslexia organisations and also because they have a distinct and different form from each other. Although the majority of dyslexia typeface recommendations are generally for sans-serif styles (British Dyslexia Association, 2000, p.1), the differences in style between the test fonts enabled categories to be established concerning form. Therefore, the three main typefaces used throughout are what I refer to as "archetypal" or "standard fonts". Arial is used as a "*standard sans-serif font*", Sassoon Primary as a "*standard handwritten-style font*" and Times New Roman as a "*standard serif font*".

There is also commentary on other typefaces which have been associated with the condition of dyslexia, and those typefaces which have either directly or indirectly influenced this investigation.

5.2 Arial

Arial (Figure 5) (13.2.1) is a sans-serif web font, which was designed by Robin Nicholas and Patricia Saunders in 1992. It is published by AGFA – Monotype and Microsoft Typography. It has a relatively large x-height in comparison to its ascenders and descenders and it was designed to match the proportions, weight and overall look of Helvetica. Indeed, it was specifically developed by Monotype as a substitute for Helvetica (Simonson, 2001, p.3). Arial was selected and used by Microsoft as the standard font format for Windows 3.1. This decision has made Arial a familiar and almost ubiquitous typeface. The easy availability of Arial may provide an explanation for its recommendation by the British Dyslexia Association as the "*preferred*" dyslexia friendly sans-serif font (British Dyslexia Association, 2000, p.1). Arial was used as a "*standard sans-serif font*" for all seven developmental typeface testing study tests.

5.3 Times New Roman

Times New Roman (Figure 7) (13.2.3) is a modern serif font which has been based on old style serifs, specifically a specimen of "modernised Plantin" (Baines, 2001, p.57). It was designed in 1932 by Stanley Morison, Victor Lardent and Starling Burgess, and was developed by *The Times* newspaper for its own use. Legibility research undertaken at the time resulted in a design that was more condensed, closely set and had more contrast than

previous newspaper fonts (Moran, 1971, pp.23-139), (Dreyfus, 1973, p.167), (Tracy, 1986, pp.194-210) and (Carter, 1987, pp.91-93). The typeface contains a combination of sloping and horizontal serifs. It is particularly legible when set as small line lengths in narrow newspaper columns, due to the relatively large and narrow x-height.

As with Arial, Times New Roman has become a familiar and almost ubiquitous typeface. "*Although figures are impossible to come by and compare, it is arguably the most widely used roman typeface in the world*" (Carter, 1987, p.88). "*Times is the most successful type of this century, and has outsold its nearest rival in the Monotype list by nearly two to one*" (Carter, 1987, p.93). It was suggested by Bevé Hornsby from the International Dyslexia Centre that texts for the dyslexic reader should be set in serif faces (contrary to the sans-serif recommendations of the British Dyslexia Association) and particularly Times New Roman (Hornsby, 1984, p.71). Times New Roman has therefore been used as a "*standard serif font*" for all seven developmental typeface testing study tests.

5.4 Sassoon Primary

Sassoon Primary (Figure 6) (13.2.2) is a sans-serif font designed by Rosemary Sassoon in 1984. It forms part of a family of Sassoon fonts which includes Sassoon Infant and Sassoon Sans. The typeface was developed as a result of research into "*the effects of models and teaching methods on the way children learn to join up their handwriting*" (Club Type, Sassoon, 2002, p.1). The opinions and judgements of young children were investigated and their comments informed the design of Sassoon Primary (Sassoon, 1993, pp.150-177, Daines, 1997, pp.33-40 and Sassoon, 2002, pp.118-131). The typeface is based on handwriting insofar as "*the movement of the arches and bowls reflect the movement of written form*" (Sassoon, 2005, p.1) and it contains several pronounced stroke exits; it is also slightly italicised with relatively long ascenders and descenders.

The Sassoon fonts have been recommended by both Dyslexic.com (Dylsexic.com, 2000, p.1 and Dyslexic.com, 2004, p.1) and also the British Dyslexia Association (British Dyslexia Association, 2000, p.1). Although Sassoon Primary is not a handwritten font per se, the decision to include it as part of the testing procedure (rather than the other forms of Sassoon) was due to its handwritten and italicised appearance. It has therefore been used as a "*standard handwritten font* " in all seven developmental typeface testing study tests.

5.5 Tiresias InfoFont

Tiresias InfoFont (Figure 8) (13.2.4) is a sans-serif font designed in 2000 by the Royal National Institute for the Blind (R.N.I.B.) under the direction of John Gill. It forms part of a family of three Tiresias fonts which have been designed for specific interfaces such as screen-based systems, signs and labels. Tiresias InfoFont was specifically designed to

improve the legibility of information signs in public terminals for people with impaired vision, providing maximum legibility at a reading distance of 30 to 100 cm (Tiresias Fonts, 2002, pp.34-40). Although not recommended by any dyslexia organisation, it was considered to be an interesting contemporary typeface to use in the developmental typeface testing process due to its specific targeted audience and its particular form. Tiresias InfoFont is a heavy font compared to the other test typefaces, it also contains a relatively large (and narrow) x-height and relatively short ascenders and descenders. it was used as the "*standard bold font*" on two occasions to test Dine 1 in Study Tests 1 and 2.

5.6 Read Regular

Read Regular is a sans-serif font which was designed by Natascha Frensch in 2003 at the Royal College of Art. It is a typeface specifically designed for dyslexic readers; the particular issues of letter reversals in pairs (such as 'b' and 'd' and 'p' and 'q') and letter spacing were important in the development of the font (Frensch, 2003, p.29 and Lantin, 2003, p.16). The typeface has a large x-height and relatively short ascenders and descenders. It also has slightly inconsistent stroke widths which gives the font a handwritten feel. Read Regular is, at the time of writing, unavailable for use on a computer, but is has been recommended by Dyslexic.com (Dyslexic.com, 2004, p.1).

5.7 MasLudica

MasLudica is an experimental sans-serif font based on Helvetica and Ludica; it was designed by Hrant Papazian in 1998. By dividing the alphabet into modules and similars (4.6.1), the structure of each letterform was manipulated in order for each character to be as distinct and different from each other without compromising the meaning of the characters. This "*maximisation of character contrast*" (Papazian, 1999) contributes to more distinct word shapes, or what Papazian referred to as "*boumas*" (Papazian, 1999, Papazian, 2000, p.123 and MacDonald, 2000, p.116). MasLudica is a monocase font with several inconsistent stroke exits. It has a large, but irregular x-height width and relatively short ascenders and descenders. It is a controversial, yet important typeface which has influenced the design of Dine 1.

5.8 Helvetica

Helvetica is a sans-serif font designed by Max Miedinger in 1957, and developed by the Haas Foundry of Switzerland. Haas was to later merge with Linotype where more weights were added. It is a clean-looking, almost neutral typeface with a relatively large x-height in comparison to its ascenders and descenders. In the 1960's the font became synonymous with the Swiss School of Typography and reflected modern and progressive attitudes

(Simonson, 2001, p.2 and Müller, 2003, p.6). However, during the 1970s and 80s it became *the* ubiquitous sans-serif typeface and fell out of fashion within the typographic design community (Bierut, 1999, p.256 and Müller, 2003, p.10). Nonetheless, it is a hugely influential and important typeface. Its impact on this research project has been great (if somewhat indirect) in that the designs of both Arial and MasLudica were based on the weight and form of Helvetica.

5.9 Comic Sans

Comic Sans is a sans-serif web font designed by Vincent Connare in 1994. It is a font that has been based on cartoon and comic script text. It was originally intended to be used in speech balloons in Microsoft 3D Movie Maker (Comic Sans Café, 2002, p.2). In 1995 it was bundled with most copies of Windows and has subsequently become a popular and somewhat ubiquitous typeface. With regards to dyslexia; "*One unexpected result was a UK study of dyslexic reading abilities where Comic Sans came out ahead of other (more normal) common fonts. The experimenters cited the design's simple forms for 'a' and 'g', so the result may be due to the researcher's unfamiliarity with the hundreds of other fonts that share these characteristics, or (more charitably) their deliberate focus on commonly available fonts*" (MyFonts.com, 2002, p.1). Whatever the reason for this outcome, Comic Sans is a clean-looking and slightly italicised font with relatively long ascenders and descenders. It has been recommended by Dyslexic.com (Dyslexic.com, 2000, p.1 and Dyslexic.com, 2004, p.2).

5.10 Olsen Regular

Olsen Regular is a serif web font designed by Morten Rostgaard Olsen specifically for the dyslexic reader. Its design has been informed by reading difficulties such as letter reversals (Gyllan, 2002, p.49). Olsen Regular has short, but distinct serifs, a large x-height and relatively short ascenders and descenders.

5.11 Cecilia

Cecilia is a serif typeface designed by the children and teenage book publisher Barrington Stoke. Their books are aimed at reluctant, underconfident and disaffected readers which includes dyslexic readers. Cecilia was "*specifically designed with modified individual letters to encourage a smooth and easy read*" (Barrington Stoke, 2003, p.3). The typeface, despite its serif form, has a handwritten quality with distinct serifs and pronounced stroke exits. It has relatively long ascenders and descenders and a generous interletter spatial quality.

5.12 Trebuchet MS

Trebuchet MS is a sans-serif web font designed by Vincent Connare in 1996. It is published by Microsoft Typography and was originally available for free download as part of Microsoft's package of True Type core fonts for the web (Identifont, Trebuchet MS, 2002, p.1). It was designed for easy screen readability and has a large x-height, relatively short descenders but longer (though still short) ascenders. Trebuchet MS has been recommended by Dyslexic.com (Dyslexic.com, 2004, p.2).

5.13 Peignot

Peignot is an experimental sans-serif display font designed by A.M. Cassandre in 1937. The lowercase characters contain both lowercase *and* uppercase forms and include thick and thin strokes, a large x-height and relatively long ascenders and descenders. Although originally designed for posters it has been used successfully (and unusually) as extended text (Baseline, 1988, p.18). Cassandre stated that "*the idea of mixing the letterforms of capitals and lowercase seemed to us to contain the seed of new developments within traditional lines*" (Heller and Pomeroy, 1997, p.117). This idea of combining letterforms to produce new developments seemed appropriate and pertinent to dyslexic issues, especially during the analysis of dyslexic handwriting. The radical lowercase form of Peignot subsequently influenced and informed the initial development of Dine 1.

5.14 Conclusion

Throughout this chapter I have described those typefaces which have been recommended by various dyslexia organisations, those typefaces used as part of the developmental typeface testing procedure and those typefaces that have influenced the Dine and Sylexiad fonts.

Fonts recommended by dyslexia organisations

Since 2000, *all* of the recommendations for dyslexia friendly fonts by Dyslexia.com and the British Dyslexia Association have been for sans-serif fonts. The only recommendation for a serif font (Times New Roman) was by Hornsby from the International Dyslexia Centre, and that was in 1987. Most of the recommendations have been for relatively recently designed fonts which have been developed specifically for the web as screen-based fonts (such as Arial, Comic Sans and Trebuchet MS), rather than those designed specifically for print (Times New Roman and Helvetica).

The recommendations are therefore based on which fonts are most effective when viewing a screen rather than which work best for viewing print, and which fonts are generally available. To highlight the point, Arial rather than Helvetica is often cited as a favoured

dyslexic typeface. Within the general typographic community, however, most would agree that "*Arial is little more than a shameless imposter*" (Simonson, 2001, p.1) and that it is "*a not-very-faithful imitation of a typeface that is no longer fashionable*" (Simonson, 2001, p.2). The reason Arial rather than Helvetica, and Comic Sans rather than other comic style fonts, and Trebuchet MS rather than other 1930's style humanist typefaces are recommended seems to be partly due to the general availability of those fonts as software bundles and partly an unfamiliarity of those organisations of other alternative typeface designs.

Archetypal fonts

Throughout the developmental typeface testing procedure it was important to test against a broad range of font '*types*', those that have different forms. These test fonts are what I refer to as "*archetypal*" or "*standard fonts*". They are: Arial, "*the standard sans-serif font*"; Times New Roman, "*the standard serif font*"; Sassoon Primary, "*the standard handwritten font*" and Tiresias InfoFont "*the standard bold font*". All of these fonts, with the exception of Tiresias InfoFont, have been recommended by dyslexia organisations.

Monocase fonts

An analysis of monocase fonts, especially the design of MasLudica (as well as the lowercase form of Peignot), highlighted a compatibility of those forms with Silverman's diagnostic dyslexic handwriting checklist. This, coupled with Javel's theory regarding the primacy of ascenders, resulted in the monocase design and development of Dine 1 being influenced by those particular fonts.

Handwritten fonts

During the latter stages of the formative developmental typeface testing process it became apparent that long ascenders and descenders and relatively short x-heights accentuate lowercase word shape. These features therefore became an important factor in the development of a typeface for the adult dyslexic reader. The handwritten style of Comic Sans, Cecilia and in particular Sassoon Primary all contain such features and became influential in the design and development of the Sylexiad fonts.

Generic typographic features

The typefaces cited in this chapter have all (either positively or negatively), informed the design and development of both the Dine and Sylexiad fonts. I have not, however, used *specific* elements or features of characters from any of those fonts and adapted them. The approach to the design and development of the precursor fonts was more generalistic, holistic and developmental involving the integration of generic typographic features rather than specific detail.

For example, as a result of reader comment produced during the developmental typeface testing of the Dine fonts (coupled with my own views as a dyslexic reader); the generic features of long ascenders and descenders found in Sassoon Primary and the short serifs of

Cecilia have had a positive (although indirect) influence on the appearance of Serif Sylexiad. Conversely, and more negatively, the intrinsic boldness of Tiresias InfoFont was not particularly favoured by readers in Study Test 1, which resulted in the strokes of subsequent precursor fonts being light rather than heavy.

There is a more detailed discussion in Chapters 6 and 8 regarding the design and development of the Dine and Sylexiad fonts, and how developmental typeface testing has impacted on those designs.

6. The precursor fonts. Dine.

6.1 Introduction

The Dine fonts are what I term to be precursor (or experimental) typefaces. They are *not* typefaces for the adult dyslexic reader, rather theoretical fonts that have been modified during the developmental typeface testing procedure. The design development of the Dine typefaces have in turn helped to inform the Sylexiad fonts, the first version of the adult dyslexia typefaces.

This chapter will explain how reader comment gathered during the developmental typeface testing process, coupled with my own insights as a dyslexic reader, have influenced each subsequent version of the Dine typeface.

6.2 Dine 1

6.2.1 Influences

The design approach to develop Dine 1 (Figure 9) (13.3.1) is experimental and radical and has been described in detail in Section 3.3. The typefaces that have indirectly influenced Dine 1 were MasLudica designed by Papazian using his aforementioned paradigm of modules and similars and also Helvetica designed by Miedinger. It is interesting to note that MasLudica itself was based on the design of Helvetica (Papazian, 1999). The lowercase form of Peignot designed by Cassandre was also indirectly influential in the development of Dine 1.

6.2.2 Design concept

The major design concept with regards to the development of Dine 1 was to provide each individual character with a distinct form which would therefore maximise its unique shape without losing any meaning associated with that shape. It was based on an extreme interpretation of the word shape model. This design approach would theoretically overcome the symptom of letter reversals in characters such as c, n and u, and N and Z, which has been identified as a key indicator of dyslexia (British Dyslexia Association, 2000.b., p.1). In order to facilitate this idea in the most effective and economical way, the alphabet was designed as a monocase.

The radical monocase form of Dine 1 can be viewed as almost illegible. It was, however, an appropriate starting point for developmental typeface testing as it easily facilitates subsequent font development into less radical and more legible forms. Of all the test typefaces, Dine 1 can be seen to be the font with most shape.

6.2.3 Design structure

Dine 1 is a radical monocase sans-serif font. It includes a combination of multiple x-heights which vary in width (from the broad to the narrow) and size. It also contains a range of different sized ascenders and descenders. The descenders tend to be shorter than the length of the ascenders.

Dine 1 is a font which contains *relatively* light strokes. The strokes combine to form an inconsistent range of shapes from the angularity of the letter 'A' to the softer, more rounded form of the letter 'W'. The font is perpendicular (with the exception of the letter S) and asymmetric. Dine 1 contains 52 characters; these include 26 letters, 10 numerals and 16 punctuation and auxiliary marks.

Space

The success of a typeface depends on setting. As Maag stated "*perfectly legible type set too tightly will become near undecipherable*" (Maag, 2006). Conversely, Reynolds suggested "*the spacing must not be so great that the horizontal emphasis … of the line is destroyed*" (Reynolds, 1988, p.28). In order to comfortably accommodate the combination of upper and lowercase letters (in what may be considered a *less than* legible typeface), and to test Reynolds' notion of horizontal emphasis Dine 1 contains generous inter-letter and inter-word spacing. The use of wide (and somewhat inconsistent) setting also conforms to the spirit and radical nature of the font.

6.2.4 Analysis and evaluation

The general consensus of opinion from the readers was that Dine 1, although "*visually interesting*" (Reader AG), was very difficult to read and "*confusing*" (Reader AB). The readers highlighted four main areas of concern and interest. They were: 1, the unfamiliarity of the typeface; 2, the inter-letter and inter-word spatial quality of the typeface; 3, the structure of the typeface and 4, the lack of visual disturbance.

6.2.4.1 Unfamiliarity

The unfamiliarity of the font was challenging for most readers. One reader summed up the general consensus, stating that "*unfamiliar words became a problem when reading an unfamiliar font*" (Reader AE). However, as Burt remarked, "*in changing to a fresh or unfamiliar typeface, the reader needs time to become adequately adapted*" (Burt, 1959, p.5). This view was echoed by other members of the group. "*The greater the familiarity the faster the read would be, and if* (you get) *used to reading the text in this face it may be agreeable*" (Reader AF). Unfortunately due to the structure of the research process the group had little or no time in which to familiarise themselves with the radical forms of Dine 1. Therefore, for subsequent fonts, rather than continue with the radical monocase form, more mainstream typographic

design forms which would be more readily acceptable for readers seemed appropriate for future precursor font design.

6.2.4.2 Space

The relatively large inter-letter and inter-word spatial units were considered by many in the group to be both "*distracting and problematic*" (Reader AG) and may confirm Reynolds point concerning the horizontal emphasis of a line. This problem, however, may not be simply due to the spatial quality alone, but rather the combination of space *and* the radical monocase form of the alphabet. In order to test this view, subsequent fonts were modified to accommodate more mainstream forms yet still include relatively large spatial units.

6.2.4.3 Structure

Many readers disliked the monocase structure and the multiple heights of the letterforms. With regards to the monocase aspect of the alphabet, the structure made "*reading difficult*" (Reader AD), and was "*contrary to how people were taught to read*" (Reader AG). Conventionally, new sentences generally usually start with an uppercase letter rather than a lowercase letter, and the middle section of a word would normally comprise exclusively lowercase letters. This situation was reversed when the text was set in Dine 1 resulting in lowercase letterforms often starting a word, and isolated uppercase letterforms being situated in the middle of a word.

The multiple heights of the letterforms made the words appear uneven and irregular, especially at the "*top of a line of text*" (Reader AH). This had an adverse effect on the fluency of the read. However, some readers liked the irregularity and suggested that it was easier to remember, and facilitated greater comprehension. "*Although a slow read, the accuracy* (of comprehension) *may be high*" (Reader AH).

To overcome these issues, the structure of subsequent fonts was modified to embrace more familiar, less irregular though still radical forms.

6.2.4.4 Visual disturbance

Some readers experienced "*a lack of visual disturbance*" (Reader AD) or glare when reading the texts. This reduction in glare may be due to the combination of relatively large inter-letter and inter-word spatial quality and the relatively lightness of letter stroke. As Hornsby argued, for dyslexic readers "*contrary to good typographic practice for fluent readers, a wide space should be used to give clear separation of words, and a double word space at the end of sentences*" (Hornsby, 2002). This advocation of large spatial quality correlates

with my own findings and views as a dyslexic reader. Therefore, the practice of using a combination of relatively light letter strokes with a large inter-word spatial unit was retained for subsequent font designs in order for some readers to experience reduced glare.

6.3 Dine 2

6.3.1 Influences

The development and design of Dine 1 had a profound influence on the subsequent design and development of Dine 2 (Figure 10) (13.3.2). The other major influences in the development of the font were more generic. The uppercase letters were indirectly influenced by two sources. Firstly, the sans-serif forms of the late '1920's' and early '1930's', specifically Futura designed by Paul Renner and Gill Sans designed by Eric Gill. Secondly, fonts based on handwriting and hand-written "printed" letterforms, especially the Sassoon family of fonts designed by Rosemary Sassoon.

6.3.2 Design concept

The radical form of Dine 1 was generally disliked by the readers in Study Test 1. The design concept therefore for the development of Dine 2 was modified yet still based on the word shape model. The design continued to allow each individual character its own distinct form, in order to maximise its unique shape without compromising any meaning associated with that shape. Unlike the monocase form of Dine 1, however, this concept was developed as a duocase alphabet. Dine 2, although still radical in form, therefore contains a set of lowercase and uppercase characters.

6.3.3 Design structure

Dine 2 is a duocase sans-serif font which has evolved as a result of the developmental typeface testing of Dine 1. In its lowercase form it includes characters which have a combination of multiple x-heights which vary in width and size. The x-heights are generally wide and appear large in comparison to the relatively short ascenders and descenders. The length range of the ascenders and descenders are varied, however the descenders tend to be shorter than the ascenders. In order to facilitate the notion of maximum character shape, the generic uppercase forms of the letters 'A' and 'N' were included as part of the Dine 2 character set.

The uppercase form is more regular in terms of height with only the vertical and diagonal strokes of the letters 'B', 'K', 'N' and 'V' protruding beyond the standard capital letter height. The only stroke below the capital letter height is that of the letter 'U'. With the exception of the tail stroke of the letter 'Q', no strokes have been drawn below the baseline. In comparison to the lowercase Dine 2 set, the uppercase set can be viewed as being less radical, more regular and more mainstream in terms of design.

The Dine 2 numerals are irregular in terms of character height, although with the exception of the numeral '9', no character strokes have been drawn below the baseline.

A *general* preference for lighter rather than heavy strokes was expressed by the readers in Study Test 1; therefore, Dine 2 has the same stroke width as Dine 1. The font (with the exceptions of the lowercase letter 'S' and uppercase letter 'S') is also perpendicular and asymmetric. The inter-letter setting in Dine 2 was tighter and more consistent than that of Dine 1, however, a generous inter-word spacing was maintained. These features provide a continuity of design between Dine 1 and Dine 2. Dine 2 comprises a total of 76 characters; these include 26 lowercase letters, 26 uppercase letters, 10 numerals and 14 punctuation and auxiliary marks.

6.3.4 Analysis and evaluation

The general consensus of opinion from the readers found Dine 2 to be the median font. Extended texts in the form of paragraphs showed that the uppercase versions of the font were more favoured (both quantitatively and qualitatively) by the readers than the more irregular lowercase forms. The readers highlighted the same four main areas of concern and interest that were identified in the developmental typeface testing of Dine 1. They were: 1, the unfamiliarity of the typeface; 2, the spatial quality of the typeface; 3, the structure of the typeface and 4, visual disturbance.

6.3.4.1 Unfamiliarity

The unfamiliarity of both forms (lowercase and uppercase) of the font was identified. However, this did not appear to be unduly problematic for the readers. "*It was OK once the words were identified, after reading a couple of lines the words became familiar*" (Reader AP). Future designs, however, although still radical and idiosyncratic, were developed to provide more familiarity with a view to increase the overall reader preference rating.

6.3.4.2 Space

The large inter-word spacing was noted by the group and generally favoured. "*The space between the words made it clearer*", (Reader AJ) and "*I like the spacing, it's not as muddled and I can catch the words*" (Reader AL). Unlike Dine 1, these outcomes challenge the importance of horizontal emphasis in a line. Subsequent designs therefore continued to retain relatively large inter-word spacing.

6.3.4.3 Structure

There was confusion experienced by readers concerning uppercase letters being part of the lowercase set. This caused the text to look "*disjointed*" (Reader AP). The fact that some capital letters were "*in the middle of a word*" (Reader AN), was problematic. These reactions support Morison's view that

"*people will tolerate novelty in alphabetical shapes and combinations provided all they do is render explicit the logic implicit in earlier forms; and only then*" (Morison, 1959, p.xii). It seemed worthwhile and appropriate that subsequent designs should become more regular in order to overcome reader confusion, without losing *all* of the radical design features used in order to enhance and maximise character shape.

6.3.4.4 Visual disturbance

Views were mixed regarding the phenomenon of visual disturbance. Some readers found Dine 2 to be "*tiring*" (Reader AQ) in comparison to other fonts. Others, however, "*liked the slimline text*" (Reader AI) and found it to be "*clear in my mind*" (Reader AJ). The practice of using light letter strokes combined with large inter-word spatial units was retained for future designs.

6.4 Dine 3

6.4.1 Influences

The development and design of Dine 2 has informed and influenced the subsequent development and design of Dine 3 (Figure 11) (13.3.3).

6.4.2 Design concept

Dine 2 was considered to be the median font by readers in Study Test 2. The design concept, therefore, for Dine 3 was to modify the perceived "*irregularities*" of form, whilst continuing to maximise the shape of each character. The design of Dine 3 was a less extreme form of previous versions.

6.4.3 Design structure

Dine 3 is a duocase sans-serif font which evolved as a result of the developmental typeface testing of Dine 2. It is the last of what I term to be precursor fonts. In its lowercase form it includes characters which (for the first time with the precursor fonts), have consistent x-heights. The x-heights are wide and appear large in comparison to the relatively short ascenders and descenders. The length range of the ascenders and descenders are much more consistent than those of previous precursor fonts. For the first time the descenders appear to be longer than the ascenders. The notion of character shape is still present in the design of Dine 3 (for example the shape of the lowercase letter 'f' and the form of a generic uppercase letter 'N' included as part of the lowercase set); however, because the form of the alphabet is more regular, familiar and conventional it has become a secondary factor in the design structure. Of all the test typefaces, Dine 3 can be seen to be the font with least shape.

The uppercase version of Dine 3, again, for the first time with the precursor fonts is very regular in terms of height. The characters are also relatively wide in form. There are no strokes drawn beyond the standard capital height and, as with Dine 2, the only stroke to be drawn below the baseline is the tail of the letter 'Q'.

Throughout the entire developmental typeface testing there has been a general preference expressed by the readers for light strokes. The stroke of Dine 3 has therefore retained the same width as those of Dine 1 and Dine 2 in order to comply with this preference (and also provide a design continuity between all the precursor fonts). Dine 3 is perpendicular and asymmetric in form, it contains relatively tight inter-letter spacing in comparison to its generous inter-word spacing. It comprises a total of 76 characters; these include 26 lowercase letters, 26 uppercase letters, 10 numerals and 14 punctuation and auxiliary marks.

6.4.4 Analysis and evaluation

There was a generally favourable response to Dine 3. Readers considered it to be the preferred typeface during Study Test 3. Interestingly, when Dine 3 was set as an extended text in the form of a paragraph the lowercase version of the font was more favoured by the readers than the uppercase version. This is not a particularly unusual finding, however it does reverse the findings for Dine 2 and indicates that the more regular and conventional forms for lowercase characters produce greater readability preferences. As in previous tests, the same areas of concern and interest were identified by the readers. They were: 1, the spatial quality of the typeface; 2, the structure of the typeface and 3, visual disturbance. However, it is interesting to note that the issue of unfamiliarity was *not* raised which tends to highlight and reinforce the more conventional form of Dine 3.

6.4.4.1 Space

As in previous tests, large inter-word spacing was generally favoured. The text set in Dine 3 "*was well spaced out*" (Reader AW and Reader AZ) which "*helped a lot*" (Reader AV). It has to be noted, however, that some readers found the large spatial units in the text "*hard to read*" (Reader AT). Whilst it goes against perceived conventional typographic rules of good practice, it was considered that, on balance, further designs should continue to accommodate large inter-word spatial units. (Although not to the same extent as the Dine fonts.)

6.4.4.2 Structure

There was not the same level of comment concerning the irregularity of the font compared to previous tests. This would seem to reflect the regularity of form of both the lowercase and uppercase versions of Dine 3. One reader was, however, "*put off by the capital N's*" (Reader AY) within the lowercase set. This mixing of generic characters within the lowercase set is still clearly problematic for some readers. It seems appropriate, therefore, that subsequent

designs should include only the conventional and regular generic forms within each lowercase and uppercase set yet *still* strive for maximum character shape within that particular format.

6.4.4.3 Visual disturbance

Again, as in the previous study test, views regarding visual disturbance were polarised. The Dine 3 text was "*not as blurred as others*" (Reader AZ) and it "*didn't mess with my eyes, I didn't go back on anything at all*". (Reader BC). Other readers, however, thought the text "*didn't flow as much as I expected*" (Reader AV) and that it "*jumped around the page a lot*" (Reader AT). Despite the polarity of views it was still considered worthwhile to continue with the combination of light letter strokes and large spatial units in future designs.

6.5 Conclusion

The development and evolution of the Dine fonts from a radical almost illegible monocase font to a more conventionally legible (yet still radical) duocase font is significant. The theoretical tenets on which Dine 1 was built comprised grounding the design in irregular dyslexic handwriting which would assist in providing the maximum shape of a character, which would in turn provide enhanced word shape. The word shape model, favoured by most typographers and on which the Dine fonts were based, implies that good contrast in word shape is considered to be good typographic practice. This maxim was taken to extremes and became more diluted as reader comment from the developmental typeface testing informed subsequent designs of Dine. The final version of Dine 3, although still radical in attempting to provide distinct character shape, became more conventional and regular in form. Dine 3 was the font with *least* shape yet was the *most* preferred for the dyslexic readers. This finding raises questions about the effectiveness of the word shape model.

The form of Dine 3 appeared at odds with the extreme form of Dine 1 and its associated theoretical tenets. It seemed apparent that future design developments should avoid mixing generic forms, specifically the incorporation of uppercase forms within a lowercase set; and in doing so embrace simple, clean and regular forms yet *still* attempt to provide maximum character contrast within that particular idiom.

The constant factors throughout the development of the Dine fonts have been the relatively light letter strokes and large inter-word spacing. This combination of features helped to reduce visual disturbance for some dyslexic readers, and was therefore maintained in future designs.

7. The outcomes of formative developmental typeface testing (Dine).

7.1 Introduction

The aims of my investigation were threefold. The first aim was to test the existing typefaces which have been recommended by various dyslexia organisations. During the formative stage of testing, these typefaces included: Arial (5.2) recommended by the British Dyslexia Association; Sassoon Primary (5.4) recommended by Dyslexic.com and the British Dyslexia Association and Times New Roman (5.3) recommended by the International Dyslexia Association. As well as these fonts, Tiresias InfoFont (5.5) was also tested as it is one of the few fonts to be designed for a specific audience (in this case, the visually impaired).

The second aim was to test my own typefaces in order to establish which typographic characteristics adult dyslexic readers prefer to read and why. In terms of the formative stage of developmental typeface testing these typefaces included: Dine 1 (6.2), Dine 2 (6.3) and Dine 3 (6.4). The Dine fonts are not typefaces for the adult dyslexic reader. They are, however, theoretical fonts that informed the Sylexiad fonts which are indeed the first versions of a typeface for the adult dyslexic reader.

These two aims have helped to facilitate my third aim which was to contribute new knowledge to the field of contemporary dyslexia typeface design.

In order to fulfil these aims, the formative stage of developmental typeface testing had distinct limits and parameters. The focus was on four areas of interest. Firstly, the personal dyslexic (or alphonomic) reading difficulties as experienced and recounted by the participants and the resultant typographic preferences. Secondly, the text formation issues which concerned the reading of individual characters, words, sentences and paragraphs and the resultant typographic preferences. Thirdly, the generic typographic design issues concerning aspects of style, form, variability and associated reading issues and the resultant typographic preferences. Finally, the Dine design issues and the resultant typographic preferences.

The objective of my research was to design a typeface for the adult dyslexic reader, and in doing so, develop a new typeface testing model. This objective had *not* been achieved during the *formative* stage. Although the formative study tests have helped to inform subsequent tests, the structure of the formative stage was experimental. Therefore, a *definitive* testing model was not yet realised. Also, as I have stated previously, the Dine fonts were not designed as dyslexic typefaces. The outcomes of the formative stage of developmental typeface testing has, however, informed the summative stage. This has, in turn, provided answers to questions relating to my research objectives (9.1). The formative stage of developmental typeface testing can therefore be seen as facilitating the aims of my research and the summative stage, the aims *and* objectives of my research.

A summary of the significant data gathered from the formative stage of developmental typeface testing is located in Chapter 13 (Figures 16 – 26). The issues raised as a result of these outcomes are discussed in detail in this chapter. Specifically, the chapter will highlight the outcomes of the dyslexic issues (7.2), text formation issues (7.3) and typographic issues (7.4) which have been identified as a result of the formative developmental typeface testing of the Dine fonts. There is also a discussion of the outcomes of the Dine design issues which emerged (7.5). In addition there is an explanation of how these outcomes have resulted in the concept, development and design of the Sylexiad fonts (7.6).

7.2 Dyslexic issues

The formative element of the developmental typeface testing procedure comprised three consecutive study tests. During Study Test 2 and Study Test 3 the reader groups were asked if they had any problems reading, and if so, how were those problems manifested. This exercise involved 21 participants and represented a total of 72% of the entire formative reader population.

The responses to the exercise identified five areas of difficulty which concerned dyslexia. They were: 1, reading difficulties; 2, visual stress difficulties; 3, comprehension difficulties; 4, psychological difficulties and 5, typographic difficulties.

7.2.1 Reading difficulties

The reading difficulties experienced by the participants are all interlinked but can be classified into five areas. These areas are: 1, slow reading; 2, decoding issues; 3, re-reading; 4, skip reading and 5, numeric issues.

