Typographic Features of Text: Outcomes from Research and Practice

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ABSTRACT:

This paper presents a comprehensive review of literature on the legibility of printed text in order to provide informed guidance on the design and preparation of typographic materials. To this end, experimental findings are taken into account, as well as the perspective of typographers, graphic designers, and authors. First, the typographic features of text are reviewed and illustrated individually to identify all the features that specifically characterise text layouts. It is emphasized, however, that the various typographic features should be selected in relation to each other, and that it is the combination and manipulation of all these typographic features as a group that makes the text legible. Studies are then reviewed and illustrated on the typographic structure of text as a whole. This information will prove useful to anyone involved in the development of typographic materials, including typographic and graphic designers, teachers and students.

KEYWORDS:

typographic features of text, text structure, legibility, typography, reading performance

1. INTRODUCTION

A comprehensive review of studies on the legibility of text is extremely useful to practitioners, researchers, and scholars, particularly when users' reading performance is the primary concern. A literature review of this nature will confirm (or dismiss) many established conventions regarding the typographic design of text. It will also help practitioners to make educated choices and produce user-orientated design outcomes. Moreover, it will give practitioners solid evidence to justify their design decisions.

Therefore, the purpose of the present paper is to draw attention specifically to the legibility of printed text. Legibility is here interpreted as the speed and accuracy with which text on a page can be read. This interpretation is in agreement with Pyke's (1926) own definition, as well as Zachrisson (1965, 36) and Reynolds' (1978, 197) opinions.

It has been argued that many typographic practices impair rather than help legibility. For example, Hartley and Burnhill (1976) have analysed and pointed out several poor typographical practices.

> Amongst these are: the centring of headings and other textual components; the practice of changing arbitrarily the internal spacing of the material in order to force the text to fill out a fixed width and depth ("justification"); inconsistency in the sequencing and the grouping of parts; excessive use of indentation in texts which do not consist simply of pages of information arranged in paragraph form; and excessive variety of sizes, styles and weights of typeface chosen to code heading levels. (Hartley and Burnhill, 1976, 100)

They go even further by arguing that these practices could "justifiably be termed "illiterate" for, clearly, parts of a text are not mere objects of varying shapes and sizes to be arranged like ornaments on a mantelshelf or pictures on a wall." (1976, 100). After illustrating these poor typographic practices through examples of *British Psychological Society Publications*, Hartley and Burnhill (1976) propose that fundamental re-thinking is required. This observation, therefore, leads to the hypothesis that the speed and accuracy of reading text may be affected by various typographic features (from the typeface used to the treatment of paragraphs, etc.).

Unfortunately, there are only a few studies on the structure and articulation of information on the page as a whole, i.e. studies that test the effects of combined typographic features on reading. For this reason, this paper starts by reviewing the typographic features of text individually. Referring to each typographic feature individually allows us to identify all of the features that specifically characterise text layouts and which one may have a bigger effect on performance. The few studies on the typographic structure of text as a whole are then reviewed.

This review also takes into account experimental findings as well as the perspective of typographers, graphic designers,

and other authors. Scientific approaches do not always reach the same conclusions as the views of practitioners and other authors. However, for a well-founded review, it makes sense to link scientific research and practice (Lupton, 2004; Hartley et al, 2006; Lonsdale *et al*, 2006; Lonsdale 2006; Beier, 2012; Dyson, 2013; Beier and Dyson, 2014). In the first instance, this allows us to identify the level of agreement between scientific studies and practice. In the second, we can identify how one approach can be used to inform and complement the other. For example, typographic practice can inform the selection and design of the experimental material. Moreover, in those situations where scientific studies are unable to give clear answers, typographic practice can help in deciding how typographic features can be manipulated to produce legible typographic materials.

2. STRUCTURE OF THE PAPER

The present literature review is limited to what is considered relevant and useful to the typographic structure of reading text in common real- life situations. With this aim in mind, this review includes research and opinions considering those design choices that might cause or prevent an unwanted effect on readers. Regarding experimental findings, this review includes studies:

- having adults as participants who regularly read books, articles, technical manuals, etc.;
- testing printed documents with a sufficient number of words to represent standard reading documents such as passages, articles, etc.;
- placing the material to be read at ordinary distances of approximately 300-350mm from the eyes;
- measuring legibility by the speed and/or accuracy of reading, as well as the readers' preference judgements.

Exceptions to this are mentioned throughout the review. However, studies related to people with impaired vision, studies focusing on writing rather than reading, and on-screen legibility studies are excluded as they have no direct relevance to this literature review.

As for the grouping of research findings and opinions according to the typographic features of text, different approaches have been taken thus far (e.g. Zachrisson, 1965; Reynolds, 1978; Wijnholds, 1997; Hartley, 2004). For the purpose of this paper, Twyman's model of verbal graphic language (Twyman, 1982, 11-6) will be followed. Twyman presents a clearly structured model with a theoretical explanation, where a distinction is made between intrinsic and extrinsic features. Intrinsic features are described as those that reside in the characters themselves and, more particularly, in the system that produces those characters (for example, manuscript as opposed to typeset). Examples of intrinsic features are size and style of letterforms, including the use of italic, bold, and small capitals

(i.e. capital letters of a typeface in smaller size that are redrawn to match the x-height and weight of lowercase letters). Extrinsic features relate to what can be done to those characters or sets of characters by changing their colour, controlling the space between them, or changing their configuration. Twyman further distinguishes spatial features at the micro level – in relation to intercharacter space, interword space or the position of subscripts and superscripts – and also at the macro level – in relation to the spacing of larger units of text.

This approach is used to group and discuss the literature on the typographic features of text in Sections 3 and 4. The combination and manipulation of the various typographic features that can make clear (or unclear) the structure of text is then addressed in Section 5.

At the end of almost every section a summary table presents the main advice that has emerged from research and practice. An example is also provided in parallel to illustrate and sometimes compare approaches. Section 6 presents a comprehensive summary table, which lists all of the empirical studies referred to in this paper, and grades their validity taking into account the parameters described below.

3. INTRINSIC FEATURES

3.1. TYPEFACE CHOICE

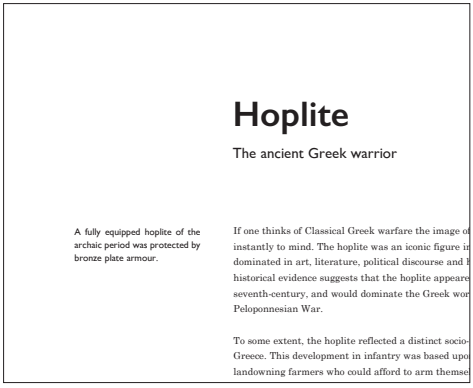

FIGURE 1.

Main text in serif, heading and caption in sans serif.

Choosing a typeface according to its legibility has been a primary concern of many designers (both typographic and graphic) when the main purpose of the text with which they are working is continuous reading. This choice has also formed the basis for experimental studies and has been widely discussed.

Three experiments measuring speed of reading have reported findings of no significant differences between typefaces in common use. One example of no significant differences between typefaces is Paterson and Tinker's (1932) test to identify which typefaces could be read most rapidly. The speed of reading for each of the six typefaces in common use at that time (Garamont, Antique, Bodoni, Old Style, Caslon Old Style, and Cheltenham) was compared with Scotch Roman (another commonly used typeface). The choice was based mainly on the opinions of a large number of editors and publishers. All typefaces were set in 10-point size, 19-pica line length (about 52 characters – Scotch Roman), and set solid (in text that is set solid, the interlinear space is equal to the point size of the type). The results showed that the six typefaces did not differ significantly from Scotch Roman. The study further included three radically different typefaces from the ones

in common use. In this case, however, two of these typefaces (American Typewriter and Cloister Black – Old English) were read more slowly than Scotch Roman. The modern typeface Kabel Lite was practically as legible as Scotch Roman. (A description of this test can also be found in Tinker's book *Legibility of Print*, 1963.)

Another example is Pyke's (1926) study testing the legibility of eight typefaces (referred to by, for example, Tinker, 1963a, 51; Cornog and Rose, 1967, 302-4; Lund, 1999, 102-5). Although Old Style No. 2 seemed the most legible and Modern Condensed No. 39 the least legible typefaces, Pyke considered the differences to be small. He concluded that typefaces used in everyday reading situations, if well printed, do not produce significant differences in legibility. Burt (1959) also conducted an investigation to determine the relative legibility of ten different book faces that were in common use at that time. However, Burt's practices and contributions are considered dubious. (see Lund, 1995 and 1999, and Hartley and Rooum, 1983, for further discussion), mainly due to concerns about whether the data were used to support a predetermined position.

Readers' preference judgement is another measure that has also been considered when researching the legibility of typefaces. Tinker (1963a, 49-50) concluded from the combined judgements of participants on the typefaces used in Paterson and Tinker's study in 1932 that readers do have preferences for typefaces, but that preferences do not always coincide with readers' performance when reading their preferred typeface.

Recommendations supported by practice have been made for how to choose an effective typeface. Simon (1945, 11) and later Hartley (1994, 32; 2004, 920), suggest that the purpose of the text should be taken into account. In agreement with Black (1990, 12-3), Hartley (1994, 32; 2004, 920) further recommends the avoidance of those typefaces with unusual features which may create irregularities in the text and confuse readers. Furthermore, typefaces which may lose their identity when printed or copied should also be avoided: typefaces with fine lines which may break down; typefaces with small internal spaces which may fill in; typefaces with a strong contrast between thick and thin strokes which may cause a dazzle effect; and typefaces in which the letters appear to touch one another. (See also Simon, 1945, 11-21, and Bringhurst, 1992.) Luna (1992, 74-6) adds to this the opinion that a typeface that calls attention to itself rather than to the text should not be chosen; nor a typeface that is based on tradition without its appropriateness having been tested more objectively.

