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Does typographic design (text and question and answer sheet layout) of examination material affect performance?

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Abstract

The present paper reports three experiments investigating the effect typographic design of examination materials has on performance. Significant differences in performance were always found in all three experiments. These differences were always in favour of the text and/or question and answer sheet layouts conforming to legibility guidelines. Participants also considered the questions with these layouts easy to answer. The main conclusion was that text and question and answer sheet layouts displaying a combination of typographic features intended to improve legibility facilitate efficient search reading and answering of questions at the perceptual level of reading. The effect of typographic layout on performance should therefore be considered in order to construct valid and reliable examination materials.

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1 Introduction

Research has shown that the text layout of English reading language examinations (i.e. examinations of reading skills) affects candidates' speed and accuracy of reading and answering (Lonsdale et al., 2006). Participants performed best with the text layout intended to be most legible, i.e. conforming to legibility guidelines. This layout was also regarded as attractive and making it easiest to locate the answers. Consequently, it was argued that the construct validity of an examination is put at risk since legibility is confounded with candidates' reading skills.

In English language reading examinations, each text passage is followed by a question and answer sheet, which is used in parallel with the text passage. In other words, candidates read the text and, at the same time, they answer questions on it. Therefore, the layout of the question and answer sheet might also affect candidates' speed and accuracy of reading and answering. This suggestion is strengthened by the literature on questionnaires and forms described in the next section (e.g. Gray, 1975; Davis, 1993; Waller, 1984; Hartley, 1994). It is further strengthened by the comments made by the participants in Lonsdale et al.'s (2006) study; a large percentage thought the text in the question and answer sheet was too tight, the question numbers were too far away from the sentences, and there was no obvious space in which to write the answers, which led to some confusion and error.

In this paper three experimental studies are presented that extend and reinforce Lonsdale et al.'s (2006) research by testing the typographic layout of examination materials as a whole, i.e. both text layout and question and answer sheet layout. The main reason for conducting these three studies was to determine the extent to which differences in the layout of the question and answer sheet, when combined with differences in the layout of the text, might further affect performance in examinations.

2 Perceptual and conceptual proccesing of reading

It has been suggested that the effect of typographic layout on performance occurs at the perceptual level of reading (Lonsdale, 2006; Lonsdale et al., 2006). This suggestion is in line with Masson's (1982 and 1985) characterisation of cognitive processes in skimming stories where he identifies the interplay of the perceptual and conceptual aspects of skimming. According to a theory put forward by Masson, when skimming a text, readers selectively process the text to extract the information important to their goal. In fact, with his investigation Masson (1982) found that some kind of perceptually selective strategy is used in situations of rapid reading, such as skimming. He also found that key words and/or particular sentences are frequently used in the selection process. This might well be the case in English language reading examinations, where candidates have to read a text and answer questions on it as quickly and accurately as possible. Masson's theory can be illustrated using English language reading examinations as an example: candidates may look for visual features, i.e. key words, in the text relevant to the question. Tjis is a perceptual process. Once they have located the relevant information, candidates then more carefully read the phrases containing the key words so that the answer can be found, accurately comprehended, and extracted to answer the question, which is a conceptual process.

A reading examination, however, involves reading a text as well as reading the questions on it and writing down the answers to those questions. In a situation of time and performance pressure, the aim of the candidates is to avoid both wasting time and making errors. Therefore, it seems reasonable to suggest that the layout of examination materials, both text and question and answer sheet, might affect performance at the perceptual level of reading at five stages of the reading and answering process:

1. When candidates read the questions and instructions. A less legible question and answer sheet layout (e.g. with inadequate distinction

between instructions and corresponding questions and list of possible answers; with instructions in small type and/or oddly positioned) might compromise the efficient completion of the reading tasks. Candidates might read the instructions and questions quickly but not accurately enough to understand exactly how to complete the task as accurately as possible. Candidates might also decide to spend too much time trying to read the instructions and the questions as accurately as possible, leaving little time to find the answers. This, in turn, might result in a low number of questions answered and a poor score.

2. When candidates locate information in the text by matching information from the question (e.g. key words noted in the question) to identical information in the text. It seems plausible that the less legible the text layout is (e.g. with insufficient interlinear space, unclear distinction of paragraphs, very long or very short line lengths), the slower the text is scanned (or skimmed) and, consequently, the slower the key words and answers to the questions are located.

3. When candidates check back with the question to make sure the specific information found answers the question. A less legible question and answer sheet layout (e.g. insufficient space between questions) might impede the candidates from quickly locating the question being answered among all the others.

4. When candidates write down the answer. With a less legible question and answer sheet layout (e.g. with no space and/or small space to write the answer) it can be very difficult for candidates to quickly identify the exact place where the answer is to be written. This decreases the speed with which questions are answered, as well as the accuracy of the answers because no answer will be considered correct if it is written in the wrong place.