7.2.1.1 Slow reading

All of the difficulties highlighted impact on and contribute to slow reading. Of the 21 participants who responded to the exercise, 7 admitted to slow reading performances. This accounted for 33% of the group. Of this percentage, 57% expressed a preference towards Arial as their favoured typeface when reading while 42% considered Times New Roman to be the least favoured.

As a dyslexic reader myself, I also suffer from a slow reading time when reading extended texts. My typographic preference however is contrary to that of the majority of the group. I favour Times New Roman over Arial. I find the seriffed quality of the font helps to link each letter (and word) to the next letter (and word).

The reason as to why Arial is preferred by the majority *may* be due to its sans-serif nature and therefore 'clean' visual appearance. This 'clean' quality, I suggest, *looks* easier to read rather than actually *being* easier to read.

Conversely, the seemingly more 'complex'; seriffed quality of Times New Roman may also suggest to the reader a more difficult and therefore slower read than it actually is.

The qualities and tone of a typeface can subconsciously trigger signals relating to legibility and readability which have a direct relationship on issues such as slow reading. The qualitative preference for Arial by the slow readers is contradicted (in some cases) by the outcomes of the quantitative Rate of Reading Tests. Times New Roman accounted for the highest words per minute rate in both Study Test 1 and Study Test 2. Arial did however provide a higher word per minute rate in Study Test 3 (Figure 23). For a more detailed account of the RRT outcomes please refer to 7.3.4.2.

7.2.1.2 Decoding issues

All of the decoding issues highlighted result in slow times for dyslexic readers. Decoding issues can be sub-divided into five areas. These sub-areas include: 1, difficulty in reading aloud; 2, decoding words; 3, pronouncing words; 4, misreading words and 5, comprehending words.

Difficulty in reading aloud

Only 14% of participants admitted to problems when reading aloud. Of this percentage, 67% favoured those texts set in Arial while 67% considered Dine 2 to be their least favoured typeface. Because of the small group sample, the preference percentages are not particularly significant. I suspect that not all participants disclosed problems when reading aloud and that the actual figure within the group may be much higher. I also experience difficulty when reading aloud and consider it to be a major manifestation of my dyslexia. The difficulty in reading aloud can be seen to be as a result of the following decoding issues.

Decoding words

A difficulty in decoding words (particularly long words) was highlighted by 9% of the group. Although the sample was small and therefore not particularly significant, it is worth noting that Times New Roman was considered to be the least favoured typeface for *all* of those participants expressing difficulty in this area.

Pronouncing words

The pronunciation of words is linked to the previous issue of decoding words and was highlighted by 9% of the group. As previously stated, the sample was small and therefore not particularly significant, however, it is interesting to note that Times New Roman was again considered to be the least favoured typeface for *all* of those participants expressing difficulty with this issue.

Misreading words

The issue of misreading words is again linked to the previous two issues of decoding and pronouncing words and was similarly highlighted by 9% of the group. There were no significant typographic preferences expressed by participants associated with this issue.

Comprehending words

The difficulty in comprehending (certain) words was identified by 14% of the group. The sample was not significant, however, the favoured typeface for 67% of participants expressing this particular difficulty was Times New Roman. This outcome contradicts the previous outcomes where Times New Roman was the *least* preferred typeface for readers with difficulty in decoding and pronouncing words.

It would appear that in terms of decoding issues, the associated typographic preferences are confused, contradictory and inconclusive.

7.2.1.3 Re-reading

Re-reading is linked to decoding issues and ultimately impacts on slow reading. Re-reading can be sub-divided into two areas: 1, re-reading words and 2, re-reading texts.

Re-reading words

Only one participant expressed a difficulty in re-reading individual single words. This accounts for only 5% of the group and therefore as a sample is clearly not significant. I find it surprising that more readers did not highlight this issue as it is an area with which I particularly have difficulties. I suspect that a much higher percentage experience the problem and suggest that the issue may have been incorporated by the group in the section below – the re-reading of *multiple* words or extended texts.

Re-reading texts

The re-reading of multiple (rather than single) words or extended texts was highlighted by 18% of the group, and as a sample was not particularly significant. Of this sample, 50% favoured Times New Roman while 50%

considered Dine 1 the least favoured typeface. This outcome corresponds with my own preferences in terms of re-reading extended texts.

It would appear that in terms of re-reading, although there was a marked preference expressed for Times New Roman and against Dine 1, the outcome is still inconclusive.

7.2.1.4 Skip reading

Skip reading, along with decoding and re-reading issues is another factor which results in slow reading and poor comprehension. Skip reading can be sub-divided into two areas: 1, inability to recognise words and 2, ignoring unfamiliar words.

Inability to recognise words

The inability to recognise words was only highlighted by one participant, which represents 4.5% of the group. As a sample this percentage is not significant and therefore any typographic preference linked to this issue is not particularly valid. The inability to recognise words is not an area I have difficulty with as an adult dyslexic reader, although as a child this problem was significant.

Ignoring unfamiliar words

Only two participants admitted to ignoring unfamiliar words when reading, which accounts for 9% of the group. This sample was not significant and no valid typographic preferences could be identified. I have on occasion read unfamiliar words, but have tended not to ignore them. In order to comprehend the meaning of a word I would either guess the meaning by understanding the context of the text (sometimes with erratic outcomes!) (4.3.1), or reference a dictionary.

7.2.1.5 Numeric issue

The numeric issue is the final area, which along with decoding, re-reading and skip reading accounts for slow reading times and poor comprehension. The numeric issue involves the confusion readers experience in decoding numbers with letters and words, and was highlighted by 14% of the group. This sample was not significant, however it is worth noting that Dine 3 was preferred by 67% of that sample. The numeric issue is not an area I experience as a dyslexic reader, however I do confuse numbers when speaking.

7.2.1.6 Reading difficulties and typographic preferences

In terms of relating and connecting reading difficulties with typographic preferences, the outcome would appear to be confused and contradictory. Arial, Dine 3 and Times New Roman all featured in at least one category as the favoured typeface, and Times New Roman, Dine 1 and Dine 2 featured in at least one category as the least favoured typeface.

7.2.2 Visual stress difficulties

This area of difficulty refers specifically to the appearance of the text on a page causing visual disturbance to the reader. The visual stress difficulties can be classified into three areas. These areas include: 1, visual distortion; 2, tracking difficulties and 3, glare.

7.2.2.1 Visual distortion

Visual distortion concerns the phenomenon of disturbance or "*swirling*" of text which can produce various tones of grey when reading. The distortion can occur on a (micro) word or (macro) multi-line level, resulting in a difficulty to focus on the text. Participants who expressed visual distortion accounted for 14% of the group. As a sample this percentage is not significant, however it is compelling to note that 100% of this sample selected the Dine typefaces (Dine 2 and Dine 3) as their most favoured typefaces and 67% stated that Times New Roman was the least favoured. These outcomes would suggest that the relatively light design and sans-serif form of the Dine typefaces may help towards alleviating visual distortion. However, as a dyslexic reader myself, who does *not* experience visual distortion, I actually favour Times New Roman as a text font. I find the serif quality of such fonts much easier to read than sans-serifs. My non-visual distortion preference for serif styles is therefore at odds with visual distortion reader preferences for lighter and more uniform sans-serif fonts.

7.2.2.2 Tracking difficulties

Tracking difficulties are concerned with the readers' tendency to lose their place when reading extended texts and therefore causing them to jump lines. Participants who expressed difficulty with tracking accounted for 27% of the group. Of this sample, 50% expressed a preference for Times New Roman as the favoured typeface while Dine 1 (33%) and Sassoon Primary (33%) were considered to be the least favoured typefaces. The serif quality of Times New Roman may be responsible for helping the reader to link and connect letters and words and therefore assist with the tracking of text, hence its favoured rating in this particular instance. Conversely, the sans-serif and exaggerated strokes and loops of Dine 1 (and to a much lesser extent Sassoon Primary), may hinder the tracking abilities of readers, hence their low preference rating.

7.2.2.3 Glare

This area of visual stress is concerned with the glare produced by black text printed on white paper and is connected to scotopic sensitivity or Meares-Irlen Syndrome (2.3.2). Participants who expressed symptoms of glare accounted for 18% of the group. Of this sample, 50% expressed a preference for Times New Roman as the favoured typeface while 75% considered Dine 1 to be the least favoured typeface. As with the tracking difficulties, the serif nature of Times New Roman may help the reader to link and connect letters and words and therefore enhance readability even within a glare situation. Conversely, the irregularity of form in Dine 1 coupled with the glare situation may compound the readability of the text and may be an explanation of its low preference rating.

7.2.2.4 Visual stress difficulties and typographic preferences

In terms of relating and connecting visual stress difficulties with typographic preferences the outcomes would again appear to be confused and contradictory. Times New Roman, Dine 2 and Dine 3 were all featured in at least one area as the favoured typeface and Times New Roman, Sassoon Primary and Dine 1 featured in at least one area as the least favoured typeface.

7.2.3 Comprehension difficulties

Comprehension difficulties refer to specific problems related to the process of understanding the text. These difficulties can be classified into two areas: 1, retaining information and 2, concentration difficulties.

7.2.3.1 Retaining information

This area involves the ability (or indeed lack of ability) to retain information after reading and therefore fail to recall the meaning of a text. Participants who expressed problems in this area accounted for 27% of the group. Of this sample 67% stated a preference for Times New Roman as the favoured typeface while 50% considered Dine 1 to be the least favoured typeface. As in the previous sections concerning tracking difficulties (7.2.2.2) and glare (7.2.2.3) the serif quality of Times New Roman may help the reader to link and connect letters and words, which enhances readability and therefore helps the reader to retain information.

7.2.3.2 Concentration difficulties

This area refers to the reader experiencing a lack of concentration and difficulty in maintaining a relevant thought process when reading texts. Readers who expressed problems in this area represented 14% of the group. As a sample this percentage is not significant, however it is worth noting that Times New Roman was preferred as the favoured typeface by 67%. The

sample also considered Dine 1 to be the least favoured typeface also by 67%. This outcome correlates with those outcomes concerned with the area of retaining information, and would tend to reinforce the idea that it is the serif quality of Times New Roman which assists readability and, in turn, facilitates concentration.

7.2.3.3 Comprehension difficulties and typographic preferences

Times New Roman was clearly shown to be the preferred typeface within this area, favoured by 63% of all readers who expressed comprehension difficulties. The Dine typefaces (Dine 1 and Dine 2) collectively were the least favoured fonts for 88% of those readers.

As Times New Roman was the only typeface tested with a serif design it seems apparent that the serif is an important design element in terms of facilitating the readability of texts, which in turn helps comprehension. As speculated previously, the seriffed nature of the typeface may help in linking one letter (and word) to another. I also have problems in comprehending certain extended texts and like the majority of readers sampled favour Times New Roman.

The low performance rating of the Dine typefaces may be due to the sans-serif and irregular quality of the fonts which appear to disrupt readability and therefore make comprehension difficult.

7.2.4 Psychological difficulties

This area concerns a lack of confidence when reading and is linked to the reading, visual stress and comprehension difficulties already outlined. Those difficulties result in a reluctance to read. One participant admitted to this area of difficulty which represents 4.5% of the group and therefore is not significant. It is interesting, however, to note that the participant read very infrequently and favoured Sassoon Primary – a typeface specifically designed for children.

7.2.4.1 Psychological difficulties and typographic preferences

Due to the low sample, no meaningful or valid typographic preferences could be made.

7.2.5 Typographic difficulties

This area relates to a difficulty in reading texts due to typographic design factors. These factors are covered in more detail in Section 7.4 of this chapter. Participants who expressed problems in this area accounted for 9% of the group, which as a sample is not particularly significant. It is interesting to note, however, that the Dine typefaces were the least favoured fonts. One reader assumed that Dine 2 (with its uppercase N within the lowercase

form) was actually two typefaces and Dine 1 was described as being "*too fussy*". It seems apparent that radical and unfamiliar typographic forms can cause confusion when reading, and may be an issue when developing a typeface for the adult dyslexic reader.

7.2.5.1 Typographic difficulties and typographic preferences

Due to the low sample, no meaningful or valid typographic preferences could be made.

7.2.6 Dyslexic issues conclusion

It is worth reiterating that the outcomes concerning dyslexic issues relate only to Study Tests 2 and 3, and were based on the participants' own reading difficulties. With regards to the relationship between dyslexic issues when reading and typographic preferences, the outcomes concerning psychological and typographic difficulties are inconclusive due to the small sample group. No real patterns emerged. The outcomes concerning reading, visual stress and comprehension difficulties, however, are both interesting and contradictory.

In the areas of reading, stress and comprehension Times New Roman was a favoured typeface in all three categories. Dine 3 was the favoured typeface in two categories. This appears to be an inconsistent outcome. Times New Roman is a serif font and has an established and recognisable appearance. Dine 3 in comparison is a sans-serif font and, due to its recent design, has an unestablished and unrecognisable appearance. What seems to unify both typefaces are the *relatively* light strokes of both fonts.

The least favoured typefaces within the areas of reading, stress and comprehension were Dine 1, which was selected in all three categories and Dine 2 and (interestingly) Times New Roman, which were selected in two categories. The low preference rating of both Dine 1 and Dine 2 is not unexpected. The radical form and design of these fonts does not seem to facilitate either effective reading, low visual stress or high levels of comprehension. The conundrum of Times New Roman being both the favoured and least favoured typeface is more interesting, and suggests that perhaps a favoured typeface for the adult dyslexic reader is due simply to personal preference rather than any dyslexic issue of difficulty.

7.3 Text formation issues

The formative developmental typeface testing procedure comprised three consecutive study tests, which involved 29 participants representing 100% of the entire reader population. The structure of these tests involved the examination of four distinct letter and text formation stages: 1, individual characters; 2, individual words; 3, individual sentences and 4, individual paragraphs.

7.3.1 Individual characters

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2) this field of study can be seen as the logographic phase. The typographic outcomes which were identified included 1, character confusion; 2, serif and sans-serif confusion and 3, punctuation confusion.

7.3.1.1 Character confusion

There were three areas of interest within this area involving character confusion:
1, single characters; 2, single letter pairs and 3, double letter pairs.

Single characters

There was a general confusion involving incorrect identifications of the following characters: l (lowercase); 1 (numerical); ! (exclamation mark); o (lowercase); O (uppercase) (Study Tests 1 and 2); p, q; b, d; j, g; m, n; m, w; g, h, t; J, L and L, I (Study Tests 2 and 3).

The confusion between the b, d and p, q characters represented 64% of admitted confusions within the Study Test 3 group.

In terms of hesitations there was a high incidence involving:
d – 66% of all hesitations (Study Test 3).
b – 30% of all hesitations (Study Test 3).

Single letter pairs

Although letter pairs as such were not tested, reader comment suggests that they may be a factor associated with poor character and word recognition (Study Test 3). One such example is the letter order of the word 'nail'. The letter order in this instance, specifically the 'a', 'i' and 'l' made it difficult for one reader and tended to "*stop the flow of the sentence*" (Reader AA) (Study Test 3). Single letter pairs such as 'ai' and 'il' may be worth investigating as a second order issue for post-doctoral research.

Double letter pairs

Double letter pairs were also not tested, however reader comment suggests they may be a factor associated with poor character and word recognition "*I am not aware of single letters, but I can get confused with words with more than one of the same letter, for example, a double 's'.*" (Reader AW) (Study Test 3). Another participant admitted to being confused with the 'ff' letter pair (Study Test 3). As with single letter pairs this may be an area worth investigating as a second order issue for post-doctoral research.

7.3.1.2 Serif and sans-serif confusion

During the administration of Study Test 1 characters from two typefaces, Sassoon Primary and Times New Roman, were mistakenly mixed up. This error in administration only occurred once, but caused confusion to the reader, which resulted in a poor character recognition outcome. The mixing of these sans-serif and serif typefaces became a determining factor in the reader's ability to use a visual or logographic reading strategy. In order to facilitate successful reading at this stage it would appear that a uniformity and consistency of form in the design of the typeface is important.

7.3.1.3 Punctuation confusion

During Study Test 1 and Study Test 2 it was noted by readers that the punctuation and auxiliary marks were difficult to read out of context. The testing to identify punctuation at this particular stage was considered to be unhelpful due to the fact that the marks should be used in conjunction with written text, and should not be seen as marks to be viewed in isolation. Punctuation and auxiliary marks were therefore not tested at this stage during Study Test 3.

For a comparative breakdown of the character reading errors including hesitations refer to Figure 18.

7.3.1.4 Impact on letterform design

The outcomes identified from the examination of individual characters suggest a confusion in recognising letters which bear a strong physical resemblance to each other, especially when the letters are reversed or inverted. It seems apparent that in order to overcome this confusion, letterforms need to be as distinctive and different from each other as possible without losing the meaning of the letter. It would also appear that further design development should involve an alphabet with a consistency of form.

7.3.2 Individual words

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2) this field of study can be seen as the alphabetic stage. It is worth reiterating that during Study Test 1 some readers were unfamiliar with particular words in an isolated context and had difficulty with pronunciation (4.8.1). In order to overcome these linguistic difficulties when testing for legibility, non-words were introduced to subsequent word tests. Only one outcome was identified which concerned individual word issues and that was the area of letter alteration.

7.3.2.1 Letter alterations

There were five main areas of interest within the outcome involving letter alteration within an individual word: 1, letter transposition; 2, letter

substitution; 3, added letters; 4, subtracted letters and 5, substituted and added letters.

Letter transposition

Words which involved letter transposition when read out aloud included:

Paris as Pairs	(Study Test 1)
Jive Dances as Jance Dive	(Study Test 1)
PAROB as PARBO	(Study Test 2)
tegwop as tegwob	(Study Test 2)
injure as injuer	(Study Test 3)
build as quilb	(Study Test 3)
JAUNT as TUANT	(Study Test 3)

It is interesting to note that in the case of 'Jive Dances' and 'Jance Dive' as well as the letter transposition of the 'D' and 'J' there is also a word inversion, which makes any meaning of the words redundant. During Study Test 3 'quilb' was identified as a real word (rather than 'build'). As well as being a transposition issue, there also appears to be reversal issues with the lowercase 'q' and 'b'. 'TUANT' was also identified as a real word (rather than 'jaunt'). This error accounted for 80% of all incorrectly identified uppercase words. I suggest there was an attempt by the reader to make meaning of the word by transposing the 'U' and 'A' to make the word 'TAUNT'. Another example from a paragraph test, concerns the misreading of the words 'god' and 'dog'. "*I associated animism with 'dog' and therefore the word didn't appear odd or wrong*" (Reader AT) (Study Test 3).

In terms of hesitations, which involved the transposition of letters, the following word pairs were identified:

injuer and injure – 40% of all hesitations	(Study Test 3)
TAUNT and JAUNT – 33% of all hesitations	(Study Test 3)
QUTOE and QUOTE – 20% of all hesitations	(Study Test 3)

Letter substitution

Words which involved letter substitution when read out aloud included:

Test as Text	(Study Test 1)
visht as visit	(Study Test 2)
BLINT as BLENT	(Study Test 2)
VISHT as VISIT	(Study Test 2)

In the case of 'visht' (in both lower and uppercase form) it would seem that there has been an attempt to make meaning of the word by substituting the 'h' for 'i' or 'H' for 'I' to make 'visit/VISIT'. The similar physical properties of both characters may be significant.

In terms of hesitations which involved letter substitution, the following word pairs were identified:
dilut and build – 30% of all hesitations (Study Test 3)
MURMER and WARMER – 27% of all hesitations (Study Test 3)

Added letters

Words which involved the addition of letters when read out aloud included:

taboo as tobacco	(Study Test 1)
Salon as Sail on	(Study Test 1)
Forld as forland	(Study Test 2)
PAROB as PAROBE	(Study Test 2)
BLINT as BLINTED	(Study Test 2)
PLOMT as PLOMET	(Study Test 2)
SINT as SIN TAT	(Study Test 2)

It is not immediately obvious as to why the reader should add letters to words. However, one reason may be an attempt to give sense to the word, for example, the invented word 'PLOMET' is phonetically similar to the real word 'PLUMMET'.

Subtracted letters

Words which involved the subtraction of letters when read out aloud included:

forld as ford	(Study Test 2)
plomt as plom	(Study Test 2)
FORLD as FOLD	(Study Test 2)

In the cases of 'ford' and 'FOLD' it seems clear that the reader is attempting to make sense of the words. The word 'plom' is less clear, however it is phonetically similar to the real word 'plum', and as in the cases of 'ford' and 'FOLD' may be an attempt to make sense of non-words.

Substituted and added letters

Words which involved a combination of substituted and added letters when read out aloud included:

visht as visits	(Study Test 2)
shumble as shrubley	(Study Test 2)
PLOMT as PLUMPTED	(Study Test 2)

In these cases it seems that the readers are still attempting to make sense of the word with variable success, the word 'visits' being the only real word.

For a comparative typeface breakdown of the word reading errors including hesitations refer to Figure 19.

7.3.2.2 Impact on letterform design

Although not a direct impact on letterform design, the issue of context was an important outcome from this stage. In order to overcome context issues with regards to individual words, it seems clear that the letterforms need to be distinctive and different from each other without any reduction in the identification or meaning of the letter. A significant point arose from Study Test 1 where 3 errors accounted for 43% of all mispronunciations were in Tiresias InfoFont, the boldest of all the test typefaces (Figure 19). The boldness of the design relates to the fact that it was designed as a signage face for people with impaired vision, and therefore may be suitable for this purpose. The high rate of mispronunciations, however, suggests that excessive weight and boldness may not be appropriate in the design of a typeface for the adult dyslexic reader.

7.3.3 Individual sentences

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2) this field of study can be seen as the orthographic stage. The outcome which was identified concerned issues with: 1, letter alteration.

7.3.3.1 Letter alterations

There were four main areas of interest within the outcome involving letter and word alteration within a read sentence: 1, letter transposition; 2, letter substitution; 3, added letters; 4, subtracted letters and 5, repeated words.

Letter transposition

The words within sentences which involved letter transposition when read out aloud included:

there as three (Study Test 2)
THERE as THREE (Study Test 2)

In some cases the previous word or words in a sentence can often provide the context or prompt for a misread word. In the upper and lowercase forms of the sentence 'Don't put another number there', the word 'there' was misread as 'three'. In this particular case the word 'number' provided the prompt for the misread word.

Letter substitution

The words within sentences which involved letter substitution when read out aloud included:

those as these (Study Test 2)
circumstantial as circumstances (Study Test 3)
adoring as annoying (Study Test 3

NOT as NOW (Study Test 2)

As in the previous case, it would appear that certain words in a sentence are acting as triggers for misread words. The most interesting example in terms of letter substitution is the word 'news' acting as a trigger for the misread word 'circumstances'.

Added letters

The words within sentences which involved added letters when read out aloud included:

girl as girls (Study Test 3)
boy as boys (Study Test 3)
boring as borning (Study Test 3)
catty as chatty (Study Test 3)
FOR as FROM (Study Test 3)

The addition of an 's' on 'girls' and 'boys' and the misreading of the word 'FROM' were the commonest of all the misreads, and occurred on more than one occasion.

Subtracted letters

The word within a sentence which involved the subtraction of a letter when read out aloud was:

school as stool (Study Test 2)

In this case the sentence was misread as 'I found a large stool' rather than 'I found a large school', and appears to be a context issue. It is typical of the type of error that I experience when I am reading.

Repeated words

The word 'and' was often either added or repeated when a sentence containing the word was read out aloud (Study Test 3). The insertion of extra words in stand alone sentences again may be related to the reader attempting to contextualise a single sentence.

For a comparative typeface breakdown of the sentence reading errors including hesitations refer to Figure 20. For a breakdown of the sentence readability ratings, based on a Likert Scale, refer to Figure 22.

7.3.3.2 Impact on letterform design

As stated in the previous stage, although not directly related to letterform design, the context of the sentence continues to be an important issue in terms of reading. There were important points made by the group with regards to Tiresias InfoFont and Dine 1. Contrary to the finding of Study Test 1 relating

to the words stage, where Tiresias InfoFont accounted for 43% of all mispronunciations (Figure 19), it was also considered to be the easiest read as a sentence (Figure 22). This apparent contradiction is problematic as it was designed as a signage font and should perform well in both sentence *and* word form. The one-line structure of the sentences, however, appears well suited to the typeface's bold form.

The radical design of Dine 1 was considered to be the most difficult typeface to read (Figure 22). The monocase design and apparent lack of structure also caused confusion with readers. Although the radical form and unfamiliarity of the typeface may not be what a reader might be used to (or indeed expect) from a font it was still correctly read in sentence form by 75% of the group (Study Test 1).

7.3.4 Individual paragraphs

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2) this field of study (along with the previous section) can be seen as the orthographic stage. In comparison to previous stages, the investigation during this stage was much more extensive. The outcomes, therefore, have been divided into much broader areas, and include:
1, qualitative factors and 2, quantitive factors.

7.3.4.1 Qualitative factors

Due to the extensive nature of the investigation during this stage, the qualitative outcomes based on reader comment have been incorporated into the next section, 7.4. It is worth noting, however, that the group considered the lowercase version of Arial to be the most readable typeface as a paragraph and Dine 1 the least readable (Figure 26).

7.3.4.2 Quantitative factors

The quantitative element of the investigation during this stage took the form of the Rate of Reading Test©. The outcomes differ from the qualitative response in that the lowercase version of Times New Roman had the highest average reading rate of 163 words per minute over the three study tests. The lowest average reading rate was Dine 1 with 144 words per minute (Figure 23).

During Study Test 2 the paragraphs comprised non-narrative text which contained 15 repeated words. The words-per-minute rates were low for all typefaces in comparison to the narrative paragraphs of the other study tests. It is relevant to note, however, that the non-narrative paragraphs set in uppercase forms of each typeface produced a higher word-per-minute rate than those set in lowercase (Figure 23).

For a comparative typeface breakdown of the paragraph words per minute rate refer to Figure 23. For a breakdown of the non-words correctly identified refer to Figure 24. For a breakdown of the correctly answered questions refer to Figure 25. For a breakdown of the paragraph readability ratings, based on a Likert Scale, refer to Figure 26.

7.3.4.3 Impact on letterform design

The impact on letterform design from this stage will be covered in detail in the next section, 7.4. It is worth, however, highlighting two points in this section. The first point is that although lowercase Arial was considered, on average, to be the most readable typeface (Figure 26), lowercase Times New Roman was in fact the most readable typeface, on average, in terms of words read per minute for narrative texts (Figure 23). The second point to make concerns the improved preference ratings for the Dine typefaces as each subsequent font was refined. Dine 1 was the least favoured typeface in Study Test 1, Dine 2 the third favoured typeface in Study Test 2 and Dine 3 the most favoured typeface in Study Test 3 (Figures 16 and 26).

7.3.5 Text formation issues conclusion

With regards to the relationship between various letter and text formations when reading, and typographic design preferences, a number of issues have been raised. A common outcome noted in all stages was the issue of context. Although not directly related to typographic design issues, it highlights the need for the letterforms of an adult dyslexic typeface to be as clear, distinctive and different from each other as possible without losing the meaning of each character. The contradictory yet favourable outcomes noted during the word and sentence tests relating to Tiresias InfoFont (Figure 22), and during the paragraph tests relating to lowercase Arial (the favoured typeface) (Figure 26) and lowercase Times New Roman (the highest rate of reading typeface) (Figure 23), has implications for future dyslexic typeface design. It would indicate no conclusive dominance of form towards either a serif or sans-serif style.

7.4 Typographic design issues

The formative developmental typeface testing procedure comprised three consecutive study tests, which involved 29 participants representing 100% of the reader population. The outcomes based on reader comment from the individual paragraph stages have been incorporated into this section. The typographic design issues which emerged from these tests were as follows: 1, typographic styles; 2, typographic form; 3, typographic variables and 4, reading issues.

7.4.1 Typographic style

The areas concerning this particular aspect of typographic design involved reader comment on the following generic style issues: 1, serif typefaces; 2, sans-serif typefaces and 3, handwritten (oblique) typefaces.

7.4.1.1 Serif typefaces

The comments made with regards to serif typefaces refer exclusively to Times New Roman due to the fact that it was the only serif font to be tested formatively. As an individual character Times New Roman was considered to be "*more familiar and more legible than a sans-serif font*" (Reader AD) (Study Test 1) and "*quite nice – not confusing*" (Reader AC) (Study Test 1). This view is later contradicted, and when read as an individual word the typeface was thought to be "*blurred*" (Reader AC) (Study Test 1). When read as an individual paragraph, views were again polarised from the favourable, "*it was very readable*" (Reader AN) and "*it is easy to see, there were no difficulties*" (Reader AO) (Study Test 2); to the unfavourable pro-serif view, "*it would be clearer without the serifs*" (Reader AJ) (Study Test 2), "*there are many points*" (Reader AV). As an individual sentence it was considered to be "*spikey and horrible*" (Reader AY) (Study Test 3).

7.4.1.2 Sans-serif typefaces

The aspect concerning sans-serif typefaces can be divided into two sections: 1, sans-serifs and 2, sans-serif bolds.

Sans-serifs

The comments made with regards to sans-serif typefaces refer exclusively to Arial. One view was that as individual characters, sans-serifs were considered to be less legible than fonts with serifs, "*there was less to go on*" (Reader AD) (Study Test 1). As a sentence, Arial in its uppercase form looked "*compacted*" (Reader AJ) (Study Test 2). In contrast to these comments, and in its lowercase form as a paragraph, the font was thought to be "*simple, easy to read and clean*" (Reader AQ) (Study Test 2). Other readers indicated an explicit preference for sans-serif typefaces, "*I prefer sans-serif fonts*" (Reader BA) (Study Test 3).

Sans-serif bolds

The comments made with regards to sans-serif bold typefaces refer to Tiresias InfoFont, and in one case Arial. The response to the boldness of Tiresias InfoFont was favourable. As individual characters "*there was nothing confusing about the font – bold*" (Reader AC) (Study Test 1) and as individual sentences the font was "*easier to read because it is bold*" (Reader AA) (Study Test 1). Another reader considered the font to be "*very readable*" (Reader

AN) (Study Test 2). One reader remarked favourably about the relative boldness of Arial, "*I like the bold type*" (Reader AW) (Study Test 3).

7.4.1.3 Handwritten (oblique) typefaces

The comments made with regards to handwritten typefaces refer to Sassoon Primary, (a typeface with its design grounded in handwriting) and in one case Dine 2. The responses to Sassoon Primary were mixed. Positive reaction as a sentence was that it had "*a good flow*" (Reader AE) (Study Test 1). Less favourable reactions as a paragraph stated that the font appeared to be "*bendy*" (Reader AF) and "*not so easy to read*" (Reader AC and Reader AF) (Study Test 1). There were numerous critical responses to the slanting appearance of the typeface ranging from, "*I found the angles of the letters confusing, too much was going on*" (Reader AP) (Study Test 2) to the highlighting of the "*prominent slant*" (Reader AP) (Study Test 2) and "*it appears to be slanting*" (Reader AY) (Study Test 3). Although not a particularly oblique typeface, one reader considered the uppercase version of Dine 2 to "*look like neat handwriting*" (Reader AI) (Study Test 2).

7.4.1.4 Impact on letterform design

The outcomes identified from the examination of typographic styles seem contradictory, however some interesting responses have been noted which will impact on the next stage of the letterform design. A preference for either serif or sans-serif fonts were inconclusive, and although serif bold fonts were favoured as individual sentences, their use when set as extended text was less favourable and considered to be overpowering to read. Positive responses which could be incorporated into the next stage of the design process include the '*familiarity*' of Times New Roman, the '*clean*' quality of Arial and the '*flowing*' quality of Sassoon Primary. Negative responses which should be avoided include the '*compacted*' quality of Arial and the '*slant*' of Sassoon Primary.

7.4.2 Typographic form

The areas concerning this particular aspect of typographic design involved reader comment on the following generic form issues: 1, uppercase letterforms; 2, lowercase letterforms and 3, numeric forms.

7.4.2.1 Uppercase forms

The comments made with regards to this aspect mainly concerned uppercase forms set as paragraphs, although there was interesting feedback about the form when set as an individual sentence. During Study Test 2, as a sentence, the total reading times were quicker on average than when set in lowercase.

However, qualitative data contradicts this finding and suggests a readability preference for the lowercase sentences.

As a paragraph the uppercase forms were often preferred to the lowercase in Study Test 2, but not in Study Test 3 (Figure 26). It is worth noting that the paragraphs in Study Test 2 comprised 15 repeated non-words which provided a non-narrative text, as opposed to the paragraphs in Study Test 3 which had a proper narrative structure. The paragraphs in Study Test 3 did however contain one non-word, and reader identification of the non-word was higher for the uppercase form (63%) in comparison to the lowercase (50%). When the readers were asked if they understood the text, 70% of the group reading uppercase letterforms stated they did compared to 66.66% for the lowercase.

General comments made regarding the uppercase letterforms as paragraphs were not favourable. "*The combination of bold and caps were overpowering*" (Reader AS). "*It is unusual to have a complete paragraph in capital letters. It affects my response to the text*" (Reader AW) (Study Test 3) and "*capitals are difficult to read generally, the letters jump around*" (Reader AT) (Study Test 3).

The comments made about specific typefaces set as paragraphs in their uppercase form was mixed. Favourable responses concerned Arial and Times New Roman. Regarding Arial, "*I can read this in more depth*" (Reader BB) and rather contentiously, "*it flows and the text doesn't jump, but I didn't take the words in*" (Reader AV) (Study Test 3). Similarly with Times New Roman, "*it flows. I made more sense of it than other fonts*" (Reader AW) (Study Test 3). Less favourable comments concerned Sassoon Primary and Times New Roman, which were both considered to be "*hard to read*" (Reader AT) (Study Test 3).

