Typographic features of text and their contribution to the legibility of academic reading materials: An empirical study

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ABSTRACT

An experimental study provided evidence that text layout affects performance when reading text to search for specific information under time pressure in an examination-type situation. The present paper reports a second experimental study conducted to ascertain whether this effect extends to similar academic reading materials and situations that, contrary to examinations, are performed under no time pressure. Three layouts were used for comparison, which replicated real-life examination materials and represented three distinct levels of legibility. The results revealed that text layout affects performance under conditions of search reading even when time pressure is absent. Moreover, participants performed better with the layout conforming to legibility guidelines and considered this layout to be the easiest to use and the most attractive. In order to understand these findings, an attempt is made to specify a theoretical model of reading in academic-type situations. The model identifies and analyses the stages of the reading process that might be affected by typographic layout and adopts the hypothesis that such effect takes place at the perceptual level of reading. The outcomes from this study will prove useful to those involved in the development of written materials used in academia such as textbooks, journal articles, magazines, and tests.

1. INTRODUCTION

In an earlier paper Lonsdale et al. (2006) reported an experimental study testing the effect of text layout on performance in the particular context of examination-type situations. The rationale behind the study was that if the layout of text affects performance, then the construct validity of the examination is put at risk since legibility is confounded with candidates' reading skills.

Lonsdale et al. (2006) showed that text layouts different in legibility lead to variation in the speed and accuracy with which participants performed tasks that involved reading a text and answering questions on it under time pressure. Of the three layouts tested, the layout conforming to legibility guidelines 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.

The texts and layouts tested by Lonsdale et al. (2006) were the ones used in the English language reading examination IELTS (International English Language Testing System). In order to match real academic reading activities, IELTS uses texts based on authentic academic sources such as journals, textbooks, newspapers, magazines, etc., and seeks to replicate the original typographic layout of the source material (Lonsdale et al., 2006; Moore et al., 2011; Weir et al., 2012).

Although in normal academic life students may find themselves in situations where they have to read under some time pressure if they have to meet deadlines, they do not feel the stress of having to read as quickly and accurately as possible as when they have to complete an examination.

With this in mind, the experimental study reported in this paper sought to expand Lonsdale et al.'s (2006) research by answering the following questions:

Is the effect of typographic layout on performance limited to academic situations where students read to search for specific information under time pressure, and therefore applies only to assessment materials?

Alternatively, does the effect of typographic layout on performance extend to other academic situations where students also read to search for information but do so under no time pressure (a normal reading speed, which applies to other academic materials such as textbooks, journals, magazines, etc.)?

Additionally, in order to provide a theoretical basis for the outcomes of the study, an attempt is made to specify a general model of the process for search reading in academic situations.

2. BACKGROUND INFORMATION AND RATIONALE

Literature on the legibility of printed text informed the selection of the text layouts tested by Lonsdale et al. (2006). Such literature includes both experimental findings as well as the perspective of typographic practitioners and authors. Moreover, it addresses how each individual typographic feature may affect legibility (interpreted as the speed and accuracy of reading a text).

Several authors (e.g. Hartley and Burnhill, 1976; Lund, 1999; Lonsdale et al., 2006; Lonsdale, 2014) argue, however, that it is important to consider, combine, and manipulate all the typographic features as a group in order to achieve good legibility. This is because in real documents several features interact simultaneously in the same layout.

However, very few studies have actually tested the effects of combined typographic features on the speed and accuracy of reading (e.g. Hartley and Burnhill, 1976; Hartley and Trueman, 1981; Lonsdale et al., 2006; Lonsdale, 2007). A series of experiments conducted by Paterson and Tinker (described by Tinker, 1963a, 94-102 and Tinker, 1963b) have at least considered the relationship between interlinear space, type size, and line length. This relationship is extremely important because an inadequate ratio between these features will result in an unbalanced typographic layout. For example, when it is necessary to use long line lengths, legibility can be maintained if the interlinear space is increased (Schriver, 1997, 263).

The findings that emerged from the various studies to test the effects of single features on performance have nonetheless proved quite insightful. When combined with the opinions of practitioners and authors, the findings provide useful information on the legibility of text. Table 1 lists the main outcomes from research and practice with direct relevance for the study reported here (for a more in-depth literature review see Lonsdale, 2014).

In terms of time pressure, it is not clear from the little research available whether text layout affects performance when searching for specific information in a text if no time pressure is imposed. For example, Hartley and Burnhill (1976) found significant differences in time and accuracy when students were asked to locate information with different text layouts under no time pressure. In contrast, Burnhill et al. (1975) did not find significant differences in time and in the number of errors made when two text layouts were compared under no time pressure.

Concerning reading strategies, the ones tested in IELTS reading examinations reflect the main reading strategies used in an academic context. Scanning, skimming, and careful reading are listed as the three main reading activities used by students during their academic life (Hughes, 1989; Weir, 1993; Enright et al., 2000). Scanning and skimming activities, in particular, are used in a high percentage of the reading practiced by

Typographic Features of Text

Typeface

Research

• No significant differences in the speed of reading and comprehension between serif and sans serif type No preference for either serif or sans serif type.

• Italic retards reading.

• Medium type is considered more legible and more pleasing than bold.

• Lowercase is read more rapidly than all-capitals and reders prefer lowercase.

Tinker and Paterson 1928, Paterson and Tinker 1932 and 1940 (described in Tinker, 1963a), Tinker and Paterson 1942, Tinker 1955, Poulton 1965 and 1967, Moriarty and Scheiner 1984, Schriver 1997.

Practice

• Serif should be used for the body of the text and continuous prose, and sans serif should be used for instructional manuals, headings, captions, etc.

• Typefaces with unusual features should be avoided, as well as typefaces that call attention to themselves rather than the text, that have not been tested objectively and that may lose their identity when printed or copied.

• Italic and bold can be used to distinguish pieces of information. Bold can also be used as a technique to thicken the line of characters that will be printed on a black or coloured background.

• Capitals should be reserved for the initial letter of nouns, sentences and headings.

Simon 1945, Hartley and Burnhill 1977a and 1977b, Rehe 1979, McLean 1980, Glynn et al. 1985, Black 1990, Bringhurst 1992, Luna 1992, Gilreath 1993, Hartley 1994 and 2004, Simmonds and Reynolds 1994, Schriver 1997, Wijnholds 1997, Carter et al. 2015.

Type size
Line length
Interlinear space

Research

• Moderate arrangements are read more quickly than text in relatively long or short lines, smaller type sizes and with little or no interlinear space.

• For optimal sizes of type (9-, 10-, 11-, and 12-point), an interlinear space of one to four points can be added in order to increase legibility. This depends, however, on the typeface used.

Tinker 1963a and 1963b.

Practice

• An arrangement 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 is read more quickly than text in relatively long or short lines, smaller type sizes and with tight interlinear space.

Simon 1945, Tschichold 1967, Hartley and Burnhill 1977a, Spencer 1969, Black 1990, Bringhurst 1992, Schriver 1997, Winjholds 1997, Carter et al. 2015.

Columns
Alignment
Margins

Research

• With a medium line length no difference in performance was found between fully justified and left aligned text. No difference in preferences either.

• When locating target words the double column layout seems to have an advantage. For scientific journals and reading examinations, the single column layout is read quicker.