5. When candidates double-check back with the text to make sure the information transferred to answer the question is accurate. With an unclear text structure (e.g. unclear distinction of paragraphs) it might be difficult for candidates, when returning to the text, to quickly find the particular section they want.

3 Design of experimental material

3.1 Relevant literature

The experiments reported in this paper use text layouts that have been previously tested in Lonsdale et al.'s (2006) study. To inform the selection of the text layouts, Lonsdale et al. (2006) reviewed some published views and research studies on the typographic features of printed text that contribute to legible layouts and that have practical application to examination material. A list of the legibility guidelines summarised by Lonsdale et al. (2006), based upon their review, follows:

- Serif typeface for the main text.
- Set the main text with a 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.
- Align the main text to the left and avoid hyphenation by breaking lines at the end of words.
- Place the main text in a single column layout in order to keep sufficient margins for candidates to take notes if necessary.
- Make a clear hierarchical distinction between title and subtitle.
- Distinguish paragraphs clearly with a line space.

These guidelines are also relevant to assist in the selection and re-design of the question and answer sheet layouts assessed in the present study. However, they are insufficient, as the literature on the layout of questionnaires and forms shows (see below).

The structure of questionnaires and forms is more complex than prose text. As in questionnaires and forms, question and answer sheets used in English language reading examinations have a particular hierarchical structure. That is to say, a single type of question contains different hierarchic components: the instructions, the questions, and often a list of possible answers (Gray, 1975, p. 85). These components may

be likened to what Waller (1984, p. 53) calls 'voices', i.e. components of a document that are expressed distinctively so that they may appear within, or in parallel to, the main hierarchical structure without disrupting it (e.g. instructions printed in italic).

In such a hierarchical structure, it is suggested that the various text components present on the page belonging to the same section need to be grouped together (Davis, 1993, p. 7) and arranged inside one another graphically (Waller, 1984, pp. 52-3). Ways of doing this have been proposed on the basis of empirical findings and recommendations based on practice, as summarised in Table 1.

It should be noted, however, that due to the lack of experimental research on questionnaires and forms, reference is made to only one experimental study conducted by Hartley et al. in 1977. In this study, alternative solutions in the typographic design of questionnaires were tested to assess which layout was: quickest to type; cheapest to typeset; easiest to fill-in; and easiest to code (schematic examples of the layouts are provided in Hartley et al., 1977). The results of the study showed that the layout with the spaces for the answers to the left of the question and with a consistent space between the answer box and the question was found to be slightly quicker to type and considered to be the cheapest to produce.

Although with no experimental basis, two case studies on the layout of forms should also be highlighted due to their interesting methodological approach: the study conducted by Cutts and Maher (1981) to evaluate and redesign social security forms and leaflets; and the study conducted by Waller in 1984 on the design of a government form. These studies are classified by Hartley (1989) as cyclical testing and revising. In order to design and improve the forms, Cutts and Maher (1981) and Waller (1984) revised and tested the same document several times. Individuals and small groups of 'appropriate' participants were asked to use the forms and report what they thought about them. Redesigning the document was in the end a successful task, as more forms were completed satisfactorily than with the original version.

Ways of differentiating hierarchically the components of a questionnaire and/or form are further proposed by some practitioners and reviewers such as Gray (1975), Schriver (1997), Simmonds and Reynolds (1994), and Hartley (1994). (See also Lonsdale, 2006, Chapter 4, for an extended review of literature regarding the layout of text and question and answer sheets.)

Table 1. Studies and opinions on the typographic features of questionnaires and forms.