The comparative legibility of serif and sans serif type should also be considered when choosing a typeface. Luna (1992, 74) argues that "traditional seriffed typefaces are rarely unsuitable for continuous reading, and that few sans serif are appropriate for this purpose." From studies that have compared the legibility of these two distinctive categories, no definitive conclusion has been reached. (See extensive research and conclusions of Lund, 1999.) Serif and sans serif typefaces are likely to be read equally quickly and accurately.

Examples of experiments measuring speed of reading and comprehension that have not shown a significant difference in legibility between serif and sans serif typefaces are Paterson and Tinker's study (1932) mentioned above and Moriarty and Scheiner's (1984) experiment measuring how many words were read in a given time period (the serif typeface Times New Roman and the sans serif typeface Helvetica were tested).

However, suggestions are also made that sans serif typefaces whose rhythms and spacing relate closely to those of serif typeface seem most satisfactory for continuous text (Lund, 1992, 74). In fact, it is interesting to note that some studies have found a significant difference between sans serif typefaces, despite there being no significant difference between serif and sans serif typefaces. In a study measuring rate of comprehension, Poulton (1965) found that the sans serif typeface Gill medium produced a reliably greater rate of comprehension than all the other sans serif typefaces tested (although it was not reliably better than any of the serif typefaces). Poulton attributed this result to the fact that Gill, with its geometrical approach allied to humanistic letterforms, has a stronger character differentiation than the other sans serif typefaces.

Readers' preferences have also failed to clearly distinguish between serif and sans serif typefaces. For example, Schriver and colleagues (Schriver, 1997, 288-303) conducted a study on typeface preferences using complete texts that reflected the sorts of documents people read in everyday contexts. Four different materials were assessed: a microwave manual, a credit letter, a tax form, and a short story. Each document was designed using four different serif typefaces and four different sans serif typefaces. To avoid confounding typeface legibility with differences in x-heights, Schriver and colleagues employed a larger type size in the serif versions of the documents. Although the results suggested that serif or sans serif typefaces are equally likely to be preferred, they also suggested that serif type might be better when reading continuous prose and sans serif type when reading instruction manuals. Schriver and colleagues then concluded that the situation in which reading is taking place might well influence readers' preferences.

In the 1930s, Tschichold (1967) strongly defended the use of sans serif, claiming that it "is so simple and clear that it is by far the best all-purpose type for today and will remain so for a long time to come…" (1967, 28). However, for the purpose of continuous reading, Tschichold accepted the use of serif to be appropriate. More recent opinions have favoured the use of both serif and sans serif in the same document. Serif type could be used for the body of the text (e.g. McLean, 1980; Schriver, 1997), which is in agreement with Luna's opinion referred to above, and sans serif could be used for headings, captions and marginalia (e.g. Simmonds and Reynolds, 1994, 46; Schriver, 1997).

The lack of clarity in these findings and the assumptions made suggest that Carter *et al* (1993, 88) may well be right when

TABLE 1.

Typeface

Research	Practice
• Typefaces used in everyday reading situations, if well printed, do not produce significant differences in legibility [e.g. Pyke, 1926 (described in Tinker, 1963a); Paterson and Tinker, 1932]	• Avoid typefaces: with unusual features; which may lose their identity when printed or copied; which call attention to themselves rather than to the text; which have not been tested objectively. [Simon, 1945; Hartley, 1994 and 2004; Black, 1990; Luna, 1992]
• No distinctive difference between serif and sans serif type in speed of reading and comprehension. [e.g. Paterson and Tinker, 1932; Poulton, 1965; Moriarty and Scheiner, 1984]	• Use serif for continuous prose and for the body of the text. [e.g. McLean, 1980; Schriver, 1997]
• No clear preference for either serif or sans serif type. [e.g. Schriver, 1997]	• Use sans serif for instruction manuals, headings, captions, and marginalia. [e.g. Simmonds and Reynolds, 1994; Schriver, 1997]

claiming that other typographic features seem to be far more important in the reading process than the selection of either a serif or a sans serif typeface.

3.2. TYPE VARIANTS

3.2.1. Italic

Studies have been carried out exploring the use of italic in continuous prose instead of roman lowercase characters, and have shown that the use of italics retards reading. One example is Tinker's (1955) experiment using prolonged reading tasks. Tinker's study showed that reading speed was substantially reduced when reading italic (a retardation of 15.5 words per minute). The material used included two forms set in 10-point type in a 20-pica line length (about 55 characters per line) with 12-point interlinear space. The only difference was that one form was set in Excelsior roman and the other in Excelsior italic type. Another example is Tinker and Paterson's (1928) study where italic text was read 2.8 per cent slower than lowercase text. As for preferences, in another study carried out by Paterson and Tinker (1940, described in Tinker, 1963a, 54-6), 96 per cent of the participants judged that roman lowercase could be read more easily and faster than italic.

In addition, when we analyse documents in current use, we can see how italic is frequently applied to distinguish elements in a text: for example, titles of books in bibliographies, foreign words, abstracts in journal articles, etc. (as referred to by Simon, 1945, 5; Glynn *et al,* 1985; Carter *et al*, 1993, 91; Gilreath, 1993; Hartley, 1994, 30, and 2004, 921; Simmonds and Reynolds, 1994, 65-6; Schriver, 1997, 266). Thus, despite some authors' claims that bold should be used instead of italic for differen-

tiation in text matter (e.g. Rehe, 1979, 31), the common practice of using italic for differentiation is likely to be more appropriate. At least in certain situations, readers may well prefer italic over bold because of its conventional use.

3.2.2. Bold

FIGURE 2.

Italic or bold to distinguish elements [top]. Bold for black background [bottom].

Some researchers have explored the weight of a typeface in an attempt to define the optimum degree of boldness for reading. Luckiesh and Moss (1940) examined the speed of reading Memphis typeface in four weights: light, medium (20 per cent greater boldness than light), bold (35 per cent greater boldness than light) and extra bold (69 per cent greater boldness than light). Text was set in 10-point type Memphis with 2 points of leading and a line length of 21-pica (about 53 characters for Memphis medium). There was no significant difference in speed of reading, measured by the number of lines of text read during a period of five minutes of continuous normal reading. However, the medium and bold settings produced the highest reading speeds (an improvement of only three per cent).

Tinker and Paterson's (1942) study also failed to find any difference when participants read continuous text at a normal distance. Both weights, i.e. standard and bold, were read at the same rate. The text was printed in 10-point Scotch Roman type, 19-pica (about 52 characters) line length and set solid. As for judgements, a different group of 224 participants thought that standard type was more legible and pleasing than bold face.

Readers' judgements, therefore, seem to correspond to the opinions of authors who suggest that for continuous text a typeface of medium weight, not too heavy or too light, should be employed (e.g. Rehe, 1979, 31). Nonetheless, bold can be very effective to emphasise one piece of information over another (e.g. Reynolds, 1978, 199; Rehe, 1979, 31; Bringhurst, 1992, 52; Carter *et al*, 1993, 91; Schriver, 1997, 267-8; Wijnholds, 1997; Strizver, 2014), or as a technique to thicken the lines of characters that will be printed in pale ink, or on a black or coloured background (Bringhurst, 1992, 52). Because bold type draws attention, this variant is best used for specific situations that require emphasis. So, for example, it can be used to distinguish words (e.g. 'not', 'NB') or headlines, rather than whole sentences. But because bold has different weights (bold, semi-or demi-bold, black or ultra) from which we can choose, care should be taken when using bold for emphasis where the aim is to create enough contrast. A slight difference in weight will be ineffective and can actually look like a print error.

TABLE 2.

Type variants: italic and bold

Research	Practice
• When compared to roman lowercase text, italic retards reading. [e.g. Tinker and Paterson, 1928; Paterson and Tinker, 1940 (described in Tinker, 1963a); Tinker, 1955]	• Use italic to distinguish elements in a text. For example: titles of books (in bibliographies), foreign words, abstracts in journal articles. [e.g. Simon, 1945; Glynn *et al*, 1985; Carter *et al*, 1993; Gilreath, 1993; Hartley, 1994 and 2004; Simmonds and Reynolds, 1994; Schriver, 1997]
• Both medium and bold text are read at the same rate. [Luckiesh and Moss, 1940; Tinker and Paterson, 1942]	• Bold can be very effective to emphasise one piece of information over another. [e.g. Reynolds, 1978; Rehe, 1979; Bringhurst, 1992; Carter *et al*, 1993; Schriver, 1997; Wijnholds, 1997]
• Readers consider medium type more legible and pleasing than bold type. [Tinker and Paterson, 1942]	• Bold can be used as a technique to thicken the lines of characters that will be printed in pale ink, or on a black or coloured background. [Bringhurst, 1992]

3.3. ALL-CAPITALS VERSUS LOWERCASE

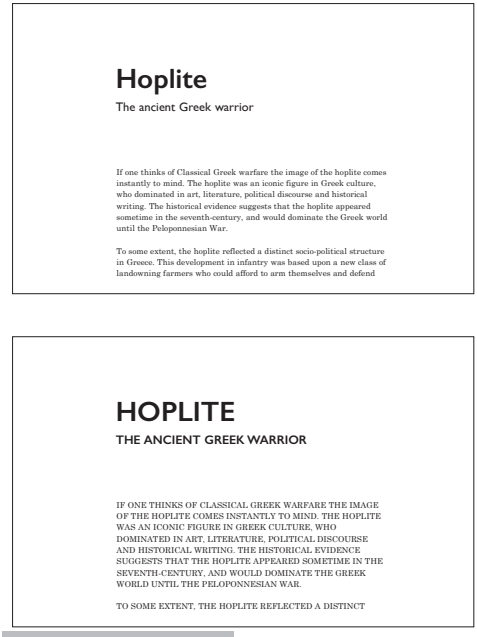

FIGURE 3.
Main text in lowercase [top] and all-capitals [bottom].