Paterson and Tinker 1940 (described in Tinker, 1963a), Poulton 1959, Zachrisson 1965, Fabrizio et al. 1967, Becker et al. 1970, Foster 1970, Gregory and Poulton 1970, Wiggins 1977, Hartley et al. 1978, Lonsdale et al. 2006, Lonsdale 2007.

Practice

• Fully justified text with rivers and excessive hyphenation should be avoided because it disrupts reading.

• A double column layout with a medium line length or a single column layout with wide margins (to avoid long line lengths), are the best solutions for straightforward prose.

• If headings or non-textual elements that could occupy the space of two columns need to be integrated, then it is advisable to use a single column layout.

• As column/line length measure increases, the interlinear space needs to increase as well.

• Margins are very functional and should be considered. Margins allow to make notes, punch and clip copies for filing without damaging the text, and hold the book without covering the text.

Simon 1945, Tschichold 1967, Spencer 1969, Hartley and Burnhill 1977a, Rehe 1979, McLean 1980, Southall 1984, Bringhurst 1992, Simmonds and Reynolds 1994, Schriver 1997, Hartley 2004, Carter et al. 2015..

Headings
Paragraphs

Research

• The best cue to distinguish the hierarchy of headings is to use relative differences in size. Readers seem to agree.

• Paragraphs denoted by one line space are significantly superior. Readers prefer paragraphs denoted by indentation and additional space.

Hartley et al. 1978, Hartley and Trueman 1983, Williams and Spyridakis 1992, Schriver 1997.

Practice

• If serif is used for the main text, the headings should be set in semi-bold or bold (either serif or sans serif). But, if sans serif is used for the main text, then the heading should be set only in sans serif.

• Headings should be aligned left and the first paragraph in an article/chapter should have no indent.

Simon 1945, Tschichold 1967, Simmonds and Reynolds 1994, Carter et al. 2015.

students (Enright et al., 2000, 4). These strategies are intrinsic to the search reading process of looking for specific information in a text.

As described and exemplified by Weir (1993, 70), in academic life scanning for specific information is used when attempting to locate specific parts of a text or specific information (table of contents, headings, an index, key words, words in dictionaries, checking spelling, a quotation, a date, etc.). Skimming text quickly to obtain the gist is used when attempting to anticipate what the text might contain; to determine what is most relevant to read first and/or more carefully; and to review what has been already read, etc.

This is further reinforced by Weir et al.'s (2012) survey conducted for a study on the relationship between the academic reading tasks tested in IELTS and the reading experiences of students in their first year of study at a British university. Weir et al. (2012) concluded that expeditious strategies (scanning and skimming) are equally important for academic study as careful reading.

Linking typographic layout with students' reading strategies, Lonsdale et al. (2006) suggested that when searching for specific answers in a text under time pressure, participants use visual features (i.e. key words). Lonsdale et al. (2006) therefore suggested that, based on Masson's (1982 and 1985) theory of cognitive processes in skimming stories, the effect of text layout on performance may occur at the perceptual level of reading. More specifically, the treatment of typographic layout might facilitate or impede the speed and accuracy with which candidates move their eyes over the text in order to find key words. The key words are used as perceptual guides to locate the relevant information that answers the questions.

Therefore, it seems possible that even if no time pressure is imposed, participants might still use the same search reading strategy, i.e. use key words to complete the reading task as efficiently as possible (maximizing accuracy and minimizing time). In other words, it seems unlikely that participants will read the whole text each time they have to find specific information. Instead, they will probably scan/skim the text using key words. In the same way, when participants have to refer back to the text to double check whether the information they have found is accurate, they will probably scan to find that information again, rather than re-read an entire section.

Thus, and assuming that participants use a search reading strategy (involving scanning and skimming), the search reading strategy alone might be sufficient to create an effect of text layout on performance at the perceptual level of reading. Consequently, a layout conforming to legibility guidelines would result in better performance.

The study conducted to test this hypothesis is reported next. The results are then discussed and compared with the results of the study conducted by Lonsdale et al. (2006), where time pressure was imposed.

3. EXPERIMENTAL COMPARISON

3.1. METHOD

The study replicated Lonsdale et al.'s (2006) study in all respects except that no time pressure was imposed. The legibility of three text layouts was therefore compared to ascertain whether some layouts result in better performance than others when reading at a normal reading rate.

3.1.1. Participants

A similar sample to the one in Lonsdale et al.'s (2006) study was tested. Thirty undergraduate and postgraduate students at the University of Reading volunteered as participants. Their ages ranged from 21 to 44 with an average of 29.3 years. There were twenty female and ten male participants. Ten were native English speakers and twenty were non-native English speakers. Five were undergraduate and twenty-five were postgraduate. Nineteen were normal eye-sighted and eleven used vision correction (glasses or contact lenses).

3.1.2. Materials

The same material used in Lonsdale et al.'s (2006) study was tested in the study reported here. Three text layouts were used, which according to the literature differ in terms of their legibility (in a combination of typographic features, not just one individual feature).

- Text layout T1 – conforming to legibility guidelines: serif type for the main 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; paragraphs distinguished by one line space with no indent (Figure 1)
- Text layout T2 – using medium legibility: serif type for the main text and headings; type size of 10.5 points; interlinear space of 11 points; line length of 42 characters; text fully justified; double column; average margins; paragraphs with an indent of 35mm (Figure 2)
- Text layout T3 – disregarding legibility guidelines: serif type for the main text and the headings; type size of 9.5 points; interlinear space of 8.5 points; line length of 115 characters; text fully justified; single column; wide narrow margins; paragraphs distinguished by an indent of 15mm (Figure 3)

The three passages were all approximately 800 words long and addressed matters of general interest suitable for postgraduate and undergraduate students. As for the three question and answer sheets, they contained matching tasks to test the speed and accuracy of locating particular information in the corresponding passage.

This material replicated the layouts, passages, and the matching tasks used in the reading module of the IELTS examination. As already pointed out, IELTS aims to reflect real-academic reading materials. (Permission was obtained to use these texts and questions.)
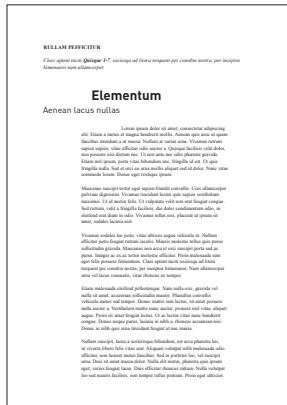
3.1.3. Measures and Experimental Design

A within subject design was used whereby each participant used each text layout to ascertain the effect that different layouts can have on the same participant. Text layout was therefore the within subject factor. A within subject design also replicated the context of reading examinations where the same candidate read different passages, each passage with a different layout, and answered questions on them.

Since each participant had to use all three layouts, each layout had to be combined with a different passage. A Greco-Latin square design was used to balance the combination of each passage with each text layout and to control the order of presentation in order to eliminate sequence effects (i.e. the same layout was not used always in first or last place).

The effects of text layout on performance were measured according to task time (time taken to read a text passage and answer questions on it), task accuracy (number of correct answers), and task efficiency (number of correct answers per second).