TYPOGRAPHIC FEATURES	
Type	**Instructions**
• Use different weights of the same type family, i.e. contrast larger and bolder with smaller and lighter type variants. Two different type families of the same kind should never be combined. *e.g. Gray (1975), Waller (1984)* • Variation of type, using roman capitals, roman capitals and lowercase, and italics to differentiate hierarchically the components. *e.g. Gray (1975)* • Increase or reduce type to make the hierarchical structure clear. *e.g. Gray (1975)* • The use of colour for the type itself or background. *e.g. Gray (1975), Waller (1984)*	• Reading lengthy instructions on how to complete a form can be confusing, especially if they are printed in small type. In such a situation, readers may well just ignore the instructions. *e.g. Hartley (1994)* • Solutions to deal with excessive instructions: – refer the readers, where appropriate, to separate notes (avoid using small type). – use a wide left-hand margin to place notes there, next to the item to be completed. *e.g. Hartley (1994)*
Systematic manipulation of space	**Answer spaces**
• Space between items is another way of expressing their connectedness: – If space is varied slightly between sections but remains consistent between questions, it can signal the end of each section. – Plenty of space between paragraphs, nearly a line space, so that the type is seen as a number of separate, yet related, blocks. *e.g. Waller (1984), Cutts and Maher (1981)* • Blank space should not be added to the document without considering how horizontal and vertical space work together in order to signal the typographic structure. The document should not be made more 'spacious' if its structure is not properly articulated. *e.g. Schriver(1997)* • The more space there is around an item of information, the more it should stand out from the surrounding text. *e.g. Simmonds and Reynolds (1994)*	• Answer spaces need to be big enough to fit in all the necessary information. *e.g. Wright and Barnard (1975), Hartley (1994)* • Concerning examination materials, the amount of space left for short-answer questions should not give clues about the length of the answer. Therefore, all answer spaces should have the same length. *e.g. Davis (1993), Jacobs and Chase (1992)* • Answer spaces need to be suitably located so that it is clear where the answers are supposed to be written (for example, alongside the respective questions). *e.g. Wright (1981), Wright and Barnard (1975), Hartley (1994)* • Concerning the matching type of question, the spaces for the answers (just enough for a number or letter) should be provided to the left of the question *e.g. Hawkes et al., [1936], Jacobs and Chase (1992)* • Appropriate location of the answer spaces is also important for convenient scoring. The spaces for the answers should be arranged in vertical columns wherever possible. *e.g. Hawkes et al. [1936]* • A layout with the spaces for the answers to the left of the question and with a consistent space between the answer box and the question, was found to be slightly quicker to type and considered to be the cheapest to produce. *Hartley et al. (1977)*
Rules and boxes	
• The use of rules to divide, close or link different components; or the use of boxes to isolate each component in space. *e.g. Waller (1984)*	

3.2 Survey and re-design of question and answer sheets

Question and answer sheets of the English language examination IELTS (International English Language Testing System) were analysed in terms of their typographic features. These were the question and answer sheets attached to the IELTS texts surveyed by Lonsdale et al. (2006), found in three books of practice tests (Jakeman and McDowell, 1996; UCLES, 2000; Jakeman and McDowell, 2001) and in the Specimen Material booklet provided by UCLES (2001). Only the question and answer sheets with three hierarchic components (instructions, questions, and list of possible answers) were surveyed, resulting in a total of nineteen question and answer sheets. It seemed reasonable to exclude the questions with two hierarchic components, as they cannot be used to inform all the existing types of questions. Furthermore, the decision was taken to limit the scope of the survey to just one type of question with three hierarchic components, i.e. the matching type of question, in order to allow a clear analysis and interpretation of the survey results.

A great variability in the typographic features of the IELTS question and answer sheets was found. However, despite this variability it was possible to identify more frequently occurring features, i.e. a typical question and answer sheet layout of IELTS.

Two text layouts were tested in the present study, which had been previously tested in Lonsdale et al. (2006): 1) Text layout T1, intended to be most legible (Figure 1); this layout conformed to the legibility guidelines listed in the beginning of the previous section. 2) Text layout T2, the typical text layout of IELTS (i.e. the layout found in the survey to be the most commonly used in IELTS), intended to be of 'medium' legibility (Figure 2); this layout followed some of the guidelines listed in the beginning of the previous section.

Consequently, of the nineteen question and answer sheets surveyed for this study, two were selected, which were intended to be different in legibility and in tune with text layout T1 and text layout T2. Some of the typographic features of the original versions of the question and answer sheets were slightly adjusted in order to increase the sensitivity of the study. Accordingly, of the two re-designed question and answer sheet layouts: layout Q1 (Figure 3), which conformed to the guidelines listed in Table 1, was intended to be more legible than layout Q2; and layout Q2 (Figure 4), the typical question and answer sheet of IELTS, was intended to be of 'medium' legibility.

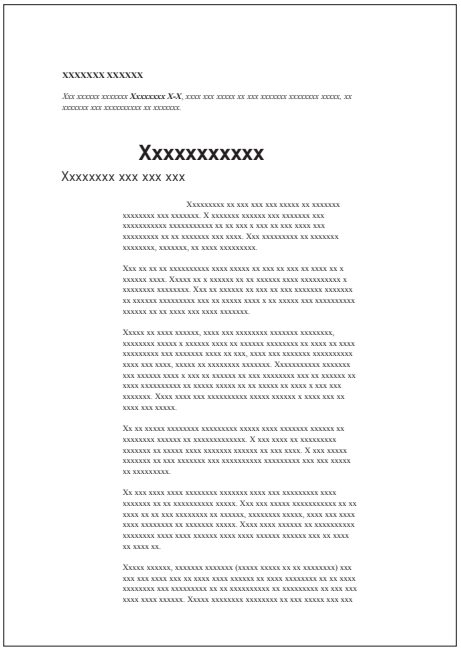


Figure 1. Layout T1, the text layout intended to be more legible. ´x´s were used to represent the text.