It has been argued that lowercase is easier to distinguish and recognise than all capitals (e.g. Rehe, 1979, 35-6; Humphreys and Bruce, 1989, 329). In fact, studies have shown that lowercase is read more rapidly than all-capitals: in Tinker and Paterson's (1928) study lowercase was read 13.4 per cent faster; in Tinker and Paterson's (1942) study lowercase was read 11.8 per cent faster; and in Tinker's (1955) study lowercase was read 10.2 to 14.2 per cent faster.

Another study, carried out by Poulton (1967), showed that readers located newspaper headlines printed in bold lowercase more quickly than headlines in all-capitals. The x-heights of the bold lowercase letters were approximately the same as the heights of the capital letters. In addition to the finding that lowercase is read more rapidly than all-capitals, Tinker and Paterson (1942) further found that readers judged lowercase as more legible and pleasing. As all continuous

reading involves more lowercase (Tinker and Paterson, 1928, 366-7 and Tinker ,1963a, 61), lowercase might be more familiar to readers, i.e. readers had more practice with it.

This evidence for the superiority of lowercase led to the conclusion that all-capital printing should be avoided whenever rapid reading is required or when readers' preferences are the main concern (Tinker, 1963a, 61; Rehe, 1979, 36). Instead it is proposed that both capitals and lowercase letters should be used, reserving the capitals for the initial letter of nouns, sentences, and headings (Poulton, 1967; Hartley and Burnhill, 1977a, 71). The use of all-capitals for main headings, or small capitals for secondary headings, may be satisfactory because such headings are normally surrounded by space, which helps in their visual distinction (Hartley, 2004, 921). Opinions expressed by Tschichold (1967, 34 and 38), Black (1990, 16 and 30), Carter *et al* (1993, 89), Simmonds and Reynolds (1994, 66), Schriver (1997, 274), Hartley (2004, 921) agree with the research findings described above.

Another interesting argument is the fact that lowercase occupies less space than all-capitals of the same body size (Hartley and Burnhill, 1977a, 71; Black, 1990, 16), about 35 per cent less (Tinker 1963a, 60; Carter *et al*, 1993, 89). This results in economy of space.

TABLE 3.

All-capitals versus lowercase

Research	Practice
• Lowercase is read more rapidly than all-capitals. [e.g. Tinker and Paterson, 1928; Tinker and Paterson, 1942; Tinker, 1955; Poulton, 1967]	• Both capitals and lowercase letters should be used, reserving the capitals for the initial letter of nouns, sentences and headings. [Poulton, 1967; Hartley and Burnhill, 1977]
• Readers prefer lowercase. [Tinker and Paterson, 1942]	• Lowercase occupies less space than all-capitals of the same body size, about 35 per cent less. [e.g. Tinker, 1963a; Hartley and Burnhil, 1977a; Black, 1990; Carter *et al*, 1993]

3.4. TYPE SIZE

In metal type the size of type is conventionally expressed in points, i.e. the measure of the whole body of the metal block for the letterform including ascenders, descenders, and the extra space at the top and bottom that is required to create space between successive lines of type. However, different typefaces with the same type size vary in their x-heights (the top-to-bottom dimension of a lowercase "x"). Several researchers have argued that point size terminology is an unsatisfactory measure for research since it does not specify the actual size of the printed typeface (Poulton, 1965, 350-60; Poulton, 1969, 58; Hartley *et al.,* 1975, 115-6; Hartley, 2004, 919-20).

This is clearly illustrated by the results of Poulton's study (1972) comparing the legibility of three typefaces, i.e. number of target words found in a list of food ingredients. When all typefaces were printed in the same point size, differences of legibility were found, but when the x-height of all three was equated to approximately the same size, no difference was found. Typographers (e.g. Simon, 1945, 13), designers (e.g. Carter *et al.,* 1993, 90), and other authors (e.g. Rehe, 1979, 27-9) seem to agree with these results. Some go even further by claiming that typefaces with greater x-heights can be set at a smaller size than typefaces with smaller x-heights without losing legibility (e.g. Schriver, 1997, 258-9). (See also Legge and Bigelow, 2011, for a discussion of x-height and a thorough review of findings from vision science and typography regarding type size.)

Sizes of type, however, have also been frequently defined by measuring the body size of the type and not the x-height (as reported below). Therefore, it is important to keep in mind that when choosing a typeface according to its body size, the same designated type sizes will not, in fact, look the same size.

The most regularly used type sizes, between 9-and 12-point, are regarded as being the most legible for text intended to be read at normal reading distances of 12-to 14-inches, i.e. about 300 to 350 millimetres (e.g. Tinker, 1963a, 69-73; Spencer, 1969, 35; Rehe, 1979, 29; Carter *et al,* 1993, 90). Furthermore, 10-or 11-point are suggested as the optimum sizes with the caveat that it depends on the typeface (e.g. Tinker 1963a, 71; Reynolds, 1978, 200). These suggestions and results concern both speed of reading and preference judgements. It is also noted that smaller sizes such as 6-or 8-point type are often used in legal documents, but these can be too small to read easily. Larger sizes of 14, 18-and 24-points are often used for headings and display purposes (Hartley, 2004, 919).

Although type size may have a strong influence on legibility, it has been argued that it is best not to consider type size separately. For example, after describing one of his extensive studies with Paterson (Paterson and Tinker, 1929) on the influence of type size on legibility of print in a chapter devoted to *Size of type*, Tinker (1963a, 69-72) discarded the data as inconclusive. In the study, speed of reading was measured comparing 6-, 8-, 12-, and 14-point type to the standard 10-point type (an illustration can be found in Tinker, 1963a, 70). The results do not seem unreasonable: texts in 6, 8, 12 and 14-point type were read significantly more slowly than 10-point type. The difference ranged from 5.2 to 6.9 per cent. However, line length and interlinear space were kept constant while type size varied. Tinker, therefore, concluded that:

> … line width, leading, and type size must be coordinated in any final judgement concerning the legibility of type size. All three factors should be studied under conditions where simultaneous and systematic variations of all three are made. (Tinker, 1963a, 73)

Others that agree with Tinker's view include Zachrisson (1965, 39), Reynolds (1978, 200), Rehe (1979, 29-30), Schriver (1997, 263), and Wijnholds (1997). Scientific evidence (Skottun and Freeman, 1983) has further shown, however, that the space between letters also affects how size of type is perceived. Therefore, interletter space should also be coordinated with type size before any conclusion can be reached on legibility.

4. EXTRINSIC FEATURES

4.1. COLOUR

4.1.1. Type and background colour

It is acknowledged that the relationship between type and background colour is another important factor for legibility. Michael and Jones (1955) conducted a meticulous study to determine the extent of differences in the average scores of students when presented with examination papers on different colours of paper. Different colours of paper were selected and randomly presented to participants. This selection took into account, for example, the complaints of faculty members and students on the unpleasant aesthetic qualities of yellow-orange paper. Results were straightforward in showing that colour of paper did not significantly affect the average number of correct answers.

Aside from the legibility of type on coloured backgrounds for examination papers, other studies have been carried out which are reviewed, described, and discussed by Tinker (1963a, 137-51) in his book *Legibility of Print* (e.g. Tinker and Paterson, 1931 and Luckiesh and Moss, 1938). The studies tested the speed of reading: black text on coloured paper, black on white versus white on black arrangements, and coloured type on coloured paper. In summary, the results from all the studies indicate that black print on a white background is much more legible than white print on a black background for materials to be read in an ordinary situation. On this basis, Tinker concludes that if white type on black is employed to attract attention, the amount of text should be small, and a sans serif type in 10 to 14-point size should be used to minimise the loss of legibility. Readers also prefer to read black on white, rather than white on black. It is further concluded that it is possible to coordinate coloured print with coloured paper so that legibility and 'pleasingness' are maintained at a satisfactory level.

Supported by references to empirical research, Hartley (2004, 921) notes that black ink on white or yellow paper is generally preferable to red ink on these colours, and that black ink on dark red or purple paper is generally to be avoided.

4.2. MICRO SPACING

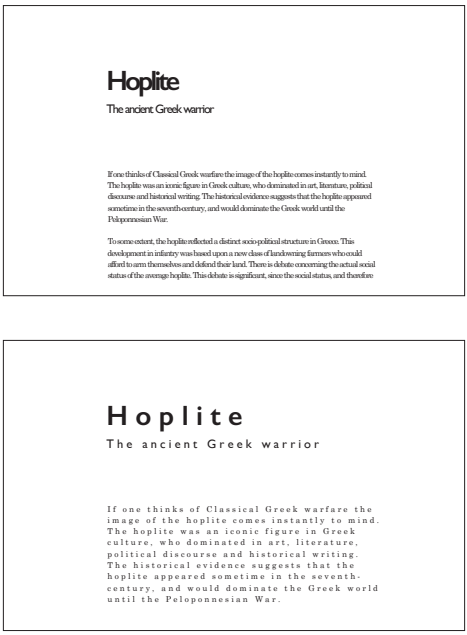

FIGURE 4.

Interletter space: too narrow [top]; too wide [bottom].

Although interletter and interword space also seem to affect legibility, limited experimental evidence is available on this matter. One of the few examples is the investigation carried out by Spencer and Shaw in 1971. The aim of the study was to find out whether variation in interletter space (close, average and wide spacing) for the sans serif type Gill Sans affected the legibility of continuous printed text. The results showed that reading speed and comprehension were the same for all the kinds of spacing tested. However, from the illustrations provided it is clear that the narrowest setting is too close to the point of making the letters collide with each other and, consequently, causes a significant decrease in legibility. We should also be aware that the same percentage of space reduction might have different effects on the legibility of other type sizes and other typeface designs. This may be the case, for instance, with a serif typeface where serifs might touch with the same interletter space for a sanserif typeface that does not touch.