A one-way analysis of variance (ANOVA) looked at each of the three measures separately and tested for statistical significant differences between the means for Layout T1, T2 and T3. With an analysis of variance, a significant result indicated that at least two layouts differed from each other, but it did not identify which layouts differed.

Therefore, *Post hoc* comparisons using the Newman-Keuls test followed the ANOVA to compare all of the layouts with each other in order to identify exactly where differences lay.

A questionnaire was also used, which asked participants to rank the text layouts according to ease of locating the answers and attractiveness. Kendall's Coefficient of Concordance was used to examine the extent of agreement between participants.

3.1.4. Tasks

In the current experiment participants were asked to complete the matching tasks as accurately as possible and at their normal reading speed (not as quickly as possible). Thus the individual sessions took between 30 and 80 minutes.

Participants were asked, as in Lonsdale at al.'s (2006) study, to judge the ease of finding the answers using the three layouts and the attractiveness of the layouts. With these types of questions it is possible to determine whether judgments are in agreement with performance.

3.2. RESULTS

3.2.1. Task Time

The one-way repeated measures ANOVA, with text layout as a within subject factor, showed a significant difference between text layouts (F (2,58)=5.47, p<0.01). Moreover, post hoc comparisons using the Newman-Keuls test demonstrated the significant superiority of layout T1 in relation to either layout T2 (p<0.05) or layout T3 (p<0.01). Layouts T2 and T3 did not differ significantly from each other.

Therefore, this provides evidence that reading and answering was faster when the layout intended to be most legible was used. Figure 4 shows the mean task times in seconds and standard errors of the means, which were as follows: layout T1 (Mean=572.3; SE=34.4); layout T2 (Mean=640.6; SE=39); layout T3 (Mean=677.8; SE=57.2).
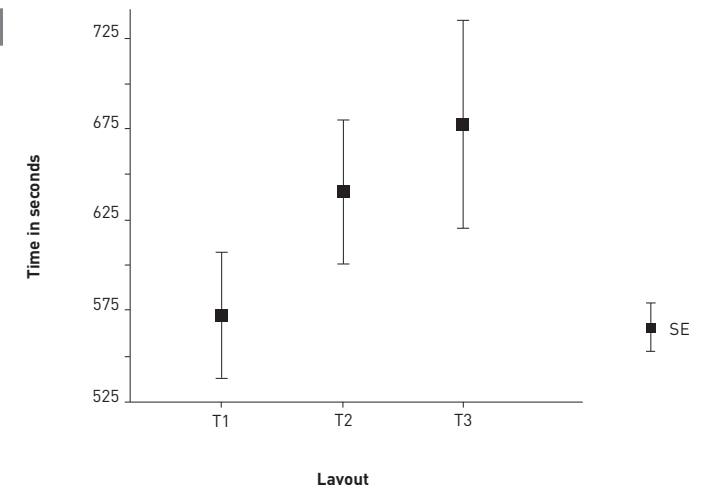
3.2.2. Task Accuracy

The one-way repeated measures ANOVA showed that there was no statistically significant difference in the number of correct answers among the three text layouts. The data for the means and respective standard error are given in Figure 5 and were as follows: layout T1 (Mean=5.93; SE=0.20); layout T2 (Mean=5.4; SE=0.31); layout T3 (Mean=5.47; SE=0.26).

3.2.3. Task Efficiency

The one-way repeated measures ANOVA showed that task efficiency scores were significantly different among text layouts (F (2,58)=6.59, $p<0.01$).

FIGURE 5. Mean task accuracy measured by the number of correct answers, and standard error of the mean for the three layouts.
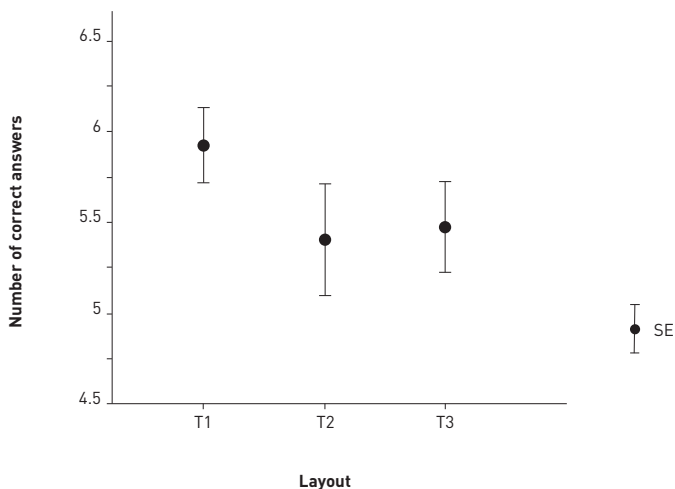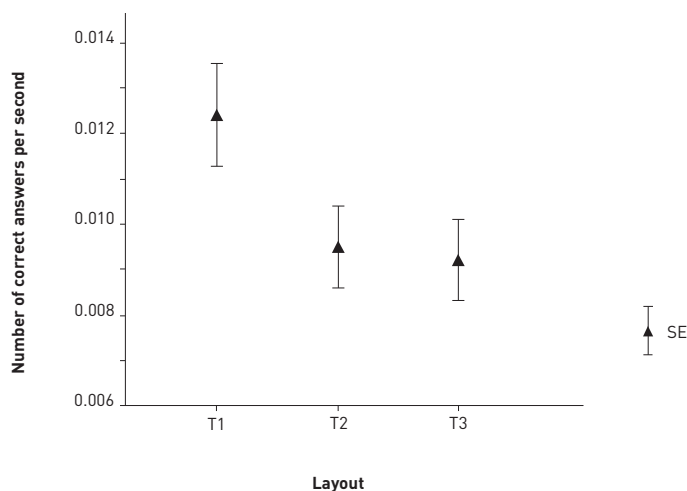
FIGURE 6. Mean task efficiency measured by the number of correct answers per second, and standard error of the mean for the three layouts.

Furthermore, with layout T1 there were significantly more correct answers per second than with layouts T2 ($p<0.05$) or T3 ($p<0.01$). No differences were found between T2 and T3. The highest number of correct answers per second was found when the layout intended to be most legible was used – layout T1. The mean scores and standard error data for task efficiency appear in Figure 6 and are as follows: layout T1 (Mean=0.0124; SE=0.0012); layout T2 (Mean=0.0095; SE=0.0009); layout T3 (Mean=0.0092; SE=0.0009).

3.2.4. Judgments of Ease of Use and Attractiveness

Kendall's Coefficient of Concordance showed that participants agreed as to which text layout made it easiest to locate the answers (W=0.35,χ^2=21.1, $p<0.001$) and which was the most attractive (W=0.60,χ^2=36.4, $p<0.001$). Layout T1 was slightly preferred over layout T2 in terms of ease of locating the answers. Layouts T1 and T2 were both preferred over layout T3 in relation to both perceived ease of locating the answers and attractiveness. The data are shown in Table 2 (a ranking of one corresponds to the easiest to use and most attractive layouts).

According to participants' comments, layout T1 was considered to make it easier to locate the answers mainly because of good line length, adequate interlinear space, and distinction between paragraphs. In general, layout T1 was identified as having the clearest structure, making it easiest to locate information. Concerning attractiveness, participants were in agreement that the generous space of layout T1 made reading relaxing and easy, and the 'journal look' of layout T2 was familiar to them. Other comments included the fact that in layout T1 there was enough space to take notes, and the question and answer sheet was very clear.