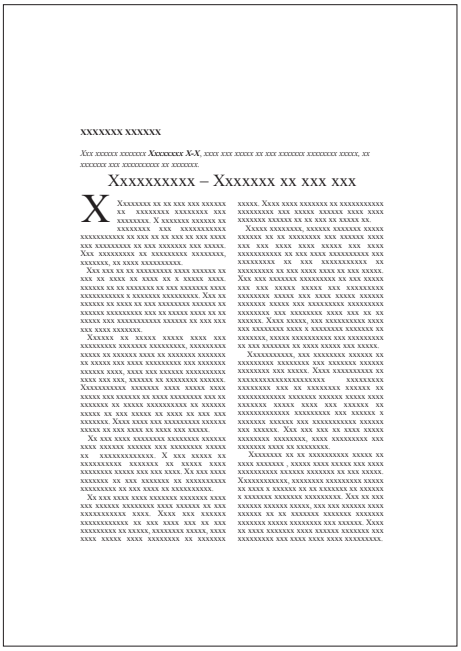


Figure 2. Layout T2, the text layout intended to be of medium legibility. ´x´s were used to represent the text.

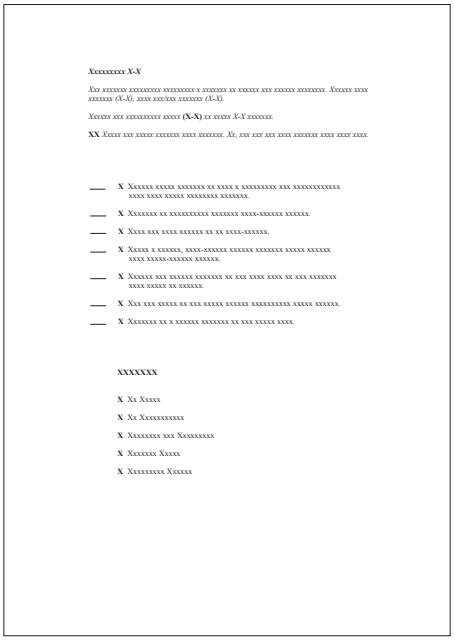


Figure 3. Layout Q1, the question and answer sheet layout intended to be more legible. ´x´s were used to represent the instructions, questions and list of answers.

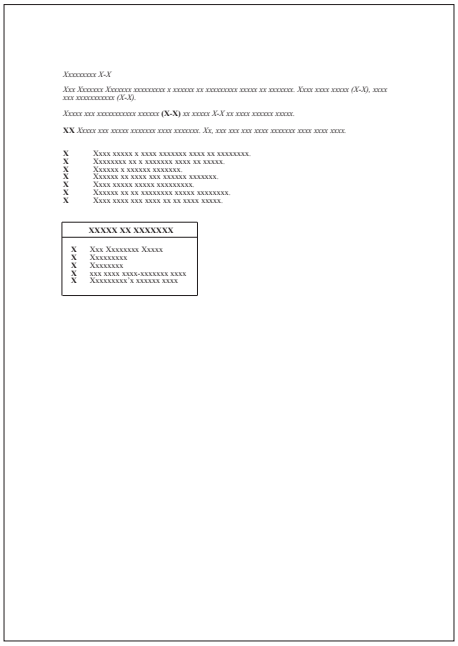


Figure 4. Layout Q2, the question and answer sheet layout intended to be of medium legibility. ´x´s were used to represent the instructions, questions and list of answers.

Table 2. Typographic features of question and answer sheet layouts Q1 and Q2.

	LAYOUT Q1	LAYOUT Q2
Typeface	• Instructions: Times New Roman Italic • Questions & Answers: Times New Roman • Title: Times New Roman Bold • Numbers and letters: Times New Roman Bold	• Instructions: Times New Roman Italic • Questions & Answers: Times New Roman • Title: Times New Roman Bold • Numbers and letters: Times New Roman Bold
Type size	• Instructions: 1.8mm x-height • Questions & Answers: 1.8mm x-height • Title: 1.8mm x-height • Numbers and letters: 1.8mm x-height	• Instructions: 1.8mm x-height • Questions & Answers: 1.8mm x-height • Title: 1.8mm x-height • Numbers and letters: 1.8mm x-height
Alignment	• Left aligned	• Left aligned
Line length	• Instructions: 85 characters • Questions & Answers: depends on the length of the sentence, but maximum is 79 characters	• Instructions: 90 characters • Questions & Answers: depends on the length of the sentence, but maximum is 79 characters
Interlinear space	• 4.3mm	• 3.7mm
Space between each question/each answer	• One line space (6mm)	• No line space
Space between components	• Between instructions and questions: 20mm • Between questions and list of answers: 20mm	• Between instructions and questions: 8mm • Between questions and list of answers: 8mm
Space between number and sentence	• 2 characters	• 7 characters
Place for answer	• Yes	• No
Box around questions	• No	• Yes
Page size	• Standard A4: 210mm X 297mm	• Standard A4: 210mm X 297mm
Margins	• 40x30x30mm (the bottom margin was defined according to the amount of text)	• 27x30x27mm (the bottom margin was defined according to the amount of text)
Paper colour	• Buttercup yellow	• Buttercup yellow