7.4.2.2 Lowercase forms

The comments made with regards to this aspect concerned lowercase forms set as sentences, and were exclusively favourable. "*The lowercase letters were easier than the caps*" (Reader AN), "*Any lowercase type is better than uppercase type*" (Reader AP), and "*I find it easier to read lowercase letters than capitals, generally*" (Reader AQ) (Study Test 2).

The lowercase forms can be divided into two further areas: 1, x-heights and 2, ascenders and descenders.

x-heights

There were no specific comments with regards to x-heights, however, the proportion of the x-height in any further design development will be important. (Refer to Section 7.6 Conclusion).

Ascenders and descenders

The only comments made with regards to ascenders and descenders were contradictory. When remarking on Tiresias InfoFont as a sentence, one view was that the ascenders "*could be longer*" and as a paragraph the same reader stated they were "*long and unambiguous*" (Reader AE) (Study Test 1). This suggests that long ascenders and descenders, in influencing the shape of a word, may favourably affect readability.

7.4.2.3 Numeric forms

The comments made with regards to this area highlighted a difficulty in reading numbers. During the paragraph tests, comments included, "*I find numbers difficult to read. I am easily put off by numbers*" (Reader AY) (Study Test 3), and regarding Times New Roman, "*I found the numbers difficult to read*" (Reader AY) (Study Test 3). It seems logical that in order to overcome such problems, numeric values should be written as words rather than numbers. This, however, could be problematic as evidenced by the high incidence of eye strain caused by reading values such as 'million, million, million' in the Telescopes paragraph. "*I was thrown by the repetition of the word 'million million' and had to read it twice*" (Reader AT) (Study Test 3).

7.4.2.4 Impact on letterform design

Despite the view that uppercase letters were preferred when reading non-narrative texts, it seems that lowercase letters are preferred when reading narrative texts. Since narrative texts account for the majority of reading experiences it would appear that future design development should continue as a double-case alphabet with an emphasis on the lowercase form of the design.

Although there were little or no comments regarding x-heights, ascenders and descenders, they will be a key aspect of any future design development.

It would seem that in order to overcome the difficulty experienced when reading numbers, the writing of numeric values as words as an alternative is not particularly helpful or viable. It would appear, therefore, that the form of each numeric character should be designed to be as clear and distinct as possible without losing any meaning to the number.

7.4.3 Typographic variables

The areas concerning this particular aspect of typographic design involved reader comment on the following generic variable issues: 1, weight; 2, space; 3, size and 4, familiarity.

7.4.3.1 Weight

The aspect of weight can be divided into two sections: 1, lightness and 2, boldness.

Lightness

The comments made with regards to the lightness of letterforms refer to Arial and Dine 2. The responses were contradictory resulting in no clear preference. Favourable comments included, "*I prefer thinner fonts to the heavy font*" (Reader AS) (Study Test 3) and in reference to Dine 2, "*I liked the slimline text*" (Reader AI) (Study Test 2). Unfavourable comments about Dine 2 in its uppercase form that "*it seemed thinner than other versions, not as good or as clear*" (Reader AL) (Study Test 2) and Arial in its uppercase form was "*soft, round and thin. Thin is bad*" (Reader AL) (Study Test 2).

Boldness

The comments made with regards to the boldness of letterforms refer to Arial and Tiresias InfoFont. Many readers appeared to have preconceived ideas. General comments about bold letterforms included the favourable, "*I prefer bolder fonts*" (Reader BB) (Study Test 3); and the unfavourable, "*I experience more visual disturbance with bold typefaces because of the contrast with white paper*" (Reader AY) (Study Test 3) and "*the combination of bold and caps was overpowering*" (Reader AS) (Study Test 3).

The boldness of the letterforms were commented on throughout all the text formation tests. With reference to individual characters, "*some letters were hard to read because of the mixture of bolds and thins. I found the bolds easier. The thinner ones were not hard, but the bold was easier*" (Reader AX) (Study Test 3). During the word test one reader suggested "*that the words which were pronounced correctly were in a much bolder typeface*" (Reader AO) (Study Test 2). The response to bold letters as individual sentences was more mixed, "*the thicker, heavier typefaces came into focus more slowly than the others*" (Reader AJ) (Study Test 2) and conversely, "*the bolder type was easier to read than the flamboyant type*" (Reader AO) (Study Test 2).

The comments with regards to bold fonts as a paragraph seem to be more polarised, with the main consensus of opinion being unfavourable. Tiresias InfoFont was "*too dark and heavy*" (Reader AC, Reader AG and Reader AH) "*the contrast of the white paper and bold type was uncomfortable*" (Reader AH) (Study Test 1). In its uppercase form it was considered to be "*too harsh, too dark*" (Reader AK). "*The text is bolder than the other typefaces and the*

letters are closer together, which may make it harder to read" (Reader AO). "*It's not easy – very heavy type*" (Reader AQ) (Study Test 2). In the lowercase form it was thought to be "*a heavy block of darkness*" (Reader AJ) (Study Test 2). There was however some favourable comment when the lowercase version of Tiresias InfoFont was considered to be "*the easiest to read so far. Initially I thought it was daunting and dense, but it was easy to identify the words*" (Reader AP) (Study Test 2). The lowercase form of Arial was thought to be "*okay, the text was big and bold but close together. A full page of this might be more difficult*" (Reader AW) (Study Test 3).

7.4.3.2 Space

The aspect of space can be divided into two sections: 1, line spacing and 2, letter and word spacing.

Line spacing

The comments with regards to close line spacing were unfavourable. The lowercase version of Arial was too "*close together*" (Reader AZ) (Study Test 3) and the uppercase version of Sassoon Primary as a paragraph "*difficult to read*" (Reader AT) (Study Test 3) because of the spacing. The lowercase version of Times New Roman was thought to "*bunch-up and join together*" (Reader AY) (Study Test 3).

Letter and word spacing

Interletter and word spacing were considered to be important factors when reading. As sentences "*the clearest texts were those which had most space between letters and words*" (Reader AI) (Study Test 2). The uppercase version of Arial as a sentence was less favoured being "*close together with little spacing*" (Reader BA) (Study Test 3) conversely the lowercase version of Times New Roman appeared "*nicely spaced out*" (Reader BC) and had "*good spacing*" (Reader AT) (Study Test 3).

As paragraphs there was either too much interletter and word spacing or too little. The lowercase version of Dine 2 had "*too much spacing for such small words*" (Reader AQ) (Study Test 2) and the uppercase version of Tiresias InfoFont "*looks glarey. There is too much white between the letters which create a funny balance*" (Reader AL) (Study Test 2)

Conversely the words of the lowercase version of Tiresias InfoFont appeared to be "*very close together*" (Reader AR) (Study Test 2) and "*the rivers in the text were noticeable*" (Reader AA) (Study Test 1). The lowercase version of Sassoon Primary looked "*cramped and squeezed together*" (Reader AX) (Study Test 3).

7.4.3.3 Size

There was only one comment regarding the size of the letterforms. As individual sentences it was considered to be "*easier to read the large type rather than the smaller*" (Reader AJ) (Study Test 2).

7.4.3.4 Familiarity

The familiarity of Times New Roman was evident and was clearly a factor in determining preferences. "*Times is easy to recognise. I like a familiar font*" (Reader BB) (Study Test 3). "*Something I am used to. I see it in books*" (Reader AX) (Study Test 3). "*I have always disliked Times Roman*" (Reader AY) (Study Test 3).

7.4.3.5 Impact on letterform design

With regards to the investigation of typographic variables, it seems that preconceptions played an important part in the reader's response to preferences. It was clear that there were no marked preferences in terms of the lightness or boldness of a typeface. However, there was a large consensus of opinion which was unfavourable towards the use of bold fonts as paragraphs or extended text.

Although there was a diverse range of opinion, space is clearly an important factor in the design process and impacts on the condition of scotopic sensitivity (as does weight). Individual paragraphs were considered to have either too much or too little interletter and word spacing. I think that for the next phase in the design process the spacing between words should be generous but still proportionate to the letterforms in order to address the comment made regarding *too* much spacing for such small words.

Familiarity is also a factor to be considered during the next stage of design.

7.4.4 Reading issues

The areas concerning this particular aspect of typographic design involved reader comment on the following generic reading issues: 1, rhythm, rhyme and repetition; 2, visual disturbance; 3, colour tints and 4, continuity and readability.

7.4.4.1 Rhythm, rhyme and repetition

Although no specific typefaces were highlighted, one of the most interesting outcomes of the developmental typeface tests was the marked increase in the sentence test errors between Study Test 2 and Study Test 3 (Figure 20). Study Test 2 did not contain any pronounced rhythmic, rhyming or repetitive elements and the occurrence of group reading errors for that test was relatively low (6%). In marked contrast, Study Test 3 contained sentences with strong

rhythmic, rhyming and repetitive elements and accounted for 52% of all group reading errors. This was an overall increase of 46% in reading errors of paragraphs containing rhythm, rhyme and repetition. The repetition issue was highlighted by reader comment during the Study Test 3 paragraph test, "*I was thrown by the repetition of the words 'million million' and had to read it twice*" (Reader AT). It would appear that highly structured sentences containing rhythm, rhyme and repetition, although not directly related to design development, is an important second order issue.

7.4.4.2 Visual disturbance

The comments made with regards to this area related to all the test fonts with the exception of the Dine typefaces (see Section 7.5). As in previous sections, the outcomes were mixed and far from conclusive. "*Certain fonts are easier than others. When you look at some fonts for a long time, they seem to 'drain'*" (Reader AV) (Study Test 3).

Positive reaction to Arial as a sentence was that it was "*easy*" (Reader AE) to read and produced "*very little glare*" (Reader AD) (Study Test 1). As a paragraph however, the lowercase version looked "*blurred*" (Reader AZ) and "*the text started to make strip patterns*" (Reader BC) (Study Test 3). The density of the text may produce "*flashing*" (Reader AG) and "*visual disturbance*" (Reader AD). Other unfavourable comments regarding Arial was that it "*caused eye strain*" (Reader AK). "*I am used to this typeface but I have always found it hard to read*" (Reader AP) (Study Test 2).

As with Arial, comments for Times New Roman as a sentence were favourable, and "*not stressful*" (Reader AP) (Study Test 2), however, as a paragraph it became "*blurred*" (Reader AZ). "*There was movement in it, but not as much as the others*" (Reader BC) (Study Test 3).

The comments regarding Sassoon Primary were entirely negative. As a lowercase, "*it made me flummoxed*" (Reader BC) (Study Test 3) and looked "*muddled*" (Reader AZ). "*There was a lot of movement and vibration. It made me have to concentrate an awful lot*" (Reader BC) (Study Test 3). In its uppercase form "*it looked jumbled*" (Reader AV) (Study Test 3).

Tiresias InfoFont had a largely negative response. As a sentence the "*contrast between black type and white paper*" (Reader AD) made it "*very hard*" (Reader AG) (Study Test 1). As a paragraph there was a great deal of "*visual disturbance*" (Reader AD) and the text appeared "*flicky*" (Readers AF and AG) (Study Test 1). In lowercase it was "*quite difficult*" (Reader AR) (Study Test 2). In contrast to the negative reactions, it was considered to be "*a relief having to read this text at the end of the test*" (Reader AP) (Study Test 2).

7.4.4.3 Colour tints

There were no specific comments regarding colour tints and typographic preference. The use of white paper throughout the testing procedure was not liked (Study Test 1) and coloured paper and tinted acetate overlays were considered important (Study Test 1). A typical general comments suggested that "*it may be easier on coloured paper*" (Reader AJ) (Study Test 2).

7.4.4.4 Continuity and readability

The comments made with regards to this area related to Arial, Sassoon Primary and Times New Roman. Concerning context, and therefore the readability and continuity of a text, one reader made the obvious but important point that "*two things happen when reading. One, the look of the typeface, and, two, the content of the words*" (Reader BC) (Study Test 3). With regards to letters, "*I don't mis-recognise them, I add letters to the words*" (Reader BC) (Study Test 3). "*I only confuse letters when writing, not reading*" (Reader AY) (Study Test 3) and "*I mix the letters up and had to think hard about the meaning*" (Reader AX) (Study Test 3). Regarding flow or continuity, "*I tried to read as quickly as I could, and therefore made mistakes*" (Reader AS) (Study Test 3) and "*I tend to hesitate towards the end of a line when reading*" (Reader AT) (Study Test 3).

With regards to specific typefaces, the response to Arial was mainly favourable. In its lowercase form as a paragraph it was "*easy to read*" (Reader AX) (Study Test 3) and in its uppercase form "*I can read this in more depth*" (Reader BB) (Study Test 3). However, on a more cautionary note, "*it flowed and the text didn't jump, but I didn't take the words in*" (Reader AV) (Study Test 3).

Sassoon Primary had mainly negative reactions. In its lowercase form as a paragraph it was "*difficult to read*" (Reader AX) "*I didn't go back on the text, but I spent a lot of time concentrating on each individual word*" (Reader BC) (Study Test 3); and in its uppercase form "*it didn't make me want to read it*" (Reader AV). "*I Had to look back at the text to confirm the meaning*" (Reader AV) (Study Test 3). One reader however, considered it "*easy to read*" (Reader BC) (Study Test 3).

There was only one comment regarding Times New Roman which was favourable. As a paragraph, "*it flowed. I made more sense of it than other fonts*" (Reader AW) (Study Test 3).

7.4.4.5 Impact on letterform design

The outcomes identified from the examination of reading issues are inconclusive. Although not directly related to the design process, text containing strong rhythmic, rhyming and repetitive elements caused a high incidence of reading errors.

The outcomes regarding visual distress were inconclusive, however, the oblique quality of Sassoon Primary and the boldness of Tiresias InfoFont were not liked when used as extended texts.

With regards to continuity and readability, the clean qualities of Arial and Times New Roman were liked. This is a particularly contradictory outcome as both fonts are visually opposed to each other in terms of form (one a sans-serif, the other a serif). The uniting factor of the two typefaces is their familiarity.

7.4.5 Typographic design issues conclusion

With regards to the relationship between specific typographic design issues and preferences, a number of outcomes emerged. There appears to be no conclusive evidence concerning a preference for either serif or sans-serif typefaces. Lowercase letters, however, were preferred when reading narrative texts. Further typographic design development should therefore continue with a double case alphabet with particular emphasis on the lowercase letters – especially the relationship between the x-heights and long ascenders and descenders. The numerals should be as clear and as distinct as possible. Design development should also provide a generous relationship between the proportion of the letterforms and surrounding space. The design of letterforms should avoid qualities of compactedness, obliqueness and boldness and develop those of cleanness and familiarity.

7.5 Dine design issues

The developmental typeface testing procedure comprised three consecutive study tests, which involved 29 participants representing 100% of the reader population. The outcomes regarding the Dine typefaces which were identified in the previous section have been incorporated into this section. The Dine design issues which emerged from these tests are as follows: 1, Dine form; 2, Dine variables and 3, Dine reading issues.

7.5.1 Dine form

The areas concerning this particular aspect of design involved reader comment on the following generic form issues: 1, monocase combination forms; 2, duocase combination forms; 3, uppercase forms; 4, unfamiliarity and 5, tone.

7.5.1.1 Monocase combination forms

The comments regarding Dine 1 and its monocase form were overwhelmingly negative. It was considered to be "*random*" (Reader AY), "*uneven*" (Reader AV) and "*erratic*" (Reader AZ) (Study Test 3). "*I don't like the big and small letters*" (Reader AX). "*It looks mad, like scribble*" (Reader AY) (Study Test 3). As a sentence, Dine 1 "*looked random, all up-and-down*" (Reader AY) (Study Test 3) and "*after the full stop, there was a problem with the new sentence not starting with a capital letter*" (Reader AF) (Study Test 1). This comment was amplified when it was suggested that the typeface was contrary to how people read. "*Sentences are meant to start with capitals*" (Reader AG) and "*the absence of capitals at the start of the sentence made reading difficult*" (Reader AD) (Study Test 1). As a paragraph, the "*uneven nature of the lines made it difficult to distinguish*" (Reader AY) (Study Test 3).

Not all the comments, however, were as negative. It was "*strange, and weird to read, but intriguing*" (Reader AV). "*From the first to about the fifth line it was confusing, but as I progressed I made more sense of it and it became easier*" (Reader AV) (Study Test 3). This is an important point and amplifies the relationship between familiarity, typographic reading preferences and comprehension. One reader goes on to suggest that "*the irregularity of the font draws attention to each individual letter more and is easier to remember. Although a slow read, the accuracy* (of comprehension) *may be high*" (Reader AH) (Study Test 1).

7.5.1.2 Duocase combination forms

The combination of capital letters within the lowercase form was problematic. With regards to Dine 2, the "*half uppercase and half lowercase in a sentence was confusing*" (Reader AP) (Study Test 2). The problem of "*the capitals in the middle of the words*" (Reader AN) (Study Test 2) was also highlighted in the less radical Dine 3 design which "*would be preferable without the capital 'N'*" (Reader AY) (Study Test 3).

7.5.1.3 Uppercase forms

There was one comment made with regards to the uppercase form of Dine 3 when set as a paragraph. It was considered to be an easy read, which "*may have been even easier if it wasn't in caps*" (Reader AV) (Study Test 3).

7.5.1.4 Lowercase forms

The comments made with regards to the lowercase forms of the Dine typefaces concerned the irregularity of the letters, especially the ascenders and descenders. The multiple heights of the words set in Dine 1 were found to be "*confusing, the eye has to travel round the words*" (Reader AF) (Study Test 1); and "*the line was not even at the bottom and looks very uneven at the top*" (Reader AH)

(Study Test 1). In the lowercase form of Dine 2 as a paragraph it was considered to be "*hard to pick out each word*" (Reader AQ) (Study Test 2).

7.5.1.5 Unfamiliarity

If the design of a typeface is too radical, it can appear confusing to the reader. With regards to Dine 1, one reader suggested "*that it was difficult to know what you are looking at*" (Reader AD) (Study Test 1). As noted earlier, the importance of familiarity is critical to reading preferences and comprehension. "*The greater the familiarity the faster the read would be. If you are used to reading the text in this face it may be agreeable*" (Reader AF) (Study Test 1). Conversely, "*unfamiliar words became a problem when reading an unfamiliar font*", (Reader AG) (Study Test 1); and "*unusual fonts are difficult to sort out, they need greater effort*" (Reader AO) (Study Test 2). One reader suggested that reading Dine 1 was "*interesting, it was a shock and looked difficult, however, once I got used to it I found it easy*" (Reader AV) (Study Test 3). The issue of unfamiliarity was also commented about Dine 2 and Dine 3, but to a much lesser extent due to their more conventional and less radical appearance. Dine 2 was thought to look "*like Arabic, or something like a mathematical equation*" (Reader AN) (Study Test 2); and Dine 3 "*looked wrong*" (Reader AT) (Study Test 3). Underlining the earlier point made about familiarity, when reading Dine 2 as a paragraph, "*I became used to the words as I progressed through the text*" (Reader AP) (Study Test 2). The more familiar the typeface the easier the read will be.

7.5.1.6 Tone

The majority of views regarding the visual appeal and tone of the Dine typefaces were that Dine 1, and to a lesser extent Dine 3, looked "*childlike*" (Readers AS) (Reader AV) and (Reader AW) (Study Test 3). Dine 3 was also considered to be "*not authoritative*" (Reader AY) and "*like advertising text*" (Reader AS) (Study Test 3); while Dine 1 was "*creative*" (Reader AV) and "*very delicate and complicated*" (Reader BC) (Study Test 3).

7.5.1.7 Impact on letterform design

The radical design and monocase form of Dine 1 was not liked and confused many readers. The combination of upper and lowercase letters and the notion of beginning a sentence with a lowercase letter was not compatible with current reading conventions. Even the more conventional and less radical Dine 3 caused some reading problems due to the inclusion of the uppercase 'N' within the lower case forms. It would appear that the radical designs were unexpected and produced a sense of unfamiliarity for the reader, which in turn had a detrimental effect on reading performances. This issue of unfamiliarity,

conversely, reinforces the relationship between familiarity, reading preferences and comprehension.

7.5.2 Dine variables

The areas concerning this particular aspect of design involved reader comment on the following generic variable issues: 1, weight and 2, space.

7.5.2.1 Weight

The aspect of weight concerned the area of lightness.

Lightness

The comments made with regards to the lightness of letterforms referred exclusively to Dine 3. General comments about the lowercase form suggested "*it was too thin*" (Reader AX) (Study Test 3). More favourable comments as a sentence was that it "*was lighter looking and not as dense on the page*"; and as a paragraph, it was "*thin and easy to read*" (Reader AY) (Study Test 3). In its uppercase form Dine 3 was "*not too blocky – structured and square-like*" (Reader AV) (Study Test 3). As a sentence it was thought to be "*easy because it is not such a heavy type*" (Reader AY) (Study Test 3). Less favourable comments about the uppercase form were that it was "*too thin*" (Reader BB) and "*not very clear*" (Reader AW) (Study Test 3).

7.5.2.2 Space

The aspect of space concerned the area of word spacing.

Word spacing

As part of the design process, and in order to test the horizontal emphasis of a line, there was a deliberate decision to increase the normal word spacing for the Dine typefaces. Reaction to this expanded spacing was mixed.

With regards to Dine 1, the "*space between the words was a problem*" (Reader AG), and the rivers in the text became "*more noticeable than the words which was distracting*" (Reader AG) (Study Test 1). Another reader thought the space to be "*too far apart*" (Reader AT) (Study Test 3). There were however favourable comments with regards to the greater word space. *"I like the spacing. I can follow the pattern. It's not confusing on the eye*" (Reader AW) (Study Test 3).

There was more favourable reaction to the spatial qualities of Dine 2. *"I like the fact that the words are differentiated. The space between the words make it clearer*" (Reader AJ). *"I like the spacing it's not as muddled, and it is easier to catch words*" (Reader AL). *"The wide spacing between words is helpful for*

concentrating on each word" (Reader AP) (Study Test 2). However, one reader thought "*there is too much spacing for such small words*" (Reader AQ) (Study Test 2). There was even more favourable response to Dine 3. "*It was well spaced out*" (Reader AW) (Reader AZ). The "*space between the words helped a lot*" (Reader AU) (Study Test 3). Conversely a negative response considered "*the spacing made it hard to read*" (Reader AT) (Study Test 3).

7.5.2.3 Impact on letterform design

The issue of weight focussed on the lightness of the Dine form. Preferences for a light typeface were inconclusive but largely favourable.

The deliberate use of large interword spatial qualities is contrary to current accepted typographic good practice, and results in the appearance of 'rivers' in extended texts and consequently the reduction of horizontal emphasis. However, the use of large word spacing for Dine 2 and particularly Dine 3 generally resulted in positive rather than negative reader comment.

Further design development will therefore be informed by comparatively light letterforms and large interword spacing.

7.5.3 Dine reading issues

The areas concerning this particular aspect of design involved reader comment on the following generic reading issues: 1, visual disturbance; 2, legibility and 3, continuity and readability.

7.5.3.1 Visual disturbance

The comments with regards to visual disturbance and Dine 1 were generally unfavourable. It was thought to be "*blurry*" (Reader AZ), and as a sentence "*very difficult*" (Reader BB) (Study Test 3). "*The first part of the sentence was okay, but the second part was more difficult*" (Reader AT) (Study Test 3). "*I preferred this font as a sentence but not as a paragraph*" (Reader AW) (Study Test 3). The converse and more favourable view was that there "*appeared to be very little visual disturbance from this typeface*" (Read AD) (Study Test 1).

The reaction to Dine 2 was mixed. The lowercase form was "*tiring and headachey*" (Reader AP) and "*a very awkward read, jumbled, not concise*" (Reader AQ) (Study Test 2). The uppercase form was however "*friendly, nice and unpressured*" (Reader AI) and it became "*clear in my mind*" (Reader AI) (Study Test 2).

A more favourable response was for Dine 3. The lowercase form "*was not as blurred as the others*" (Reader AZ) and "*it didn't mess with my eyes. I didn't go back on anything at all*" (Reader BC) (Study Test 3). In the uppercase form "*it was not dominating*" (Reader AU) and "*the letters are not too regimented*", they "*contain curves which make it easy on the eye*" (Reader AU) (Study Test 3). Others however did have problems. As a lowercase "*it jumped around the page a lot*" (Reader AT) (Study Test 3) and although one reader thought it was "*okay*", they "*would not want to read a whole book in the font*" (Reader AY) (Study Test 3).

7.5.3.2 Legibility

There were two comments with regards to legibility. The visual form of Dine 1 was "*liked for itself, but not for legibility*" (Reader BA) (Study Test 3); and some of the letters of the uppercase form of Dine 3 as a paragraph "*were hard to distinguish*" (Reader AT) (Study Test 3).

7.5.3.3 Continuity and readability

In terms of continuity and readability, the reaction to Dine 1 was unfavourable. The form of the letters made it "*hard to see each line*" Reader AX) and "*difficult to follow the lines*" (Reader BB) (Study Test 3). "*I like the font but it was difficult to read*" (Reader BA). "*I focussed on each individual word more*" (Reader AZ) (Study Test 3). One reader did however find Dine 1 to be "*easy to read*" (Study Test 3).

The comments for Dine 2 and Dine 3 were much more positive. Although the letters of the lowercase form of Dine 2 were "*not clear to me, it was easy to keep a continuity. It was easy to follow the text*" (Reader AJ) (Study Test 2). The uppercase version of Dine 3 "*was easier to read than normal*" (Reader AV) (Study Test 3) and the lowercase form "*flowed as text*" (Reader AU) (Study Test 3).

7.5.3.4 Impact on letterform design

Reader response to visual disturbance, continuity and readability became progressively more favourable as the Dine fonts evolved. This improvement of opinion may be due to the combination of light letterforms and large interword spatial qualities coupled with more familiar (and therefore less radical) character design.

7.5.4 Situation and context

Many of the formative developmental typeface tests have been based on a principle of '*situation*' and '*context*'. A good example of situation and context and its impact on design development can be seen in Study Test 1b – Words, which contains word pairs that were

misread by myself and subsequently by other readers in that particular group. Two letter pairs are worth examining in detail – Test/Text and Pairs/Paris (Figure 15).

7.5.4.1 Test/Text

When deconstructing the Test/Text word pair one can note distinct similarities between each word. They both contain four letters and start and finish with an upper and lower case 'T'. The second letter of each word contains a lowercase 'e' and the third letter of each word has a similar x-height with no ascenders or descenders. The physical shape of both words set in Arial, Sassoon Primary, Times New Roman and Tiresias InfoFont are therefore physically similar, both in terms of size and shape.

When the words are set in Dine 1, they become less similar than those words set in the other test typefaces. This is due to the large proportion of the Dine 1 's' which has a greater x-height than the Dine 1 'x'. The Test/Text pair set in Dine 1 contain a different third letter shape, allowing each word to appear more physically pronounced, or exaggerated.

The similarity of word shape occurs in the other test pairs. All either start and finish with similar-shaped letters, contain the same number of letters and have similar x-height, ascender and descender configurations. This is not the case, however, for Dine 1. The pairs when set in Dine 1 result in a very different and unique shape formation (Figure 15).

7.5.4.2 Pairs/Paris

The word pair Pairs/Paris both comprised the same letters, and the setting of the words in Dine 1 in this instance resulted in no significant change to each word shape. If word shape is an important factor within the notion of what Young and Tyre describe as situation or context for the adult dyslexic reader, then clearly Dine 1 has limitations as a dyslexic typeface.

In its current form, Dine 1 can only differentiate word shape of word pairs which contain different letters (Test/Text) and not those which contain similar letters (Pairs/Paris).

These letter pair tests are important in that they question the principle of the word shape model favoured by typographers. As each subsequent design of the experimental Dine fonts became less radical than the previous version the outline of the word shape became less distinct yet interestingly *more* legible. This finding is contrary to the notion that words are recognised by their shape outline and supports the parallel letter recognition model favoured by psychologists (Figure 15).

7.5.5 Dine design issues conclusion

With regards to the relationship between the design of the Dine typefaces and preferences, a number of outcomes emerged. Radical and therefore unfamiliar designs can often appear 'difficult' and 'daunting' for the adult dyslexic reader. This can frequently result in heightened visual disturbance and impair continuity and readability. A combination of light letterforms and large interword spatial qualities seem to have a favourable effect in reducing these difficulties.

As the design of the Dine typefaces evolved, the more familiar the form became the more favourable was the reader response (Figure 16). The familiarity of letterforms would therefore clearly seem to have a favourable effect on reading preferences and comprehension.

It would appear that the combination of comparatively light letterforms, large spatial interword quality and a familiarity of form must inform future design development. The familiarity of form however, resulted in word outlines being less pronounced than more unfamiliar forms, which puts into question the word shape principle that underpins typographic legibility.

7.6 Conclusion

The evidence gathered from the formative element of developmental typeface testing was often contradictory and inconclusive. Nonetheless, key outcomes were identified. Current perceived views with regards to the phonological aspects of dyslexia have been compared and contrasted with these outcomes. As a result of these comparisons the basic tenets of the Sylexiad typefaces have been established.

7.6.1 Key outcomes

The key outcomes identified from the analysis of formative developmental typeface testing are significant and impacted on the design of Sylexiad, a typeface for the adult dyslexic reader.

From the section regarding dyslexic issues (7.2), in general terms Dine 3 and Times New Roman were both favoured for readability, low visual stress and good comprehension. This is a rather contradictory outcome as there are numerous differences between the two fonts. Dine 3 is an unfamiliar sans-serif while Times New Roman is a familiar serif. What links the two typefaces is a relatively lightness of stroke. The other finding from this section was that radical and unfamiliar typographic form does not facilitate effective reading.

The section concerning text formation issues (7.3) showed that sans-serif fonts (in the form of Arial) had the highest preference rating as a paragraph (Figure 26); whereas a serif font

(in the form of Times New Roman) was the most efficient read in terms of words per minute (Figure 23). The other important finding, although not directly related to letterform design, was the issue of context. The context of a word within a sentence and paragraph highlights the need for letterforms to be clear, distinctive and different from each other without losing any meaning to the character.

With regards to outcomes involving typographic design issues (7.4), there was no conclusive evidence in favour of either serif or sans-serif styles. However, lowercase letterforms were generally preferred when reading narrative texts (Study Test 3) (Figure 26). It would appear to be appropriate to develop Sylexiad as a double-case font, with particular focus on the lowercase characters and the relationship of the x-heights to the ascenders and descenders. It was also found that compact, oblique and bold letterforms should be avoided and qualities of 'cleanness' and familiarity developed.

The outcomes relating to Dine issues (7.5) were that a combination of relatively light strokes and relatively normal inter-letter spacing coupled with large inter-word spacing had a favourable reader response, especially with regards to visual disturbance. It also seems that radical design can be difficult for the reader resulting in high levels of visual distress. The more familiar the form the more favourable the response. It is interesting however to note that, of all the typefaces tested, the readers considered Dine 1 (which has maximum shape) to be their least favoured font and Dine 3 (which has the least shape) to be their most favoured (Figure 16). This finding however questions the word shape model favoured by typographers. Although the familiar forms were more legible, they had *less* word shape than the unfamiliar forms.

7.6.2 Perceived views

This section will attempt to relate existing perceived views regarding dyslexia and associated typographic design issues with the outcomes from the formative developmental typeface tests.

Serifs

Serif fonts "*tend to obscure the shapes of letters, so sans-serif fonts are generally preferred*" (Dyslexic.com, 2004).

The findings from the formative developmental typeface tests refute this statement. Serif fonts, certainly in the form of Times New Roman do not necessarily '*obscure the shapes of letters*' as the Rate of Reading Test outcomes show. The preference for sans-serif fonts was also shown to be inconclusive, because views from the reader group were so polarised (7.4.1.1).

Handwritten or oblique fonts

"*Many dyslexic people also find it easier to read a font that looks similar to handwriting as they are familiar with this style*" (Dyslexic.com, 2004).

Again, findings show that a preference by dyslexic people for handwritten fonts was inconclusive. Handwritten fonts can have a good 'flow', but the slanting or oblique quality of a font such as Sassoon Primary was not particularly liked. (7.4.1.3).

Ascenders and descenders

"*Many dyslexic readers rely on recalling the visual shape of a word due to poor phonological awareness. If ascenders and descenders are too short the shape of the word is more difficult to identify and can make reading slower and less accurate*" (Dyslexic.com, 2004).

"*The combination of fashion and the desire to pack as many lines as possible onto a page has resulted in decreased ascenders and descenders. This tendency eventually erodes the shape of the word as well as the identity of individual letters*" (Sassoon, (1993b), pp.149-152).

Both these views support the idea of long ascenders and descenders improving word shape and therefore improving readability. Although there was little reader comment about this issue one reader suggested that long ascenders and descenders made the reading of the text unambiguous. (7.4.2.2).

x-heights

"*The large x-height in relationship to short ascenders and descenders* (makes) *the letters harder to tell apart*" (Dyslexic.com, 2004).

This view concerns many modern fonts which have been designed to be read on screen. There was no reader opinion regarding x-heights which either supports or refutes this statement. The relationship, however, between x-heights and ascenders is inextricably linked. Large x-heights are synonymous with short ascenders and descenders and vice versa. The relationship between x-heights, ascenders and descenders is an important one which will impact on the development of Sylexiad.

Letter combinations

"*There can be confusion with some letter combinations such as 'oa' and 'oo', and 'rn' and 'm'*" (Dyslexic.com, 2004).

This is a valid difficulty which can be confirmed by the findings concerning character confusion. (7.3.1.1). With regards to single characters, a main area of confusion was found to be the letter reversal issue between 'b' and 'd'; and 'p' and 'q'. As well as the single letter combinations highlighted by Dyslexic.com, the single letter pairs of 'th' and 'ir' were also problematic for some readers.