Layout	Ease of locating answers			Attractiveness		
	rankings					
	1	2	3	1	2	3
T1	17	10	3	16	12	2
T2	11	14	5	14	15	1
T3	2	6	22	0	3	27

T1 – text layout intended to be most legible
T2 – text layout intended to be of medium legibility
T3 – text layout intended to be least legible

3.2.5. Participants Groups

Although the sample used in this study was selected to represent the typical mix of students who attend higher education, it may be of interest for future research to see whether the pattern of performance is the same across different groups: native and non-native English speakers, male and female, postgraduate and undergraduate, and normal eye-sighted and those using vision correction (glasses or contact lenses).

Table 3 shows the average time, number of correct answers, number of correct answers per second, and preferences obtained per group and per layout. A comparison between the means revealed that the layout conforming to legibility guidelines (T1) always lead to better performance regardless of the participants' group. Moreover, even those groups that understandably read faster (native English speakers, postgraduate, and female participants) perform better when reading a more legible layout.

TABLE 3.
Performance obtained in Experiment 2, per group and per layout.

| | Groups | | | | | | | | |
	All	Native	Non–native	Male	Female	Undergrad	Postgrad	NES*	VC**
N	30	10	20	10	20	5	25	19	11
Experiment 2									
Time									
• T1	572.3	468.6	624.2	622.5	547.2	627	561.4	586.1	548.5
• T2	640.6	514	703.9	683.1	619.3	754.4	617.2	650.8	622.9
• T3	677.8	523.8	754.7	698.7	667.3	897.6	633.8	687.9	660.2
Accuracy									
• T1	5.93	6.3	5.75	5.8	6	6.2	5.9	5.9	6
• T2	5.4	6.2	5	5.1	5.55	6.2	5.3	5	5.55
• T3	5.47	6.1	5.15	4.4	6	5.6	5.3	5.6	6
Efficiency									
• T1	0.0124	0.0145	0.0113	0.0126	0.0122	0.0116	0.0126	0.0129	0.0115
• T2	0.0095	0.0133	0.0075	0.0079	0.0102	0.0093	0.0095	0.0095	0.0094
• T3	0.0092	0.0132	0.0072	0.0067	0.0104	0.0081	0.0094	0.0090	0.0097
Ease of use									
• T1	17	6	11	7	10	2	15	11	6
• T2	10	4	7	2	9	2	8	7	3
• T3	3	0	2	1	1	1	2	1	2
Attractiveness									
• T1	16	5	11	5	11	3	13	10	6
• T2	12	5	9	5	9	2	10	9	3
• T3	2	0	0	0	0	0	2	0	2

Note: within the body of the table, the numbers for 'Ease of use' and 'Attractiveness' refer to the number of participants who ranked the layouts as first, i.e. as the easiest or as the most attractive.
* Normal eye-sighted
** Using vision correction (glasses or contact lenses)

3.3. CONCLUDING COMMENTS

The hypothesis underlying this experiment was that typographic layout would affect performance when participants were asked to read a text and answer questions on it at their normal reading rate.

The findings revealed that text layout affected performance when there was no time pressure, with this particular material and this reading task. It was evident that with layout T1, the one conforming to legibility guidelines, participants performed best. Moreover, layout T1 was also regarded as making it easiest to locate the answers, as well as being attractive.

However, contrary to the results found in the experiment conducted by Lonsdale et al. (2006), in the present experiment there were no differences in task accuracy among the layouts. As participants were given all the time they wanted to complete the reading task, they may have focused more on the accuracy of the answers than on the time spent. This, therefore, would have resulted in differences in task time with little difference in task accuracy.

An informal observation of how participants completed the task revealed two different general approaches:

— Participants read the questions first and then went straight to the text to scan/skim for the answers.

— Participants read the whole text first, then the questions, and then went back to the text to scan/skim for the answers.

It is clear that, with either approach, participants used search-reading strategies to locate the specific information that answered the questions. Moreover, the frequent underlining of words in the text and questions also revealed that participants used key words to help them complete the task. This therefore reinforces Lonsdale et al.'s (2006) suggestion that the effect of text layout on performance may occur at the perceptual level of reading. In other words, text layout may help or impair readers' attempts to locate the key words in the text and identify the relevant information necessary to answer the questions more efficiently.
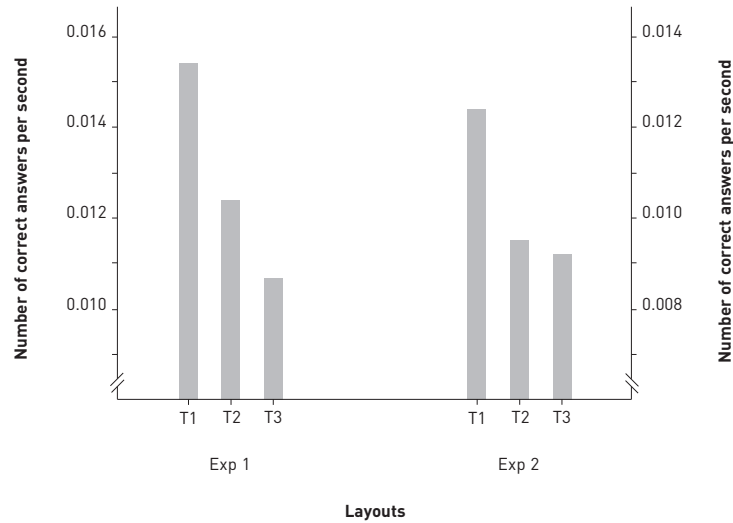
If people have to search for target information in academic-type situations where no time pressure is imposed, then the layout of the texts used can make a difference to performance.

4. COMPARISON BETWEEN THE TWO EXPERIMENTS

There is accumulating evidence from the experiment reported by Lonsdale et al. (2006) – Experiment 1 – and the experiment reported in this paper – Experiment 2 – for the superiority of layout T1, the one conforming to legibility guidelines (Figure 7).

FIGURE 7.

Comparison of the effects of
text layout on performance
across Experiments 1 and 2.

Moreover, text set according to legibility guidelines made it
easiest to locate the information in two distinct situations:

— An examination-type situation where readers had insufficient
time to carefully read a whole passage whilst at the same time
having to answer questions on it.

— A general academic situation (class activity, assignment, library
search, etc.) where readers could look for specific information in
a text at their normal and comfortable reading speed.

An additional two-way repeated measures ANOVA was
done, which combined the results of the two experiments to confirm that
there was no interaction between them, i.e. the two experiments were
independent. The ANOVA included one within subject variable (text layout)
and one between subject variable (experiment). The results were as follows
(Table 4, 5, and 6):

— In task time, there was a significant effect of text layout
(F (2,116)=10.55, $p<0.001$) and of experiment (F (1,58)=4.63,
$p<0.05$).

— In task accuracy, there was an effect of text layout (F (2,116)=4,
$p<0.025$) but no effect of experiment.

— In task efficiency, there was a significant effect of text layout
(F (2,116)=16.54, $p<0.001$) but no effect of experiment.

— There was no interaction between the two variables text layout
and experiment in task time, task accuracy, or task efficiency.