Table 2 illustrates the differences between the typographic features of question and answer sheet layouts Q1 and Q2 for the matching type of question. In short, the differences in legibility of the two layouts rely mainly on the manipulation of horizontal and vertical spacing (e.g. space between instructions, questions and list of possible answers; space between numbers and questions; length and position of the answer spaces).

The same four conditions combining two text layouts with two question and answer sheet layouts were tested in the three experiments reported here. However, in Experiments 2 and 3 the matching test to measure performance contained two sets of matching questions in each condition, as opposed to one in Experiment 1 (for the reasons mentioned below). The typographic arrangement for the second set of matching questions, known as 'completion questions', was slightly different due to the nature and length of the answers, i.e. the answer space is given in the middle of the sentence to be completed (Figures 5 and 6). (Full details of the surveys and redesign of the text layouts and question and answer sheet layouts can be found in Lonsdale, 2006, Chapter 5).

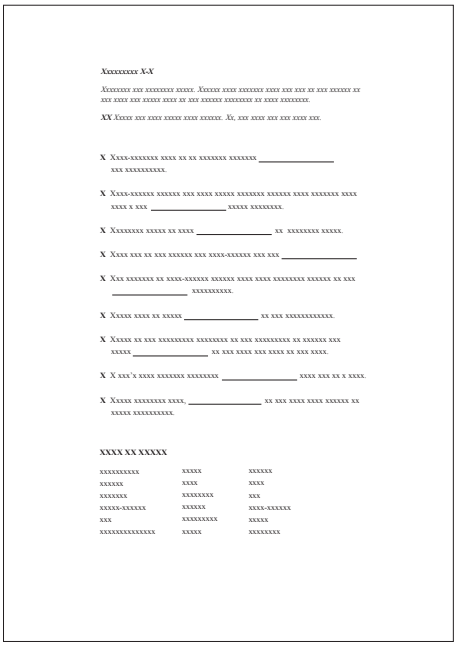


Figure 5. Layout Q1 with the second set of matching questions (completion questions), using 'x's to represent the instructions, questions and list of answers.

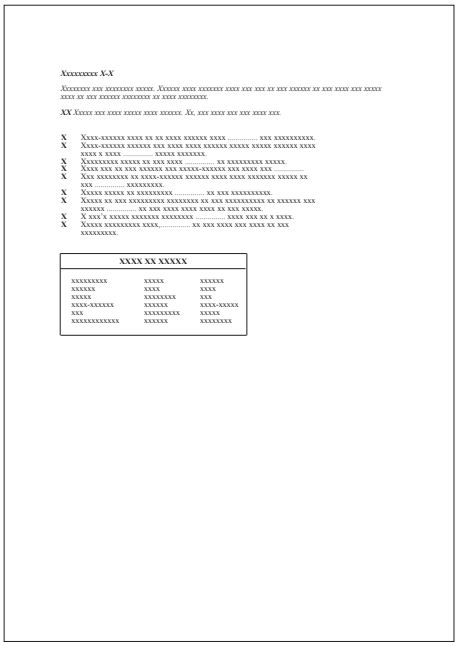


Figure 6. Layout Q2 with the second set of matching questions (completion questions), using 'x's to represent the instructions, questions and list of answers.

4 Experimental comparisons overview

Experiments 1, 2 and 3 investigated the effects of typographic layout on participants' performance in an examination-type situation that involved reading a text and answering specific questions on it under time and performance pressure. Each one of the experiments partially replicates and builds upon the previous one. Therefore, the design of Experiment 2 followed from the results obtained in Experiment 1, and the design of Experiment 3 followed from the results obtained in Experiment 2. A detailed summary of the experiments can be found in Table 3.

4.1 Aims

The main aim of the three experiments was to find out the extent to which differences in the layout of the question and answer sheet, when combined with differences in the layout of the text, might affect performance in examination-type situations.

Experiment 1 further aimed to confirm the findings of Lonsdale et al.'s (2006) study suggesting that a text layout displaying a combination of typographic features that conform to legibility guidelines supports efficient search reading and answering under time pressure.