The area of letter combinations is clearly important and further research into single and double letter pairs would be worthwhile at a post-doctoral level.

Space

The findings from the formative developmental typeface tests indicate that space may well be significant. Many readers found that generous inter-word (rather than inter-letter spacing) to be beneficial. This would indicate that the horizontal emphasis of a line may not be as important to the dyslexic reader as it is for the non-dyslexic reader, and support the International Dyslexia Centre advocation of "*clear word separation*" (Hornsby, 2006) (6.2.4.4).

7.6.3 Sylexiad development

Much of the evidence gathered from the formative developmental typeface testing was contradictory and inconclusive. Perhaps the most contradictory finding concerned word shape. Lowercase forms in general were preferred over uppercase when reading extended texts, yet Dine 3 (the typeface with least shape) was preferred overall (Figure 16). In order to test this anomaly further during the summative stage the initial version of Sylexiad will be based on word shape and include long ascenders and descenders, however, extended texts set in uppercase forms (and therefore minimum shape) will also continue to be part of the testing process.

The condition of dyslexia is extremely complex. Different reading difficulties result in different reading manifestations which in turn result in different preferred typefaces. Because of the inconclusive findings the development of Sylexiad will also be in two separate typographic styles. One version will be as a serif, the other as a sans-serif. When designing a typeface for the adult dyslexic reader the notion of "*one size fits all*" is clearly inappropriate.

In conclusion, the key outcomes identified from the developmental typeface testing have been incorporated into the design of Sylexiad. The design will therefore include:

1. a serif *and* sans-serif version
2. a series of double-case alphabets
3. the use of relatively light letter strokes
4. the use of relatively long ascenders and descenders
5. an attempt to make each letterform as clear and distinct as possible without compromising the meaning of the character.
6. a generous interword spatial quality

The design will not include:

1. the use of relatively oblique letterforms
2. the use of relatively compact letterforms
3. the use of relatively bold letterforms
4. the use of radical letterforms

8. Sylexiad. A typeface for the adult dyslexic reader.

8.1 Introduction

This chapter will explain the design concepts which led to the development of Sylexiad. It will also describe the unique characteristics and features of the typeface.

8.2 Design concept

As shown in the previous chapter, the formative developmental typeface testing of the Dine fonts has been key to informing the design of Sylexiad. Sylexiad forms the first version of a typeface for the adult dyslexic reader. As the evidence has shown, diverse reading difficulties have resulted in diverse typographic preferences. Some readers, for example, preferred lighter, serif typefaces when reading individual word pairs; others favoured bolder, san serif fonts as extended paragraph texts. The actual undetermined nature of the findings has however had a positive effect on the design outcome, and has resulted in the design of two versions of the typeface – a serif form (Serif Sylexiad) (Figure 12) and a sans-serif form (Sylexiad Sans) (Figure 13). Both forms of Sylexiad include the design characteristics which were, for the most part, generally favoured by readers during the formative developmental typeface testing of the Dine fonts. These characteristics and features have been outlined in Section 7.6.3 and will be explained in greater detail later in this chapter.

8.3 Sylexiad generic features

The generic features, which have been incorporated into the design of both Sylexiad forms, are as follows: 1, the use of double case alphabets; 2, the use of relatively light letter strokes; 3, the use of relatively long ascenders and descenders; 4, an attempt to make each letterform clear and distinct from each other (without compromising meaning) and 5, a generous inter-word spatial quality.

8.3.1 Double case alphabet

The evolution of the Dine fonts through the formative process of developmental typeface testing has resulted in both forms of Sylexiad featuring double cases.

8.3.1.1 Lowercase

It is an obvious point, but the inclusion of a lowercase form within the Sylexiad alphabet increases the shape of a word for the reader. As Haley stated: "*Word shape becomes an aid to recognition when the word is seen again. Because of this recall factor, words comprised of lowercase characters can be read much faster than words set in all capitals. All-cap typography*

creates only a rectangle as a visual identifier" (Haley, 1993, p.15). Bouma confirmed this view: "*Word recognition is a key determiner of reading central to any theory of reading processes*" (Papazian, 2000, p.23).

It has been estimated that lowercase text also saves between 35% (Huot-Marchand, 2004) to 50% (Jury, 2002, p.70)) more space than text set in all caps. This results in fewer fixations and saccades being made by the reader's eye in order to access the same information. This perceived general typographic wisdom, coupled with the outcomes from the formative developmental typeface testing, necessitated lowercase Sylexiad forms.

The lowercase forms of Sylexiad are perpendicular, well proportioned, clear and rounded. The lowercase characters have more uniformed and regular x-heights than those of the Dine fonts. Sylexiad x-heights are relatively wide, especially in characters such as the 'a', 'd', 'h', 'n', 'r', 'u' and 'y'. The appearance of the x-heights is smaller than those of Dine 3, which help to create a more comfortable visual relationship between the ascenders and descenders.

With regards to the counters (the open and closed inner spaces within the x-heights), Huot-Marchand pointed out that: "*White space, character fit and counters are of great importance. In continuous reading, the typeface structure is also very important, in so far as it conditions the alternation, the rhythm and the distribution of white and black in the line*" (Huot-Marchand, 2004, p.46). He argued that by optimising the counters, the "*blocking-up*" of letters is prevented, which in turn, reduces visual disturbance, or what he refered to as "*irradiation*" (Huot-Marchand, 2004, p.49). As Jury confirmed, large counters tend to facilitate legibility (Jury, 2002, p.58). The counters within the lowercase Sylexiad form have therefore been designed to be large, especially within the 'a', 'h' and 'u' characters. The design of lowercase Sylexiad letterforms continued to be based on the word shape model.

8.3.1.2 Uppercase

Conventional typographic thinking suggests that: "*Words set in all caps force the reader to read individual letters, mentally combine the letters into words, and the words into phrases and sentences. The result is at least a 10 to 25% slow down in reading speed and comprehension*" (Haley, 1993, p.15). This idea is reinforced by Huot-Marchand who stated that: "*A text written with capitals, with no ascenders or descenders, and of a greater structural homogeneity would be 12% less legible*" (Huot-Marchand, 2004, p.47). This figure of 12% is however, misleading and is based on tests conducted by Tinker and Paterson in 1928. Further experiments by Tinker in 1955 involving the reading of uppercase texts for 5 and 10 minutes indicated a 19%

slower reading time when compared with u/lowercase texts; whereas reading texts over a 20 minute period indicated only a 14% slower time (Jury, 2004, p.70 and Tinker, 1963).

This improved slower percentage rate over a longer reading time implies that the difference between reading texts in all caps and u/lowercase may not be as significant as Huot-Marchand suggested. Indeed Babbage as early as 1827 conducted legibility experiments of old style and modern typefaces and concluded that typefaces of uniform height were *more* legible than lowercase typefaces (Spencer, 1968, p.13). Larson, as recently as 2004, agreed with this view: "*The weakest evidence of word shape is that lowercase text is read faster than uppercase text. This is entirely a practise effect*" (Larson, 2004, p.76). It would seem that the more texts are read in uppercase forms, the more familiar the reader becomes with the text and the quicker the reading times become.

This notion is reinforced by outcomes from the formative developmental typeface testing process which occasionally indicated a reader preference for all uppercase forms (See 7.4.2.1). The inclusion therefore of the uppercase forms within the design of Sylexiad is due to these outcomes and from a desire to test and research further the notion of all-cap texts. The design of uppercase Sylexiad letterforms was therefore based on the parallel letter recognition model favoured by psychologists.

The uppercase Sylexiad characters are perpendicular, well-proportioned, clear and rounded. They are also wide, particularly the 'D', 'I', 'Q', 'R', 'S', 'U' and 'W', which helps with the alternation, rhythm and distribution of white and black within the line.

8.3.2 Light strokes

When testing modern typefaces, Burt argued that letter strokes should be uniform. "*Legibility is still further diminished by the excessive disparity between the thick vertical strokes and the thin curves and slanting strokes*" (Burt, 1958, p.8). This view, coupled with reader comment during the formative developmental typeface testing concerning a preference for lighter fonts, has influenced the stroke quality of Sylexiad. The letter strokes are therefore uniform and light. These qualities help to enhance and exaggerate the internal pattern and shape of the counterforms. In order to provide distinction between similar letters there are also pronounced exit strokes on the lowercase 'd', 'n' and 'u' characters and a pronounced entry stroke on the uppercase 'J'.

8.3.3 Ascenders and descenders

As previously noted, conventional typographic wisdom indicated that when reading texts it is the shape of a word that is important rather than individual letters (Haley, 1993, Papazian, 2000, Jury, 2002 and Huot-Marchand, 2004). More specifically, a finding put forward by Javel in 1905 and supported by earlier work conducted by Messiner in 1903 was that it was the upper section of a lowercase word that was the most legible (Spencer, 1968, p.14). The importance of the upper part of a lowercase word may be due to the fact that more lowercase letters protrude above the x-height line than below the baseline.

With this in mind (and against the contemporary typographic fashion of large x-heights and short ascenders and descenders) the ascenders and descenders of the Sylexiad fonts are relatively long in comparison to the x-height. This feature enables words set in Sylexiad to achieve maximum word shape compared to the other test typefaces.

8.3.4 Clear letterform distinction

When discussing legibility, McLean suggested that sans-serif types "*are more like each other than letters that have serifs, and so the certainty of decipherment is diminished*" (McLean, 1980, p.44). To overcome this problem with Sylexiad, the difference between each character has been emphasised in order to limit any potential confusion between one letter and another. For example, the lowercase forms of 'b' and 'd' and the uppercase forms of 'I' and 'J' have been designed to be as distinct as possible without compromising the meaning of the characters. As Huot-Marchand stated: "*Significant parts of the signs should be exploited as much as possible*" (Huot-Marchand, 2004, p.51).

8.3.5 Inter-word spatial quality

The space between words enables the reader to recognise each word shape. Morison even argued that spacing is more important than the size or design of a particular typeface (Morison, 1959, p.x). The perceived typographic view is that inter-word spacing should be the width of a lowercase 'i' (McLean, 1980, p.45 and Jury 2002, p.92). The inter-word spacing for Sylexiad is however the width of *two* lowercase 'i''s as advocated by Beve Hornsby from the International Dyslexia Centre (Hornsby, 2002) (6.2.4.4). This relatively large spatial quality was supported by the outcomes of the formative developmental typeface testing process, which suggested that the majority of readers preferred a generous inter-word spacing. Although the horizontal emphasis of a line may not be as significant to the dyslexic reader, it is however, important not to generate too much inter-word space, as was the case with Dine 3. This resulted in too many rivers appearing in the paragraph texts, which may have consequently affected comprehension and interrupted the reading flow. The inter-letter spacing for Sylexiad can be seen as being normal and corresponds to that of the other test typefaces.

8.4 Generic features not included

The generic features identified in the previous chapter (7.6.3) which have *not* been incorporated into the design of both Sylexiad forms are as follows: 1, the use of relatively oblique letterforms; 2, the use of relatively compact letterforms and 3, the use of relatively bold letterforms.

8.4.1 Oblique letterforms

The function of oblique letterforms, or italics, is to highlight and focus particular words in order to emphasise specific meaning. When used exclusively as extended text they take longer to read (Jury, 2002, p.72), and can even "*impede reading*" (Carter, Day and Meggs, 1993, p.91). It is for this reason, coupled with findings gathered from the formative developmental typeface testing, that relatively oblique letterforms have *not* been incorporated into the design of Sylexiad. The structure of the letterforms is therefore perpendicular.

8.4.2 Compact letterforms

The wider and more expanded the letterform, the more legible it becomes. "*A narrower letter changes the form/counterform relationship, causing letters to have extreme vertical posture that can alter eye movement and reading patterns, diminishing legibility*" (Carter, Day and Meggs, 1993, p.91). Consequently, the design of Sylexiad features relatively wide rather than narrow or compact letterforms.

8.4.3 Bold letterforms

There are two schools of typographic thought regarding bold letterforms. One view, as Carter, Day and Meggs suggested, is that "*a typeface that is too heavy has a tendency to lose its internal pattern of counterforms*" (Carter, Day and Meggs, 1993, p.91) and therefore its legibility. Conversely, Jury stated that because "*bolder faces have greater visibility, and in some cases greater legibility than light or medium roman or italic faces, and if a face is chosen which has been designed with open counters, then there is no reason why it should not be as readable as a medium weight face*" (Jury, 2002, p.92). The findings from the formative developmental typeface testing tend to confirm these two opposing views in that the outcomes were also inconclusive; some readers preferring heavy typefaces, others not. My own view as a dyslexic reader favours lighter typefaces and consequently bold characteristics (at this stage of research) have not been incorporated into the Sylexiad design.

8.5 Serif Sylexiad

8.5.1 Serif forms

Serifed letterforms are generally considered to be more legible than sans-serif forms. Morison argued that "*the serif is essential to the reading of alphabetical composition in long passages and consecutive pages*" (Morison, 1959, p.xi). This point was more forcefully made by Ovnik, who stated that: "*No one can seriously dispute the important function of the serifs in the constitution of the word-gestalt*" (Ovnik, 1938, p.78). According to Burt, the serif "*contributes to the uniting of separate letters into word-wholes*" (Burt, 1959, p.9). The seriffed nature of a letterform it is argued can give greater shape to a word and therefore assist in greater legibility. Indeed, "*the neurological structure of the human visual system benefits from serifs in the preservation of the main features of letters*" (Robinson, Abbamonte and Evans, 1971, pp.353-359). The more distinctive the outline, the more perceptible it is.

8.5.2 Design concept and influences

The development and design of Serif Sylexiad has been informed and influenced by the formative developmental typeface testing of the Dine fonts. Because of the inconclusive nature of the findings regarding a preferred typographic style, two forms of Sylexiad have been created. Serif Sylexiad represents the initial serif version.

8.5.3 Design structure

Serif Sylexiad is a duocase serif font. It is the first serif version of a typeface for the adult dyslexic reader. The serifs within the font are unconventional in that they appear as small, indistinct, rounded nodes rather than long, sharp serifs. The nodes at this stage represent an initial starting point. The intention is to increase the length of these nodes and modify the shape into more conventional serif forms as the research develops at a post-doctoral level.

Serif Sylexiad in its lowercase form includes characters which have consistent x-heights. The x-heights are wide and well proportioned against the relatively long ascenders and descenders. The length range of the ascenders and descenders are consistent. The descenders appear longer than the ascenders and the counterforms within the lowercase alphabet are large.

The uppercase alphabet is regular in terms of height and is wide in form. There are no strokes drawn beyond the standard capital height, and the only stroke to be drawn below the baseline is the tail of the letter 'Q'.

Serif Sylexiad has light strokes and is perpendicular, rounded and well-proportioned in form. It incorporates a relatively wide inter-word spatial quality and comprises a total of 84 characters; these include 26 lowercase letters, 26 uppercase letters, 10 numerals and 22 punctuation and auxiliary marks.

8.5.4 Analysis and evaluation

A detailed analysis and evaluation of Serif Sylexiad can be found in Chapter 9.

8.6 Sylexiad Sans

8.6.1 Sans-serif forms

The consensus view within the mainstream typographic community can be summed up by McLean who stated that "*Sans-serif type is intrinsically less legible than serifed type*" (McLean, 1980, p.44). Morison added that sans-serif forms are "*insufficiently legible in terms of 'word recognition' and can only be read in comfort for short notices*" (Morison, 1959, p.xiv). In terms of visual disturbance, Huot-Marchand suggested that "*a sans-serif typeface does not stand so well the effects of irradiation*" (Huot-Marchand, 2004, p.51). Tinker (1963) and Cheetham and Grimbly (1965), however, disagree with the consensus and conclude that there is no significant difference between reading sans-serifs or serifs (Unger, 1992, p.109). This view correlates with the findings of the formative developmental typeface testing.

8.6.2 Design concept and influences

The development and design of Sylexiad Sans has been informed and influenced by the formative developmental typeface testing of the Dine fonts. Because of the inconclusive nature of the findings regarding a preferred typographic style, two forms of Sylexiad have been created. Sylexiad Sans represents the initial sans-serif versions.

8.6.3 Design structure

Sylexiad Sans is a duocase sans-serif font. It is the first sans-serif version of a typeface for the adult dyslexic reader. The strokes used to define the font are uniform, and represent an initial starting point in terms of design progression. The intention at post-doctoral level is to make the strokes less uniform, which would emphasise and de-emphasise the stress points within the letters. This in turn would provide more shape to the characters and therefore more shape to the words.

Sylexiad Sans in its lowercase form includes characters which have consistent x-heights. The x-heights are wide and well proportioned against the relatively long ascenders and descenders. The length range of the ascenders and descenders is consistent. The descenders appear longer than the ascenders, and the counterforms within the lowercase alphabet are large.

The uppercase alphabet is regular in terms of height and is wide in form. There are no strokes drawn beyond the standard capital height, and the only stroke to be drawn below the baseline is the tail of the letter 'Q'.

Sylexiad Sans has light and uniform strokes, and is perpendicular, rounded and well proportioned in form. It incorporates a relatively wide inter-word spatial quality, and comprises a total of 84 characters; these include 26 lowercase letters, 26 uppercase letters, 10 numerals and 22 punctuation and auxiliary marks.

8.6.4 Analysis and evaluation

A detailed analysis and evaluation of Sylexiad Sans can be found in Chapter 9.

8.7 Conclusion

The development of Serif Sylexiad and Sylexiad Sans has been informed by the formative developmental typeface testing of the Dine typefaces. They represent the first versions of a typeface for the adult dyslexic reader and have been based on the word shape model favoured by typographers *and* the parallel letter recognition model favoured by psychologists. Further modification to the designs will be generated as a result of subsequent summative developmental typeface testing. The Sylexiad fonts are perpendicular and rounded and contain light, uniform and long strokes.

When considering such qualities in 1905, Javel was critical and unfavourable; "*The trouble with straight, long and thin serifs, very common in France, is that they tend to be very fragile. They have to be thickened, but they also have to be shortened so they don't look too big*" (Huot-Marchand, 2004, p.51).

Javel was referring specifically to serifs, and these comments may well have been appropriate for non-dyslexic readers in the early 20th century. However, the very fragility of the straight, long and thin strokes contained within the Sylexiad forms, conversely, may well be the very typographic qualities that dyslexic readers favour in the early 21st century.

9. The outcomes of summative developmental typeface testing (Sylexiad).

9.1 Introduction

As stated previously, the aims of my investigation were threefold. The first aim was to test the existing typefaces which have been recommended by various dyslexia organisations. During the summative stage of testing, these typefaces included Arial (5.2) recommended by the British Dyslexia Association, Sassoon Primary (5.4) recommended by Dyslexic.com and the British Dyslexia Association and Times New Roman (5.3) recommended by the International Dyslexia Association.

The second aim was to test my own typefaces in order to establish which typographic characteristics adult dyslexic readers prefer to read and why. In terms of the summative stage of testing these typefaces included Serif Sylexiad (8.6) and Sylexiad Sans (8.7). The Sylexiad fonts can be seen as the first versions of a typeface for the adult dyslexic reader.

These two aims have helped to facilitate my third aim, which was to contribute new knowledge to the field of contemporary dyslexia typeface design.

In order to fulfil these aims, the summative stage had the same distinct limits and parameters as the formative stage. The focus was on four areas of interest. Firstly, the personal dyslexic (or alphonomic) reading difficulties as experienced and recounted by the participants and the resultant typographic preferences. Secondly, the text formation issues which concerned the reading of individual characters, words, sentences and paragraphs and the resultant typographic preferences. Thirdly, the generic typographic design issues concerning aspects of style, form, variability and associated reading issues and the resultant typographic preferences. Finally, the Sylexiad design issues and the resultant typographic preferences.

The objective of my research was to design a typeface for the adult dyslexic reader, and in doing so, develop a new typeface testing model. In order to achieve this objective a number of questions were asked. Is there a preferred typeface for the adult dyslexic reader? Is it different from the control? What are the typographic characteristics that dyslexic readers favour? These questions have all been answered and the summative stage of developmental typeface testing can therefore be seen as facilitating the aims *and* objective of my research. In order to realise my objective it was essential to establish control groups (not used during the formative stage) in order to compare and contrast outcomes with dyslexic groups (4.8.2).

A summary of the significant data gathered from the summative stage of developmental typeface testing is located in Chapter 13 (Figures 16 – 26). The issues raised as a result of these outcomes are discussed in detail in this chapter. Specifically, the chapter will highlight the outcomes from both the internal and external dyslexic groups and the internal and external controls. A detailed comparison of data will also be made between internal and external groups. The outcomes for the dyslexic groups concerned dyslexic issues (9.2), text

formation issues (9.3), and typographic issues (9.4); for the controls, the outcomes concerned reading issues (9.5), text formation issues (9.6) and typographic issues (9.7). The chapter will also provide a comparison of outcomes between the dyslexic and control groups (9.8). In conclusion, the chapter will highlight the similarities and differences between the preferences of the dyslexic readers and those of the controls (9.9).

9.2 Dyslexic issues for the internal and external dyslexic groups

The summative element of the developmental typeface testing procedure involved both internal and external groups (Study Tests 4 and 6). The reader groups were asked if they experienced any problems when reading, and if so, how these problems are manifested. This exercise involved 22 participants and six areas of difficulty were identified. They were: 1, reading difficulties; 2, stress difficulties; 4, psychological difficulties; 5, typographic difficulties and 6, non-reading (writing difficulties).

9.2.1 Reading difficulties

The reading difficulties experienced by the dyslexic participants are all interlinked, however I have classified them into four distinct areas. These areas are: 1, slow reading difficulties; 2, de-coding issues; 3, re-reading issues and 4, skip reading issues. All of the difficulties I have highlighted impact and contribute to slow reading.

9.2.1.1 Slow reading

Of the 22 participants who responded, 4 readers admitted to slow reading speeds. Each reader expressed a different typeface preference of Arial, Sassoon Primary, Serif Sylexiad and Times New Roman.

Summary

There was no preferred typeface to emerge in terms of qualitative outcomes from the slow readers. The quantitive Rate of Reading Tests, however, resulted in Sassoon Primary (as a family) having the highest word per minute rate of 327 words for both dyslexic groups combined, compared to Serif Sylexiad which had the lowest rate of 313 words (Figure 23). (For a more detailed account of the dyslexic groups' RRT outcomes please refer to 9.3.4.1).

The preferences of the slow readers, particularly for Arial and Times New Roman, tends to support the view of Zuzana Licko, the digital typographer, who proclaimed in *Émigré* that " '*you read best what you read most'. She also states that letters are not inherently legible but become more legible through repeated usage, and that* '*legibility is a dynamic process*'" (Unger,

1994, p108). This view, however, does not account for the high word rate and preference for Sassoon Primary (Figure 23) or indeed the preference for Serif Sylexiad. Both fonts are less familiar in appearance, and their preference by the group supports the suggestion by Dyslexic.com that "*many dyslexic people also find it easier to read a font that looks similar to handwriting as they are familiar with this style*" (Dyslexic.com, 2004, p.1).

9.2.1.2 Decoding issues

All of the decoding issues highlighted result in slow reading times for dyslexic readers. Decoding issues can be sub-divided into four areas. These sub-areas include: 1, difficulty in reading aloud; 2, decoding words; 3, misreading words and 4, comprehending words.

Difficulty in reading aloud

The number of participants who admitted to problems when reading aloud was 14% – the same figure identified during formative developmental typeface testing (7.2.1.2). Of this percentage, 67% favoured texts set in Arial and 33% Serif Sylexiad.

Decoding words

A difficulty in decoding words, resulting in some cases in a tendency to break down each word individually, was highlighted by 9% of the group. Once again, Serif Sylexiad and Arial were the preferred fonts in this instance.

Misreading words

The tendency to misread and add words when reading was a difficulty which 18% of the group acknowledged. Of this percentage 75% of readers preferred Serif Sylexiad and 25% Arial.

Comprehending words

The difficulty in comprehending certain words and digesting large amounts of text was identified by 22% of the group. Of this percentage, 67% preferred Serif Sylexiad and 33% Sassoon Primary.

Summary

The preferred typefaces for the dyslexic readers who acknowledge difficulties with decoding words were Serif Sylexiad and Arial. With regards to Arial, this outcome again seems to reinforce Licko's view concerning repeated usage. The clean, neutral and (crucially) familiar appearance of Arial may have appeared less intimidating for these readers, resulting in the high preference rating. As I have commented previously, I too experience decoding issues – especially when reading aloud. When I am reading texts set in Arial I find the font too "*hard*" and rather heavy and consider fonts with a more

(seriffed) shape to be easier to read. This favour for greater letter shape, coupled with the Dyslexic.com view regarding handwritten fonts, may explain the group preference for Serif Sylexiad.

9.2.1.3 Re-reading

The re-reading of texts can be seen as a decoding issue, which ultimately impacts on slow reading. Re-reading issues can be sub-divided into three areas: 1, re-reading texts; 2, hesitation and 3, losing place in texts.

Re-reading texts

Two participants expressed a difficulty with the re-reading of texts, which accounted for 9% for both groups. The preferred typefaces in this case were Sylexiad Sans and Sassoon Primary.

Hesitations

The tendency to hesitate on certain words was highlighted by one participant, which accounted for 5% for both groups. The preferred typeface to emerge in this instance was Serif Sylexiad.

Losing text place

One reader acknowledged a tendency to lose her place in texts. This participant accounted for 5% for both groups. The preferred typeface in this case was Times New Roman.

Summary

For the dyslexic readers who stated that re-reading of texts was a significant issue, handwritten-style fonts in the form of both Sylexiad fonts and Sassoon Primary accounted for 75% of the preferred typefaces. This outcome again reinforces the idea put forward by Dyslexic.com that dyslexic readers prefer handwritten style fonts.

9.2.1.4 Skip reading

Skip reading, along with decoding and re-reading issues is another factor which results in slow reading and poor comprehension. Skip reading can be sub-divided into two areas: 1, skip reading and 2, omitting words.

Skip reading

A tendency to skip read was noted by two readers, which accounted for 9% for both groups. In this instance both readers considered Serif Sylexiad to be the preferred typeface.

Omitting words

One reader stated a tendency to omit words when reading, which accounted for 5% for both groups. In this case, Times New Roman was the preferred typeface.

Summary

The outcomes for dyslexic readers who acknowledged problems with skip reading suggest a preference for serif fonts in the form of Serif Sylexiad and Times New Roman. This outcome tends to contradict the Dyslexic.com view, who considered that "*serif fonts, with their 'ticks' and 'tails' at the end of most strokes, tend to obscure the shapes of letters, so sans-serif fonts are generally preferred*" (Dyslexic.com, 2004, p.1).

9.2.2 Visual stress difficulties

This area of dyslexic difficulty refers specifically to the appearance of text on a page resulting in visual disturbance for the reader. The visual stress difficulties can be classified into three areas. These areas include: 1, visual distortion; 2, tracking difficulties and 3, glare.

9.2.2.1 Visual distortion

Visual distortion concerns the phenomenon of "*swirling*" (Irlen, 1991, pp.34-36), which causes the reader to experience the text as various tones of grey resulting in movement. The distortion can occur on a single word (micro) or multi-line (macro) level, resulting in a difficulty to focus on the text. Readers who expressed problems with text movement resulting in focussing difficulties accounted for 27% for both groups. Of these readers 50% preferred Arial (as a family) and 33% preferred Serif Sylexiad (as a family). The least favoured typeface was Times New Roman (as a family).

These outcomes indicate a preference for two, visually, very different fonts. Arial has a simple, neutral, yet relatively heavy, appearance whereas Serif Sylexiad looks spacious, relatively narrow and relatively light. What links both of these fonts are the relatively uniform strokes. However, the appearance of Serif Sylexiad, I would suggest, is more complex than Arial because of its seriffed quality, and has more in common with Times New Roman. In terms of typographic characteristics, the font preferences of readers who experience visual distortion is far from conclusive. It may be relevant to note that during the formative analysis, readers who experienced visual distortion also found Times New Roman to be the *least*-favoured font (7.2.2.1). It would seem that dyslexic readers who experience aspects of visual distortion dislike the irregular stroke forms typified by fonts such as

Times News Roman in favour of the more uniform, and therefore cleaner, strokes of typefaces such as Arial and Serif Sylexiad.

9.2.2.2 Tracking difficulties

Unlike those outcomes identified during the formative analysis (7.2.2.2), no participants admitted to experiencing tracking difficulties when reading extended texts. Because the issue of tracking was not raised, it does not mean it is not an issue. I find as a dyslexic reader myself that without the use of my finger or ruler to guide me, I often lose my place when reading long texts. For me, tracking issues are a major influence on my own ability to read texts effectively.

9.2.2.3 Glare

This area of visual stress is concerned with the glare produced by black text printed on white paper and is connected to scotopic sensitivity (2.3.2). Participants who expressed symptoms of glare accounted for 9% for both groups. Of this sample, 50% expressed a preference for Serif Sylexiad and 50% for Sassoon Primary. The least favoured typefaces were Arial, which accounted for 50% of this group and also Serif Sylexiad, which also accounted for 50%. These outcomes appear unclear and somewhat contradictory, with Serif Sylexiad being both the favoured and least-favoured font in equal measure. As a dyslexic reader who suffers occasionally from glare I find it easier to read lighter rather than bolder fonts. I therefore find the form of both Sylexiad fonts, out of all the test typefaces, the most effective in reducing the experience of glare.

9.2.2.4 Visual stress difficulties and typographic preferences

In connecting the areas of visual stress difficulties and typographic preferences, it would appear that both Serif Sylexiad and Arial are the favoured fonts. Both fonts however have very different visual qualities. Arial is familiar, neutral and relatively heavy, whereas Serif Sylexiad is unfamiliar, distinctive and relatively light. What links both fonts is the relative uniformity of stroke, which provides a clean look to both designs. It is this quality of “cleanness” which may influence reader preference with regards to visual stress difficulties.

9.2.3 Comprehension difficulties

Comprehension difficulties refer to specific problems related to the process of understanding the text. These difficulties can be classified into two areas: 1, retaining information and 2, concentration difficulties.

9.2.3.1 Retaining information

This area involves the ability (or, more precisely, lack of ability) to retain information after reading, resulting in failure to recall the meaning of a text. One participant admitted to a tendency to forget the meaning of a text after it has been read, accounting for 5% for both groups. Of this sample, Serif Sylexiad was the favoured font and Sylexiad Sans the least favoured font. During the formative analysis (7.2.3.1) Times New Roman was the favoured font within this particular area. The serif quality of both Sylexiad Serif during the summative testing and Times New Roman during the formative testing may have helped the readers to link and connect letters and words more easily than sans-serif fonts. This quality may enhance readability, which in turn may have helped readers to retain information more effectively. As a dyslexic reader myself, I also experience difficulty in retaining information when reading, which may explain my preference for serif fonts over sans-serif fonts as main text.

9.2.3.2 Concentration difficulties

This area refers to a reader not being able to concentrate easily whilst reading, resulting in a difficulty in comprehending texts. Readers who expressed difficulty within this area represented 18% of both groups. Of this sample, 50% considered Serif Sylexiad to be the preferred typeface while 50% considered Sassoon Primary to be the least favoured font. During the formative analysis of concentration difficulties (7.2.3.2), Times New Roman was the preferred font. Again, the quality, which links both Serif Sylexiad and Times New Roman, is the seriffed and relatively complex nature of both fonts. I also experience problems with concentration when reading extended texts over long periods of time, and find reading such texts easier in serif fonts.

9.2.3.3 Comprehension difficulties and typographic preferences

Serif Sylexiad was clearly the preferred typeface within this area during summative testing, favoured by 60% of readers who expressed comprehension difficulties. As with Times New Roman during the formative testing stage, it would seem that the serif element of the Serif Sylexiad design, coupled with the lightness of stroke contained within the font, are important elements in terms of facilitating the readability of texts, which in turn helps comprehension.

9.2.4 Psychological difficulties

This area concerns a lack of confidence when reading and is linked to the reading visual stress and comprehension difficulties already outlined. Those difficulties result in a reluctance to read. As in the formative developmental typeface testing, one person admitted

to a lack of confidence when reading, which represents 5%. The favoured typeface for this participant was Arial, with Times New Roman being the least favoured font.

9.2.4.1 Psychological difficulties and typographic preferences

During the formative testing stage (7.2.4), Sassoon Primary was considered to be the preferred font within this area of difficulty. Therefore, when combining the outcomes of both formative and summative stages (although the sample is small) it would seem that participants who admit to a lack of confidence when reading tend to prefer texts set in sans-serif rather than serif fonts. The weight of the font may also be a factor, as the sample seemed to prefer the relatively heavier weights of fonts such as Sassoon Primary and Arial.

9.2.5 Typographic difficulties

This area relates to a difficulty in reading texts due to typographic design factors. These factors are covered in more detail in Section 9.4 of this chapter. Participants who expressed problems in this area accounted for 27% for both groups. Of this percentage, 50% stated that they disliked long lines of text (which resulted in the use of a finger or ruler in order to improve tracking), 33% disliked small print or typefaces, 16% disliked tightly spaced text and 16% stated a difficulty with punctuation. The favoured typeface of the sample was Arial, which accounted for 67% of preferences. The least favoured typefaces were both Sylexiad fonts with 33% each.

9.2.5.1 Typographical difficulties and typographic preferences

It would seem that readers who identified specific reading problems relating to typographic issues tended to prefer the simple, neutral and familiar qualities of Arial, as opposed to the more complex, distinctive and unfamiliar qualities of the Sylexiad fonts. As a dyslexic reader myself, the outcomes of the sample contradict my own typographic preferences which are for seriffed and lighter forms.