A more recent study conducted by Chung (2002) has shown that reading speed is at its peak with standard letter spacing, and decreases for both smaller and larger letter spacing. As later found and explained by Yu *et al* (2007), with extra wide spacing, reading becomes slower because the size of the visual span (the number of letters recognized with high accuracy without moving the eyes) becomes smaller. However, in these studies the text was presented on a computer monitor. Therefore, these results are only used in this paper for theoretical reflection.

Opinions expressed by authors and practitioners indicate interletter space that is too wide disrupts the reading process since the readers are forced to read the letters individually. Moreover, extreme interword space also creates vertical white spaces that look like rivers running down the page, which destroys the normal page texture. This is especially apparent in newspapers where text is fully justified, resulting in inconsistent interword and interletter spacing. On the other hand, with space that is too narrow, the letters and words join together and readers have more difficulty in recognising adequately each individual letter and word. All these issues should be considered (Simon, 1945, 30; Tschichold, 1967, 37-8; Black, 1990, 17-8 and 39-41; Carter *et al,* 1993, 89-90), especially when the information has to be taken in at a quick glance (Hartley and Burnhill, 1977a, 69).

Therefore, where quick reading seems to be the first concern, it is definitely wiser to avoid setting the type too wide or too

close. However, research and practice are yet to give us quantifiable definitions for 'too wide' and 'too close'. Based on the studies reported above, it seems that for a 10 to 12-point type size, 'too wide' letter spacing would correspond to an overall space character above a "thick" space (1/3 the width of an em). An 'em' is defined by Simmonds and Reynolds (1994, 173) as the width of a lowercase letter 'm'. 'Too close' letter spacing would correspond to an overall space character below a "thin" space (about 1/5 to 1/8 of an em). In fact, type in smaller sizes, lighter weights, and expanded style can actually benefit from wider letter spacing. Type in larger sizes, heavier weights, and condensed style can also benefit from closer letter spacing.

TABLE 4.

Interletter and interword space

Research	Practice
• Reading speed is not affected when interletter space is changed slightly. [Spencer and Shaw, 1971]	• Interletter space that is too wide or too narrow disrupts the reading process. [e.g. Simon, 1945; Tschichold, 1967; Black, 1990; Carter *et al*, 1993] • Extreme interword space creates vertical white spaces that look like rivers running down the page, which destroys the normal page texture. [e.g. Simon, 1945; Tschichold, 1967; Black, 1990; Carter *et al*, 1993]

4.3. MACRO SPACING

4.3.1. Alignment

Type set fully justified seems to represent a more traditional approach (Luna, 1992, 640). In fully justified setting the space between words is inconsistent in order to fill the width of the column (as mentioned above, newspapers are a good example of justified setting with clearly inconsistent word spacing). Conversely, text aligned on the left and ragged right creates consistent word spacing and has become an increasingly popular practice (Gregory and Poulton 1970, 427; Reynolds, 1978, 203, Luna, 1992, 64).

Unlike right alignment and centred text, the effect of full justification and left alignment on the legibility of text has been the subject of a number of studies (e.g. Zachrisson, 1965; Fabrizio *et al,* 1967; Becker *et al,* 1970; Gregory and Poulton, 1970; Hartley and Burnhill, 1971; Hartley and Mills, 1973; Wiggins, 1977). When comparison was made between the two type settings, no differences in reading times were found when a medium line length was used.

Of the studies comparing full justfied and left aligned text, Gregory and Poulton's study (1970) is the most clearly

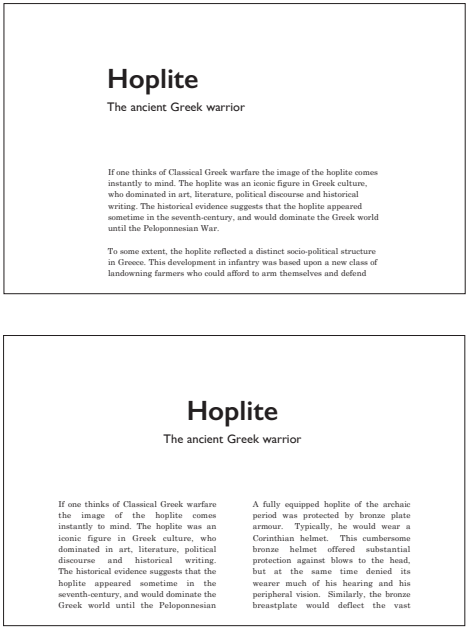

FIGURE 5.

Left aligned text [top]. Justified text with rivers [bottom].

articulated. It also contains a clear attempt by the researchers to maximise the sensitivity of the study (Gregory and Poulton, 1970, 428). A comparison was made between the rate of comprehension when reading passages presented in three different styles – fully justified, left aligned with hyphenated words (i.e. broken words), and left aligned with no hyphenated words. All passages were printed in one style only and set in 9-point type with 10-point interlinear space and in a line with a maximum length of seven words per line, about 42 characters (a single narrow column). To confirm some of the findings of this first experiment, Gregory and Poulton conducted two additional experiments with some adjustments, including an increase in the line length from an average of seven words per line to twelve words per line (about 70 characters). Over the whole study, the alignment of text made no difference for good readers, but for poor readers the fully justified style resulted in significantly worse performance when reading the shorter lines of seven words. Zachrisson (1965, 145-55), in an earlier study, had also cited evidence that left aligned text is read more quickly by less proficient readers when the lines are, on average, 9 words (about 52 characters).

A study carried out on readers' preferences for typeface, alignment and interlinear space by Becker *et al* (1970) showed no differences in preferences for fully justified or left aligned text. The researchers concluded, however, by saying that definitive conclusions could not be drawn since the number of participants was small (ten), and that it was hard to say how far the findings could be generalised for other typefaces or situations.

As no definitive conclusions have been reached with these studies concerning the alignment of text, it seems that the real issue here has more to do with interletter and interword space than with the alignment of text. As Schriver (1997) concluded, "Justifying the text or not is probably the wrong concern. The right concern is how to achieve a text without rivers and excessive hyphenation." (1997, 270). Rivers can be prevented by aligning text to the left or by avoiding short line lengths. However, if justification has to be used, then a consistent texture can be achieved by hyphenating at the ends of lines whenever possible (Carter *et al,* 1993, 93). Further practical considerations of hyphenation on the legibility of text are given by Bringhurst (1992, 40-1) and Luna (1992, 58-66).

Hartley and Burnhill (1971) compared various settings of standard left aligned text (i.e. with no hyphenated words at the end of the text lines) and left aligned text with a moderate hyphenation (i.e.

where 33 per cent of the text lines end with hyphenated words). No differences were found between them in the number of words read. However, after showing the differences between the typographic layouts to the subjects, 24 preferred the standard left aligned version against 10 that preferred the hyphenated version, while 8 subjects had no preference. This suggests that, if readers' preferences are to be taken into account, hyphenation should be used sparingly, or not used at all.

TABLE 5.

Alignment

Research	Practice
• No difference in performance between fully justified or left aligned text with a medium line length. [e.g. Zachrisson, 1965; Fabrizio *et al*, 1967; Becker *et al*, 1970; Gregory and Poulton, 1970; Wiggins, 1977]	• Reading is disrupted when text is fully justified, with rivers and excessive hyphenation that disrupts reading. [Carter *et al*, 1993; Schriver, 1997]
• No difference in preferences for fully justified or left aligned text. [Becker *et al*, 1970]	

4.3.2. Line length

Driven by technology, different measures have been used for line length (sometimes called line width). These include ems, picas, points, millimetres, and inches. To avoid confusion, some authors have described line length in terms of the average number of characters per line (e.g. Spencer, 1969, 35). Other authors have explicitly recommended checking the number of characters and spaces as a practical expedient, rather than using a linear measurement (e.g. Reynolds, 1978, 201;and Wijnholds, 1997). Each letter, numeral, punctuation mark, and space is considered a 'character' (Simmonds and Reynolds, 1994, 48). However, studies rarely describe line length as the average number of characters and spaces per line. Since characters-per-line is a more precise unit of measure, in this paper all line length measures were converted into an approximate number of characters per line.

As previously discussed, it is generally accepted that an optimal typographic arrangement is dependent upon the simultaneous variation of type size, line length, and interlinear space for any final judgement concerning the legibility of type. However, the few available studies conducted to test the effects of line length on legibility did not consider the three variables together (except for some studies carried out by Tinker and Paterson which are discussed in the next section).

For example, Wiggins (1977) tested only one or two variables at the same time. In one experiment, line lengths of 10-, 11-

and 12-picas (about 26, 29 and 33 characters respectively) were tested in combination with three different typefaces and a 10-point type size (the x-height varied). In a second experiment, line lengths of 10-, 14-, 19-, 24-, and 29-picas (about 26, 39, 52, 65 and 78 characters respectively) were tested using constant and variable space between words for 10-point size in order to produce uneven and even right margins, accordingly. Wiggins (1977) found that lines of medium length were read faster than the shorter and longer lines. The 12-pica line was read faster than 10-and 11-pica lines when averaged over three different typefaces; the 14-pica line was the optimum for constant interword space; and the 19-pica line was the optimum for variable space. Thus, it seems that in all cases moderate line lengths were read faster than shorter or longer line lengths.