There are two points of interest to note. First there were
significant differences in time across the two experiments. Examination of
the means revealed that participants took less time in Experiment 1 (where

In addition, according to the similar comments made by
participants in the two experiments, layout T1 made it easiest to locate the
answers and was attractive mainly because of good line length, generous
interlinear space and the clear separation of paragraphs. This evidence
suggests that the effect of text layout on performance may have been
caused by these particular typographic features: line length, interlinear
space, and paragraph distinction. Further and systematic investigation
would be required to confirm this.

TABLE 4.
 Mean task time in seconds
and standard error of the
mean for the text layouts
and experiments..

TASK TIME

Layout	Exp1			Exp2			
	N	Mean	SE	N	Mean	SE	*Overall mean*
T1	30	477.4	34.3	30	572.3	34.4	524.4
T2	30	532.6	33.1	30	640.6	39	586.6
T3	30	550.9	34.3	30	677.8	57.2	614.3
Overall mean		520.3			630.2		

Exp1 – participants were asked to perform as quickly and accurately as possible

Exp 2 – participants were asked to perform as accurately as possible but at their normal reading rate

T1 – text layout intended to be most legible

T2 – text layout intended to be of medium legibility

T3 – text layout intended to be least legible

TABLE 5.
Mean task accuracy
measured by the number
of correct answers, and
standard error of the mean
for the text layouts
and experiments.

TASK ACCURACY

Layout	Exp1			Exp2			
	N	Mean	SE	N	Mean	SE	Overall mean
T1	30	5.86	0.23	30	5.93	0.20	5.89
T2	30	5.86	0.20	30	5.4	0.31	5.63
T3	30	5.1	0.25	30	5.47	0.26	5.28
Overall mean		5.61			5.6		

Exp1 – participants were asked to perform as quickly and accurately as possible
Exp 2 – participants were asked to perform as accurately as possible but at their normal reading rate
T1 – text layout intended to be most legible
T2 – text layout intended to be of medium legibility
T3 – text layout intended to be least legible

TABLE 6.
Mean task efficiency
measured by the number of
correct answers per second,
and standard error of the
mean for the text layouts
and experiments.

TASK EFFICIENCY

Layout	Exp1			Exp2			
	N	Mean	SE	N	Mean	SE	Overall mean
T1	30	0.0145	0.0013	30	0.0124	0.0012	0.0134
T2	30	0.0125	0.0010	30	0.0095	0.0009	0.0109
T3	30	0.0107	0.0011	30	0.0092	0.0009	0.0099
Overall mean		0.0125			0.0103		

Exp1 – participants were asked to perform as quickly and accurately as possible
Exp 2 – participants were asked to perform as accurately as possible but at their normal reading rate
T1 – text layout intended to be most legible
T2 – text layout intended to be of medium legibility
T3 – text layout intended to be least legible

time pressure was imposed) than in the Experiment 2 (where there was no time pressure). However, there was no significant difference in accuracy across the two experiments. This validates the method of imposing time pressure used in Experiment 1 and indicates that participants did follow the instructions to read as accurately as possible, whether under time pressure or not. Second as no interaction was found between text layout and experiment for any of the three measures, the pattern of performance across the three text layouts was not affected by time pressure. Thus given that

with no time pressure participants may focus more on the accuracy than on the time spent, the explanation above is not supported.

5. RECOMMENDATIONS

As suggested by Lonsdale et al.'s (2006) study and later by Lonsdale (2007), the general reading strategy used in examination-type situations accommodates the strategic reading process known as search reading. They also suggest that their findings could assist in the design of academic texts that students often read/use in and outside the classroom (e.g. periodicals and magazine articles, journal papers, book sections, textbooks). Such a claim is now supported by the findings emerging from the study reported in this paper.

As already mentioned, Lonsdale et al.'s (2006) and Lonsdale (2007) go even further by suggesting that two distinct aspects of selective processing of text seem to be involved in the search reading strategy: perceptual and conceptual processing of text. In sum, participants use key words to search for the specific information that answers the questions as efficiently as possible (i.e. as quickly and accurately as possible).

In order to discuss the findings from this research and as an attempt to understand more clearly the role typographic layout may have in academic reading, it seems reasonable to attempt to specify a single general model for the process of reading in academic situations.
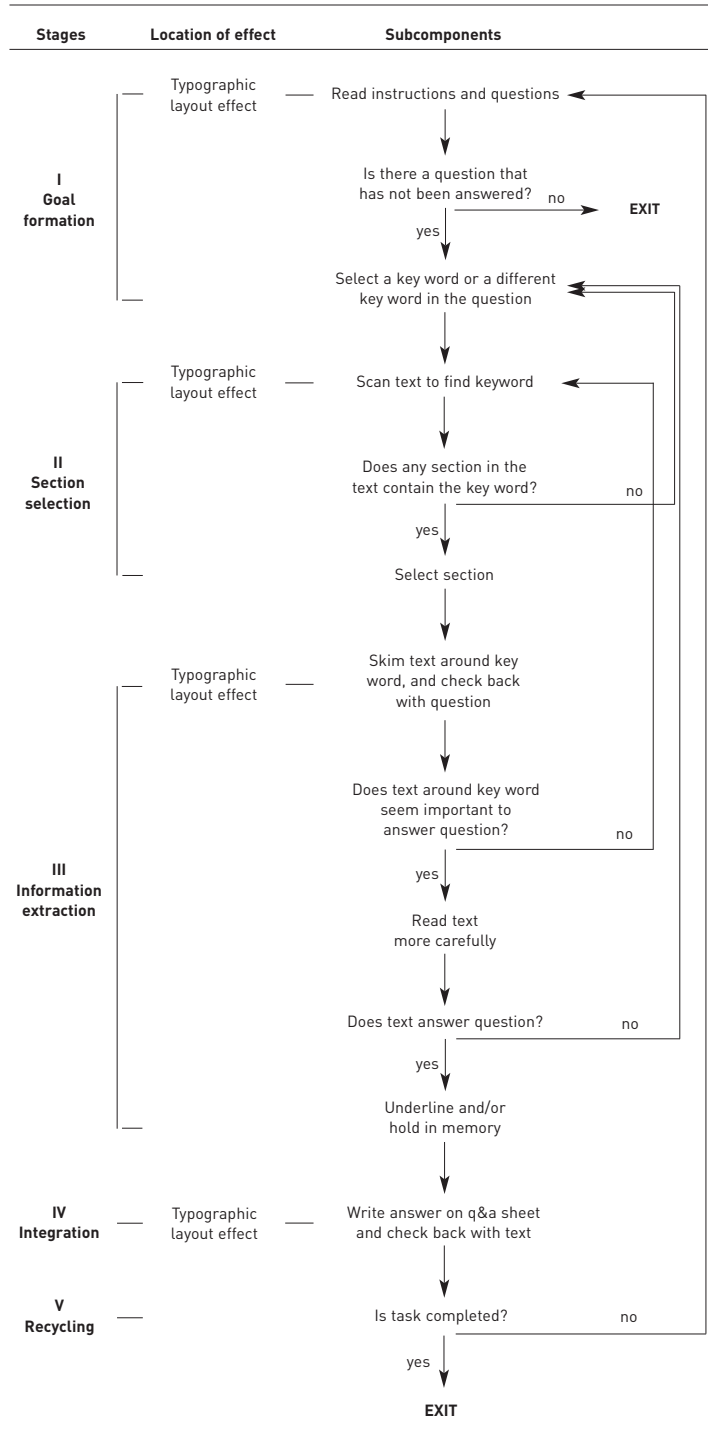
It is obvious from several descriptions of reading models (e.g. Harri-Augstein et al., 1982; Masson, 1985; Rayner and Pollatsek, 1989; Urquhart and Weir, 1998; Allen, 2003; Samuels and Kamil, 2003), that search reading, when compared to careful reading, has received little attention from reading researchers. This is true even though the wide use of search reading in professional and academic contexts is recognized (e.g. Urquhart and Weir, 1998; Guthrie and Mosenthal, 1987; Guthrie, 1988; Guthrie et al., 1991; Dreher, 1992; Enright et al., 2000; Weir et al., 2012). Consequently, even fewer search-reading models have been proposed.