9.2.6 Writing difficulties

The issue of writing difficulties was not identified during the formative testing stage. Although writing can be seen as somewhat tangential, the issue is nonetheless synonymous with reading. Participants who expressed difficulty with writing accounted for 13% of the group. Of this sample, 67% stated a difficulty with note-taking in a lecture situation and 33% stated a difficulty with (exclusively) writing rather than reading. There were no conclusive outcomes from this sample, as no typefaces or typographic style emerged as being significant.

9.2.7 Dyslexic issues conclusion

For both the internal and external dyslexic groups, the relationship between the dyslexic issues highlighted in this section and reading issues indicate a clear preference for the Serif Sylexiad font. Serif Sylexiad was the favoured typeface with regards to reading difficulties concerning decoding, re-reading and skip-reading; visual stress difficulties concerning visual distortion and glare; and comprehension difficulties concerning the retention of information and concentration. This amounts to seven distinct categories of dyslexic difficulty. The second favoured font was Arial, which was preferred in five categories. The least favoured font was Times New Roman. It would seem that the distinctive, complex, handwritten, light and uniformed stroke qualities of the Serif Sylexiad font were preferred by the majority of the internal and external dyslexic groups. This finding *may* support Burt's notion of aesthetic preference (3.3). With regards to Arial as the second favoured font, I would agree with Licko (9.2.1.1) and suggest that the reason for its preference *may* be due to the familiarity of the font, resulting in the notion of what the participant reads best is what the participant reads most, rather than because of any intrinsic design qualities.

9.3 Text formation issues for the internal and external dyslexic groups

The summative element of the developmental typeface testing procedure involved both internal and external groups (Study Tests 4 and 6). The tests involved 22 participants and concerned the examination of five distinct letter and text formation stages: 1, individual characters; 2, individual words; 3, individual sentences; 4, individual paragraphs and 5, overall typeface preference.

9.3.1 Individual characters

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2), this field of study can be seen as the logographic phase. The typographic outcomes which were identified included: 1, character confusion; 2, incorrect character identification and 3, character hesitation.

9.3.1.1 Character confusion

Difficulties concerning character confusion were experienced by 68% of both groups; of this sample 54% admitted to letter confusions between lowercase b/d, while 31% had difficulty with p/q. Other letter confusions concerned a/e, b/k, u/v and the numerals 6/9. All of these difficulties are related to the similarity in design of the character forms, resulting (in the examples of b/d, p/q and 6/9) in letter reversals. Vowel letters (in the example of a/e) may also be a factor in dyslexic character confusion. The difficulty of character confusion however is

not exclusively associated with reading but also with writing. One participant admitted to reversal problems when writing the letter 'S', and another admitted to difficulties *only* with writing.

It is significant to note that *all* of the character confusions were in lowercase forms (Figure 18). (Other uppercase errors refer to hesitations). One participant suggested that capital letters were much easier to read. It would seem that when reading individual characters, the evidence suggests that the most effective typographic form for dyslexic readers when reading individual characters are uppercase forms (Figure 18).

9.3.1.2 Incorrect character identification

When participants were asked to identify letters by reading character strings from right to left two incorrect identifications were made; these were in lowercase Arial and uppercase Sassoon Primary (Figure 18). (Other errors refer to hesitations). Of all the typefaces tested, both of these fonts have the widest stroke quality, which accounts for their tonally heavy appearance. All characters were correctly identified in the lighter-looking typefaces of Times New Roman and both Sylexiad fonts.

The evidence seems to suggest that dyslexic readers find lighter-stroked fonts more effective in identifying individual characters.

9.3.1.3 Character hesitation

When participants were asked to identify individual characters, all reader hesitations were noted. The highest hesitation rates were for Sassoon Primary (as a family) with 6 hesitations, Arial (as a family) with 5 and Times New Roman (as a family) with 4. The lowest rates were for both Sylexiad fonts (as a family) with 2 hesitations each (Figure 18). (Other errors refer to reading errors). It is also important to note that of all the hesitations made by the groups, 84% were in lowercase forms.

The evidence suggests that dyslexic readers hesitate less when identifying individual characters when the letterforms are relatively light and in uppercase form (Figure 18).

9.3.1.4 Individual character outcomes

The evidence from the individual character outcomes highlight two areas of importance. Firstly, that when reading individual characters, dyslexic readers prefer the relatively lighter strokes of fonts such as Serif Sylexiad and Sylexiad Sans. Secondly, that the majority of dyslexic readers read individual characters more effectively in uppercase rather than lowercase forms (Figure 18).

9.3.2 Individual words

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2) this field of study can be seen as the alphabetic stage. The typographic outcomes, which were identified, included: 1, incorrect word identification and 2, word hesitation.

9.3.2.1 Incorrect word identification

When participants were asked to identify the real word during the word pair tests, 13 incorrect responses were made (Figure 19). (Other errors refer to hesitations). Of these responses, 5 were in Arial (as a family) and 4 were in Sassoon Primary (as a family). The fonts with the least number of incorrect responses were both Sylexiad fonts (as a family) with 2 each and Times New Roman (as a family) with none. The relatively heavier fonts of Arial and Sassoon Primary accounted therefore for 69% of all incorrect responses. Out of all the incorrect responses, 61% were in uppercase typefaces (Figure 19). This outcome reverses the preference for uppercase during the individual character identification test.

The evidence would suggest that dyslexic readers find lighter-stroked fonts more effective in the identification of individual words. It also shows that within the area of individual word identification, lowercase fonts were the most effective typographic form (Figure 19).

9.3.2.2 Word hesitation

During the word pair tests, all reader hesitations were noted. The highest hesitation rates were for Sylexiad Sans (as a family) with 12 hesitations and Sassoon Primary (as a family) with 11. The lowest rates were Times New Roman (as a family) and Serif Sylexiad (as a family) both with 9 and Arial (as a family) with 8 (Figure 19). (Other errors refer to reading errors). There was an even relationship between lowercase hesitations of 49% and uppercase hesitations of 51%, indicating no particular dominant form (Figure 19).

The typographic outcomes with regards to word hesitations appear to be inconclusive, although it could be argued that the handwritten qualities of Sassoon Primary and Sylexiad Sans which resulted in high hesitation rates was difficult for readers. This observation, however, contradicted by the handwritten quality of Serif Sylexiad, which resulted in a low hesitation rate.

9.3.2.3 Individual word outcomes

The evidence from the individual word outcomes indicates two areas of importance. Firstly that when reading individual words, dyslexic readers prefer the relatively light strokes of both the Sylexiad fonts and Times New

Roman. Secondly, that the majority of dyslexic readers read individual words more effectively in lowercase, rather than uppercase forms (Figure 19).

9.3.3 Individual sentences

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2) this field of study can be seen as the orthographic stage. During the previous field studies concerning individual characters and individual words, all of the outcomes have concerned quantitative factors. During this study (and that for individual paragraphs (9.3.4)), the investigation was be more extensive. The study was therefore divided into quantitative and qualitative factors. The outcomes, which concerned quantitative issues, were: 1, misread sentences including hesitations and 2, sentence reading times; the qualitative issue was 3, sentence readability.

9.3.3.1 Misread sentences including hesitations

Participants were asked to read sentences aloud as quickly and accurately as possible. There were 39 misread sentences (including hesitations). Of these misreads, 10 were in Arial (as a family), 9 were in Serif Sylexiad (as a family) and 8 were in Times New Roman (as a family). The fonts with the least number of misreads were Sylexiad Sans (as a family) and Sassoon Primary (as a family) both with 6 each (Figure 20). Again, it is important to note that those sentences set in lowercase fonts had a higher misread rate of 55%, compared to uppercase fonts with a rate of 45%.

The evidence would suggest that most dyslexic readers find the handwriting quality of Sylexiad Sans and Sassoon Primary favourable when reading individual sentences. It also indicates that when reading individual sentences, uppercase fonts are generally the most effective form (Figure 20).

9.3.3.2 Sentence reading times

During the sentence tests, reading was timed. The quickest average sentence reading time was both Sylexiad fonts; 6.19 seconds for Sylexiad Sans (as a family) and 6.43 seconds for Serif Sylexiad (as a family). The longest reading times were for Arial (as a family) with 7.01 seconds. In the case of both Sylexiad fonts, the uppercase form resulted in the fastest times, whereas in the case of Arial the opposite was true (Figure 21).

The evidence suggests that the handwritten, uniform stroked and light form of both Sylexiad fonts, especially in uppercase forms facilitated the fastest reading times of individual sentences.

9.3.3.3 Sentence readability

After the sentence tests, participants were asked which typeface they considered to be the most readable. The participants thought that Arial (as a family) was the most readable font with an average rate of 1.7 (very easy). Sylexiad Sans (as a family) was considered to be the least readable with an average rate of 2.3 (easy). The most favoured lowercase form was Arial with a rate of 1.4 (very easy), and the most favoured uppercase form was Serif Sylexiad with 1.8 (very easy) (Figure 22).

The qualitative evidence suggests that the familiarity of a typeface may be an important factor when assessing the readability of individual sentences. The familiarity of Arial (as a family) was favoured over the unfamiliarity of Sylexiad Sans (as a family). However, when analysing individual typographic forms this notion of familiarity is contradicted (certainly in the case of uppercase forms), as participants found uppercase Serif Sylexiad to be the second most readable font. Serif Sylexiad cannot be described as familiar so it must be the design features in this typeface that dyslexic readers favour.

9.3.3.4 Individual sentence outcomes

The evidence from the individual sentence outcomes indicates four areas of significance. Firstly, quantitative data shows that when reading individual sentences, most dyslexic readers favour the handwritten qualities of Sylexiad Sans and Sassoon Primary. Secondly, quantitative data indicates that both the Sylexiad fonts (as a family) accounted for the quickest reading times. Thirdly, both qualitative and quantitative data suggests that the majority of dyslexic readers read individual sentences more effectively in the uppercase forms of both Sylexiad fonts. Fourthly, qualitative data suggests that the familiarity of fonts such as Arial may be a factor when dyslexic readers consider the readability of a typeface.

9.3.4 Individual paragraphs

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2) this field of study can be seen as the orthographic stage. As with the study into individual sentences the outcomes involved quantitative and qualitative factors. The outcomes, which concerned quantitative issues, were: 1, paragraph rate of reading times; 2, incorrectly identified words; and 3, correctly answered questions; the qualitative issue was 4, paragraph readability.

9.3.4.1 Paragraph rate of reading times

Participants were asked to read paragraphs as quickly and accurately as possible. The rate of words read per minute by each reader was calculated. The typefaces with the highest reading rates were Sassoon Primary (as a family) with an average of 163 words-per-minute, and Sylexiad Sans (as a

family) with 160 words-per-minute. The typeface with the lowest rate was Serif Sylexiad (as a family) with 156 words-per-minute (Figure 23).

In the case of Sylexiad Sans, the uppercase form of the typeface had a higher word per minute rate than the lowercase form. Uppercase Sylexiad Sans also accounted for the highest rate of any uppercase form with an average of 164 words-per-minute. The font form with the highest overall rate was lowercase Arial with an average of 167 words-per-minute (Figure 23).

The evidence suggests that dyslexic readers read more words-per-minute in typefaces such as Sassoon Primary (as a family) and Sylexiad Sans both (as a family), both of which have handwritten and uniform stroke qualities. The evidence also showed that the familiarity of lowercase Arial resulted in the highest word-per-minute rate (Figure 23).

9.3.4.2 Incorrectly identified words

After reading the paragraphs, participants were asked if they could identify the incorrect word. The typeface that accounted for the highest number of successful identifications was Times New Roman (as a family) with 12. The typeface with the least number was Sylexiad Sans (as a family) with 8. The total number of identifications was 52, of this figure, 50% were in lowercase forms and 50% in uppercases forms (Figure 24).

No real patterns emerged from this field of study. The evidence would indicate that most dyslexic readers found Times New Roman (as a family) to be the most effective typeface when identifying incorrect words. The dominance of typographic form within this field towards either uppercase or lowercase fonts was inconclusive (Figure 24).

9.3.4.3 Correctly answered questions

After reading the paragraphs, participants were asked if they understood the text, and if so, were asked to answer a question about the text. The typeface that accounted for the most correct answers was Serif Sylexiad (as a family) with 15. Arial (as a family) and Sylexiad Sans (as a family) accounted for the least, both with 9. The total number of correct questions answered was 59, of this figure, 53% were in lowercase and 47% in uppercase forms (Figure 25).

As with the previous field study, no real patterns emerged. The evidence would indicate that most dyslexic readers comprehend texts more when they are set in Serif Sylexiad (as a family). The dominance of typographic form within this field towards either uppercase or lowercase fonts was inconclusive (Figure 25).

9.3.4.4 Paragraph readability

After the paragraph tests were completed, participants were asked which typeface they considered to be the most readable. The participants thought that Serif Sylexiad (as a family) was the most readable font with an average rate of 2.1 (easy). Times New Roman (as a family) was considered to be the least readable with an average rate of 2.5 (easy). Echoing the findings from the sentence readability study (9.3.3.3), the most favoured lowercase form was Arial with a rate of 1.9 (very easy), with the most favoured uppercase forms being both Sylexiad fonts with 2.0 (easy) each (Figure 26).

The qualitative evidence suggests that most dyslexic readers considered Serif Sylexiad (as a family) to be the most readable font for paragraphs. The evidence also indicates that familiarity of form may again be a factor in readability preferences due to the favoured lowercase Arial rate. The outcomes also show that the second highest overall rating was for both uppercase forms of the Sylexiad fonts (Figure 26).

9.3.4.5 Individual paragraph outcomes

The evidence from the individual paragraph outcomes indicates five areas of importance. Firstly, quantitative data shows that when reading individual paragraphs, most dyslexic readers favour the handwritten qualities and uniform strokes of Sassoon Primary (as a family) and Sylexiad Sans (as a family). Secondly, quantitative data indicates that the serif qualities of Serif Sylexiad (as a family) and Times New Roman (as a family) accounted for the best comprehension rates. Thirdly, both qualitative and quantitative data suggests that most dyslexic readers read individual paragraphs more effectively in the uppercase forms of both Sylexiad fonts. Fourthly, quantitative data suggest that the familiarity of fonts such as Arial and Times New Roman *may* be a factor with regards to reading rates and readability. However, this is not reflected in the qualitative data that indicates Times New Roman to be the least favoured font (9.3.5). Finally, qualitative data shows that most dyslexic readers consider Serif Sylexiad (as a family) to be the most readable font for paragraphs.

9.3.5 Overall typeface preference

After all of the text formation tests were completed, the participants were asked to consider which typeface was their preferred font. Serif Sylexiad (as a family) with an average rate of 2.8 (easy) was considered to be the most favoured font, followed by Sylexiad Sans (as a family) with 2.9 (easy). The least favoured font was Times New Roman (as a family) with an average rate of 3.2 (difficult). It is also interesting to note that the highest overall rates (lowercase and uppercase) were for the uppercase form of the Sylexiad fonts both with an average rate of 2.3 (easy) (Figure 16).

The evidence suggests that for the dyslexic groups, the handwritten, uniform stroked and light form of both Sylexiad fonts, especially in uppercase forms, resulted in the highest preference ratings (Figure 16).

9.3.6 Dyslexic text formation issues conclusion

With regards to the relationship between text formation issues and typographic design preferences, the dyslexic readers raised a number of issues and observations. They include the following:

1. The light strokes of Serif Sylexiad and Sylexiad Sans were clearly favoured.
2. The handwritten quality of Sylexiad Sans and Sassoon Primary were clearly favoured.
3. The uniform strokes of Sylexiad Sans and Sassoon Primary were clearly favoured.
4. The serif qualities of Serif Sylexiad and Times New Roman helped with comprehension.
5. The uppercase forms of Serif Sylexiad and Sylexiad Sans were favoured during the character, sentence and paragraph studies.
6. In general, lowercase typefaces were favoured during the word study.
7. The quickest sentence reading times were in Serif Sylexiad and Sylexiad Sans.
8. The familiarity of Arial influences readability and reading rates.
9. The preferred adult dyslexic typeface is Serif Sylexiad.

9.4 Typographic design issues for the internal and external dyslexic groups

The summative developmental typeface testing procedure involved both internal and external groups (Study Tests 4 and 6). The 22 participants were asked to comment on issues concerning the typographic aspects of the various test fonts. Comments regarding the visual tone of the fonts have also been included in this analysis. The typographic design issues which emerged from these tests, were as follows: 1, typographic styles; 2, typographic form; 3, typographic variables and 4, reading issues.

9.4.1 Typographic style

The areas concerning this particular aspect of typographic design involved reader comment about the following generic style issues: 1, serif typefaces; 2, sans-serif typefaces and 3, oblique or handwritten typefaces.

9.4.1.1 Serif typefaces

The comments made with regards to serif typefaces refer to Times New Roman and Serif Sylexiad. In terms of visual tone, both serif fonts were considered to be, in the case of Serif Sylexiad, "*serious*" (Reader BD) (Study

Test 4) yet "*informal*" (Readers BX and CA) (Study Test 6); and in the case of Times New Roman, "*traditional*" (Reader BH) (Study Test 4) and "*familiar*" (Reader BY) (Study Test 6).

With regards to the serif nature of Serif Sylexiad, one reader thought that the typeface had no serifs, which made the font "*clearer*" (Reader BX) (Study Test 6). Others, however, thought the font "*merged*" (Reader BE) (Study Test 4), and caused "*blurring*" (Reader BD) (Study Test 4) and (Reader CS) (Study Test 4).

The anecdotal evidence seems somewhat confusing: some readers found seriffed typefaces to be blurry, for others the fonts were clear. My own view as a dyslexic reader is that I consider seriffed texts to be easier. This may be due to the fact that most extended texts are written in serif forms, which makes those typefaces (especially Times New Roman) seem familiar. This familiarity, as Licko has argued, facilitates more effective reading. I also consider that serifs help the textual flow of letters and words, which in my case makes reading easier.

9.4.1.2 Sans-serif typefaces

The comments made with regards to sans-serif typefaces refer to Arial, Sassoon Primary and Sylexiad Sans. Arial was considered to be "*serious*" (Readers BX and CB) (Study Test 6) and "*official"* (Reader CR) (Study Test 4). Sassoon Primary was "*historical*" (Reader BH) (Study Test 4) and "*friendly*" (Reader CB) (Study Test 6). Sylexiad Sans was thought to be "*cartoony*" (Reader BH) (Study Test 4) and "*arty*" (Reader BY) (Study Test 6). The comment that linked all of the sans-serif faces was that they were "*clear*" (Reader BE) (Study Test 4), (Reader BH) (Study Test 4), (Readers BD and BH) (Study Test 4), (Reader BX) (Study Test 6), (Reader BZ) (Study Test 6) and (Reader CB) (Study Test 6).

The anecdotal evidence would suggest that different sans-serif designs emanate different visual signals. What unifies this particular typographic style however is the quality of "*clearness*".

9.4.1.3 Handwritten or oblique typefaces

The comments made with regards to handwritten-style or oblique typefaces refer to Sassoon Primary, Serif Sylexiad and Sylexiad Sans. It was observed that Sassoon Primary had an "*italic*" look (Reader BX) (Study Test 6) and was "*easy to read*" (Reader BE) (Study Test 4). Serif Sylexiad was "*not messy*" (Reader BX) (Study Test 6) and "*friendly*" (Reader BY) (Study Test 6). Although Serif Sylexiad is not an italicised font (rather very perpendicular) it was noted that it appeared "*slightly slanted*" (Reader BK) (Study Test 4).

Sylexiad Sans was thought to be like "*newspaper text*" (Reader BX) (Study Test 6) and "*articles type*" (Reader BD) (Study Test 4). The comment that linked all of the oblique typefaces was that they looked "*clear*" (Reader BI) (Study Test 4), (Reader BE) (Study Test 4), (Readers BD and BH) (Study Test 4), (Reader BX) (Study Test 6), (Reader CB) (Study Test 6) and (Reader CB) (Study Test 6).

The anecdotal evidence would suggest that a significant percentage of dyslexic readers (27% of this particular sample) find the visual quality inherent in oblique style typefaces to be "*clear*".

9.4.2 Typographic form

The areas concerning this particular aspect of typographic design involved reader comment about the following generic form issues: 1, uppercase letterforms and 2, lowercase letterforms.

9.4.2.1 Uppercase forms

The comments made with regards to this aspect mainly concerned uppercase fonts set as paragraphs. In general, the uppercase forms of Arial, Sassoon Primary and Times New Roman were not liked. In the case of Arial it "*kept jumping lines, it didn't flow*" (Reader BL) (Study Test 4) and looked "*harsh*" (Reader CS) (Study Test 4); Sassoon Primary looked "*clogged*" (Reader BJ) (Study Test 4) and "*messy*" (Reader CF) (Study Test 6); and Times New Roman was "*horrible*" (Reader BM) (Study Test 4) and "*harsh*" (Reader CD) (Study Test 6). These outcomes are unsurprising as those typefaces were not designed to be read exclusively as paragraphs in the uppercase form. The response, however, for both Sylexiad fonts was generally more favourable. With regards to Serif Sylexiad, "*the writing* (text) *blends with the background better*" (Reader CS) (Study Test 4) and it looked "*elegant*" (Reader CD) (Study Test 6). Sylexiad Sans was considered to be "*definitely clearer*" (Reader BM) (Study Test 4) and "*the white* (background) *doesn't stand out*" (Reader (CS) (Study Test 4). The more positive outcomes for both Sylexiad fonts in uppercase forms may be due to the fact that both typefaces were designed to be read as paragraphs in *either* upper or lowercase forms.

The anecdotal evidence would suggest that there were fewer negative responses to uppercase forms or Serif Sylexiad and Sylexiad Sans compared to the uppercase forms of Arial, Sassoon Primary and Times New Roman.

9.4.2.2 Lowercase forms

In general, the responses to the lowercase forms were mixed. The reaction to Serif Sylexiad, however, was mainly favourable, "*it was nice to read*" (Reader

BY) (Study Test 6) and "*it would encourage me to read, and keep me interested in the text*" (Reader CA) (Study Test 6). Sylexiad Sans "*suited the length of the paragraph*" (Reader BY) (Study Test 6) but "*the words seemed to bump into each other*" (Reader BZ) (Study Test 6). Arial was "*explanatory*" (Reader BZ) (Study Test 6) but "*boring*" and "*monotonous*" (Reader CA) (Study Test 6). Sassoon Primary looked "*nice to read*" (Reader BZ) (Study Test 6) but the sentences seemed "*disjointed*" (Reader BX) (Study Test 6). Times New Roman was "*crisp*" (Reader CA) yet "*a lot of this text would be overwhelming*" (Reader BX) (Study Test 6) and looked "*bizarre*" (Reader BH) (Study Test 4).

There were no real patterns to emerge from the anecdotal evidence which concerned lowercase forms. The relatively long ascenders of the lowercase form of Serif Sylexiad were, however, noted by one participant who suggested that the "*long letters*" resulted in the text "*blending with the background better*" (Reader CS) (Study Test 4).

9.4.3 Typographic variables

The areas concerning this particular aspect of typographic design involved reader comment about the following generic variable issues: 1, weight; 2, space and 3, familiarity.

9.4.3.1 Weight

The aspect of weight can be divided into two sections: 1, lightness and 2, boldness.

Lightness

The comments made by participants with regards to the lightness of form or stroke refer to both Sylexiad fonts. With regards to Serif Sylexiad, readers considered the strokes to be "*delicate*" (Reader BF) (Study Test 4). "*I liked the spacing and thinness*" (Reader BX) (Study Test 6). With Sylexiad Sans "*the thinner writing was more defined on the page*" (Reader BX) (Study Test 6), however others thought the weight looked "*weak*" (Reader BK) (Study Test 4).

The anecdotal evidence concerning the lightness of stroke seemed generally favourable. My own view as a dyslexic reader also favours light strokes, in that they reduce my experience of visual disturbance and subsequent movement of texts.

Boldness

The comments made by participants with regards to the boldness of form and stroke refer to Arial and were generally unfavourable. With regards to Arial,

"*some of the letters merged*", and it was "*overwhelming*" (Reader BX) (Study Test 6). Others thought the weight was "*brutal*" (Reader CD) (Study Test 6) and "*too bold*" (Reader CE) (Study Test 6).

The anecdotal evidence regarding bold weights suggests that dyslexic readers tend to dislike bolder strokes.

9.4.3.2 Space

The comments made by participants concerned letter, word and line spacing as a whole. Serif Sylexiad was considered to be "*well spaced*" with the "*sentences well-organised*" (Reader BI) (Study Test 4), "*I liked the big spaces between letters*" (Reader CD) (Study Test 6). Comments for Sylexiad Sans were also positive; the font was seen as "*spacious*" (Readers BF and BH) (Study Test 4), "*making it easier to read*" (Reader CG) (Study Test 6). The comments regarding Arial were mixed, as it appeared "*cluttered*" (Reader BI) (Study Test 4). Others, however, thought it had "*clear, comfortable spacing*" (Reader BZ) (Study Test 6). Sassoon Primary looked "*open*" (Reader BZ) (Study Test 6) yet "*clogged, closed-in and squashed*" (Reader BJ) (Study Test 4). Times New Roman looked "*painful to read*" (Reader CG) (Study Test 6) and "*closed-in*" (Reader BJ) (Study Test 4).

Although the anecdotal evidence was somewhat contradictory, there were more positive rather than negative comments for both Sylexiad fonts. As both Sylexiad fonts have more generous word-space than the other test typefaces the findings would suggest that dyslexic readers prefer fonts with such qualities.

9.4.3.3 Familiarity

The comments regarding familiarity of form concerned both Arial and Times New Roman. Both fonts were considered to be "*familiar*" (Reader BY) (Study Test 6). More negatively, both fonts were also considered to be "*boring*" and "*monotonous*" (Reader CA) (Study Test 6). Unsurprisingly there were no comments regarding the familiarity of the Sylexiad fonts. However, during the control tests, one reader suggested that although Serif Sylexiad was "*unfamiliar*", it "*did not impede reading*" (Reader CL) (Study Test 7).

Anecdotal evidence with regards to familiarity and the dyslexic readers was somewhat neutral and inconclusive.

9.4.4 Reading issues

The area concerning this particular aspect of typographic design involved reader comment about the generic reading issue of visual disturbance.

9.4.4.1 Visual disturbance

Negative comments were made with regards to visual disturbance about all of the test typefaces. With regards to Serif Sylexiad, "*it looked like it merged into one*" (Reader BE) (Study Test 4). The quality of Sylexiad Sans "*vibrates, the glare is noticeable*" (Reader CR) (Study Test 4). With Arial "*I jumped from one word to another*" (Reader CS) (Study Test 4). In the case of Sassoon Primary "*all the 'o's' pop out at you*" (Reader CR) (Study Test 4) and Times New Roman was "*horrible*" (Reader BM) (Study Test 4) and "*muddled*" (Reader CS) (Study Test 4).

The anecdotal evidence has shown that all the typefaces have been responsible for some aspect of visual disturbance. The link between visual disturbance and typographic design would seem to be one of personal preference. The design quality of one font can be as beneficial to one dyslexic reader as it is detrimental to another.

9.4.5 Dyslexic typographic design issues conclusion

For both the internal and external dyslexic groups, the anecdotal evidence concerning typographic design issues and reading was often contradictory and inconclusive. With regards to issues of typographic style, there was no dominance shown towards either serif or sans-serif style. There was an indication, however, that sans-serif styles had a quality of "*cleanness*". Handwritten font styles were liked by a significant percentage of readers for their quality of "*cleanness*".

With reference to the area of typographic form, there were fewer negative responses for the uppercase Sylexiad fonts compared to the other uppercase and lowercase test fonts. This would indicate a preference by the readers for uppercase forms, especially Serif Sylexiad and Sylexiad Sans.

With regards to typographic variables there seemed to be a preference towards the lighter weights of the Sylexiad fonts rather than the relatively heavier weights of Arial. There were also more positive reactions concerning the spatial qualities of both Sylexiad fonts compared to the other test typefaces. This would indicate that readers favoured the more generous spatial aspects associated with Serif Sylexiad and Sylexiad Sans. The evidence regarding dyslexic attitudes to notions of familiarity was inconclusive. The evidence relating to the area of reading issues, particularly visual disturbance was also inconclusive. The comments indicated that the difficulty was experienced by readers in texts set in all of

the test typefaces. This suggests that with regards to visual disturbance, the design quality of one font can be as beneficial to one reader as it is detrimental to another.

9.5 Reading issues for the internal and external control groups

The summative element of the developmental typeface testing procedure involved both internal and external control groups (Study Tests 5 and 7). These groups comprised 20 participants who were asked if they experienced any problems when reading. All participants stated that they did not. There were therefore no reading issues identified by the controls.

9.6 Text formation issues for the internal and external control groups

The summative element of the developmental typeface testing procedure involved both internal and external control groups (Study Tests 5 and 7). The tests involved 20 participants and concerned the examination of five distinct letter and text formation stages: 1, individual characters; 2, individual words; 3, individual sentences; 4, individual paragraphs and 5, overall typeface preference.

9.6.1 Individual characters

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2), this field of study can be seen as the logographic phase. The typographic outcomes which were identified included: 1, character confusion; 2, incorrect character identification and 3, character hesitation.

9.6.1.1 Character confusion

Difficulties concerning character confusion were experienced by 10% of both groups; of this sample 67% admitted to letter confusions between lowercase b/d, while 33% had difficulty with p/q. There were no other admitted character confusions. One participant considered that the uppercase forms were easier to recognise.

As with the dyslexic groups, but to a lesser extent, the character confusions of the controls were all in lowercase forms. The evidence would suggest, therefore, that the most effective typographic form for the controls when reading individual characters are uppercase forms.

9.6.1.2 Incorrect character identification

When participants were asked to identify letters by reading character strings from right to left there were no incorrect identifications (Figure 18). (Other errors refer to hesitations). Therefore no conclusions can be made regarding the control groups' typographic preference and individual character identification.

9.6.1.3 Character hesitation

When participants were asked to identify individual characters, all reader hesitations were noted. The highest hesitation rates were for Times New Roman (as a family) with 2 hesitations and Sassoon Primary (as a family) with 1. All the other test typefaces accounted for no hesitations (Figure 18). It is interesting to note that all the hesitations made by the controls were in lowercase forms.

The evidence suggests that the controls hesitate less when identifying individual characters when the letterforms are in uppercase forms.

9.6.1.4 Individual character outcomes

The evidence from the individual character outcomes highlights one area of importance, that the great majority of the controls read individual characters more effectively in uppercase rather than lowercase forms (Figure 18).

9.6.2 Individual words

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2), this field of study can be seen as the alphabetic stage. The typographic outcomes, which were identified, included: 1, incorrect word identification and 2, word hesitation.

9.6.2.1 Incorrect word identification

When participants were asked to identify the real word during the word pair test, 3 incorrect responses were made, (Figure 19) (Other errors refer to hesitations) all of which were in the uppercase form of Sylexiad Sans. This outcome reverses the preference for uppercase forms during the individual character identification test.

The evidence would suggest that within the area of individual word identification, lowercase fonts were the most effective typographic form for the controls.

9.6.2.2 Word hesitation

During the word pair tests, all reader hesitations were noted. The highest hesitation rates were for Sylexiad Sans (as a family) with 5. The lowest rates were Times New Roman (as a family) with 3 and Serif Sylexiad (as a family) with 0 (Figure 19). (Other errors refer to reading errors). The uppercase forms accounted for 77% of all hesitations.

The typographic outcomes of the controls seem more emphatic than those of the dyslexic groups. The evidence indicates that the serif forms of Times New Roman and Serif Sylexiad result in low hesitation rates. It also shows that for the great majority, the controls hesitate less when reading fonts in lowercase forms (Figure 19).

9.6.2.3 Individual word outcomes

The evidence from the individual word outcomes indicates two areas of interest. Firstly that when reading individual words, the controls prefer the serif quality of Serif Sylexiad and Times New Roman. Secondly, for the great majority, the controls read individual words more effectively in lowercase, rather than uppercase forms.

9.6.3 Individual sentences

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2), this field of study can be seen as the orthographic stage. During the previous field studies concerning individual characters and individual words, all of the outcomes have concerned quantitative factors. During this study (and that for individual paragraphs (9.6.4)), the investigation was more extensive. The study was therefore divided into quantitative and qualitative factors. The outcomes which concerned quantitative issues were: 1, misread sentences including hesitations and 2, sentence reading times; the qualitative issue was 3, sentence readability.

9.6.3.1 Misread sentences including hesitations

Participants were asked to read sentences aloud as quickly and accurately as possible. There were 10 misread sentences (including hesitations). Of these misreads, 4 were in Serif Sylexiad (as a family), 2 were in Sassoon Primary (as a family) and 2 were in Times New Roman (as a family). The fonts with the least number of misreads were Sylexiad Sans (as a family) and Arial (as a family) with 1 each (Figure 20). It is interesting to note that those sentences set in uppercase fonts had a higher misread rate of 82% compared to lowercase fonts with a rate of 18%.

The evidence would suggest that the controls found the sans-serif quality of Arial and Sylexiad Sans favourable when reading individual sentences. It also indicates an emphatic reversal of the outcomes from the dyslexic groups in

that when reading individual sentences, the controls find lowercase fonts to be the most effective form (Figure 20).

9.6.3.2 Sentence reading times

During the sentence tests, reading was timed. The quickest average sentence reading time was for Sassoon Primary and Arial: 3.90 seconds for Sassoon Primary (as a family) and 3.91 seconds for Arial (as a family). The longest reading time was for Serif Sylexiad (as a family) with 4.22 seconds. It is interesting to note that in all instances the lowercase forms resulted in the fastest reading times (Figure 21).

The evidence again reverses the outcomes of the dyslexic groups. Arial was the joint fastest read whereas Serif Sylexiad was the slowest. The outcomes also emphatically indicate that lowercase forms facilitated the fastest reading times of individual sentences for the controls.