On the basis of Experiment 1, Experiment 2 sought to investigate the absence of a significant difference on performance in Experiment 1 when different question and answer sheet layouts were used.
On the basis of the results of Experiments 1 and 2, Experiment 3 aimed to check whether, with a high number of questions (twenty questions as opposed to seven) and with more stringent time pressure (with limited time), the effects would be restricted to the question and answer sheet layout, or would extend to both text layout and question and answer

Table 3. Detailed summary of Experiments 1, 2 and 3.

	EXPERIMENT 1	EXPERIMENT 2	EXPERIMENT 3
Pressure	• Work as quickly and accurately as possible	• Replicated Experiment 1 but with more questions	• Replicated Experiment 2 but with a time limit of 7 minutes
Questions	• 1 set of matching questions with 7 questions	• 2 sets of matching questions: 11 and 9 questions respectively	• As in Experiment 2
Independent variables	• Text layout. • Question and answer sheet layout	• As in Experiment 1	• As in Experiment 2
Layouts	• Text: – T1 – intended to be more legible than T2. – T2 – intended to be of medium legibility • Question and answer sheet: – Q1 – intended to be more legible than Q2 – Q2 – intended to be of medium legibility	• As in Experiment 1	• As in Experiment 2
Passages	• 4 passages: – from IELTS practice book – around 800 words each – about a matter of general interest – same level of difficulty (as shown in Lonsdale *et al.*'s study)	• As in Experiment 1	• As in Experiment 2
Experimental design	• 2 x 2 experimental design: – Condition 1 = T1 + Q1 – Condition 2 = T1 + Q2 – Condition 3 = T2 + Q1 – Condition 4 = T2 + Q2	• As in Experiment 1	• As in Experiment 2
Measures	• Task time • Task accuracy • Task efficiency	• As in Experiment 1	• Task accuracy
Preferences	• Judgement: – Ease of locating the answers with each combination of text layout and question and answer sheet layout; – Confidence of getting answers right with each combination.	• Judgement: – Ease of answering with each question and answer sheet layout	• As in Experiment 2
Participants	• 32 undergraduate and postgraduate students: – Between 22 and 38 years old – average of 26.6 years – 19 female and 13 male. – 11 native English speakers and 21 were non-native English speakers.	• 32 undergraduate and postgraduate students: – Between 21 and 36 years old – average of 25.6 years – 16 female and 16 male. – 10 native English speakers and 22 were non-native English speakers.	• 32 undergraduate and postgraduate students: – Between 23 and 50 years old – average of 29.8 years – 17 female and 15 male. – 11 native English speakers and 21 were non-native English speakers.

sheet layout. Experiment 3 would also be an opportunity to test the influence of typographic layout on performance in a situation as much like an examination as possible, i.e. with a time limit, as well as in groups. Moreover, if the same results were found when using a time limit as a way of imposing time pressure, then the method of imposing time pressure used in Experiments 1 and 2 (i.e. asking participants to read as quickly and accurately as possible) would be validated.

4.2 Experimental design and measures

A within subject design was used in all three experiments. In a within subject design each person uses each typographic layout so that the influence that different layouts can have on the same person is ascertained. A within subject design also reflects the context of examinations where the same candidate reads all the different passages and answers questions on them. Therefore, as each participant was to work with all layouts, they needed to see each layout with a different passage. Moreover, to eliminate sequence effects, the same layout was not used always in first or last place. A Greco-Latin square design balanced the combination of each passage with each text layout and controlled the order of presentation.

The effects of text layout and question and answer sheet layout on performance were examined according to the three measures: (1) task time: the time taken to read the passage and answer questions on it; (2) task accuracy: the number of questions answered correctly; (3) task efficiency: a measure of the number of correct answers per second, calculated by dividing accuracy by time. Differences between the means were tested for statistical significance by a two-way analysis of variance, with text layout and question and answer sheet layout as within subject factors. Kendall's Coefficient of Concordance was used to examine the extent of agreement between participants regarding the layout of the examination material.

4.3 Procedure and tasks

In Experiment 1 and 2 participants were tested individually. As for Experiment 3 participants were tested in groups (each group on a different day and with a different number of participants) and given a time limit. According to Poulton (1965, pp. 69-70) and Gregory and Poulton (1970, p. 428), small differences in performance stand the greatest chance of being revealed if the time allowed for reading is

chosen so that the average score for comprehension is in the region of fifty per cent. Using the results of Experiment 2 as the basis (which tested exactly the same conditions as Experiment 3), and after piloting Experiment 3, the most appropriate time limit seemed to be seven minutes for each condition. Emphasis was given in all three experiments to working as quickly and accurately as possible.