Of relevance to this paper is Guthrie's (1988) process model, which accounts for performance on document searching. Guthrie's search-reading model addresses text search as a problem-solving process (as also emphasized by Symons and Specht, 1994, 268-9). That is, readers attempt to locate information that fulfills a particular goal requirement, i.e. that answers a specific question. Moreover, it involves the efficient selective search of documents as the solution to maximize accuracy and minimize time, and not other reading skills such as recalling prose material.

Guthrie's (1988) model proposes that the searcher engages in five component processes, which are adapted here to illustrate where specifically in the reading process typographic layout might have an effect on performance at the perceptual level of reading. Deconstructing the reading task into its component stages is important as it will provide

FIGURE 8.

Process model of
searching information
in academic written
materials.

Stages	Location of effect	Subcomponents

**I
Goal
formation** — Typographic layout effect — Read instructions and questions

Is there a question that
has not been answered? — no → **EXIT**

yes

Select a key word or a different
key word in the question

**II
Section
selection** — Typographic layout effect — Scan text to find keyword

Does any section in the
text contain the key word? — no

yes

Select section

**III
Information
extraction** — Typographic layout effect — Skim text around key
word, and check back
with question

Does text around key word
seem important to
answer question? — no

yes

Read text
more carefully

Does text answer question? — no

yes

Underline and/or
hold in memory

**IV
Integration** — Typographic layout effect — Write answer on q&a sheet
and check back with text

**V
Recycling** — Is task completed? — no

yes

EXIT

information on what proportion of the task will be affected by the
typographic layout (as suggested also by Dillon et al., 2004, in relation to the
quality of image presented on screen).

The model proposed in this paper is first divided into three
general areas, as illustrated in Figure 8.

— Stages, i.e. each of the component processes involved in read-
ing a text to locate information, which will fulfill a particular
goal or answer predetermined questions

— Location of effect, i.e. where in the reading process typographic
layout of the reading material might influence the way the
reading strategy is carried out and, therefore, influence readers'
performance

— Subcomponents, i.e. each of the steps readers take during the
strategic process of reading

Five stages of the strategic reading process are also proposed
(as described next), and each stage addresses the perceptual and
conceptual processing of text. It should be highlighted that the main
purpose of identifying these stages is to understand, as far as possible,
how (and not just where) the effect of typographic layout on performance
might occur: i.e. how typographic layout might decrease or increase speed
and accuracy of reading and locating information in order to answer
specific questions (in examinations, achievement tests, assignments, essays,
classroom activities, homework, quizzes, etc.).

It should be further noted that in the experiment conducted
by Lonsdale et al. (2006), as well as in the present study, the comments
made by participants suggested that the layout of the question and answer
sheet could also affect speed and accuracy of reading and answering. This
is actually supported by Lonsdale's (2007) experimental studies testing the
effect of typographic layout of question and answer sheets on performance.
It seems therefore logical that in the proposed model the effect of both text
layout and question and answer sheet layout on performance should
be considered.

Theoretical predictions for future research paths are also
suggested for each stage of the reading model to add value to research
regarding the legibility of instructional materials.

Stage I – Goal Formation

When given an assignment with a question sheet, students read the instruc-
tions and questions carefully before they read the text that might answer
those questions. This is essential to complete the task efficiently. However,
according to some authors (e.g. Hartley, 1994), the layout of questionnaires
and forms can affect the way the respondent deals with them. Some com-
mon typographic faults have been identified that may lead to difficulties in
using questionnaires and forms (Hartley, 1994, 111-2; Wright, 1981; Waller,
1984): insufficient space, inappropriate sequencing of information, oddly
positioned instructions, and instructions in small type.

This seems to be a stage at which typographic layout may affect students' performance at the perceptual level of reading. If the accuracy and the speed with which the instructions and questions are read can be affected by the legibility of the layout, then the efficient completion of the assignment can be compromised.

Space could be systematically manipulated to show the structure of the question sheet, clearly indicating the hierarchy and sequence of the information on the page. As Hartley (1994, 111) argues, systematic spacing in the text of a questionnaire or form is required to help the respondent deal with the complexity of the information.

Additionally, instructions also set the scene for the task and indicate exactly what the task is. The clear understanding of what the question is asking is therefore crucial because it will direct the students more quickly to the correct information and relevant text section. It is also common practice that students highlight key words in the question sheet because it helps to focus on what is being asked. Understanding the questions and choosing key words involves conceptual processing of text.

Stage I Future Research

Although the three text layouts tested in the study reported above differ in their typographic design, the instructions that accompany the text and questions share the same design (as shown in Figure 1, 2, 3 and 9) and are always set in italic. Research shows, however, that italic retards reading when compared to Roman lowercase text (e.g. Tinker and Paterson, 1928; Paterson and Tinker, 1940; Tinker, 1955). Future research could therefore compare, at Stage I (Goal Formation) of the reading model, the impact on student performance of reading instructions in italic versus Roman type. It seems that setting the instructions in Roman type could further improve the speed and accuracy of completing reading and academic tasks involving search reading, specially in situations involving complex and long instructions.

FIGURE 9.

Question and answer sheet using dummy text.

Quisque 1-7

Lorem ipsum dolor sit amet, consectetur adipiscing elit Etiam a metus. Magna hendrerit (A-E), Aenean quis arcu ut quam (1-7).

*Nullam at varius urna Vivamus **(A-E)** trum sa 1-7 sapien vitae efficitur.*

NB *Quisque facilisis velit dolor, non posuere nisi dictum nec non ante nec odio pharetra.*

1   Etiam nisl ipsum, porta vitae bibendum nec id est.
2   Forci eu urna mollis aliquet sed id dolor.
3   Ut quis fringilla nulla sed et.
4   Maecenas suscipit tortor eget sapien blandit.
5   Cras ullamcorper pulvinar dignissim.
6   Nunc vitae commodo lorem donec eget tristique.
7   Vivamus tincidunt lectus quis sapien vest.

ID AUCTOR FELIS	
A	Donec neque purus
B	Maecenas
C	Intergeracs
D	Nullam efficitur justo tortoram
E	Suscipit porta sed ac purus

Stage II – Section Selection

Students quickly locate the section of the text containing the relevant key words in order to identify where in the text the answer is to be found. For that, students scan the text, i.e. move their eyes over the text very quickly in order to find the specific key word. This is compatible with what Masson (1982) describes as 'perceptual selectivity', where readers use perceptual guides to locate only those parts of the text containing evidence relevant to the question (avoiding wasting time reading irrelevant text).