9.6.3.3 Sentence readability

After the sentence tests, the controls were asked which typeface they considered to be the most readable. Participants thought that Arial (as a family) was the most readable font with an average rate of 1.4 (very easy). Sylexiad Sans (as a family) was considered to be the least readable with an average rate of 1.9 (very easy). The most favoured lowercase font was Arial with a rate of 1.5 (very easy), and the most favoured uppercase form was also Arial with the highest rate of all forms tested of 1.3 (very easy) (Figure 22).

The qualitative evidence emphatically echoes the outcomes from the dyslexic groups, in that the familiarity of a typeface may be an important factor when assessing the readability of individual sentences. The controls found that the familiar qualities of Arial (as a family) were favoured over the unfamiliarity of Sylexiad Sans (as a family) (Figure 22).

9.6.3.4 Individual sentence outcomes

The evidence from the individual sentence outcomes indicates five areas of importance. Firstly, quantitative data show that when reading individual sentences, the control favour the sans-serif qualities of Arial. Secondly, quantitative data indicate that Arial (as a family) and Sassoon Primary (as a family) accounted for the fastest reading times. Thirdly, both qualitative and quantitative data suggest that the control read individual sentences more effectively in lowercase forms. Fourthly, qualitative data suggest that the familiarity of fonts such as Arial may be a readability factor. Finally, qualitative and quantitative data indicate Serif Sylexiad (as a family) to be the least favoured font for the control when reading individual sentences.

9.6.4 Individual paragraphs

Using Frith's literacy development model (Frith, 1985, pp.301-330) (2.5.2), this field of study can be seen as the orthographic stage. As with the study into individual sentences the outcomes involved quantitative and qualitative factors. The outcomes which concerned quantitative issues were: 1, paragraph rate of reading times; 2, incorrectly identified words and 3, correctly answered questions; the qualitative issues was 4, paragraph readability.

9.6.4.1 Paragraph rate of reading times

Participants were asked to read paragraphs as quickly and accurately as possible. The rate of words read per minute by each reader was calculated. The typeface with the highest reading rate was Arial (as a family) with an average of 232 words-per-minute. The typefaces with the lowest rates were Sylexiad Sans (as a family) with 212 words-per-minute, Times New Roman (as a family) with 211 and Serif Sylexiad (as a family) with 210. It is significant that with all of the typefaces (with the exception of Sylexiad Sans), the uppercase forms accounted for the higher word-per-minute rates. The font form with the highest overall rate was uppercase Arial with an average of 233 words-per-minute (Figure 23).

The evidence would indicate that the controls found the relatively heavy and familiar form of Arial (as a family) produced the highest word per minute rate. The lowest rate was for the relatively light and unfamiliar form of both Sylexiad fonts (as a family). In the case of Sylexiad Sans, this outcome reverses that of the dyslexic group. It would also appear that the controls read more words-per-minute in uppercase typefaces. It is interesting to note that the rates for the controls were less than a typical reading rate, which is usually 250 to 300 words-per-minute (Spencer, 1968, p.102 and Larson, 2004, p.74).

9.6.4.2 Incorrectly identified words

After reading the paragraphs, participants were asked if they could identify the incorrect word. The typeface that accounted for the highest number of successful identifications was Serif Sylexiad (as a family) with 20. The typefaces with the least number were Arial (as a family) and Sassoon primary (as a family) with 15 each. The total number of identifications was 86, of which 48% were in lowercase forms and 52% in uppercase forms (Figure 24).

As with the dyslexic groups' outcomes, no real patterns emerged from this field of study. The evidence would indicate that the controls found Serif Sylexiad (as a family) to be the most effective typeface when identifying incorrect words. Also, as with the dyslexic groups' outcomes, a dominance of typographic form within this field towards either uppercase or lowercase fonts was inconclusive.

9.6.4.3 Correctly answered questions

After reading the paragraphs, participants were asked if they understood the text, and if so, were asked to answer a question about the text. The typeface that accounted for the most correct answers was Times New Roman (as a family) with 18. Sylexiad Sans (as a family) accounted for the least with 10. The number of correct questions answered was 72, of which 47% were in lowercase and 53% were in uppercase forms (Figure 25).

As with the dyslexic group outcomes, no real patterns emerged from this field of study. For both the controls and the dyslexic groups, Sylexiad Sans accounted for the least number of correctly answered questions. The dominance of typographic form within this field towards either uppercase or lowercase fonts was also inconclusive.

9.6.4.4 Paragraph readability

After the paragraph tests were completed, participants were asked which typeface they considered to be the most readable. The participants thought that Times New Roman (as a family) was the most readable font with an average rate of 1.6 (very easy). Sylexiad Sans (as a family) was considered to be the least readable with an average rate of 2.0 (easy) (Figure 26).

The qualitative evidence suggests that the controls considered Times New Roman (as a family) to be the most readable font for paragraphs. This outcome reverses the findings of the dyslexic groups, who considered Times New Roman (as a family) to be the least readable font.

9.6.4.5 Individual paragraph outcomes

The evidence from the individual paragraph outcomes indicates three areas of importance. Firstly, quantitative data show that when reading individual paragraphs, the controls favour the familiar qualities of Arial (as a family) and Times New Roman (as a family). Secondly, quantitative data indicate that the serif qualities of Times New Roman (as a family) and Serif Sylexiad (as a family) accounted for the best comprehension rates. Thirdly, qualitative data show that most of the controls considered Times New Roman (as a family) to be the most readable for paragraphs and Sylexiad Sans (as a family) the least readable.

9.6.5 Overall typeface preference

After all of the text formation tests were completed, the participants were asked to consider which typeface was their preferred font. Times New Roman (as a family) with an average rate of 2.5 (easy) was considered to be the most favoured font, followed by Arial (as a family) with 2.8 (easy). The least favoured font was Sassoon Primary (as a family) with an

average rate of 3.3 (difficult) (Figure 16). The highest average lowercase rate was for Arial with 2.4 (easy), and the highest uppercase rate was for Times New Roman with 2.6 (easy) (Figure 17).

The evidence suggests that for the controls, the familiar qualities of Arial and Times New Roman resulted in the highest preference ratings. These outcomes in the case of Times New Roman are a reversal of the findings from the dyslexic groups.

9.6.6 Control text formation issues conclusion

With regards to the relationship between text formation issues and typographic design preferences, the controls raised a number of issues and observations. They include the following:

1. The serif qualities of Serif Sylexiad and Times New Roman were preferred when reading individual words and resulted in the best comprehension rates during the paragraph study.
2. The sans-serif quality of Arial was favoured during the sentence study.
3. The sans-serif qualities and relatively heavy weight of Arial and Sassoon Primary accounted for the fastest reading times.
4. Uppercase typefaces were favoured during the character study.
5. Lowercase typefaces were favoured during the word and sentence studies.
6. The familiarity of Arial and Times New Roman may have been a factor during the sentence and paragraph studies.
7. During the sentence and paragraph studies, Sylexiad Sans was the least favoured typeface.
8. The preferred control typeface was Times New Roman.

9.7 Typographic design issues for the internal and external control groups

The summative developmental typeface testing procedure involved both control groups (Study Tests 5 and 7). The 20 participants were asked to comment on issues concerning the typographic aspects of the various test fonts. Comments regarding the visual tone of the fonts have also been included in this analysis. The typographic design issues which emerged from these tests, were as follows: 1, typographic styles; 2, typographic form; 3, typographic variables and 4, reading issues.

9.7.1 Typographic style

The areas concerning this particular aspect of typographic design involved reader comment about the following generic style issues: 1, serif typefaces; 2, sans-serif typefaces and 3, oblique or handwritten typefaces.

9.7.1.1 Serif typefaces

The comments made with regards to serif typefaces refer to Times New Roman and Serif Sylexiad. In terms of visual tone Times New Roman was considered to be "*traditional*" (Readers BN and BQ) (Study Test 5) and "*formal*" (Readers BO and BQ) (Study Test 5); Serif Sylexiad was also considered to be "*traditional*" (Reader BQ) (Study Test 5) but "*informal*" (Reader BO) (Study Test 5) and (Reader CK) (Study Test 7). With regards to the serif qualities of Serif Sylexiad readers thought the style to be "*ornate*" (Reader BP) (Study Test 5), "*intricate*" (Reader BQ) (Study Test 5) and "*spiny*" (Reader BN) (Study Test 5). Times New Roman was thought to be "*sharp*" (Reader BU) (Study Test 5) and similar to Arial, "*but with more detail*" (Reader CQ) (Study Test 7).

Anecdotal evidence with regards to serif fonts was somewhat neutral. The controls did however consider serif typefaces to have "*traditional*" qualities.

9.7.1.2 Sans-serif typefaces

The comments made with regards to san serif typefaces refer to Arial, Sassoon Primary and Sylexiad Sans. The visual tone of Arial was considered to be "*authoritative*" (Readers BN and BR) (Study Test 5) and (Reader CJ) (Study Test 7). It was also "*formal*" (Reader CH) (Study Test 7) yet "*informal*" (Reader BO) (Study Test 5). Sassoon Primary was "*flowing*" (Reader CH) (Study Test 7) and "*old-fashioned*" (Reader BR) (Study Test 5). Sylexiad Sans was thought to be "*informal*" (Reader BQ) (Study Test 5) and "*casual*" (Reader CH) (Study Test 7).

Anecdotal evidence with regards to sans-serif fonts was once again neutral. No real patterns emerged which indicated the dominance of a particular sans-serif font.

9.7.1.3 Handwritten or oblique typefaces

The comments made with regards to handwritten-style or oblique typefaces refer to Sassoon Primary, Serif Sylexiad and Sylexiad Sans. It was observed that Sassoon Primary had an "*italic look*" (Reader BN) (Study Test 5) and (Readers CJ and CK) (Study Test 7) and was "*more fluid and not so upright*" (Reader CK) (Study Test 7). Another reader, however, suggested that "*the sloping letters muddle the words*" (Reader CM) (Study Test 7). Serif Sylexiad was "*wavy looking*" (Reader CJ) (Study Test 7), while Sylexiad Sans seemed "*too stringy*" (Reader CM) (Study Test 7).

The anecdotal evidence concerning oblique typefaces was mixed and inconclusive, however the responses about the handwritten nature of both Sylexiad fonts were more negative.

9.7.2 Typographic form

The areas concerning this particular aspect of typographic design involved reader comment about the following generic form issues: 1, uppercase letterforms and 2, lowercase letterforms.

9.7.2.1 Uppercase forms

The comments made with regards to this aspect mainly concerned uppercase fonts set as paragraphs. In general, the controls' responses to uppercase forms were mixed. Serif Sylexiad was considered to be "*clear*" (Reader BV) (Study Test 5) and "*OK to read, but I did not like the roundness of the letters*" (Reader CM) (Study Test 7). It was also thought to be "*too square and too busy*" (Reader CN) (Study Test 7). Sylexiad Sans was "*subtle and easy on the eye*", (Reader BS) (Study Test 5) yet "*annoying*" (Reader CP) (Study Test 7). Arial looked to be "*instructive, clear and precise*" (Reader CM) (Study Test 7) yet "*the words were confusing and jumbled*" (Reader BS) (Study Test 5). Times New Roman was thought to be "*refined*" (Reader CP) (Study Test 7) yet "*angular and difficult*" (Reader CK) (Study Test 7).

The anecdotal evidence with regards to uppercase forms was inconclusive, with no dominant font emerging.

9.7.2.2 Lowercase forms

In general, the responses by the controls to the lowercase forms were mixed. Sylexiad Sans was "*liked*" "*and the letters were clear*" (Reader CJ) (Study Test 7) and there seemed to be "*an emphasis on the ascenders*" (Reader BO) (Study Test 5), however the font was considered to be "*difficult to read*" (Reader BP) (Study Test 5). Serif Sylexiad was also "*liked*" (Readers CH and CQ) (Study Test 7) and was thought to be "*soothing*" (Reader BQ) (Study Test 5), however although it looked "*quite easy to read … it was difficult in reality*" (Reader BN) (Study Test 5). Arial was "*easy and clear*" (Reader BO) (Study Test 5) and the "*characters were well formed*" (Reader CL) (Study Test 7) yet "*not inviting, you have to force yourself to read it*" (Reader CH) (Study Test 7). Sassoon Primary looked "*fancy*" (Reader BN) (Study Test 5) and "*feminine*" (Reader BQ) (Study Test 5) and looked "*easy to read*" (Reader CL) (Study Test 7) yet was "*not easy on the eye*" (Reader CH) (Study Test 7). Times New Roman had the most favourable responses. It was considered to be "*easy to read*" (Reader BP (Study Test 5) and "*user friendly*" (Reader BQ) (Study Test 5). "*The words flowed a lot easier. I had no trouble in*

pronouncing the words in my head. I didn't return to any words. I didn't have to concentrate" (Reader BN) (Study Test 5). However, another reader thought that Times New Roman was "*not very clear, it can be confusing*" (Reader CM) (Study Test 7).

The anecdotal evidence with regards to lowercase forms was again inconclusive. There was, however, a more favourable response by the controls to the lowercase qualities of Times New Roman compared to the other test fonts. This would suggest a preference by the controls for lowercase Times New Roman.

9.7.3 Typographic variables

The areas concerning this particular aspect of typographic design involved reader comment about the following generic variable issues: 1, weight; 2, space and 3, familiarity.

9.7.3.1 Weight

The aspect of weight can be divided into two sections: 1, lightness and 2, boldness.

Lightness

The comments made by the controls with regards to lightness of form or stroke refers to both Sylexiad fonts. With regards to Serif Sylexiad, responses were again mixed. One reader "*liked the thickness*" (Reader CI) (Study Test 7) however another considered the font to be "*too thin*" (Reader CK) (Study Test 7). Sylexiad Sans had the exact same responses by the same readers (Study Test 7).

The anecdotal evidence concerning aspects of lightness was inconclusive with no dominant issues emerging.

Boldness

The comments made by the controls with regards to the boldness of form and stroke refers to Arial and were generally unfavourable. "*It looked bold, my eyes averted to different words. I had to go back on words*" (Reader BN) (Study Test 5). Other readers agreed, suggesting that "*the boldness slowed down the reading*" (Reader CJ) (Study Test 7) with the weight being "*too dark, short and chubby*" (Reader CI) (Study Test 7).

The anecdotal evidence regarding bold weights indicates that (like the dyslexic groups) the controls tend to dislike the bolder strokes of the relatively heavier Arial typeface.

9.7.3.2 Space

The comments made by the controls concerned letter, word and line spacing as a whole. With regards to Serif Sylexiad, although one reader "*liked the spacing*" (Reader CI) (Study Test 7), others did not. "*I didn't like the large spacing and had to go over the words again*" (Reader BN) (Study Test 5) and the words looked "*bunched up*" (Reader CL) (Study Test 7). Similar comments by the same readers were made regarding the spatial qualities of Sylexiad Sans. It was "*liked*" (Reader CI) (Study Test 7) yet looked "*bunched-up and close together*" (Reader CL) (Study Test 7). The font was also considered to be "*visually broken-up*" (Reader CJ) (Study Test 7). Arial was considered to be "*close-aligned*" (Reader BN) (Study Test 5) while others "*would like to have had more spacing between the lines*" (Reader CI) (Study Test 7). Times New Roman was "*well spaced out*" (Reader CL) (Study Test 7).

The anecdotal evidence from the controls was again inconclusive and contradictory, however the most favoured responses were for the spatial quality of Times New Roman.

9.7.3.3 Familiarity

The comments regarding familiarity of form concerned both Arial and Times New Roman. Both fonts were considered to be "*familiar*" (Readers CH and CK) (Study Test 7) and (Reader CP) (Study Test 7). Unsurprisingly there were no comments regarding the familiarity of the Sylexiad fonts. However one reader suggested that although Serif Sylexiad was "*unfamiliar*" it "*did not impede reading*" (Reader CL) (Study Test 7).

The anecdotal evidence with regards to familiarity of form was somewhat neutral and inconclusive. However, the comment concerning unfamiliar forms not impeding reading supports Tinker's view (3.3) that familiar fonts do not necessarily facilitate effective reading.

9.7.4 Reading issues

Because the control groups indicated they had no difficulties when reading, this area concerned issues relating to general physiological imperatives of reading. The comments regarding this area were generally negative. Serif Sylexiad was considered to be "*difficult to read*" (Reader BP) (Study Test 5). Sylexiad Sans "*was quite hard to read. I was distracted by the subsequent lines. I didn't take the meaning in because I was concentrating so much on where I was. There was an area where I got totally lost*" (Reader BN) (Study Test 5). With Arial one reader's eyes were "*averted to different words*" (Reader BN) (Study Test 5). Sassoon Primary was "*confusing*" (Reader CQ) (Study Test 7). With Times New Roman, it looked "*a bit blurry*" (Reader CI); however other readers were more favourable "*the words flowed a lot easier. I had no trouble in pronouncing words in*

my head. I didn't return to any words. I didn't have to concentrate" (Reader BN) (Study Test 5). "*It was clear and easy to read*" (Reader CJ) (Study Test 7).

The anecdotal evidence indicates that all the typefaces caused some physiological difficulty for the controls and was therefore inconclusive. However, of all the test typefaces Times New Roman accounted for the most favourable feedback with regards to this issue.

9.7.5 Control typographic design issues conclusion

For both the internal and external control groups the anecdotal evidence concerning typographic design issues and reading was often inconclusive and neutral. With regards to typographic style there was no dominance towards a particular style. Serif forms were considered to be "*traditional*", and the handwritten qualities of both Sylexiad fonts were not particularly favoured. This outcome reverses that of the dyslexic groups.

With reference to the area of typographic form, no dominant form emerged. However the lowercase qualities of Times New Roman seemed to be favoured by the control. This outcome again reverses and contradicts that of the dyslexic group, who indicated a preference for the uppercase qualities of both Sylexiad fonts.

With regards to typographic variables there was no evidence to suggest that the controls favour lighter fonts. This again contradicts the outcomes of the dyslexic groups, who tended to favour the lighter weights of the Sylexiad fonts. However, the controls did not particularly favour the relatively heavier weight of Arial either, which suggests a preference for medium weights. The evidence concerning the spatial qualities of Times New Roman tended to be preferred by the controls. Again this outcome contradicts that of the dyslexic groups, who favoured the more generous spatial qualities of both Sylexiad fonts. As with the dyslexic groups, the evidence regarding familiarity of form was inconclusive and the evidence relating to reading issues such as physiological difficulty indicated a preference for Times New Roman.

9.8 A comparison of evidence between the dyslexic and control groups

This section will describe and compare the dyslexic, text formation and typographic evidence between the dyslexic groups and the controls.

9.8.1 Dyslexic issues

The outcomes with regards to dyslexic issues concerning the dyslexic groups (9.2) indicated a clear preference for Serif Sylexiad (as a family). Serif Sylexiad was the favoured typeface for seven distinct categories of dyslexic difficulty. The least favoured typeface for the dyslexic groups was Times New Roman. There were obviously no dyslexic issues

identified by the controls, so therefore a comparison of dyslexic issues between the two groups cannot be made. It is interesting to note, however, that the average reading rate for the controls was 216 words-per-minute compared to the dyslexic groups with 159 words-per-minute (Figure 23).

9.8.2 Text formation issues

The comparison of the outcomes of the text formation issues between the dyslexic groups (9.3) and the controls (9.6) was often contrasting. The relatively light and uniform strokes and handwritten quality of the Sylexiad fonts (especially Sylexiad Sans) were favoured by the dyslexic groups; whereas the Sylexiad fonts, particularly during the sentence and paragraph tests, were the least favoured typefaces for the controls. In general, the uppercase forms of both Sylexiad fonts were favoured by the dyslexic groups during the character, sentence and paragraph studies; whereas lowercase fonts tended to be favoured by the controls. Finally, with regards to contrasting outcomes, both Sylexiad fonts resulted in the fastest sentence reading times for the dyslexic groups; whereas they were the least favoured fonts for the controls during the sentence and paragraph studies.

There were also similar outcomes in other areas when comparing both groups. The serif qualities of both Serif Sylexiad and Times New Roman seemed to be a positive factor during the comprehension tests for both groups, as was the dominance of uppercase forms during the character study. The familiarity of the Arial form may also have been a favourable reading factor for the dyslexic and control groups during the sentence and paragraph studies.

To summarize, with regards to text formation issues, the preferred typeface for the dyslexic group was clearly Serif Sylexiad (as a family), whereas for the controls it was Times New Roman (as a family).

9.8.3 Typographic issues

The comparison of the outcomes concerning specific typographic issues between the dyslexic groups (9.4) and the controls (9.7) was again contrasting. It is interesting to note that neither group showed a marked preference towards either a serif or sans-serif style. However, the dyslexic group seemed to favour a handwritten style, (particularly that of the Sylexiad fonts); whereas it was not especially favoured by the controls. The dyslexic groups indicated a preference for the uppercase forms of both Sylexiad fonts; whereas for the controls, no dominant form emerged – although there was a preference for lowercase Times New Roman. The dyslexic groups also indicated a more marked preference for the lighter weights and more generous spatial quality of the Sylexiad fonts, whereas for the controls, the spatial quality of Times New Roman was preferred.

9.9 Conclusion

With regards to the legibility of the typefaces tested, it would seem that the evidence indicates similarities and marked differences between the dyslexic groups and the controls.

In terms of similar outcomes, both groups favoured the serif qualities found in Serif Sylexiad (for the dyslexic readers) and Times New Roman (for the non-dyslexic readers). All readers identified individual characters more effectively in uppercase forms. It would also seem that the familiarity of a typeface (especially the ubiquitous form of Arial) may be a legibility factor which affects all readers.

Regarding differences, the evidence indicates that the majority of dyslexic readers preferred the relatively light and uniform strokes, the handwritten style and the spacious quality of the Sylexiad fonts. They also preferred the uppercase forms of those fonts when reading individual sentences and paragraphs. Serif Sylexiad was the preferred typeface for the dyslexic readers with Times New Roman being the least favoured.

For the non-dyslexic readers, the Sylexiad fonts were not particularly liked. They also preferred lowercase rather than uppercase forms when reading individual sentences and paragraphs. The tighter spatial quality and heavier and less consistently uniform strokes of Times New Roman were liked, resulting in that font becoming the preferred typeface for non-dyslexic readers.

10. Legibility and typographic preferences for the adult dyslexic reader.

10.1 Introduction

It is worth reiterating that a summary of the significant data gathered from developmental typeface testing is located in Chapter 13 (Figures 16 – 26). The key findings which raise conceptual issues that impact on and challenge theory are discussed in detail in this chapter. Specifically, the chapter will compare and contrast the legibility and typographic preferences of adult readers who have no reading difficulties with those of adult dyslexic readers. In doing so the word shape model will be challenged by the evidence gathered from the developmental typeface testing of the Sylexiad and other test fonts.

Starting with the area concerning typographic style, the chapter will explain issues and ideas concerning serif, sans-serif and handwritten styles (10.2). It will then examine the typographic forms with regards to uppercase and upper and lowercase reading issues (10.3). The chapter will then describe those typographic variables concerning x-heights, ascenders, descenders, weight, space and familiarity (10.4). In conclusion there will be a summary of the similarities and differences experienced by the two types of reader (10.5). Finally, the chapter will highlight and compare the specific dyslexic typographic preferences identified as a result of this research with those of non-dyslexic readers (10.6).

10.2 Typographic styles

The area of typographic style involves issues concerning (amongst others): 1, serif styles; 2, sans-serif styles and 3, handwritten (or oblique) styles.

10.2.1 Serif styles

"*It is argued that serifs give horizontal emphasis that helps to hold letters together as words, and to guide the eyes along each line….. The German school of Gestalt psychologists described a number of principles by which we try to group areas of the retinal image that are likely to be part of the same object. One of these is the principle of 'good continuation', whereby separate elements with a common direction or trend are seen to form a line. This would suggest that serifs may indeed help adjacent letters to be grouped as words, and words to be grouped into lines*" (Reynolds, 1988, p.27). This view is typical of current typographic thinking in terms of the legibility of serif styles and has been endorsed by writers such as Rehe who stated that because words are perceived by their outline shape, serifs "*which have a more distinctive outline shape over sans-serif letters, may also be more easily perceptible than sans-serif letters*" (Rehe, 2000, p.104).

It would seem therefore that the general consensus of typographic opinion is that serif texts are more readable, especially when set as extended text. The outcomes of the control groups during the developmental typeface testing would support this view with their preference for Times New Roman (Figure 16). The view was also supported by the

dyslexic groups, but to a lesser extent. In this instance the preference was for Serif Sylexiad in which, although it is a serif font, the serifs are certainly not as prominent as those in Times New Roman (Figure 16). The dyslexic groups, however, also considered Times New Roman (as a family) to be their least favoured typeface (Figure 16). The outcomes of the dyslexic groups would therefore seem to be less than conclusive.

In summary, it would appear therefore that for the non-dyslexic readers, the evidence gathered from summative developmental typeface testing supports the general typographic view that serifs tend to be more readable, especially as extended texts. The less conclusive evidence for the dyslexic groups, however, (particularly with regards to Times New Roman) tends to support the statement of Dyslexic.com that "*serif fonts, with their 'ticks' and 'tails' at the end of most strokes, tend to obscure the shapes of letters*" (Dyslexic.com, 2004, p.1).

10.2.2 Sans-serif styles

"*The general consensus is that whilst sans-serif (and slab serifs) generally have a high legibility factor, they have a relatively low readability factor because they are less efficient at projecting word recognition. In other words, the characters tend to have poor left-to-right momentum, tending to stand independently of each other*" (Jury, 2002, p.74). This view is typical of current typographic thinking with regards to sans-serif styles. Reynolds stated that "*sans-serif faces are considered by some to be intrinsically less legible*" (Reynolds, 1988, p.27). She also suggested that "*the tops of some sans-serif letters are very much alike*" (Reynolds, 1988, p.27), which could result in reader difficulties with character identification.

With regards to sans-serif typefaces, it would seem that the general consensus of typographic opinion is that they are less readable than serif typefaces especially when set as extended text. The outcomes of the control groups during the developmental typeface testing would support this view as we have seen in their preference for Times New Roman. The outcomes, however, were less conclusive for the dyslexic groups. In this instance Sylexiad Sans (as a family) was a close second to Serif Sylexiad (as a family) in terms of overall preference (Figure 16). The dyslexic groups also considered Times New Roman (as a family) to be the least preferred of all the fonts (Figure 16).

In summary, as in the case of serif styles, it would appear that for the non-dyslexic readers, the evidence gathered from summative developmental typeface testing supports the general typographic view that sans-serifs tend to be less readable, especially as extended texts. The less conclusive evidence for the dyslexic groups, however, may support the view of Dyslexic.com that "*sans-serif fonts are generally preferred*" (Dyslexic.com, 2004, p.1) by dyslexic readers. Although far from conclusive, the greater preference of the dyslexic groups in favour of sans-serif styles may be significant. As previously stated, serif fonts tend to facilitate greater word shape than sans-serif fonts. The preference for sans-serifs by

the dyslexic groups would, therefore, tend to support the parallel letter recognition model over the word shape model.

10.2.3 Handwritten (and oblique) styles

Handwritten-style fonts are usually associated with children's reading or juvenile reading such as early learning or comic books. Handwritten (and oblique) fonts are generally not taken seriously by the typographic community as a style appropriate for adult reading. The oblique nature inherent in some handwritten styles is considered difficult to read as extended text. With regards specifically to italic styles (rather than general handwritten styles) Reynolds stated that "*italics have been shown to be less legible than roman letters for continuous text. This may be because the italic letters are less easily distinguished from one another*" (Reynolds, 1988, p.27). The oblique nature of the style, as Jury suggested, is "*narrower, containing smaller and therefore less defined counters than roman*" (Jury, 2002, p.72).

It would seem that the general consensus of typographic opinion is that the oblique nature inherent in some handwritten fonts results in reduced legibility compared to more perpendicular typefaces. The outcomes of the control groups during developmental typeface testing would confirm this view as the perpendicular styles of Times New Roman and Arial were preferred. Sassoon Primary, the only *oblique* handwritten-style font to be tested, was the least favoured typeface of the control (Figure 16).

The view was less conclusive for the dyslexic group as Sassoon Primary was considered to be the median font. The perpendicular handwritten styles of both Sylexiad fonts, however, were both preferred (Figure 16).

In summary, it would appear that for both non-dyslexic readers and to a lesser extent dyslexic readers, the evidence supports the general view that oblique qualities in typefaces may hinder legibility. General handwritten qualities, however, although not favoured by the non-dyslexic readers were favoured by the dyslexic groups, which supports the Dyslexic.com view that "*many dyslexic people find it easier to read a font that looks similar to handwriting*" (Dyslexic.com, 2004, p.1).

10.3 Typographic forms

The area of typographic form involves ideas concerning: 1, uppercase forms and 2, lowercase forms.

10.3.1 Uppercase forms

"*If a text is set entirely in capital letters, it suffers a loss of legibility and the reader is placed at a significant disadvantage. Type set in this manner severely retards reading –*

more so than any other legibility factor" (Carter, Day and Meggs, 1993, p.89). This view is typical of current typographic thinking in terms of the legibility of uppercase forms. Reynolds stated that "*any word in capitals has a rectangular outline. Capitals also take up more space than lowercase letters, so more fixations of the eyes are needed to perceive the same number of words. This slows reading*" (Reynolds, 1988, p.27). Indeed, texts set exclusively in uppercase retards reading speed by 13% (Rehe, 2000, p.106).

It would seem that the general consensus of typographic opinion is that uppercase forms affect legibility and result in slow reading. It is interesting to note that for both the controls and dyslexic groups the evidence during developmental typeface testing does *not entirely* support this view. For the controls, when comparing the performance between each font form as a paragraph, with the exception of Sylexiad Sans, all the uppercase forms resulted in the *highest* rates of words read per minute (Figure 23). It is interesting to note that both Sylexiad fonts were favoured by the control in their uppercase form (Figure 17). For the dyslexic groups the outcomes were reversed in that all of the lowercase fonts with the exception of Sylexiad Sans resulted in the *highest* rates of words read per minute (Figure 23). The uppercase forms of both Sylexiad fonts, however, were preferred over all lowercase font forms (Figure 17).

In summary, the research shows that for the controls the lowercase fonts (with regards to rate of reading) were the least efficient. This evidence contradicts the typographic idea that uppercase forms result in a loss of legibility and slower reading times. This outcome would support the idea that Charles Babbage put forward in 1827 that "*figures of uniform height were more legible than figures with ascenders and descenders*" (Spencer, 1968, p.13). It also supports the parallel letter recognition model favoured by psychologists that states it is the letters within a word that are recognised simultaneously and the letter information is then used to recognise that word (Larson, 2004, p.74).

10.3.2 Lowercase forms

"*Text set in lowercase letters forms words that are distinct, based upon their irregular word shape and internal pattern. A variety of letter shapes, ascenders and descenders provide rich contrasts that assure satisfactory perception*" (Carter, Day and Meggs, 1993, p.89). This view is typical of typographic thinking in terms of lowercase forms. Rehe expanded, stating that "*words are perceived by their specific word-shape outline, which is unique for lowercase words. Once the outline of the words has been perceived and stored in memory, future recognition or recall of the word takes place without letter by letter deciphering*" (Rehe, 2000, p.103).

It would appear therefore that the general consensus of typographic opinion is that lowercase forms aid legibility and result in faster reading times. The evidence echoes and mirrors the findings of the uppercase forms (10.3.1); it shows that for both the controls and dyslexic groups this notion is contradicted. For the controls, when comparing the performance between each font form as a paragraph, with the exception of Sylexiad Sans all

the lowercase forms resulted in the *lowest* rates of words read per minute (Figure 23). It is also interesting to note that both Sylexiad fonts were least favoured by the control in the lowercase form (Figure 17). For the dyslexic groups these outcomes were reversed in that all of the lowercase fonts with the exception of Sylexiad Sans resulted in the *highest* rates of words read per minute (Figure 23). The uppercase forms of both Sylexiad fonts, however, were preferred over *all* lowercase font forms (Figure 17).

Summary

In summary, and somewhat controversially, *superficially* it would appear that for the controls the evidence contradicts the notion that lowercase fonts result in higher legibility and faster reading times. This would support Tinker's observation made in 1932 that more reading errors were made in reading lowercase text than text set exclusively in capitals (Rehe, 2000, p.105). However, on closer inspection of the evidence, for the internal control all the lowercase fonts resulted in the highest reading rates (Study Test 5), whereas for the external control it was all of the uppercase fonts which resulted in the highest rates (Study Test 7) (Figure 23). This disparity of evidence resulted in the averaged outcomes for both controls having higher rates for uppercase fonts. Conversely, for the internal dyslexic group, uppercase fonts resulted in the highest reading rates (Study Test 4), whereas for the external dyslexic group they resulted in the lowest rates (Study Test 6) (Figure 23). This anomaly may have been a problem with the administration of this aspect of the external control test and, if so, may have resulted in a distorted outcome. Whatever the outcome, further research into this area would seem worthwhile at post-doctoral level.

Although the evidence is very contradictory, and based on the *internal evidence alone*, I would suggest that for the controls, lowercase fonts result in higher readability rates and greater legibility. For the dyslexic group, however, the uppercase form of both Sylexiad fonts resulted in the highest preference rates for *both* dyslexic groups and the uppercase form of Sylexiad Sans had the highest reading rate compared to its lowercase form. The evidence would therefore indicate that for dyslexic readers uppercase forms, especially Sylexiad, may be more preferable than lowercase forms.

10.4 Typographic variables

The area of typographic variables involves ideas concerning (amongst others): 1, x-heights, ascenders and descenders; 2, weight; 3, space between words and 4, familiarity.