Tinker (1963a, 86) also reports that readers favour moderate line lengths. This advantage of moderate line length over short or long line length, for both reading speed and preference, seems to be for two distinct reasons. First, more fixation pauses of greater duration seem to be employed when reading very short line lengths than when reading moderate line lengths (e.g. Tinker, 1963a, 86). Moreover, with very short line lengths the readers have to change lines too frequently, thus making inefficient use of their peripheral vision when reading (e.g. Simmonds and Reynolds, 1994, 48). The number of hyphenations is also greater with very short line lengths than with moderate line lengths. Second, with very long line lengths it is more difficult for the eyes to make an accurate return sweep, i.e. a long movement to the left from the end of a given line to the beginning of the next line (e.g. Luna, 1992, 54; Carter et al, 1993, 90; Simmonds and Reynolds, 1994, 48; Schriver, 1997, 263; Wijnholds, 1997). Consequently, several fixations may be required before the correct line is found (e.g. Simmonds and Reynolds, 1994, 48) and the number of regressions after the return sweep of the eyes may be greatly increased, which leads to less efficient reading (e.g. Tinker, 1963a, 86).

According to Spencer's (1969, 35) review of scientific studies, the optimal line length seems to be between ten to twelve words, or 60 to 70 characters per line. Opinions of both authors and practitioners concur with this recommendation (Simon, 1945, 7; Tschichold, 1967, 40; Lewis, 1963, 57; Rehe, 1979, 30; Black, 1990, 43; Bringhurst, 1992, 26-7; Carter *et al*, 1993, 91; Simmonds and Reynolds, 1994, 48; Schriver, 1997, 263; Wijnholds, 1997).

4.3.3. Interlinear space and relationship with type size and line length

Interlinear space is used in this paper as a term to describe 'baseline to baseline measurement', i.e. the amount of vertical space placed between the baseline of one text line and the baseline of the next, and is expressed in points. (As mentioned above, in text that is set solid the interlinear space is equal to the point size of the type.) Interlinear space has also been described

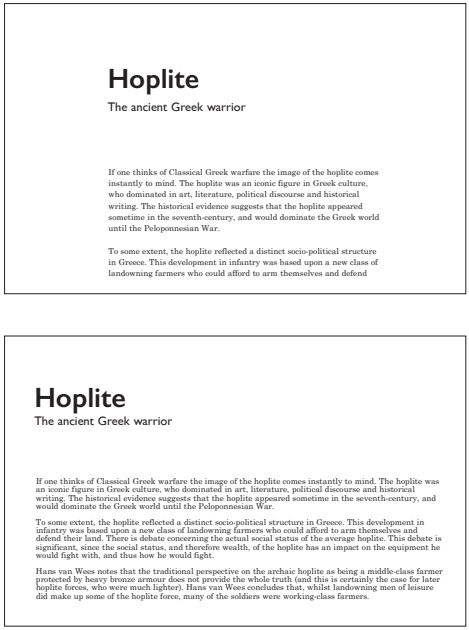

FIGURE 6.

Moderate line length and an additional interlinear space of 4 points [top]. Long line length and type set solid [bottom].

as 'leading', relating to the strips of lead of varying thickness that were placed between lines of type to increase the space.

As already highlighted, researchers, authors, and practitioners agree that line length must be coordinated with type size and interlinear space for any final judgement concerning the legibility of type (Tinker, 1963a, 73; Zachrisson, 1965, 39; Reynolds, 1978, 200; Rehe, 1979, 29; Carter *et al*, 1993, 91; Wijnholds, 1997). An inadequate ratio of type size to line length results in the text appearing unbalanced. For instance, when text is set fully justified, a badly chosen ratio can result in stretched words separated by large gaps (Wijnholds, 1997). These observations offer a clear suggestion that line length cannot be determined without considering type size. The same association has been made between line length and interlinear space. When it is really necessary to use long line lengths, legibility can be preserved if interlinear space is increased (Schriver, 1997, 263) in order to help the eye find the following line accurately.

Paterson and Tinker (described by Tinker, 1963a, 94-102) completed a series of experiments between 1932 and 1949, which varied line length (from 7 picas, about 18 characters, to 43 picas, about 124 characters) and interlinear space (from solid to an increase of 4 points) for each of the commonly used type sizes (from 6-to 12-point type). Speed of reading for material set in each of the variations in line length and interlinear space was compared for each size of type. This extensive and detailed investigation made it possible to list 'safety zones' for each type size. (See Tinker, 1963a, 106.) According to Tinker, the safety zone refers to the limits of variation in line length and interlinear space that may be used for a given type size without appreciable loss of legibility. On the basis of Tinker's (1963a) safety zones, it seems that for the sizes of type suggested above as the most legible (9-, 10-, 11-, and 12-point), one to four points can be added to the interlinear space in order to increase legibility. However, this surely depends on the typeface used. Extreme line lengths were omitted from the list. For example, for 10-point type, line lengths below 14 picas (about 38 characters) and above 31 picas (about 83 characters) were omitted. An examination of the results in Tinker's tables shows that, independent of the interlinear space used, those extreme line lengths always fell in the region of poor legibility.

Tinker (1963b) then carried out another experiment, which confirmed Paterson and Tinker's findings. Moderate arrangements (in this case of 8-point type with a line length of 12 picas – about 41 characters, or 9-point type with a line length of 18 picas – about 55

characters, both with an additional interlinear space of 2 points) were read more rapidly than text in relatively long or short lines, smaller type sizes, and with little or no interlinear space. Readers' choices were consistent with their performance and they definitely disliked text in relatively short or long lines, small type, as well as material set solid.

Becker *et al* (1970) also found that according to readers' judgements, different typefaces need a different amount of interlinear space. For instance, sans serif and italic may need an additional interlinear space of 1 point more than serif roman types. Schriver (1997, 263) also suggests that it is a good idea to insert more interlinear space between the lines of sans serif type because the uniform line weight and similarity of letterforms may make it harder to read the text smoothly.

Authors and practitioners (e.g. Simon, 1945; Tschichold, 1967; Spencer, 1969; Rehe, 1979; Black, 1990; Bringhurst, 1992; Carter *et al*, 1993; Schriver, 1997, Wijnholds, 1997) seem to agree with these findings and indeed go further by adding other considerations concerning interlinear space that should be taken into account when arranging text. For example, body text usually needs an interlinear space in a point size bigger than the size of the type. Even though the type is designed to maintain a legible appearance when set solid, the space between lines can still look insufficient. If so, the eyes take in other lines as well. However, too much interlinear space is also bad because when lines are too separated it will take longer to get to the following line (Tschichold, 1967, 44; Rehe, 1979, 31; Bringhurst, 1992, 34-5; Carter *et al*, 1993, 91; Schriver, 1997, 260-1). That is to say, it is more difficult for the eyes to make an accurate return sweep to the beginning of each new line of text (Simmonds and Reynolds, 1994, 35 and 52). Furthermore, it is also more expensive because of the additional paper used (Wijnholds, 1997). As discussed above, longer line lengths always need more interlinear space than shorter ones (Schriver, 1997, 262-3).

TABLE 6.

Type size, line length and interlinear space

Research	Practice
• For sizes of type 9-, 10-, 11-, and 12-point (suggested as the most legible) an interlinear space of one to four points can be added to increase legibility [Tinker, 1963a]	• Arrangements of 10- and 11- point size, with a line length of 60 to 70 characters per line, and additional interlinear space of one to four points, are considered most legible. [e.g. Simon, 1945; Tschichold, 1967; Hartley and Burnhill, 1977; Spencer, 1969; Black, 1990; Bringhurst, 1992; Carter *et al*, 1993; Schriver, 1997; Winjholds, 1997]
• Moderate arrangements are read more quickly than text in relatively long or short lines, smaller type sizes and with little or no interlinear space. [Tinker, 1963b]	• Italic, body text and sans serif type, may need an additional interlinear space of one point more than serif roman types. [Becker *et al*, 1970; Schriver, 1997]
• Readers definitely dislike very short and very long lines, small type, as well as material set solid. [Tinker, 1963b]	

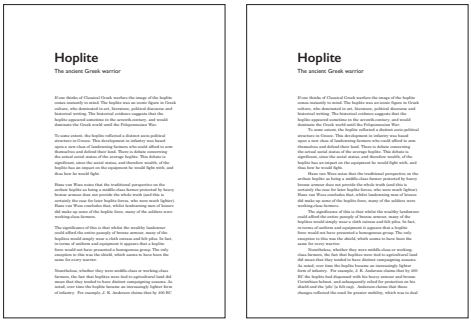

FIGURE 7.

Paragraphs denoted by one line space [left] or by a new line with a moderate indentation of 3 ems [right].

Paragraphs distinguish units of thoughts. The most common ways of showing the beginning of paragraphs are the introduction of an indentation, a line space, or a combination of both.

Paterson and Tinker (1940; described in Tinker, 1963a, 122) examined the effects of paragraph denotation on speed of reading. Results showed that indentation at the beginning of a paragraph improved, or at least did not decrease, the legibility of printed matter. Hartley *et al* (1978), with a later experiment, investigated the effects of paragraph denotation on legibility of text by measuring speed of scanning, i.e. the number of items scanned in a given period. For each setting the start of new paragraphs was denoted in one of four ways: [1] one line space but no indent; [2] a new line with indent; [3] a new line with no indent; [4] no denotation at all. Results clearly showed that paragraphs denoted by one line space but no indent were significantly superior to paragraphs denoted only by a new line with no indent, and also superior to those units of text with no denotation at all. However, paragraphs denoted by one line space but no indent were not significantly different from paragraphs denoted by a new line with indent.

Schriver (1997, 356-7) added to Tinker and Hartley's findings. For continuous text, thirteen participants preferred the double-signalled layout using both indentation and additional line space; three chose the layout with additional line space between paragraphs; and two favoured the layout that employed indented paragraphs without extra line space. The comments made by the thirteen readers who chose the same style suggested that they thought this style made the text appear easier and shorter than the others.