Participants were given four passages and a set of matching questions for each passage (an example of a passage and the corresponding matching question is given in Appendix 1). For each question, participants were asked to choose the correct answer from a list of alternatives, and they could repeat some answers more than once. In Experiments 2 and 3, however, participants were also given a second set of matching questions, and in the second set they would not have to use all the alternative answers (an example of the second set of matching questions is shown in Appendix 2). Participants were always allowed to switch between the passage and the set of questions as many times as they wanted. It should be further noted that, as in Experiment 3, the performance test was time-limited, and a practice test differing typographically from the experimental conditions was presented before the experiment proper. (The purpose of the practice test was to allow participants to adjust to the experimental situation, which imposed a very limited time for the reading task employed, i.e. seven minutes to complete twenty matching questions.) Moreover, in Experiment 3 participants were told when they were entering the final two minutes of the seven minutes given to find and write down all the answers in each condition. A short break of one minute was given between each text.

In the three experiments participants were also asked about their judgements in relation to the layouts. In Experiment 1, after completing each set of questions, participants were asked to rate each layout combination in relation to the ease of locating the answers and how confident they were in their answers, and why. The rating scale ranged from: 1 (very difficult) to 5 (very easy) in relation to ease of locating the answers; and from 1 (very unsure) to 5 (very sure) in relation to confidence that the answers were right. Participants' confidence was ascertained, as it seemed reasonable that the layout of examinations might well increase confidence if it is clear and easy to understand. This argument is supported by the opinions of researchers that the loss of confidence in a document, or in the answers given, might produce an effect upon readers such as slowing readers down (Fisher, 1975, p. 194; Waller, 1984, p. 38). Informal inquiries were also made with students at the University of Reading who made reference to the feeling of confidence (or lack of confidence) in their answers, both when writing them down and after completing the examination.

As for Experiments 2 and 3, after the whole performance task, participants were given a questionnaire asking simply which question and answer sheet layout made it easier to answer the questions. This time participants had to rank (not rate) the two question and answer sheet layouts in order of preference and explain their choice. Ranking was used rather than rating since this time only two layouts had to be judged. Moreover, the judgement was concerned with the question and answer sheet layout (and not on the text layout), and on how easy it was to answer (and not to locate the answers).

4.4 Results

The data for mean scores and respective standard errors of the means from the three experiments are presented in Table 4.

Table 4. Summary of the results from the three experiments: mean task time, mean task accuracy, mean task efficiency, and standard error of the mean for the four conditions.

	TASK TIME		TASK ACCURACY		TASK EFFICIENCY	
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**
EXPERIMENT 1						
T1+Q1	430.5	28.6	6.06	0.18	0.0160	0.0011
T1+Q2	435.9	22.2	5.84	0.23	0.0143	0.0009
T2+Q1	467.5	34	5.75	0.22	0.0144	0.0013
T2+Q2	502.3	45.4	5.78	0.20	0.0139	0.0012
EXPERIMENT 2						
T1+Q1	981.4	62.3	16	0.48	0.0188	0.0014
T1+Q2	1043.4	73.3	14.94	0.52	0.0166	0.0012
T2+Q1	1019.9	62.3	15.19	0.57	0.0173	0.0015
T2+Q2	1014.3	70.9	14.28	0.60	0.0169	0.0016
EXPERIMENT 3						
T1+Q1	--	--	8.22	0.63	--	--
T1+Q2	--	--	7.57	0.70	--	--
T2+Q1	--	--	9.22	0.82	--	--
T2+Q2	--	--	7.84	0.71	--	--

T1 – text layout intended to be more legible

T2 – text layout intended to be of medium legibility

Q1 – question and answer sheet layout intended to be more legible

Q2 – question and answer sheet layout intended to be of medium legibility

Table 5. Summary of the results from the three experiments: analysis of variance

		df	N	F	P	Significant?	Eta-Squared
EXP 1	**Task Time**						
	Text	1,31	32	7.31	0.011	p<0.025	0.079
	Q&A	1,31	32	3.40	0.075	NS	--
	Text X Q&A	1,31	32	0.56	0.462	NS	--
	Task Accuracy						
	Text	1,31	32	1.02	0.32	NS	--
	Q&A	1,31	32	0.42	0.52	NS	--
	Text X Q&A	1,31	32	0.45	0.51	NS	--
	Task Efficiency						
	Text	1,31	32	2.36	0.13	NS	--
	Q&A	1,31	32	3.21	0.08	NS	--
	Text X Q&A	1,31	32	0.55	0.46	NS	--
EXP 2	**Task Time**						
	Text	1,31	32	0.03	0.86	NS	--
	Q&A	1,31	32	0.93	0.34	NS	--
	Text X Q&A	1,31	32	2.62	0.12	NS	--
	Task Accuracy						
	Text	1,31	32	5	0.03	p<0.05	0.087
	Q&A	1,31	32	8.41	0.006	p<0.01	0.093
	Text X Q&A	1,31	32	0.03	0.87	NS	--
	Task Efficiency						
	Text	1,31	32	0.54	0.47	NS	--
	Q&A	1,31	32	5.07	0.03	p<0.05	0.041
	Text X Q&A	1,31	32	1.60	0.22	NS	--
EXP 3	**Task Accuracy**						
	Text	1,31	32	2.33	0.13	NS	--
	Q&A	1,31	32	6.03	0.020	p<0.025	0.081
	Text X Q&A	1,31	32	0.69	0.41	NS	--

The F-values, the p-values, and the effect size (eta-squared) for the significant effects, from the three experiments are presented in Table 5.