10.4.1 x-heights, ascenders and descenders

"*Generally, the most legible typefaces are those with larger, open or closed inner spaces (counters). This inevitably means a generously large x-height. However, if the x-height is 'over generous' then, as a consequence, the ascenders and descenders will be too short*" (Jury, 2002, p.58). This view is typical of current typographic thinking with regards to x-heights, ascenders and descenders. It is also echoed by Dyslexic.com who stated that "*the*

size of the ascenders and descenders of letters is also important as many dyslexic readers rely on recalling the visual shape of a word due to poor phonological awareness. If ascenders and descenders are short, the shape of the word is more difficult to identify and can made reading slower and less accurate" (Dyslexic.com, 2004, p.1). Reynolds also suggested that "*a relatively large x-height in relation to the capital letter height … will make the lowercase letters easier to discriminate*" (Reynolds, 1988, p.26).

The Sylexiad fonts have large counters, resulting in relatively generous x-heights, however the fonts both contain long ascenders and descenders. In comparison to the other test fonts this gives Serif Sylexiad and Sylexiad Sans a slightly condensed appearance. The x-heights also look relatively large in relation to the capital heights. The design of the Sylexiad fonts therefore conforms to current typographic thinking concerning x-heights *without* compromising ascender and descender lengths.

However, with regards to the rate of reading outcomes, it would appear from the evidence that these *combined* qualities were not favoured by either group. Both the controls and the dyslexic groups considered the lowercase forms of Sylexiad to be amongst their least favoured fonts. This outcome would seem, on one level, to contradict current typographic thinking concerning the benefits of large x-heights and long ascenders and descenders, in that these qualities within the design of Sylexiad were implicitly not favoured. Alternatively, the reason for the low ratings may be because both qualities were combined, resulting in a slightly condensed look. It could be the combined qualities within the design rather than individual qualities that were problematic for the readers. Further research into long ascenders and descenders as individual entities (and exclusive from large x-heights) would therefore seem worthwhile at post-doctoral level.

10.4.2 Weight

"*When considering the legibility of a typeface, the thickness (weight) of the strokes should be examined. A typeface that is too light or too heavy has diminished legibility*" (Carter, Day and Meggs, 1993, p.91). The aspect of weight has therefore been divided into two areas: 1, lightness and 2, boldness

Lightness

"*Light typefaces cannot be easily distinguished from their background*" (Carter, Day and Meggs, 1993, p.91). This view is typical of current typographic thinking with regards to light weights, and is supported by Rehe who also considered that "*light design provides a rather poor differentiation from the paper background and reduces legibility*" (Rehe, 2000, p.104).

The Sylexiad fonts, which have the lightest strokes of all the test typefaces, were not favoured by the controls, who preferred the comparatively middle tone of Times New Roman. The evidence, therefore, regarding the non-dyslexic readers would seem to confirm the general typographic consensus regarding light weights. For the dyslexic groups,

however, the outcomes were reversed with both Sylexiad fonts being regarded as the preferred typefaces.

Boldness

"*Bold type … is likely to reduce legibility when used for continuous text. The dense black type tends to create after-images, noticeable as bright glowing areas between the lines*" (Reynolds, 1988, p.27). This view is typical of current typographic thinking with regards to heavy weights. It is also thought that "*a typeface that is too heavy has a tendency to lose its internal pattern of counter forms*" (Carter, Day and Meggs, 1993, p.91).

Although it is not a particularly heavy font, Arial has the heaviest strokes of all the test typefaces. It had a high preference rating from the control groups who considered the font to be "*easy*" to read; whereas the dyslexic groups thought it to be "*difficult*". Times New Roman, however, which is the most medium weight of all the test typefaces was the overall preferred font for the controls. The evidence therefore would tend to support the general typographic consensus that links heavy weights with reduced legibility. However, this idea would seem to be more pronounced for dyslexic readers.

In summary, the evidence from the non-dyslexic readers supports the view of Luckiesh and Moss who stated that the "*ideal text type should be medium, not too heavy, nor too light*" (Rehe, 2000, p.104). For the dyslexic readers, however, this view is contradicted as the relatively very light weights of the Sylexiad fonts were preferred.

10.4.3 Space between words

"*The space between words must of course be perceptibly greater than the space between letters within a word. The Gestalt principle of grouping by 'proximity' is at work here. However, the spacing must not be so great that the horizontal emphasis, or 'good continuation' of the line is destroyed. Optimum word spacing will therefore depend on both letter spacing and line spacin*g" (Reynolds, 1988, p.28). This view is typical of current typographic thinking with regards to inter-word spacing. Jury added that "*the sole reason for spaces between words is to help the reader to recognise individual word shapes. The space should be the minimum to fulfil this task, commonly stated as the width of an i*" (Jury, 2000, p.92).

The Sylexiad fonts have the widest inter-word spacing of all the summative test typefaces. Indeed, the space between the words is almost the same as between the lines. This goes against the maxim "*that there should be more space between the lines than between the words*" (McLean, 1980, p.45). For the control groups, both fonts were not particularly favoured. However, for the dyslexic groups Serif Sylexiad and Sylexiad Sans were the preferred fonts. This would seem to confirm that the general typographic consensus concerning inter-word spacing is valid for non-dyslexic readers. For dyslexic readers, the horizontal emphasis of the line seems not to be as significant; therefore, a more generous inter-word spacing would seem more appropriate. This would support the view of Hornsby who argued that "*contrary to good typographic practice for fluent readers, a fairly wide*

space should be used to give clear separation of words" (Hornsby, 2002, p.5) for dyslexic readers.

The inter-letter spacing of all the summative test fonts were relatively consistent and was not identified as an issue by the readers. However, further investigation into letter space at post-doctoral level may be worthwhile.

10.4.4 Familiarity

"*Zuzana Licko proclaims "You read best what you read most" … she states that letters are not inherently legible but become more legible through repeated usage, and that 'legibility is a dynamic process'.*" (Unger, 1992, pp.100-101). This view is typical of current typographic thinking with regards to familiarity of form. Reynolds is more specific, stating that "*most of us are more familiar with seriffed faces, and it may be that we tend to prefer what we're used to*" (Reynolds, 1988, p.27).

With regards to the control groups, these views would appear to be confirmed by the preference for the familiar typefaces Times New Roman and Arial. For the dyslexic groups the non-familiar Sylexiad fonts were preferred. which would seem to negate this view. However, Dyslexic.com suggested that "*many dyslexic people find it easier to read a font that looks similar to handwriting as they are familiar with this style*" (Dyslexic.com, 2004, p.1). The outcomes of the dyslexic groups would therefore also tend to support the view that we read best what we are most familiar with.

10.5 Conclusion

The investigation of typographic legibility and the typeface preferences of non-dyslexic and dyslexic readers indicates similarities and differences between the two groups.

The analysis of legibility in this chapter has shown that with regards to typographic style, the non-dyslexic readers found serif styles, particularly Times New Roman, to be more readable than sans-serif styles. This outcome supports the general typographic consensus that serif styles are more readable as extended texts. However, the evidence suggests that for the dyslexic readers, the handwritten and perpendicular style of both Sylexiad fonts were more readable. I would contend, therefore, that the majority of dyslexic readers find the perpendicular and handwritten style of the Sylexiad fonts easier to read compared to other styles. A preference by the dyslexic group towards a serif style was inconclusive and less pronounced than that of the controls. A greater preference for sans-serif styles by the dyslexic groups may support the parallel word recognition model.

With typographic forms, the evidence shows that for the *internal* control lowercase typefaces resulted in faster reading rates compared with uppercase forms. This outcome was reversed for the *internal* dyslexic group. The evidence also shows an indication that for

a significant percentage of dyslexic readers (and contrary to current typographic doctrine) uppercase forms of Sylexiad were preferred over lowercase forms. This finding supports the theory of the parallel letter recognition model over the word shape model. I would therefore contend that Sylexiad uppercase forms are more preferable than other uppercase typeface forms for many dyslexic readers.

Concerning typographic variables, both the non-dyslexic and dyslexic readers did not favour the *combined* qualities of large x-heights and long ascenders and descenders found in the Sylexiad fonts. I would argue, however, that this indifference was not specifically due to either large x-heights or indeed long ascenders and descenders, rather the resultant relatively condensed appearance of both fonts when these two qualities are combined. As a result of her research into reading and typographic design, Rosemary Sassoon has for some time been an advocate for long ascenders and descenders (Sassoon, 2004). My own view as a dyslexic reader also favours the notion of long ascenders and descenders. I would concur with the reader who suggested that long letters (ascenders and descenders) result in the text blending more effectively with the background (9.4.2.2).

The evidence of the non-dyslexic readers with regards to weight supports the general typographic consensus that ideal text-type weight should be medium. This notion however is contradicted by the dyslexic readers who preferred the lighter strokes of the Sylexiad fonts. I would contend therefore that most dyslexic readers find lighter forms more readable.

With regards to inter-word spatial quality, the evidence of the non-dyslexic readers supports the general typographic consensus that the space between words should commonly be the width of a lowercase ‘i’. The dyslexic groups, however, again contradict this notion as they found the more generous spatial qualities of the Sylexiad fonts to be more readable. I therefore contend that most dyslexic readers find a more generous interword spatial quality beneficial.

Finally, with regards to issues of familiarity the evidence of both the non-dyslexic and, to a lesser extent, the dyslexic readers seems to support the general typographic consensus that we read best what we are most familiar with.

Word shape issues

The analysis of outcomes from the summative stage of developmental typeface testing has raised some interesting issues, from a dyslexic perspective, concerning the word shape model. They were:

1. Serif fonts, by the nature of serifs, provide more word shape than sans-serif fonts. The controls preferred Times New Roman the font with the most prominent serifs. This evidence supports word shape. For the dyslexic readers, however, Times New Roman was the least preferred font which challenges word shape.

2. Lowercase fonts, by the nature of ascenders and descenders provide more word shape than uppercase fonts. For the internal control lowercase fonts resulted in the highest paragraph reading rates. This evidence supports word shape. For the internal dyslexic readers, however, uppercase fonts resulted in the highest paragraph reading rates. For both dyslexic groups the uppercase form of Sylexiad was preferred over the lowercase form. This evidence challenges word shape.

The analysis of outcomes from the formative stage of testing also raised an interesting issue. It was:

1. Dine 1 was designed as an experimental and radical font with maximum word shape. As the subsequent versions were developed the forms were modified and became less radical with less word shape yet the preference ratings increased. Dine 1 the font with the most shape was the least preferred typeface, whereas Dine 3 the typeface with least shape was the most preferred. This evidence challenges word shape.

It is worth noting that during both stages of developmental typeface testing, most dyslexic readers stated that they experienced difficulty with letter reversals. This finding challenges word shape as all letter reversals occur in lowercase forms.

Although far from conclusive these issues highlight a general trend, from a dyslexic perspective, away from word shape as a viable recognition model.

10.6 Typographic preferences

The following typographic preferences represent a distillation of the evidence gathered throughout this research.

The majority of non-dyslexic readers preferred:
serif style
lowercase forms
large x-heights
medium weight
variable stokes
normal inter-word spacing
familiarity
Times New Roman (as a family)

The majority of dyslexic readers preferred:
handwritten style
uppercase Sylexiad forms rather than lowercase forms
long ascenders and descenders

light weight

uniform strokes

perpendicular design

generous inter-word spacing

familiarity

Serif Sylexiad (as a family)

11. Conclusions.

11.1 Introduction

The primary objective of my practice based research was to design a typeface for the adult dyslexic reader in conjunction with the adult dyslexic reader. In doing so, a new typeface testing model has been developed by connecting the fields of typographic design and cognitive psychology.

The research was prompted by an increased interest during the late 1990s in the subject of dyslexia within the art and design higher education sector. In my Introduction I noted that there were more dyslexics amongst art and design students than in other areas of the higher education sector (Padgett, 1999, p.1). I also identified the typographic recommendations suggested by various dyslexic organisations which included Arial, Times New Roman and Sassoon Primary. All of these typefaces were designed by non-dyslexic designers for a non-dyslexic audience. There was no typeface available at the time which was *specifically* designed for the adult dyslexic reader. (This situation has since changed with the designs of Olsen in 2001 and Read Regular in 2003 by Olsen and Frensch respectively. Both of these fonts have interesting features but are ultimately limited as dyslexia typefaces as they have not been tested with the same rigour as the Sylexiad fonts).

As a designer myself, with a particular interest in typography, and as a dyslexic reader, I felt it necessary and important to test these recommendations and design and develop an alternative typeface for a dyslexic audience based on clear research aims. These aims involved the testing of existing typefaces against my own typeface designs in order to establish which fonts and typographic characteristics adult dyslexic readers prefer. In doing so, a contribution to new knowledge within the field of dyslexia typographic research was made with the development and design of a new typeface for the dyslexic rather than non-dyslexic reader. These aims were embedded within a new design and testing process I established called "*developmental typeface testing*". This process enabled my research objective to be realised. A preferred typeface for the adult dyslexic reader has been informed by my new developmental typeface testing model.

Before my investigation there was little or no collaboration between the fields of typographic design research and cognitive psychological research. It is important to note that most legibility testing of typefaces was exclusively conducted by psychologists and not typographers. There was also no theoretical correlation between the two fields. For example, typographers consider that lowercase letters are more legible than uppercase forms because ascenders and descenders provide greater word shape for the reader. This is called the word shape model. Cognitive psychologists, however, consider that the letters within a word are recognised simultaneously and the letter information is used by the reader in order to recognise that word. This is called the parallel letter recognition model. In order to bring the two fields together my investigation accommodated both theoretical models within my own developmental typeface testing model.

The developmental typeface testing involved a unique series of small-scale evaluative studies, which included a formative and summative approach to the testing for legibility. These studies were influenced by Papazian's paradigm of modules and similars (Papazian. 1999), Silverman's diagnostic handwriting checklist (Silverman, 2000) and Sassoon's theories concerning the design of Sassoon Primary (Sassoon, 1993c., pp.149-152). They formed the basis of the developmental typeface testing process. The starting point of the formative element within the process was grounded from a position of illegibility with the design of Dine 1. Dine 1 is an experimental and theoretical font, which was based on dyslexic handwriting. The outcomes from the testing of Dine 1 informed the design and development of Dine 2, which in turn informed Dine 3. The summative element of the process concerned the design and testing of the Serif Sylexiad and Sylexiad Sans fonts, which were informed by the evidence of the formative data. The Sylexiad fonts are the first versions of a typeface for the adult dyslexic reader.

The research comprised four distinct phases as well as a preliminary stage. The preliminary stage involved a literature search and review of dyslexic and typographic issues in order to provide a context and framework for the research. As a result of this review the design of the developmental typeface testing model was established. The model was grounded in the visual (or what I term as *alphonomic*) aspects of dyslexia. It incorporated elements of Frith's literacy development model as well as Tinker's methodological approach to measuring legibility. The model was also influenced by Sassoon's formative work with children during the design and development of the Sassoon Primary typeface. Ideas from Anisson's comparative typographic tests, Babbage's notion of the primacy of uniform letters, Javel's notion of the primacy of the upper half of a word, Zachrisson's testing of serif and sans-serif forms, Burt's notion of aesthetic preference and Wilkins's Rate of Reading Test have also all impacted either directly or indirectly on my developmental typeface testing model. Most crucially, the developmental typeface testing model allowed for an *ongoing* typographic design process within its formative and summative structure, and accommodated both the word shape model and parallel letter recognition model as part of the theoretical framework. The developmental typeface testing model therefore integrates psychological and typographic ideas as well as my own experiences as a dyslexic reader and designer. In developing the model an ongoing record of my own experiences of misreading texts was kept as a "Diary of misread words".

The design process underpinned the developmental typeface testing model. During the preliminary stage, the rationale for the initial design development was based on the word shape model; hence, only lowercase forms were tested. The process was also grounded from a dyslexic viewpoint and was influenced by Papazian's paradigm of modules and similars and Silverman's diagnostic dyslexia handwriting checklist. In order to produce maximum word shape, a visual analysis of the similarities and differences of the Helvetica typeface was made. (Helvetica represents a typical sans-serif font – the style approved by

most dyslexia organisations). The analysis grouped the characters into three basic categories, letters with diagonals, letters with curves and letters with right angles. A monocase version of Helvetica was then made based on this analysis, which informed the first version of the Dine fonts, Dine 1.

Phase one can be considered to be the formative element of the developmental typeface testing process. It involved three study tests comprising dyslexic readers from Norwich School of Art and Design. During these tests the Dine fonts were tested against Arial, Sassoon Primary, Times New Roman and Tiresias InfoFont. The outcomes, coupled with reader feedback and my own experiences as a dyslexic reader, helped to inform the design and development of each subsequent version of the Dine fonts. Phase two involved a detailed analysis of the formative developmental typeface testing process, and included an evaluation of the evidence gathered from that process. Phase three can be considered to be the summative element of developmental typeface testing. The outcomes gathered from the previous phase, coupled with my own experiences as a dyslexic reader, helped to inform the design of the Sylexiad fonts, as well as to refine the developmental typeface testing model. Phase three involved four study tests. During these tests the Sylexiad fonts were tested against Arial, Sassoon Primary and Times New Roman. The key difference between the formative and the summative elements was the establishment of *internal* groups at the Norwich School of Art and Design and *external* groups at the University of East Anglia. As well as dyslexic groups, controls were also set up. Phase four was the final part of the research, which involved a further analysis of the evidence gathered from the developmental typeface testing of the Sylexiad fonts against the other test fonts. This analysis resulted in an overview of the legibility and typographic preferences of adult dyslexic readers and how they compare with non-dyslexic preferences.

11.2 Findings

The development and evolution of the Dine fonts from the radical, illegible, monocase design of Dine 1 with extreme word shape to the less radical, legible, duocase design of Dine 3 was informed by the outcomes of the formative developmental typeface testing process. These outcomes indicated that radical and unfamiliar design can be difficult and daunting for the dyslexic reader, which in turn can result in heightened visual disturbance, thus impairing readability. However, evidence indicated that the combination of light letterforms and large interspatial word qualities had a favourable effect in reducing these difficulties. As the subsequent versions of Dine evolved, the more familiar and conventional the form became, which resulted in more favourable reader responses. This would indicate that familiarity of form is an important factor for dyslexic readers.

The other findings from the formative testing process highlighted three other areas of interest. They concerned dyslexic issues, text formation issues and typographic design issues. With regards to dyslexic issues, Dine 3 and Times New Roman were both favoured

for readability, low visual stress and good comprehension. This outcome seems, on one level, to be contradictory as Dine 3 is an unfamiliar sans-serif, whilst Times New Roman is a familiar serif font. What links the two fonts would seem to be a relative lightness of stroke. The area concerning text formation issues showed that a sans-serif style (in the form of Arial) had the highest preference rating as a paragraph whereas a serif style (in the form of Times New Roman) produced the most efficient read with the highest word-per-minute rate. This would indicate no conclusive dominance of form towards either a serif or sans-serif style. Context was also identified as an issue and highlighted the need for letterforms to be as clear, distinctive and different from each other without losing the intrinsic meaning of the character. The outcomes concerning typographic design issues also indicated no evidence to suggest dominance either for or against serif or sans-serif styles. Dyslexic readers did however prefer lowercase forms when reading narrative texts. Qualities of cleanness and familiarity were also liked by the dyslexic readers, whilst compact, oblique and bold letterforms were disliked.

Much of the evidence concerning the formative developmental typeface testing was contradictory and inconclusive. Nonetheless, key outcomes were identified which, coupled with my own views as a dyslexic reader, were incorporated into the design of Sylexiad. The design of Sylexiad therefore included:

1. a serif *and* sans-serif version
2. a series of double-case alphabets
3. the use of relatively light letter strokes
4. the use of relatively long ascenders and descenders
5. an attempt to make each character as clear and distinct from each other as possible without compromising the meaning of the character.
6. a generous inter-word spatial quality

The design did not include:

1. the use of relatively oblique letterforms
2. the use of relatively compact letterforms
3. the use of relatively bold letterforms
4. the use of radical forms

The development of Sylexiad therefore resulted in two typefaces being designed. Sylexiad Sans is the sans-serif form and Serif Sylexiad the (very slight) serif form. Both fonts have a handwritten appearance and represent the first version of a typeface for the adult dyslexic reader. The Sylexiad fonts are perpendicular and rounded in appearance, and contain light uniform strokes. The subject of legibility is inherently visual and it was deemed important to conduct tests outside the art school environment. The summative element of the developmental typeface testing process therefore involved external as well as internal groups. It was also important to establish controls in order to compare data. The findings

of the summative testing process highlighted three areas of interest, which concerned dyslexic/reading issues, text formation issues and typographic design issues.
For the internal and external dyslexic groups the relationship between dyslexic issues and reading indicated a clear preference for the Serif Sylexiad font, especially with regards to reading, visual stress and comprehension difficulties. The least favoured font was Times New Roman. With regards to text formation issues, the dyslexic groups favoured the handwritten, light and uniform strokes of the Sylexiad fonts and Sassoon Primary. They also favoured the serif quality of Serif Sylexiad and Times New Roman. The uppercase forms of both Sylexiad fonts were favoured during the character, sentence and paragraph studies and both fonts accounted for the quickest sentence reading times. The readers considered Serif Sylexiad to be the preferred typeface with regards to text formation issues. The anecdotal evidence concerning typographic design issues indicated no dominance towards either a serif or sans-serif style. Despite this outcome the quality of cleanness was liked in sans-serif, handwritten styles. There was a preference indicated by the dyslexic readers for uppercase forms and the lighter weight and generous spatial qualities of the Sylexiad fonts.

For the internal and external controls, there were no dyslexic or reading issues identified. With regards to text formation issues, the serif qualities of Times New Roman and Serif Sylexiad were preferred when reading individual words and also resulted in the best comprehension rates during the paragraph studies. The sans-serif quality and relatively heavy weights of Arial and Sassoon Primary were favoured during the sentence studies and accounted for the fastest reading times. The Sylexiad fonts were the least favoured during the sentence and paragraph studies, the preferred font being Times New Roman. The anecdotal evidence concerning typographic design issues indicated no dominance towards either a serif or sans-serif style or upper or lowercase forms. This may however have been due to testing anomalies (see 11.4 Critique). The controls did however favour the lowercase and spatial qualities and medium weight of Times New Roman.

The comparisons between the dyslexic groups and the controls indicate similarities and differences. Both groups favoured serifs (Serif Sylexiad for the dyslexic readers and Times New Roman for the non-dyslexic readers). Both groups also identified individual characters more effectively in uppercase rather than lowercase forms. The familiarity of a typeface may also have been an important legibility factor, which affects *all* readers. As for the differences, the evidence suggests that the majority of dyslexic readers preferred the relatively light and uniform strokes, the handwritten style and the spacious quality of the Sylexiad fonts. They also preferred the uppercase forms of those fonts when reading individual sentences and paragraphs. For the non-dyslexic readers, lowercase rather than uppercase forms were preferred when reading individual sentences and paragraphs. The normal spatial qualities, medium weight and less uniform strokes of Times New Roman were liked. For the non-dyslexic readers, Times New Roman was the preferred font, whereas for the dyslexic readers it was Serif Sylexiad.

11.3 Contexts and arguments

Based on the extrapolation of the outcomes of developmental typeface testing, generic conclusions were made concerning adult dyslexic readers as exemplified by my reader groups. In comparing and contrasting the evidence-based outcomes between the non-dyslexic and dyslexic readers, a number of key ideas emerge which both confirm and challenge current typographic legibility principles.

The research has conclusively shown that for the majority of non-dyslexic readers, serif styles (particularly in the form of Times New Roman) were more readable as extended texts; lowercase typefaces resulted in good legibility and faster reading rates compared to uppercase forms*; typefaces with medium weights were preferred, and normal inter-word spatial relationships were preferred. These findings confirm current typographic maxims concerning legibility. The research has also conclusively shown that for *all* readers condensed-looking typefaces were not favoured, which also supports current typographic doctrine. The evidence also indicates that for *all* readers, the familiarity of a font facilitated effective reading.

Conversely, the research has shown that for the majority of dyslexic readers: the handwritten and perpendicular styles of both Sylexiad fonts were more readable as extended texts compared to the other test fonts; uppercase typefaces *often* resulted in good legibility and faster reading rates compared to lowercase forms; typefaces with light weights were preferred; and a more generous than normal inter-word spatial relationship was preferred. The issue of long ascenders and descenders improving legibility was inconclusive. However, as a dyslexic reader myself, I agree with Sassoon and some of the participants of this research in advocating that they do indeed facilitate effective reading (Sassoon, 2004), especially for dyslexic readers.

My findings have often contradicted current typographic legibility maxims. For the majority of dyslexic readers tested generous word spacing allied to the (light) weight and slightly condensed form (due to long ascenders and descenders) of the Sylexiad fonts were important. This would suggest that for subjects with reading difficulties it is the combination of spacing, weight and overall form of a typeface that is important rather than individual letterform design.

The outcomes of developmental typeface testing has raised issues that challenge the word shape model. From the formative stage the testing of the Dine fonts have shown that as each subsequent design became less radical than previous versions, the word shape became less distinct yet more preferred. From the summative stage the testing outcomes indicated a

*This applied to the internal control only (see 11.4 Critique).

preference by dyslexic readers for the uppercase rather than lowercase Sylexiad forms. The internal dyslexic group also had a higher reading rate in uppercase forms. There was also a low preference rating for Times New Roman (and its "shaped" serifs). All of this evidence (coupled by the fact that all letter reversals occur in lowercase forms), although far from conclusive, highlights a general trend, from a dyslexic perspective, away from word shape as a viable recognition model.

The research aims were to:

1. Test existing typefaces (Arial, Sassoon Primary, Times New Roman and Tiresias InfoFont) in order to establish which of those fonts adult dyslexic readers prefer and why.

This aim has been achieved. Arial was found to be the preferred *existing* font. This, I would argue, is as a result of a practice effect. Arial is a ubiquitous and familiar font, and the evidence (taken as a whole) would support Licko's theory that we read best what we read most (Unger, 1992, pp.100-101).

2. Test my own typeface designs (the Dine and Sylexiad fonts) in order to establish which typographic characteristics adult dyslexic readers prefer and why.

This aim has been achieved. The typographic characteristics that the majority of adult dyslexic readers preferred were: a handwritten style, uppercase (Sylexiad forms) rather than lowercase forms, long ascenders and descenders*, light weight, uniform strokes, perpendicular design, generous inter-word spacing and familiarity.

3. Contribute new knowledge to the field of contemporary dyslexia typeface design.

This aim has been achieved in three ways. Firstly, for the first time a series of fonts have been designed *and* tested for a specific dyslexic audience. For the majority of adult dyslexic readers who were tested, Serif Sylexiad was considered to be the preferred typeface. Secondly, a new technique of developmental typeface testing has been established in order to measure legibility and readability. It includes a formative and summative element and therefore allows for a design to be modified *during* the testing process. Previously all legibility studies have been conducted retrospectively as the design process always came before the testing process and was never conducted in tandem. Thirdly, by accommodating the word shape model and parallel letter recognition model within the developmental typeface testing process the previously distinct and distant fields of typographic design and cognitive psychology have been brought together. As a result the existing word shape model favoured by most typographic designers has been challenged.

*The evidence for this preferred characteristic was inconclusive.

For some dyslexic readers it seems clear that certain current typographic legibility principles may not be appropriate. They were established by non-dyslexic typographers for a non-dyslexic audience. The current advice by dyslexic organisations for dyslexic readers is often confused as it both supports and contradicts these principles. The British Dyslexic Association, for example, offers advice supporting a current maxim by recommending that dyslexic readers use lowercase rather than capital letters (British Dyslexic Association, 2005, p.1). As my research has shown, this is not necessarily the case. Conversely the organisation contradicts another current maxim by advocating the use of sans-serif (rather than serif) fonts, particularly Arial (British Dyslexic Association, 2005, p.1). This advice, I would argue, is because of the practice effect associated with familiar fonts. These recommendations are too specific and unhelpful. I think that broader recommendations concerning typographic characteristics would be more appropriate for dyslexic readers than simply specific fonts. As the research has shown there are fonts which are more legible than Arial. With this in mind, new typographic rules concerning legibility for dyslexic readers will need to be considered.

11.4 Critique

Looking back at the research with hindsight, there are a number of aspects that I would have possibly changed. With regards to the test typefaces, Sassoon Primary was chosen because it was recommended by both Dyslexic.com and the British Dyslexia Association (Dyslexic.com, 2000, p.1)(British Dyslexia Association, 2000, p.1). The typeface was specifically designed for children and, therefore, because I was testing on adults, perhaps the adult form of Sassoon Sans would have been more appropriate. It was also unfortunate that Read Regular was designed by Natascha Frensch during the latter stages of this research in 2003 and that it was not available earlier in order to test the font against the other typefaces.

The formative developmental typeface testing process in many ways acted as a dry run for the summative process and, as such, the first study test was not particularly comprehensive or expansive. However, this situation improved as the formative process developed. Many procedures were trialled in order to measure reading times and many techniques were tested before employing the most effective method for the summative process. This sampling of various techniques resulted in the first three study tests being somewhat inconsistent, which in turn, occasionally made the comparison of data difficult. The situation may have been alleviated had controls been used during this stage.

The summative developmental typeface testing process was much more consistent, and due to the inclusion of the controls, allowed for data comparisons to be made between the two groups. The summative process did however produce an outcome that was difficult to explain and that concerned the reading rate of the external control being higher in uppercase forms compared to lowercase forms. This outcome was unexpected as it contradicted

current typographic legibility maxims and the internal control outcomes. As a consequence, this would suggest some sort of testing anomaly. These issues however did not affect the overall validity or reliability of the developmental typeface testing model. The detailed explanation of the developmental typeface testing procedure will allow other typeface designers interested in legibility and readability to use the process and expect to achieve similar outcomes.

11.5 Post-doctoral research

The aims of work planned beyond this investigation will be to continue to test other typeface recommendations (including Read Regular and Olsen) and to continue to test my own typeface designs (including current and future versions of Sylexiad). In doing so a further contribution to new knowledge will be made to the field of contemporary dyslexia typeface design.

The objective of any post-doctoral research would be to investigate the *possibility* of a shift away from the word shape model accepted by most typographic designers to a parallel letter recognition model. A more deductive (rather than inductive) approach would also be taken. Therefore, a hypothesis would be *postulated* that "*A preferred typeface for the adult dyslexic reader can be informed by the parallel letter recognition model rather than the word shape model*".

In terms of developmental typeface testing, future research will continue to be both formative and summative. However, the structure of the current formative stage would be replaced with that of the current summative stage. This would, therefore, facilitate the comparative testing of dyslexia *and* control groups during the formative stage.

Specifically, in terms of typographic design (and in particular, the design of Sylexiad) further investigation into weight, ascenders and descenders, leading and more pronounced serif styles especially when combined with uppercase forms would seem to be important.

The research also identified a number of interesting second order issues which would be worth continued investigation. With regards to the aspect of individual character confusion, further research into combination issues concerning parallel letter recognition, single-letter pairs and double-letter pairs would be advantageous. Other potentially beneficial areas include reading models such as word association and the whole issue of alphabet reform and morphemic systems.

If the current versions of Sylexiad are to be made commercially available the fonts need to be refined and appropriately digitised to include a full range of weights and italicisations. Due to my limited technical expertise within this area I would see the engineering and production of the fonts to be undertaken by a professional digital type-foundry.*

11.6 In conclusion

This investigation has continued a long tradition of legibility studies most of which have been conducted by psychologists. What makes my investigation distinctive is that it was developed by a designer rather than a psychologist. This has resulted in the inclusion of a formative and summative element within the developmental typeface testing framework. These elements enabled the design process to be conducted in tandem with the testing process rather than being separate. My developmental typeface testing model allows the process of legibility study to be more organic than in previous studies. In an attempt to connect the worlds of typographic design and cognitive science which have previously been separate, the two distinct and different word recognition models favoured by both fields were incorporated into the design process. This has resulted, for the majority of dyslexic readers tested, (as exemplified by the reader groups) in the word shape model to be challenged.

The objective of my research was to design a typeface for the adult dyslexic reader and, in doing so, develop a new typeface testing model. This has been achieved through developmental typeface testing and has resulted in Serif Sylexiad being the favoured typeface for the majority of dyslexic readers tested. Although all of my research questions have been answered many other questions have yet to be asked and my developmental typeface testing model and initial Sylexiad fonts may provide a template for future investigations, questions and subsequent answers regarding the subject of dyslexia and legibility.

11.7 Postscript

Since writing this thesis Sylexiad has been expanded, refined and appropriately digitised with the help of the typographer Adrian Williams. There is now a complete range of Sylexiad fonts commercially available on http://www.robsfonts.com/

The first independent practical application of Sylexiad was for the Serpentine Gallery Project *Neveroddoreven*. As part of the project the design group åbäke and artist Abigail Reynolds have used Sylexiad Sans Medium as the sole font for a pack of playing cards developed to exploit a dyslexic's ability to think divergently. The project involved a

*Refer to 11.7 Postscript

conference *Playful Experiments : Dyslexia and the Arts* at the Goethe-Institut as well as an exhibition at the Serpentine Gallery.

I presented my research findings at the 5th Annual Friends of St Bride Library Conference "Fast Type, Slow Type" in Birmingham, UK. I have also written a paper that was featured in the Spring 2007 (Issue 2) edition of Ultrabold, the Journal of St Bride.

12. Reflections.

The research has had an enormous impact on my intellectual and personal development. As a result of the investigation my first paper, "*A typeface for the dyslexic reader*" (Hillier, 2002a, pp.27-29), was published. I also delivered my first national conference paper at the "*Crossed words, mixed messages – The experience of dyslexia*" (Hillier, 2002b.), conference at Norwich School of Art and Design. In February 2006 I presented my findings at the "*Writing PAD Symposium – Integrating writing and technology in art and design* (Hillier, 2006) at the University of Wolverhampton which resulted in an invitation from Professor Arnold Wilkins of the University of Essex to mathematically analyse Sylexiad using a technique called autocorrelation.