Authors and practitioners are in favour of denoting paragraphs in books, magazines and newspapers, with a moderate indentation of one to three ems (Rehe, 1979, 51; Bringhurst, 1992, 38; Carter *et al*, 1993, 93).

As for the first paragraph in an article, chapter or advertisement, it should have no indent (Simon, 1945, 9; Tschichold, 1967, 49; Carter *et al*, 1993, 93). This is a way of maintaining the square corner of the first column for aesthetic reasons. The use of paragraphs separated by one line space is also advocated (Hartley and Burnhill, 1977a, 71; Rehe, 1979, 51; Hartley, 1994, 35). However, Carter *et al* (1993, 93) suggest that this system should be avoided when the text is composed mainly of short paragraphs, not only because it creates a disturbing texture but also because it occupies too much space.

Simmonds and Reynolds (1994, 61) further point out that with scientific and technical information, one line space between

paragraphs makes it easier for readers to return to the paragraphs and find their points of interest.

TABLE 7.

Paragraphs

Research	Practice
• Paragraphs denoted by one line space (no indent) are significantly superior than paragraphs denoted only by a new line, but not superior than paragraphs denoted by a new line with an indent. [Hartley *et al*, 1978]	• In books, magazines and newspapers, paragraphs should be denoted with a moderate indentation of one to three ems, or separated by one line space. [Hartley and Burnhill, 1977a; Rehe, 1979; Bringhurst, 1992; Carter *et al*, 1993; Hartley, 1994]
• Readers favour paragraphs denoted by indentation and additional line space. [Schriver, 1997]	• The first paragraph in an article, chapter or advertisement, should have no indent. [Simon, 1945; Tschichold, 1967; Carter *et al*, 1993]
	• Paragraphs separated by one line space should be avoided when the text is composed mainly of short paragraphs. [Carter *et al*, 1993]

4.3.5. Margins

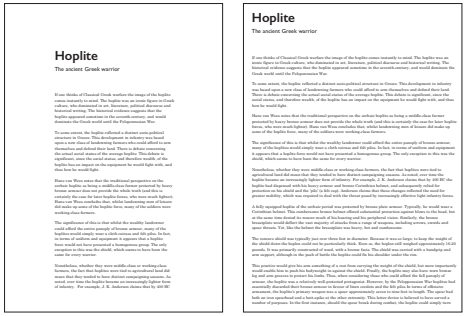

FIGURE 8.

Wide margins [left] and narrow margins [right].

Unfortunately, the amount of research with regard to margins is very limited. Of the very few studies on the effects of margins on legibility, a study by Paterson and Tinker (1940; summarised in Tinker, 1963a, 114) investigated the effects of margins on reading speed. Material with $^{7}/_{8}$ inch margins on the right and on the left of the column of print was compared with material without margins at either end of the lines. (It is likely that there was a very small margin, but no illustration is given to confirm this.) The results showed no significant speed difference when reading material printed on a flat page with or without margins. The final conclusion was that margins do not increase legibility measurably, so the use of margins on a flat page can be justified only for aesthetic reasons.

Spencer (1969, 48) criticised Paterson and Tinker's conclusion for ignoring practical factors. As Spencer stressed, margins have the important function of allowing the readers to make notes and hold the book without covering any part of the printed text or image. Hartley (2004, 918) also mentions the fact that the printed page may be copied at some time, and the copies punched or clipped for filing with

other material. These issues have been discussed by several authors and practitioners such as Simon (1945), Tschichold (1967), Bringhurst (1992), and Carter *et al* (1993). As McLean (1980, 126) further emphasises, the smaller the margins, the less they can fulfill these practical functions.

TABLE 8.

Margins

Research	Practice
• Margins do not seem to increase reading speed. [e.g. Paterson and Tinker, 1940 (described in Tinker, 1963a, and cited in Spencer, 1969)]	• Margins are functional as they allow the readers to: make notes; hold the book without covering any part of the printed text or image; punch or clip copies for filing without damaging the text. [e.g. Simon, 1945; Spencer, 1969; Tschichold, 1967; McLean, 1980; Bringhurst, 1992; Carter et *al*, 1993; Hartley, 2004]

4.4. CONFIGURATION

4.4.1. Headings

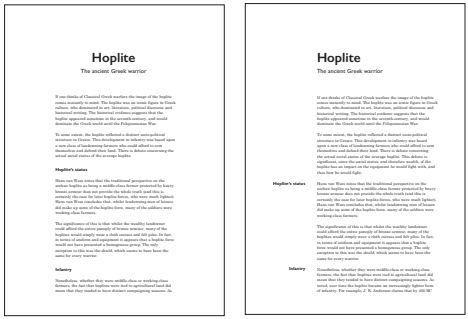

FIGURE 9.

Embedded headings [left] and marginal headings [right].

Headings are claimed to be a significant help for readers in decoding the main topic of the subsequent text they are planning to read (Schwarz and Flammer, 1981, 61 and 65; 1985; Lorch, 1989, 210), as well as the hierarchical structure of the text (Glynn *et al*, 1985, 197). Due to the importance of headings, it has been suggested that when discussing the treatment of headings three factors should be considered for good legibility: type size, type weight (Glynn *et al*, 1985, 197) and spatial location on the page (Lorch, 1989, 214). These are the most frequently used ways of emphasising and distinguishing headings from the main text or distinguishing between headings at different levels.

Type variation has been addressed by Williams and Spyridakis (1992)in a detailed study that looked at the visual distinction of headings in text. Participants were presented with 16 cards with the same meaningless text, but each one had different heading treatments. The results indicated that participants could discriminate between different hierarchical levels of headings more quickly when fewer typographical variations were used. Size (when used alone) was chosen by readers as the most powerful visual feature of a group of four (type size, underlining, case, and position) to distinguish the hierarchy of headings. The experiment showed that relative, not absolute, differences in heading sizes provided the most distinguishable cues to hierarchical level. Size differences of 3 points

between headings were discriminated more rapidly with headings ranging between 12 and 21 points in size than with headings in larger sizes.

In relation to the spatial location of headings, Hartley and Trueman (1983) conducted a series of experiments to examine the effects of headings in text on recall, search, and retrieval. The results revealed no difference in accuracy between marginal and embedded headings for recall, search, or retrieval. Williams and Spyridakis (1992), however, showed that participants consistently judged centred headings as most important and embedded headings as least important. Left aligned and indented headings were ranked second and third in importance.

Some considerations to take into account when setting text headings have been pointed out by the typographer Tschichold (1967):

- When the heading spans over more than one line, the first line of the heading must be either longer or shorter than the second one. If necessary, interword space can be slightly changed, but word breaks should be avoided (1967, 44).
- When the text is set in sans serif type, only sans serif type should be used for headings, either in the same weight or bolder. With serif text, either the same type may be used for headings, or the semi-bold or bold, or a suitably and pleasing contrast type (1967, 89).
- Normal paragraph headings, if set heavier than the body face, do not need to be in a larger size. A blank line is preferable between them and the text (1967, 89).

Simmonds and Reynolds (1994, 67) add to this the recommendation that headings should be aligned left because the eye automatically returns to the left-hand margin of the text. Moreover, a heading with more space around it has more emphasis, but it is important to define a system of spacing for headings and use it consistently.

Hartley (2004, 921) also suggests that the use of all-capitals for main headings, or small capitals for secondary headings, may be satisfactory because such headings are normally surrounded by space, which helps in their perception (as already remarked above regarding capitals versus lowercase). He also regards large sizes of 14-, 18-and 24-points as suitable for headings (Hartley, 2004, 919).

There has also been research on newspaper headlines. In terms of the typeface, scientific evidence reveals that headlines in newspapers are more difficult to locate (measured by speed of search) when printed in all-capitals (whose height is about the same as the x-height of the lowercase letters) than when printed in bold lowercase letters (Poulton, 1967, 424). In his review, Rehe (1979, 52) recommends the best type sizes for newspaper headlines as between 14-and 30-point.

Wright and Barnard (1975) warn that, although there are several options for distinguishing headings from the subsequent

text, departures from the horizontal arrangement of words are less easily read. This means, "a heading printed sideways, to bracket several rows of questions all relating to the same topic, will be less effective than a heading written horizontally." (Wright and Barnard, 1975, 216).

TABLE 9.

Headings

Research	Practice
• Relative differences in sizes provide the best cue to distinguish the hierarchy of headings. [Williams and Spyridakis, 1992]	• When serif type is used for the main text, set the heading in semi-bold or bold, or in a suitable and pleasing contrast type. [Tschichold, 1967]
• Readers consider size (when used alone) to be the most powerful visual feature to distinguish headings. [Williams and Spyridakis, 1992]	• When sans serif type is used for the main text, only sans serif type should be used for headings, either in the same weight or bolder. [Tschichold, 1967]
• No difference in accuracy between marginal and embedded headings. [Hartley and Trueman, 1983]	• Normal paragraph headings, if set heavier than the body type, do not need to be in a larger size. A blank line is preferable between them and the text. [Tschichold, 1967]
• Centred headings are judged as most important, then left aligned and indented headings, and embedded headings as least important. [Williams and Spyridakis, 1992]	• The first line of the heading must be either longer or shorter than the second one (word breaks should be avoided). [Tschichold, 1967]
	• Headings should be aligned left. [Simmonds and Reynolds, 1994]

4.4.2. Columns

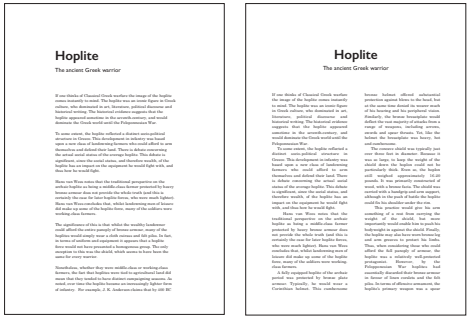

FIGURE 10.