This, therefore, seems to be another stage at which typographic layout may influence students' performance at the perceptual level of reading. Typographic layout might affect (facilitate or impede) the speed with which students move their eyes over the text.

By making the structure of the text sufficiently clear, typographic layout should help students to quickly and easily locate the section of text they are looking for to answer the question. This claim is consistent with empirical evidence concerning text structure (e.g. Hartley and Burnhill, 1976; Hartley and Burnhill, 1981; Lonsdale et al., 2006; Lonsdale, 2007). A legible structure could be achieved, for example, manipulating the space systematically in order to distinguish clearly the several paragraphs of the text and to distinguish successive text lines from one another (as it is the case of Layout T1 shown in Figure 1).

Stage II Future Research

Taking a close look at the data of the study described in this paper, it is interesting to note that for layout T3 (less legible) the average time spent completing the examination was a lot lower when participants underlined relevant information (as shown in Figure 10). Layout T2 (medium legibility) did not benefit from the underlining (participants actually spent more time on the task when they underlined the text). As for Layout T1, once again this

FIGURE 10.

Comparison of the average time spent between participants who underlined text/key words, versus no underlining.
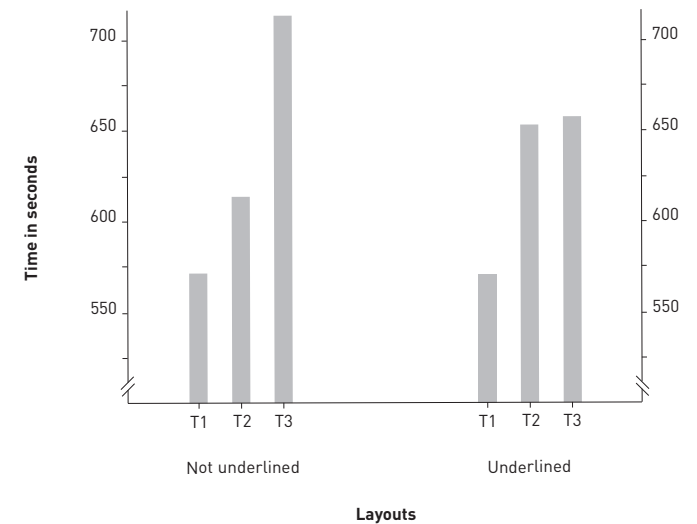
was the layout where participants always performed better, and the average time spent remained the same whether participants underlined information or not.

This seems to indicate that typographic legibility principles have a greater impact on reading speed than typographic cueing. However, for layouts disregarding legibility principles, underlining might enhance performance.

Research has actually shown that students understand and recall pre-underlined information in a long text passage better than when the same information is not underlined (e.g. Crouse and Idstein, 1972; Cashen and Leicht, 1970) or when readers underline the information themselves (e.g., Fowler and Parker, 1974; Rickards and August, 1975; Fass & Schumacher, 1978).

However, there are situations in academia where underlining is not permitted, such as textbooks that students borrow from the library. In this case, cueing could be used instead. As several studies have shown, using typographic cueing to emphasise specific information in a text is beneficial to achieve visual relief in uniform pages of text. For example, bold typeface not only helps readers to comprehend information (e.g. Foster and Coles,1977) but also helps to follow directions (e.g. Poulton and Brown,1968; Salcedo et al.,1972). Colour is also a more effective and attractive highlighting technique than black and white (e.g. Katzman and Nyenhuis,1972) for both high and low aptitude learners (e.g. Chute,1979).

It should be noted, however, that whilst research supports specific typographic cueing, it also shows that multiple cueing (i.e. using several cueing techniques together) can be confusing and impair comprehension (e.g. Hershberger and Terry, 1965; Glynn and Di Vesta, 1979).

In conclusion, although typographic legibility seems sufficient to enhance performance, combining typographic legibility principles with single typographic cueing could be beneficial in a few particular cases (i.e. adult language learning). Learning a second language in adulthood can be frustrating and very difficult: i.e. because with age our brain's plasticity and ability is reduced (Asher and Garcia, 2011) or because (contrary to children) adults approach learning a new language with a problem-solving process (Gass and Schachter, 1989).

Future research could therefore assess, at Stage II (Section Selection) of the reading model, the impact of typographic legibility together with single typographic cueing on adult language learning. Such a combination of typographic features could lead to better comprehension and learning, especially in terms of vocabulary and grammar.

Stage III – Information Extraction

Once the key word has been found in the text, students skim the text immediately before and after the key word to get an idea of whether that section might contain the right answer. In the particular situation where students are given a question sheet they might use it in parallel with the text. In that case, while skimming the text around the key word to get a general idea as to whether it answers the question, students may find themselves switching rapidly from the section where the key word is, back to the question sheet, and back again to the text, and so on. This means that at Stage III both text layout and question and answer sheet layout might have an effect on the speed and accuracy of reading a text and answering questions at the perceptual level of reading.

In relation to the text layout, it seems likely that the more legible the layout is, the quicker the text is skimmed. This statement is supported by empirical evidence concerning the legibility of text (as summarized in Table 1 and by Lonsdale, 2014).

In relation to the question and answer sheet, when several questions are asked, legible questions and a clear typographic structure are necessary for students to quickly locate the question that is being answered among all the other questions. This claim is strengthened by the findings of Hartley et al. (1973) who showed that the design of the response sheet in a test could affect the scores obtained. Similar results were also found by Lonsdale (2007), whose experiments showed that significant differences in performance were always in favour of the question and answer sheet layout conforming to legibility principles.

Once students have skimmed the text immediately before and after the key word, they decide whether the section contains the right answer. If the section does not seem important, then students quickly check other possible sections in the text containing the same key word (the arrow in Figure 8 reflects this return in the strategic reading process). Even if students feel that they have found the answer, they might still want to quickly check other remaining possible sections.

As soon as students feel they have found the section that contains the answer, they read it more carefully in order to confirm whether the text answers the question fully or not. Getting this part right involves conceptual processing. Once again, if the text does not answer the question, students might go back to the question and choose another key word (the arrow in Figure 8 illustrates this return). If it does answer the question, students either memorize the words or underline them for reference. Stage III is therefore another stage involving conceptual processing of text.

Stage III Future Research

When observing students taking class tests and examinations, it is interesting to note their physical interaction with the assessment, i.e. how they handle the sheets of paper. Tests/examinations are usually printed on both sides of the page. Reading text on a page and answering questions that are printed on the back of that same page, or on another page, can prove difficult. When switching rapidly from the section where the information that answers the question might be, back to the question sheet, and back again to the text, students find themselves turning the pages over numerous

times. A few more audacious students, when the examination is stapled, end up removing the staple in order to have the text and the questions side by side to save time and avoid inaccuracies.

Future research could therefore compare, at Stage III (Information Extraction), the impact on students' performance of completing an examination that is stapled and printed on both sides versus completing an examination with loose sheets and printed only on one side. Although no research is available on this matter, it follows that the former scenario would slow down the answering process and result in more inaccuracies when checking the information (Stage III – Information Extraction), as well as transferring it to the answer sheet (Stage IV – Integration, as will be discussed next).