Throughout the investigation, the annual research seminars I presented were of great benefit. The first seminar was in 2002 and became a dry run for the "*Crossed words, mixed messages*" conference paper. For the second seminar in 2003 I conducted a live demonstration of the developmental typeface testing process which resulted in Dine 3 being the favoured typeface. The final seminar in 2004 was a formal presentation of the Sylexiad design process. All of these seminars have helped me to formulate, articulate and consolidate complex ideas and, as a consequence have helped me in the process of writing.

As a result of these activities, there has been interest in my research from institutions including the Royal College of Art and the University of Wales. I have also had enquiries from overseas, the most distant of which came from a student based in Los Angeles, California. Closer to home, the research has impacted in a significant way on my teaching practice particularly with regards to student dyslexic needs and the teaching of typographic principles.

On a more personal note, since embarking on the research I have found that I make fewer reading errors and that my spelling has greatly improved. The investigation has enabled me to visit new places and meet new people, all of whom have been tremendously helpful and encouraging. I would particularly like to thank Rosemary Sassoon, Roger Watt, George MacLennan, Helen Boorman, Jane Key, Margaret Fieldhouse and the late Béve Hornsby; as well as The University of Oxford, The University of Stirling, The University of East Anglia, Anglia Ruskin University and Norwich School of Art and Design for all their support. The discourse, debate and discussion I have had with others over the last five years has given me renewed confidence as a teacher, designer, reader and now writer. It has been an enjoyable and enriching experience.

13. Plates.

13.1 Sans-serif alphabet analysis (Figures 1 – 4).

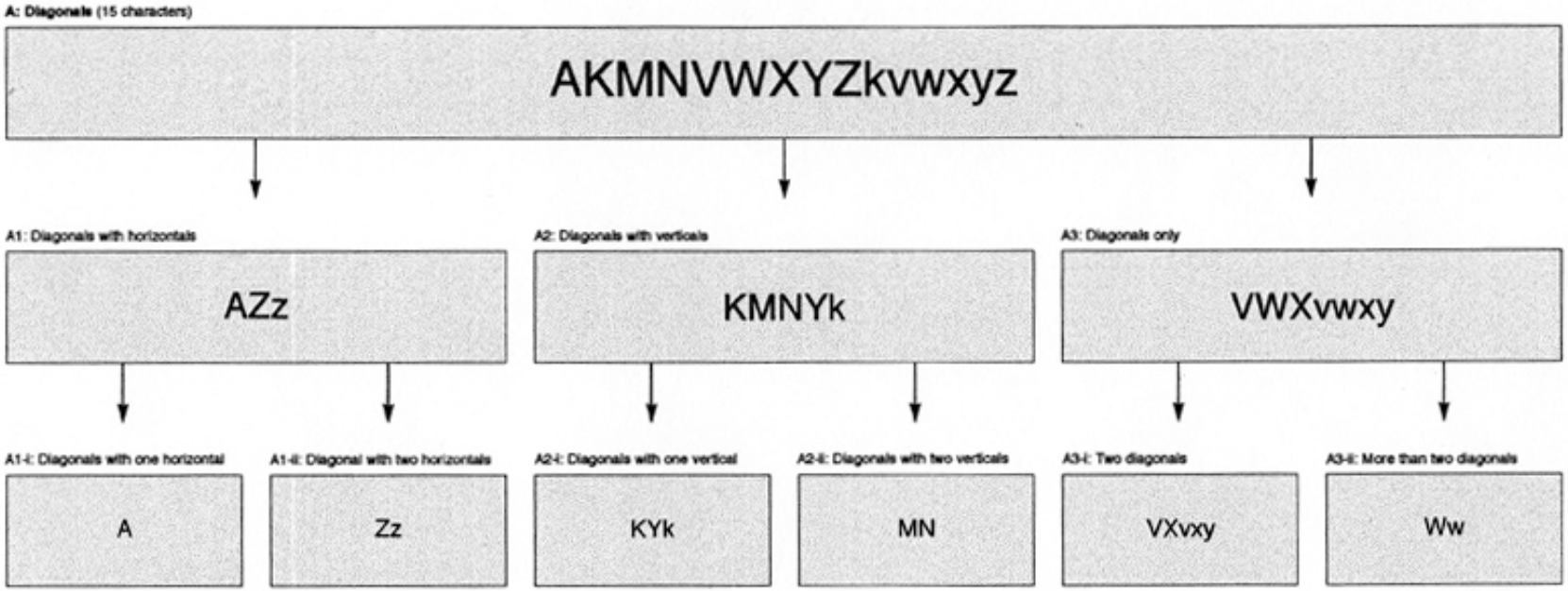

Figure 1. Sans serif alphabet analysis - Diagonals

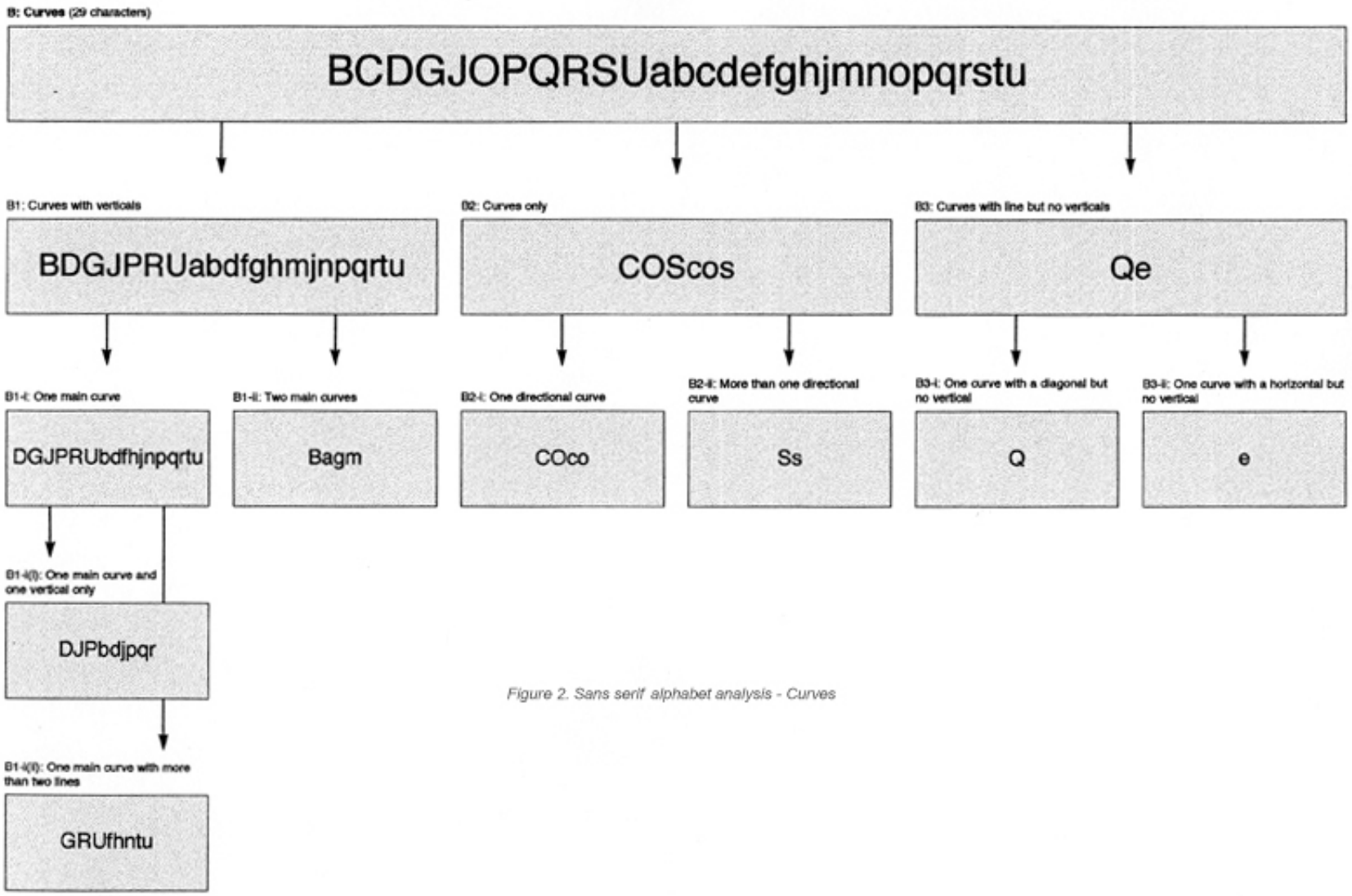

Figure 2. Sans serif alphabet analysis - Curves

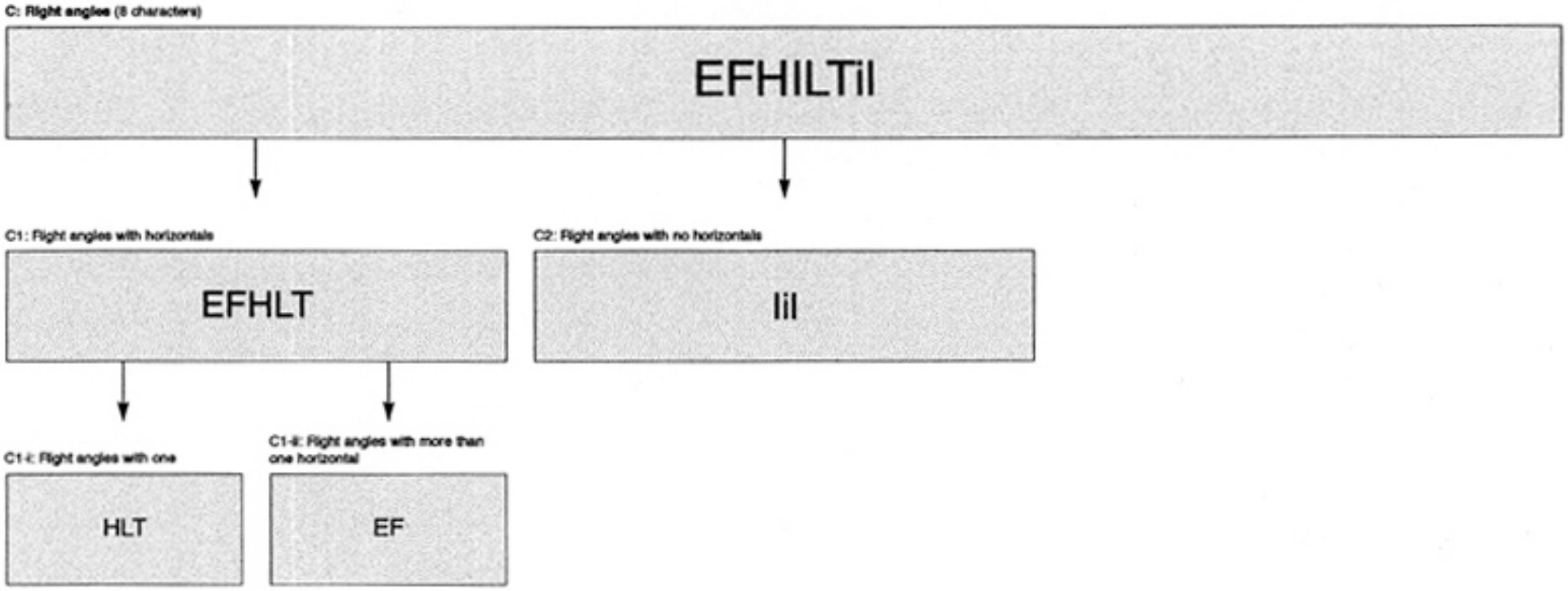

Figure 3. Sans serif alphabet analysis - Right angles

Figure 4. Sans serif monocase (based on Helvetica)

13.2 Test typefaces (Figures 5 – 8).

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
0123456789&*@\:,$=!<>()%.+?"';£

Figure 5. Arial

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
0123456789&*@\:,$=!<>()%.+?"';£

Figure 6. Sassoon Primary

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
0123456789&*@\:,$=!<>()%.+?"';£

Figure 7. Times New Roman

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
0123456789&*@\:,$=!<>()%.+?"';£

Figure 8. Tiresias InfoFont

13.3 Precursor fonts (Figures 9 – 11).

ABcdefghijklmnopqrstuvwxyz
0123456789!£[]-+=:;\,.?

Figure 9. Dine 1

Abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ
0123456789!£[]-+=:;\,.?

Figure 10. Dine 2

abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

1234567890!£()-+=:;\,.?

Figure 11. Dine 3

13.4 Sylexiad fonts (Figures 12 – 13).

abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ
0123456789&*@\:,$=!<–>()%.+?"';£

Figure 12. Serif Sylexiad

abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ
0123456789&*@\:,$=!<–>()%.+?"';£

Figure 13. Sylexiad Sans

13.5 Word shape and situation and context. (Figures 14 – 15).

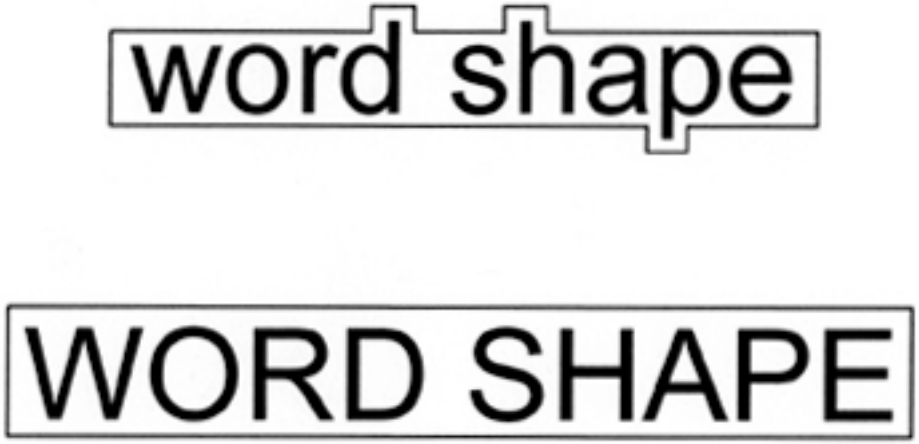

Figure 14. Word shape model

test text pairs paris

tεSt tεXt pAirS pAriS

Figure 15. Situation and context. Arial (top) Dine 1 (bottom)

13.6 Developmental typeface testing comparative typeface outcomes. (Figures 16 – 26).

		Arial	Sassoon Primary	Times New Roman	Tiresias InfoFont	Dine 1	Dine 2	Dine 3	Serif Sylexiad	Sylexiad Sans	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)	1.8 (2nd)	3.0 (3rd)	1.7 (1st)	3.0 (3rd)	4.4 (5th)					FORMATIVE
	Study Test 2 (Internal Dyslexic)	2.0 (1st)	2.8 (2nd)	3.5 (4th)	3.5 (4th)		3.2 (3rd)				
	Study Test 3 (Internal Dyslexic)	2.9 (4th)	2.6 (2nd)	2.6 (2nd)		4.2 (5th)		2.5 (1st)			
	Study Test 4 (Internal Dyslexic)	3.0 (3rd)	2.7 (2nd)	3.5 (5th)					3.0 (3rd)	2.5 (1st)	SUMMATIVE
	Study Test 6 (External Dyslexic)	3.0 (3rd)	3.3 (5th)	2.9 (2nd)					2.5 (1st)	3.3 (5th)	
CONTROL	Study Test 5 (Internal Control)	2.7 (2nd)	3.3 (5th)	2.6 (1st)					3.2 (3rd)	3.2 (3rd)	
	Study Test 7 (External Control)	2.9 (2nd)	3.3 (4th)	2.5 (1st)					3.3 (4th)	3.0 (3rd)	

Figure 16. Average typeface preference ratings (as a family)

Ratings are based on a Likert Scale of 1 to 5 (1, being the preferred typeface and 5 being the least preferred)

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)																		FORMATIVE
	Study Test 2 (Internal Dyslexic)																		
	Study Test 3 (Internal Dyslexic)																		
	Study Test 4 (Internal Dyslexic)	2.1	4.0	2.6	2.8	2.8	4.1								4.3	1.8	3.0	2.1	SUMMATIVE
	Study Test 6 (External Dyslexic)	3.2	2.8	3.1	3.4	2.4	3.4								2.2	2.8	4.0	2.6	
CONTROL	Study Test 5 (Internal Control)	1.6	3.8	3.4	3.2	2.4	2.6								3.8	2.6	3.6	2.8	
	Study Test 7 (External Control)	3.2	2.6	3.2	3.4	2.4	2.6								3.2	3.4	3.0	3.0	

Figure 17. Average typeface preference ratings (lowercase and uppercase)

Ratings are based on a Likert Scale of 1 to 5 (1, being the preferred typeface and 5 being the least preferred). No preference ratings between lower and uppercase typefaces were made during formative testing.

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)	3		1		2		0		2									FORMATIVE
	Study Test 2 (Internal Dyslexic)	1	0	4	1	2	1	4	4		3	3							
	Study Test 3 (Internal Dyslexic)	0	1	3	4	0	0			3 | 1*			1	0					
	Study Test 4 (Internal Dyslexic)	2	0	1	2	1	0								0	0	1	0	SUMMATIVE
	Study Test 6 (External Dyslexic)	4	0	4	0	1	2								2	0	1	0	
CONTROL	Study Test 5 (Internal Control)	0	0	0	0	0	0								0	0	0	0	
	Study Test 7 (External Control)	0	0	1	0	2	0								0	0	0	0	

Figure 18. Character tests: Reading errors including hesitations

**Dine 1 outcomes when tested against typefaces with lowercase and uppercase forms.*

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)	0		1		1		3		2									FORMATIVE
	Study Test 2 (Internal Dyslexic)	4	4	4	4	4	6	5	4		5	5							
	Study Test 3 (Internal Dyslexic)	4	3	4	3	0	5			1 | 3*			3	6					
	Study Test 4 (Internal Dyslexic)	1	5	5	3	3	0								3	3	4	4	SUMMATIVE
	Study Test 6 (External Dyslexic)	2	5	3	4	3	3								2	3	3	3	
CONTROL	Study Test 5 (Internal Control)	1	2	1	2	0	0								0	0	1	2	
	Study Test 7 (External Control)	0	0	0	0	0	2								0	0	0	5	

Figure 19. Word tests: Reading errors including hesitations

**Dine 1 outcomes when tested against typefaces with lowercase and uppercase forms.*

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)	0		3		1		2		2									FORMATIVE
	Study Test 2 (Internal Dyslexic)	0	0	0	0	1	2	2	0		1	0							
	Study Test 3 (Internal Dyslexic)	5	4	6	4	2	4			6 | 4*			5	1					
	Study Test 4 (Internal Dyslexic)	3	2	3	3	5	3								4	4	2	3	SUMMATIVE
	Study Test 6 (External Dyslexic)	3	2	0	0	0	0								1	0	1	0	
CONTROL	Study Test 5 (Internal Control)	0	1	0	1	0	0								0	1	0	0	
	Study Test 7 (External Control)	0	0	0	1	0	2								1	2	0	1	

Figure 20. Sentence tests: Reading errors including hesitations

**Dine 1 outcomes when tested against typefaces with lowercase and uppercase forms.*

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)																		FORMATIVE
	Study Test 2 (Internal Dyslexic)																		
	Study Test 3 (Internal Dyslexic)																		
	Study Test 4 (Internal Dyslexic)	6.86 secs.	8.60 secs.	6.00 secs.	8.54 secs.	8.98 secs.	8.18 secs.								6.34 secs.	7.98 secs.	6.78 secs.	7.18 secs.	SUMMATIVE
	Study Test 6 (External Dyslexic)	6.60 secs.	6.00 secs.	6.20 secs.	4.60 secs.	5.40 secs.	4.40 secs.								6.80 secs.	4.60 secs.	6.40 secs.	4.40 secs.	
CONTROL	Study Test 5 (Internal Control)	4.75 secs.	4.71 secs.	4.71 secs.	4.91 secs.	4.61 secs.	4.84 secs.								4.62 secs.	5.47 secs.	4.74 secs.	4.73 secs.	
	Study Test 7 (External Control)	3.00 secs.	3.20 secs.	2.80 secs.	3.20 secs.	3.20 secs.	3.60 secs.								3.60 secs.	3.20 secs.	2.80 secs.	3.80 secs.	

Figure 21. Sentence tests: Total average sentence reading times

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)																		FORMATIVE
	Study Test 2 (Internal Dyslexic)	2.0	2.2	2.0	2.4	2.1	2.4	1.6	2.2		2.0	2.4							
	Study Test 3 (Internal Dyslexic)	1.8	1.8	2.5	2.2	2.7	2.4			2.7 | 3.8*			3.0	2.0					
	Study Test 4 (Internal Dyslexic)	1.6	2.0	1.8	2.1	2.3	2.6								2.6	2.3	2.3	2.5	SUMMATIVE
	Study Test 6 (External Dyslexic)	1.4	2.0	2.0	1.6	1.6	1.6								1.8	1.2	2.4	2.0	
CONTROL	Study Test 5 (Internal Control)	1.6	1.2	2.0	1.6	1.8	2.4								1.8	2.2	2.4	2.0	
	Study Test 7 (External Control)	1.4	1.4	1.8	1.4	1.6	1.6								1.8	1.4	1.8	1.4	

Figure 22. Sentence tests: Sentence readability ratings

Ratings are based on a Likert Scale of 1 to 4 (1, being very easy to read; 2, being easy to read; 3, being difficult to read and 4, being very difficult to read). Study Test 1 did not involve a sentence readability test.

**Dine 1 outcomes when tested against typefaces with lowercase and uppercase forms.*

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)	205		197		219		202		158									FORMATIVE
	Study Test 2 (Internal Dyslexic)	101	115	107	119	119	123	113	181		102	121							
	Study Test 3 (Internal Dyslexic)	162	145	165	141	153	133			132 | 129*			151	136					
	Study Test 4 (Internal Dyslexic)	136	144	146	156	140	146								135	161	137	162	SUMMATIVE
	Study Test 6 (External Dyslexic)	199	158	187	166	192	156								187	144	175	166	
CONTROL	Study Test 5 (Internal Control)	219	184	214	184	212	183								200	186	206	178	
	Study Test 7 (External Control)	242	283	219	252	205	244								205	251	224	241	

Figure 23. Paragraph tests: Average words read per minute

**Dine 1 outcomes when tested against typefaces with lowercase and uppercase forms.*

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)																		FORMATIVE
	Study Test 2 (Internal Dyslexic)																		
	Study Test 3 (Internal Dyslexic)	3	3	4	1	2	0			3 | 3*			3	2					
	Study Test 4 (Internal Dyslexic)	2	4	1	3	4	2								4	2	3	1	SUMMATIVE
	Study Test 6 (External Dyslexic)	2	2	4	3	2	4								2	3	2	2	
CONTROL	Study Test 5 (Internal Control)	3	4	3	3	4	5								5	5	4	5	
	Study Test 7 (External Control)	4	4	5	4	4	5								5	5	4	5	

Figure 24. Paragraph tests: Non-words correctly identified

Study Tests 1 and 2 did not involve non-word identification tests.

**Dine 1 outcomes when tested against typefaces with lowercase and uppercase forms.*

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)																		FORMATIVE
	Study Test 2 (Internal Dyslexic)																		
	Study Test 3 (Internal Dyslexic)	3	4	3	3	3	4			3 | 3*			4	2					
	Study Test 4 (Internal Dyslexic)	4	3	4	3	3	5								4	5	3	2	SUMMATIVE
	Study Test 6 (External Dyslexic)	1	1	4	2	2	3								3	3	3	1	
CONTROL	Study Test 5 (Internal Control)	4	4	3	4	5	5								4	5	1	3	
	Study Test 7 (External Control)	2	5	3	2	4	4								5	3	3	3	

Figure 25. Paragraph tests: Text comprehension – correctly answered questions

Study Tests 1 and 2 did not involve text comprehension tests.

**Dine 1 outcomes when tested against typefaces with lowercase and uppercase forms.*

		Arial		Sassoon Primary		Times New Roman		Tiresias InfoFont		Dine 1	Dine 2		Dine 3		Serif Sylexiad		Sylexiad Sans		
		lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	monocase	lower case	upper case	lower case	upper case	lower case	upper case	lower case	upper case	
DYSLEXIC READERS	Study Test 1 (Internal Dyslexic)	1.7		2.0		1.7		2.7		3.1									FORMATIVE
	Study Test 2 (Internal Dyslexic)	2.4	2.6	3.0	1.4	2.8	2.6	2.4	3.0		3.0	2.0							
	Study Test 3 (Internal Dyslexic)	1.8	2.2	2.6	2.4	2.0	2.0			3.8 | 2.6*			2.3	2.8					
	Study Test 4 (Internal Dyslexic)	2.1	3.0	3.0	2.1	2.3	3.0								3.1	1.8	2.8	1.8	SUMMATIVE
	Study Test 6 (External Dyslexic)	1.6	2.0	1.6	2.2	1.6	3.2								1.2	2.2	2.0	2.2	
CONTROL	Study Test 5 (Internal Control)	2.0	2.4	2.4	1.8	1.6	1.8								1.8	1.8	2.6	2.2	
	Study Test 7 (External Control)	2.0	1.2	1.6	2.0	1.2	1.8								1.2	1.8	1.8	1.6	

Figure 26. Paragraph Tests: Paragraph readability ratings

Ratings are based on a Likert Scale of 1 to 4 (1, being very easy to read; 2, being easy to read; 3, being difficult to read; and 4, being very difficult to read). Study Test 1 did not involve a paragraph readability test.

**Dine 1 outcomes when tested against typefaces with lowercase and uppercase forms.*

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Carey, J. (2004) *Mind Reading 1/5* Monday 29 November 2004.
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Producer: Lore Widemuth. BBC Radio 4

Carey, J. (2004) *Mind Reading 4/5* Thursday 2 December 2004.
Producer: Julia Adamson. BBC Radio 4

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Producer: Julia Adamson. BBC Radio 4

Dispatches (2005) *The Dyslexia Myth*. Thursday 8 September 2005.
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6.00 BBC News (2003) Wednesday 2 July 2003. BBC 1

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14.4 Conferences Workshops and Seminars

Atypi Association Typographique Internationale. (1999) *Annual Conference.* Boston, USA. 7-10 October.

Falmouth College of Arts. (2003) *Arts and Visual Thinking*. Falmouth. 18 and 19 September.

Kingston University. (2003) *The New Typography : An Interdisciplinary Symposium*. London. 13 March.

London College of Printing. (2000) *Enhancing the Course Offer, Disability in Arts Education Conference Day*. London. 5 July.

London College of Printing. (2000) *Visual Spatial Learners – The Power of Images*. London. 16 November.

Norfolk County Council Education. (2000) *Psychological Assessment*. Norwich. 31 July

Norwich School of Art and Design. (2001) *Staff Development: Dyslexia Awareness Workshop*. Norwich. 9 March.

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University of Wolverhampton. (2006) *Writing PAD Symposium. Creative Diversity : Integrating writing and technology in Art and Design*. Wolverhampton. 3 February.

14.5 Libraries

Central Library, St. Peter's Square, Manchester, M2 5PD

Collier Row Library, 45 Collier Row Road, Collier Row, Romford, RM5 3NR

Deichmanske Bibliotek, Hovedbiblioteket, Henrik Ibsensgt. 1, 0179 Oslo, Norway

Didsbury Library, 692 Wilmslow Road, Didsbury, Manchester, M20 2DN

The John Rylands University Library of Manchester, The Deansgate Building, 150 Deansgate, Manchester, M3 3EH

The John Rylands University Library of Manchester, The Main Library, Burlington Street, Oxford Road, Manchester, M13

The New York Public Library, Humanities and Social Sciences Library, Fifth Avenue and 42nd Street, New York, NY 10018-2788

Norwich School of Art and Design, St George Street, Norwich, Norfolk, NR3 1BB

Romford Central Library, St Edward's Way, Romford, RM1 3AR

St. Bride Printing Library, Bride Lane, Fleet Street, London, England, EC4Y 8EE

Trondheim Folkebibliotek, Peter Egges p1 1p, 7001 Trondheim, Norway

University of East Anglia Library, Norwich, Norfolk NR4 7BR

Westminster Reference Library, 35 St. Martins Street, London, England, WC2H 7HP

14.6 Miscellaneous

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The Daily Telegraph (2002) *New hope for dyslexic children*. p.8. 21 January.

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15. Glossary.

Action research: Research involving an intervention carried out in the real world resulting in a close examination of that intervention.

Alphabetic: A stage of literacy development that relies on grapheme-phoneme relationships.

Alphonanic: The visual anomalies associated with the alphabet system which influence an individual's ability to decode and encode language.

Archetypal fonts: A typeface design that typifies a particular typographic form or style.

Ascender: The section of the stroke of a lowercase letterform that protrudes above the x-height.

Auxillary marks: The punctuation, symbols, ornaments and miscellaneous characters within an alphabet.

Baseline: The imaginary line that defines the visual base of a letterform.

Bold: A letterform characterised by a thicker stroke than the roman form.

Bouma: A word with heightened shape.

Centred: An arrangement of text which is symmetrical giving equal value and weight to each end of the line.

Character: A letterform or punctuation mark within an alphabet.

Characters: A letterform or punctuation mark within an alphabet.

Cognition: A mental process that involves thinking, reasoning or some other type of mental information processing.

Cognitive psychology: An area of psychology that seeks to understand how the brain processes information.

Condensed: A letterform characterised by a condensed version of the roman form.

Control: A non-dyslexic reading group.

Counter: The negative space within a letterform which is either fully or partially closed.

Cursive: Written characters that are joined up.

Decode: To convert a coded form into an intelligible language. For example, reading.

Descender: The section of the stroke of a lowercase letterform that protrudes below the baseline.

Developmental typeface testing: A formative and summative method of testing a series of typefaces in order to measure readability and legibility.

Duocase font: A typeface that contains an uppercase and lowercase set of letters.

Dyslexia: A phonological defect that influences an individual's ability to decode and encode language.

Encode: To convert into a coded form. For example, writing.

Ethnographic research: Research involving the researcher as participant in order to share the same experiences as the subjects.

Fixation: The looking at a point or letter on a page.

Gestalt psychology: An area of psychology that emphasises the importance of understanding phenomena as structured wholes rather than individual components.

Grapheme: The smallest unit of a writing system that carries meaning.

Handwritten font: A typeface that is characterised by either cursive and/or oblique strokes.

Inductive research: Research involving the development of theory through fieldwork that has been grounded in evidence resulting in highly valid conclusions.

Interlinear spacing: see *Leading*.

Italic: A slanted letterform style.

Justified: An arrangement of text which is symmetrical, but unlike centred text, is achieved by increasing or reducing spaces between words.

Kerning: The adjustment of space between letterforms.

Leading: Interlinear or line spacing.

Legibility: Factors that concern the visual and typographic elements of a text.

Light: A letterform characterised by a thinner stroke than the roman form.

Logographic: A stage of literacy development that relies on simple letter cues.

Lowercase: The lowercase letters within an alphabet.

Meares-Irlen Syndrome: See *scotopic sensitivity.*

Metacognition: The highest order skill within the language system. Readers make inferences from letters and words and use prior knowledge in order to understand text.

Monocase font: A typeface that contains only one set of letters.

Morpheme: The smallest unit of language that carries meaning.

Numerals: The lining figures within an alphabet.

Oblique font: A typeface that contains a slanting element.

Orthographic: A stage of literacy development that relies on the understanding of syntax and semantic elements which enable fluent reading.

Parallel letter recognition model: A word recognition model that states that the letters within a word are identified simultaneously.

Phoneme: A basic unit of spoken language.

Phonological: The relationship between the fundamental speech sounds of a language. The lowest order skill within the language system.

Pica: A typographic unit of measurement equal to 12 points. There are 6 picas to an inch.

Point: A typographic unit of measurement equal to 0.35 mm.

Precursor fonts: The Dine family of typefaces.

Range left: An arrangement of text where each line starts at the same left-hand point and finishes irregularly at the end of the line.

Range right: An arrangement of text where each line finishes at the same right-hand point and starts irregularly at the beginning of the line.

Readability: Factors that concern the visual and typographic elements of a text.

Readability: Factors that concern the meaning, comprehension and understanding of a text.

Roman: The basic letterform style.

Saccade: The eye's movement from one point or fixation to another.

Sans-serif: A letterform without any right-angled or oblique marks at the end of a stroke.

Scotopic sensitivity: A visual perceptual distortion problem relating to light sensitivity. Also known as Meares-Irlen Syndrome.

Serial letter recognition model: A word recognition model that states that words are identified in a linear manner. The first letter is recognised first, then the second and so on until the word has been identified.

Serif: A letterform that contains right-angled or oblique marks at the end of a stroke.

Set width: The width of a letterform plus the negative space on either side which prevents one character merging into another.

Stroke: Any line that defines a letterform.

Text formations: Arrangements of text as either individual characters, words, sentences or paragraphs.

Typographic form: Characteristics concerning the uppercase, lowercase and numeric forms of a typeface.

Typographic style: Characteristics concerning serif, sans-serif and oblique typefaces.

Typographic variables: Characteristics concerning the weight, space, size and familiarity of a typeface.

Typography: The design and study of printed matter.

Unjustified text: An arrangement of text which is asymmetrical, being either ranged left or range right. Unlike justified text the spatial quality between words is usually consistent.

Uppercase: The capital letters within an alphabet.

Word shape model: A word recognition model that states that words are identified as complete units.

x-height: The height of a lowercase 'x'.

A Typeface for the Adult Dyslexic Reader

Robert Alan Hillier