Single column [left] and double columns [right].

Little attention appears to have been paid to how text is set in columns. However, the evidence available on single or multiple columns suggests that neither of these layouts is superior to the other. In fact, it seems that any advantage in terms of legibility, i.e. speed of reading, for either of these layouts largely depends on the column width, on the nature of the text, and on the circumstances of use.

In situations where participants are required to scan the text and search for key words, the double column layout seems to have an

advantage over the single column layout. An example of this is the study carried out by Foster (1970) on the legibility of single and double column layouts. Participants had to scan a one-column text and a two-columns text for target words. Page size, typeface and type size used were identical in both texts. Foster (1970) concluded that for this particular arrangement, the single column layout significantly diminished legibility, i.e. the number of target words located.

Hartley *et al* (1978) used texts arranged in either single or double column to test the effects of line length and paragraph denotation on the retrieval of information from prose text. Performance was measured by the number of items scanned. Again, results were in favour of the double column layout in terms of the average number of items scanned. It is concluded that the double column layout is probably preferred to a single column for the setting of straightforward prose, at least in terms of cost-effectiveness, as it is possible to get more words in the page.

In relation to textbooks for secondary schools, in Wendt's (1979) study, participants were asked to read the texts completely and carefully. They took, on average, a little less reading time and had slightly higher achievement with the single column version compared to the double column version. However, these results were not significant. The students slightly preferred the double column version, though.

A similar preference was reported in a study conducted by Paterson and Tinker (1940; cited in Tinker, 1963a, 117-8), where samples of single and double column layouts were submitted for preference. It was reported that a large percentage of participants preferred the double column layout over the single column layout. But preferences may have been influenced by the fact that a double column is more familiar, since printing practice has favoured double column layouts.

For scientific journals, Poulton (1959) reported an advantage in favour of single columns, which were read more rapidly than the double column. Passages were printed in a layout of a scientific paper (but without title, subheadings, summary, tables, etc.). However, the two single column layouts had a larger serif type and a longer line length. Therefore, it is possible that the significant advantage of the single column layout over the double column layout in terms of speed of reading and comprehension might have also been related to the change in type size, and not just to the number of columns.

For reading examination materials using academic texts from scientific journals and magazines, Lonsdale *et al* (2006) and Lonsdale (2007) reported an advantage in favour of the single column layout. Participants took less time to read and answer questions with the single column layout. The number of correct answers was also higher with this layout. In terms of judgement, participants also considered that the answers were easier to locate with the single column layout. However, as in Poulton's (1959) study, other typographic features were manipulated. Both layouts

had the same Time News Roman typeface and the same type size of 10.5 points. Logically, as the page size was the same, the single column layout had a longer line length (70 characters) than the double column layout (42 characters). In addition, the single column layout had an interlinear space of 14 points (as opposed to 11 points), and the paragraphs were distinguished by a line space (as opposed to an indent of 35mm at the beginning of the paragraphs with no line space). Therefore, the advantage of the single column layout over the double column layout seems to be related to a combination of typographic features that work together in order to produce a more legible layout.

Authors have also made some recommendations concerning the structural nature of the text, page size, margin width, as well as circumstances of use. It has been proposed that for straightforward prose to be set on an A4 page, a double column arrangement with a medium line length is probably better than a single column arrangement with long lines (Rehe, 1979, 50), unless wide margins are used with the single column (Simmonds and Reynolds, 1994, 54). Moreover, if the text requires headings or integrates non-textual elements that could occupy the space of two columns (e.g. large tables, diagrams, or figures), then a single column layout is advisable (e.g. Hartley and Burnhill, 1977a, 69; Southall, 1984, 87). However, if the non-textual elements have different sizes, two columns give more flexibility (Simmonds and Reynolds, 1994, 54). If the two columns are asymmetric, for example, a wider column and a narrow column, even more flexibility is possible. As explained by Simmonds and Reynolds (1994, 54), with a wider and a narrower column the non-textual elements can occupy the wider column, the narrower column, or both. According to the authors, the narrower column can also be used for headings, captions, and notes, as well as small illustrations. However, Simmonds and Reynolds emphasise the importance of avoiding having too many different elements competing for attention in the narrower column.

In conclusion, decisions regarding columns cannot be taken by considering line length alone. Instead, all the structural requirements of the text and circumstances of use have to be taken into account (Hartley *et al,* 1978, 193-4). Carter *et al* (1993, 91) add that, as column measure increases, the interlinear space should also increase to maintain a proper ratio of column width to interlinear space (as discussed above).

TABLE 10.

Columns

Research

- When scanning for target words, the double column layout seems to have an advantage.
  [Foster, 1970; Hartley *et al*, 1978]
- For scientific journals and exams, a single column layout is read quicker.
  [Poulton, 1959; Lonsdale *et al*, 2006; Lonsdale, 2007]

Practice

- For straightforward prose a double column layout with a medium line length is better than a single column layout with long lines. Unless wide margins are used with the single column.
  [Rehe, 1979; Simmonds and Reynolds, 1994]
- If the text requires headings or integrates non-textual elements that could occupy the space of two columns, a single column layout is advisable.
  [Hartley and Burnhill, 1977a; Southall, 1984]
- If the two columns are asymmetric the narrower column can be used for headings, captions, and notes, as well as small illustrations
  [Simmonds and Reynolds, 1994]
- As column measure increases, the interlinear space should also increase.
  [Carter *et al*, 1993]

FIGURE 11. BELOW

Layouts intended to be: more legibile [top left], of medium legibility [top right], less legible [bottom left] – based on Lonsdale et al's study (2006).

5. TYPOGRAPHIC STRUCTURE

5.1. TEXT STRUCTURE


READING PASSAGE

Greek hoplite

The ancient warrior


READING PASSAGE

Greek hoplite – The ancient warrior


READING PASSAGE

Greek hoplite – The ancient warrior

Jonassen (1985, 187) notes that text structure should be clear to readers, as it can give clues about the location of information in the text. Hartley and Burnhill (1976, 100) also argue that a clear structure of text is important, as readers cannot focus on the content if at the same time they have to sort out the arrangement of the material (see also Hartley, 1980a, 1980b, 1994, 2004; and Hartley and Burnhill, 1977b). With this view as a basis, some experimental comparisons have been conducted to assess legibility of original versus revised layouts, using speed of reading and accuracy as measures. Hartley and Burnhill (1976), for example, revised and compared a printed document circulated by the British Psychological Society (BPS) with the original version. The revision consisted of manipulating a combination of typographic features, mainly the rational use of vertical (additional space between line and sections) and horizontal space (wider margins and inclusion

of some marginal headings) to clarify the hierarchical structure of the document. Participants were asked to find and circle information in one or other of the two documents. The results demonstrated that participants with the original document took longer to find the main items on the page, and a considerable percentage (50 per cent) did not find any item at all. Hartley and Burnhill's (1976) concluding comment was that function and form must work in parallel, and if writers, editors, and printers think more about the spatial arrangement of text, then the way the content is logically structured will be improved.

Two other studies (Lonsdale *et al*, 2006 and Lonsdale, 2007), already mentioned in the previous section, tested the effect of text layout on performance in the particular context of examination-type situations. The three layouts tested were chosen from existing examinations and were intended to represent three levels of legibility: layout 1 was intended to be more legible than the other two; layout 2 was intended to have medium legibility, and layout 3 was intended to be the least legible of the three. Results showed that layout 1, the one conforming to legibility guidelines (serif type for the text, sans serif type for the headings, type size of 10.5 points, interlinear space of 14 points, line length of 70 characters, text left aligned, single column, wide margins and paragraphs distinguished by one line space with no indent) resulted in a shorter task time, better accuracy, and more correct answers per second. This layout was also perceived as making it easier to locate answers.

Preferences for different typographic layouts have been further examined. Hartley and Trueman (1981) developed an experimental comparison to see the contributions that changes in layout could

TABLE 11.

Text structure

Research	Practice
• The rational use of horizontal and vertical space clarifies the hierarchical structure of the document. Readers favour these structures. [Hartley and Burnhill, 1976; Hartley and Trueman, 1981]	• Text structure should be clear and give clues about the location of information in the text. [Jonassen,1985; Hartley and Burnhill, 1976; Hartley, 1980a, 1980b, 1994 and 2004; Hartley and Burnhill, 1977b]
• Layouts conforming to legibility guidelines (serif type for the text, sans serif type for the headings, type size between 10- and 11-points, interlinear space of 14 points, line length of 70 characters, left aligned text, single column, wide margins), result in better performace and are perceived as easier to read. [Lonsdale *et al*, 2006; Lonsdale, 2007]	

make to the effectiveness of a particular text. A large number of students were asked for their preferences for text versions that varied in terms of their layout (features such as typeface, space, and configuration). Results showed a significantly greater preference for the layout in which the typographic features had been manipulated in order to increase the effectiveness of a particular text.

In all these experiments, great importance was given to the manipulation of space as a simple way to help readers see clearly the structure of the printed information when looking at the whole page.

6. SUMMARY AND RATING OF STUDIES

All of the studies mentioned in this paper are listed in Table 12 to give further information on the different approaches followed by each researcher, as well as the results obtained. The studies have been rated taking into account sensitivity and detail, i.e. whether

_ more than one measure was used,
_ there was an adequate check of accuracy when testing only reading speed,
_ there was a sufficient number of participants,
_ the reading materials tested were real-life materials, as opposed to unrealistic simulations,
_ the reading materials had the same level of difficulty,
_ an example/illustration of the reading materials was presented,
_ the reading task tested was a task performed in real-life reading situations,
_ the reading materials were long enough to produce reliable results,
_ the x-height was considered when testing different fonts,
_ different typographic variables were considered in relation to each other.