Stage IV – Integration

This stage applies to academic situations where students are required to write the answers down on a question and answer sheet and integrate the text with the question on the sheet. Examples of such situations are assignments, class activities, textbooks, quizzes, examinations, achievement tests, etc.

Once more, it seems plausible that the layout of the question and answer sheet may affect speed and accuracy of answering at the perceptual level of reading. As stated by some authors (e.g. Hawkes et al., 1936, 115), the answer sheet should be made as suitable and useful as possible to fulfill the needs of the responder. For example, marked spaces for students to write their responses should be provided to the left of the question, and written instructions should be provided at the top (Jacobs and Chase, 1992, 98).

Therefore, in addition to directing students' attention to the place where the question being answered is located on the question and answer sheet, typographic features may also be used to help locate the precise place to write the answer. This can further increase, not just the speed of answering the questions, but the accuracy as well, as shown by Lonsdale (2007). If an answer is written in the wrong place, it will not be considered correct in an assessment, or (in the case of textbooks) will lead the student into error when revising at a later date.

At this stage students might also want to go back to the text in order to double check and make sure the information they transferred is accurate. This also reinforces the importance text layout can have for students to find and review this information quickly. (Double checking information is common practice in academia, such as the transfer of text extracts from a book to a notebook, computer, etc.).

Stage IV Future Research

The effect that text layout has on performance when answering different types of question has been ascertained by Lonsdale (2015). The two types of questions tested by Lonsdale (2015) had some slight typographic differ-ences, but the aim was not to compare their typographic layout. Instead, the aim was to compare two questions that require different reading processes, i.e. location versus comprehension processing. Language examinations, however, include a range of questions that differ in their design, and some of them have a complex structure. Examples are 'table completion' and 'diagram completion' types of question which are very common in examina-tions such as IELTS, as well as standard language examinations.

Future research could therefore ascertain, at Stage IV (Integration) of the reading model, the effect typographic layout has on performance when answering questions with a more complex typographic structure. Based on Hartley et al. (1973) and Lonsdale's (2007) findings, it follows that the application of typographic legibility principles to types of question displaying a complex structure would also result in better performance.

Stage V – Recycling

If the reading task is not completed, students return to Stage I, i.e. carefully re-read the instructions and questions (this is again indicated with an arrow in Figure 8). Completion of the reading task means either the completion of a whole class activity, or a test, or an assignment, etc.

5.1. CONCLUDING REMARKS

The reading model proposed here is a research tool capable of covering academic reading tasks that involve one, two, three, four, or all stages of the model. If students read with the single purpose of identifying specific information (i.e. an author's name, a date) but do not have to answer a pre-set question, then only Stage II – Section Selection – of the reading model needs to be researched. If, however, students read to find specific information, as well as make sense of it (i.e. a definition), then the reading process needs to be studied up to Stage III – Information Extraction. Finally, if students read to find specific information, make sense of it and then write down the answer to a set of questions (i.e. an examination), then the reading process should be investigated all the way up to Stage IV – Integration. Stage V – Recycling – applies to any reading task that has not been completed.

It is also important to make a connection between the reading model, the findings of the study reported in this paper, and Lonsdale et al.'s (2006) findings. At every stage of the reading model where typographic layout might affect performance at the perceptual level of reading, text layout T2 (medium legibility) and T3 (less legible) seem to slow down the reading process and lead to inaccuracies, whilst text layout T1 (more legible) seems to allow reading and answering to flow better. Furthermore, such slow-down and error-increase is greater with text layout T3 than with text layout T2. Although the layout of the question and answer sheet was not addressed in the experiment reported here, Lonsdale's (2007) findings provide strong evidence to suggest that the exact same effect occurs with less and more legible question and answer sheet layouts.

Certain typographic features can also be linked to each individual stage of the reading model:

- Stage I – Goal formation should be supported by structure and hierarchy-related features such as well positioned instructions, sufficient space between instructions and remaining text/questions, and appropriate sequencing of information. It should also be supported by legibility features such as type size of 10 to 11-point, a line length between 60 to 70 characters and spaces per line, and an additional interlinear space of one to four points.
- Stage II – Section selection should be supported mainly by structure related features such as clear distinction of paragraphs and sufficient interlinear space to distinguish successive text lines.
- Stage III – Information extraction should be supported mainly by legibility features such as the ones listed for Stage I.
- Stage IV – Integration, which relates greatly to the question and answer sheet, should be be supported by sufficient space between questions, adequate space to write the answers, and numbers placed close to the corresponding question. Because of the switching process that happens at this stage between text and question and answer sheet, the same structure-related features listed in Stage II should be used here.

6. DISCUSSION AND CONCLUSION

The main conclusion to be drawn is that text layout affects performance in academic reading situations involving both time and no time pressure. Specifically, a text layout displaying a combination of typographic features that conform to legibility guidelines seems to support efficient search reading in both situations of time and no time pressure. This suggests that the superiority of the layout conforming to legibility guidelines is related to search reading strategies used to complete the reading task and not to time pressure.

A theoretical explanation for such an effect of typographic layout on performance was given by attempting to specify a general model of the process of reading in academic-type situations. The model refines Guthrie's (1988) model to try to capture the search reading strategy used and proposes the stages of the strategic reading process where typographic layout might influence performance at the perceptual level of reading. According to the reading model, text layout may help or impair students' performance in the following activities:

- Reading the instructions and questions.
- Scanning the text to locate relevant information that answers specific questions.
- Skimming the text immediately before and after a key word to get an idea of whether that section contains the right answer.
- Referring back to the text to make sure the information is accurate.
- Writing down the answers (in those cases where students have a question sheet).

By emphasizing the relationship between the findings emerging from the present experimental study and the reading model suggested here, more information is provided to those designing academic and instructional materials. In other words, the design of academic texts that are published in journals, textbooks, periodicals, magazines, etc., can be improved if legibility is considered. Consequently, these outcomes can apply to a vast range of written materials that students have to read/use in and outside the classroom in order to support learning and search for specific information on the subjects they are studying.

The present research is also relevant to people in academia other than students (e.g. lecturers, researchers, librarians, etc.), who also practice search reading on a daily basis to look for specific information in written documents. (Of course, some written documents will be closer than others to the circumstances of the experimental work conducted in the present study.)

Furthermore, the present study can make a valuable contribution to knowledge. Documents requiring exclusively or predominantly search reading have not been given much attention. Legibility research on the effects of several typographic features in combination (not as independent features) has not been given much attention either. However, the treatment of typographic features as a whole is validated by consistent better performance with the typographic layout intended to be more legible.

In relation to readers' judgments, this study can also provide information on layout characteristics that are considered to contribute to the ease of locating information, the ease of answering, and attractiveness. The reactions to the particular materials tested here may well reflect the reactions to other printed materials if they are typographically similar or read for the same purpose of locating specific information and answering.

Further evidence on the reading model proposed here could be obtained as suggested above. Experimental studies could also assess whether people actually go through the stages proposed in the model and whether the theory that typographic layout affects readers' performance at the perceptual level of reading is valid.

The value of experimental findings is reinforced if more research is carried out to confirm them. The present study therefore indicates a need to conduct more studies on the typographic layout as a whole, as well as studies on the design of teaching and learning support material.

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