After reviewing the literature, it seems that speed of reading continuous text is one of the most satisfactory methods available for investigating typographic legibility and, therefore, the most widely used. Preferences are not as sensitive as speed of reading and users' judgements do not always agree with their performance. For these reasons, studies testing only preferences do not score high on the table. It should be also noted that secondary sources (indicated with SS on the table) are not rated because there is not sufficient information to make a fair judgment.

TABLE 12.

	RESEARCHERS	MEASURE	SUBJECTS	MATERIAL	FINDING	RATING
Typeface	Pyke (1926)	Reading speed Accuracy Preferences	–	48 lines of text per page	NS	SS
	Paterson and Tinker (1932)	Reading speed w/ accuracy check	900 (10gp X 90)	30 paragraphs of 30 words each	NS	***
	Burt (1959)	Reading speed Accuracy Preferences	–	One page long passage	NS	SS
	Tinker (1963a)	Preferences	210	–	S	SS
Serif vs sans serif	Poulton (1965)	Reading speed w/ accuracy check	375 (6 groups)	450 words long passages	NS	****
	Moriarty and Scheiner (1984)	Reading speed	260	Sales brochure	NS	***
	Schriver (1997)	Preferences	67	Documents typically used	NS	***
Italic	Tinker and Paterson (1928)	Reading speed w/ accuracy check	320 (4gp X 80)	30 paragraphs of 30 words each	S	***
	Paterson and Tinker (1940; described in Tinker 1963a)	Preferences	224	–	S	SS
	Tinker (1955)	Reading speed w/ accuracy check	192 (6gp X 32)	450 items of 30 words each	S	***
Bold	Luckiesh and Moss (1940)	Reading speed Rate of blinking	40	Continuous text	NS NS	***
	Tinker and Paterson (1942)	Reading speed w/ accuracy check Preferences	100 224	5 paragraphs of 30 words each	NS S	***
All-capitals vs lowercase	Tinker and Paterson (1928)	Reading speed w/ accuracy check	320 (4gp X 80)	30 paragraphs of 30 words each	S	***
	Tinker and Paterson (1942)	Reading speed w/ accuracy check Preferences	320 224	5 paragraphs of 30 words each	S S	***
	Tinker (1955)	Reading speed w/ accuracy check	254 (2gp X 127)	450 items of 30 words each	S	***
	Poulton (1967)	Searching speed w/ accuracy check	264	Newspaper (2 sheets)	S	*****
Type size	Paterson and Tinker (1929)	Reading speed w/ accuracy check	320 (4gp X 80)	30 sentences of 30 words each	S	**
	Tinker (1963a)	Preferences	224	–	S	SS
	Poulton (1972)	Searching speed w/ accuracy check	262	List of food ingredients	S	****

	RESEARCHERS	MEASURE	SUBJECTS	MATERIAL	FINDING	RATING
Colour	Tinker and Paterson (1931)	Reading speed w/ accuracy check	850 (10gp X 85)	30 paragraphs of 30 words each	S	***
	Luckiesh and Moss (1938, described in Tinker 1963a)	Reading Speed Rate of blinking Preferences	20	Continuous text	NS S	SS
	Michael and Jones (1955)	Accuracy	688 (4 groups)	Examinations	NS	***
	Tinker (1963a)	Preferences	210	30 paragraphs of 30 words each	S	SS
Interletter/ interword spacing	Spencer and Shaw (1971)	Reading speed Accuracy Searching speed	100 (5 groups)	500 words long texts	NS	*****
Alignment	Zachrisson (1965)	Reading speed (eye-movements)	48	20 lines of text	NS	**
	Fabrizio et al (1967)	Accuracy speed and level Reading speed (eye-movements)	216 18	Davis Reading Test = 4 test forms with 80 items each	NS	***
	Becker et al (1970)	Preferences	80	6 pages long text	NS	**
	Gregory & Poulton (1970)	Reading speed Accuracy	72	450 words passages	NS	*****
	Hartley and Burnhill (1971)	Reading speed Accuracy Preferences	49	2500 words long passages	NS	*****
	Hartley and Mills (1973)	Reading speed Accuracy Preferences	156 (2 groups) 61	700 words long passages	NS NS	*****
	Wiggins (1977)	Reading speed w/ accuracy check	324	30 paragraphs of 30 words each	NS	***
Line length	Wiggins (1977)	Reading speed w/ accuracy check	300	30 paragraphs of 30 words each	S	***
Interlinear space Type size Line length	Paterson and Tinker (1932 to 1949; described in Tinker 1963a)	Reading speed w/ accuracy check	11420	30 paragraphs of 30 words each	S	SS
	Tinker (1963b)	Reading speed w/ accuracy check Preferences	820 (10gp X 82) 180	30 paragraphs of 30 words each	S S	****
Paragraphs	Paterson and Tinker (1940; described in Tinker 1963a)	Reading speed w/ accuracy check	180	6 paragraphs with 15 words each	S	SS
	Hartley et al (1978)	Scanning speed w/ accuracy check	500 (8 groups)	4 pages long text	S	****
	Schriver (1997)	Preferences	18	2 page spreads	S	**

TABLE 12. *CONTINUED*

	RESEARCHERS	MEASURE	SUBJECTS	MATERIAL	FINDING	RATING
Margins	Paterson and Tinker (1940; described in Tinker 1963a)	Reading speed w/ accuracy check	190	30 paragraphs of 30 words each	NS	SS
Headings	Poulton (1967)	Searching speed w/ accuracy check	264	Newspaper (2 sheets)	S	*****
	Hartley and Trueman (1983)	Recall + Search + Retrieval (all w/ accuracy check)	1270 (9 groups)	3 1/2 pages long passages	NS	****
	Williams and Spyridakis (1992)	Discriminability Preferences	30	16 cards with meaningless text	S S	****
Columns	Paterson and Tinker (1940; described in Tinker 1963a)	Preferences	241	Article	S	SS
	Poulton (1959)	Reading speed w/ accuracy check	275	2 passages of 1,150 words	S	****
	Foster (1970)	Reading speed w/ accuracy check	40	One page article	S	***
	Hartley et al (1978)	Scanning speed w/ accuracy check	500 (8 groups)	4 pages long text	S	****
	Wendt (1979)	Reading speed Achievement Preferences	600 (4gp X 150)	2 page spread – textbook	NS –	*****
	Lonsdale (2006)	Reading speed Accuracy Efficiency Preferences	30	Passages of 800 words	S S	*****
	Lonsdale (2007)	Reading speed Accuracy Efficiency Preferences	90 (3gp X 30)	Passages of 800 words	S S	*****
Text structure	Hartley and Burnhill (1976)	Reading speed w/ accuracy check	20	Pamphlet pages of 300 words	S	****
	Hartley and Trueman (1981)	Preferences	315 (5 studies)	Pages of instructional text	S	***
	Lonsdale (2006)	Reading speed Accuracy Efficiency Preferences	30	Passages of 800 words	S S	*****
	Lonsdale (2007)	Reading speed Accuracy Efficiency Preferences	90 (3gp X 30)	Passages of 800 words	S S	*****

7. CONCLUSION

This literature review started by discussing evidence on how each typographic feature may affect legibility, i.e. the speed and accuracy of reading text. Legibility can be affected by the way features are treated that reside in the characters themselves, the horizontal and vertical space between characters or sets of characters, and the configuration of the text. However, it was clear throughout this individual analysis that, for good legibility, the various typographic features should be selected in relation to each other (as highlighted before by, for example, Lupton, 2004; Lonsdale *et al*, 2006; Lonsdale, 2007). Each typographic choice affects the other. For example, it does not seem sufficient to have text set in a moderate line length if at the same time a small type size with little or no interlinear space are used and paragraphs are not sufficiently distinguished. Therefore, the various features that define a typographic layout should be combined and manipulated as a group to make the layout legible.

Equally important is the fact that the present literature review took two fundamental and distinct approaches into account, i.e. legibility research and typographic practice. Although legibility research and typographic practice do not always reach the same conclusions, both contribute to the study of the typographic features of text. Typographic practice can usefully inform legibility research on which material is relevant to test, whilst legibility research can give us clear information regarding readers' performance, tolerance, and preferences.

To give a concrete example, the mutual relationship between research and practice is of most importance in those particular cases where 1) the reader has no power to decline reading a text that he/she does not find legible and 2) reading a text has a direct link on performance and achievement. This is certainly the case in examinations (as supported by Lonsdale *et al*, 2006 and Lonsdale's, 2007 studies – Section 5) which are used extensively every academic year and for every subject field. But, interestingly enough, it is also the case for essays that are submitted by the students for assessment. This is supported by Hartley's *et al*' (2006) study conducted to test the effects of typographic variables on essay grades. The results showed that essays using a combination of popular and more legible typographic features gained significantly higher marks than those using other combinations.

Just in these two particular cases, the combined effort between research and practice would benefit teaching and learning by designing well informed solutions, as well as making available clear guidance on how typographic features of text can be used to minimise unwanted effects on performance and consequently on students' grades.

This is true for examinations and essays but would also be true for many other graphic materials similar to examinations and essays that are used everyday to teach, learn, study (e.g. classroom material,

textbooks, virtual learning environments), to research (e.g. journals, primary sources, academic books), to write about one's work (e.g. dissertations, projects, reports, presentation material), to read for general information (e.g. newspapers, magazines, websites, apps), to read for pleasure (e.g. magazines, books), to advertise (e.g. direct mail, brochures), and so on.

This review is therefore valuable in providing guidance on the design and preparation of typographic materials. It will help designers, researchers, scholars, as well as students and anyone using typography to make informed and educated typographic choices. If the aim is to communicate objectively and to facilitate ease of reading, then typographic legibility is the answer.

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