4.4.1 *Task time*

The two-way ANOVA on task time showed a significant effect for text layout ($F(1,31)=7.31$, $p<0.025$) in Experiment 1. Examination of the means revealed that participants took less time to read and answer questions with text layout T1, the one intended to be more legible, than with the other text layout T2, the one intended to be of medium legibility.

There was no effect for question and answer sheet layout in either Experiment 1, 2 or 3. However, in Experiment 1 there was a trend towards faster performance with layout Q1, the question and answer sheet layout intended to be more legible ($F(1,31)=3.4$, $p=0.074$, not significant). There was no interaction between the two variables, text layout and question and answer sheet layout in either Experiment 1 or 2. (Because Experiment 3 was time limited, the performance data consisted only of task accuracy as all participants spent the same time overall).

4.4.2 *Task accuracy*

The results for task accuracy obtained using the two-way ANOVA showed a significant effect for text layout ($F(1,31)=5$, $p<0.05$) and for question and answer sheet layout ($F(1,31)=8.41$, $p<0.01$) in Experiment 2. It is clear from the results that the layouts intended to be more legible (text layout T1 and question and answer sheet layout Q1) were superior to the layouts intended to be of medium legibility (T2 and Q2). The number of correct answers was significantly higher with text layout T1 (across the two question and answer sheet layouts) and question and answer sheet layout Q1 (across the two text layouts).

Significant differences in the question and answer sheet layouts using the two-way ANOVA were also found in Experiment 3 ($F(1,31)=6$, $p<0.025$). The data indicated that Q1, the question and answer sheet layout intended to be more legible, resulted in higher numbers of correct answers. No interaction was found between text layout and question and answer sheet layout in any of the three experiments.

4.4.3 *Task efficiency*

The two-way ANOVA carried out on task efficiency showed a significant effect for question and answer sheet layout ($F(1,31)=5$, $p<0.05$) in Experiment 2. The difference in the number of correct answers per

second was in favour of the question and answer sheet layout intended to be more legible – Q1.

There was no significant effect for text layout and there was no interaction between text layout and question and answer sheet layout in either Experiment 1 and 2. (As already highlighted, the performance data in Experiment 3 consisted only of task accuracy, since a time limit was imposed).

4.4.1 Judgements

Ease of locating answers and confidence in the answers (Experiment 1)

The ratings are provided in Table 6. The ratings were converted into rankings following Friedman's rationale in Greene and D'Oliveira (1982, pp. 55-9). Then, Kendall's Coefficient of Concordance was used to assess participants' agreement on how easy or difficult it was to locate the answers. Kendall's Coefficient of Concordance revealed statistically significant results ($W=0.095, \chi 2=9.15$, $p<0.05$). However, the same analysis regarding confidence in the answers did not show any significant result.

Table 6. Rating results for ease of locating answers and confidence in the answers – Experiment 1

	Ease of locating answers			**Confidence**		
	ratings					
Layout	**Q1**	**Q2**	*Totals*	**Q1**	**Q2**	*Totals*
T1	125	112	237	117	110	227
T2	105	102	207	112	106	218
Totals	230	214		229	216	

T1 – text layout intended to be more legible
T2 – text layout intended to be of medium legibility
Q1 – question and answer sheet layout intended to be more legible
Q2 – question and answer sheet layout intended to be of medium legibility

A two-way ANOVA on participants' judgement on the easiness of locating the answers showed a significant effect for text layout

(F (1,31)=6.05, p<0.025). There was no significant effect for question and answer layout (F (1,31)=2.69, not significant) and there was no interaction between text layout and question and answer sheet layout (F (1,31)=1.13, not significant). However, more participants considered that answers were particularly easy to find when layout T1 was combined with Q1 (both text and question and answer sheet layouts intended to be more legible). This seems to reinforce the need to consider the design of text layout and question and answer sheet layout together (as well as separately). According to participants' comments, this preference for the combination T1 + Q1 was related to the:

- Generous interlinear space.
- Separation between paragraphs in the text.
- Distinction between questions in the list of questions
- and between answers in the list of answers, in the question
- and answer sheet.

Ease of answering (Experiment 2 and 3)

Kendall's Coefficient of Concordance indicated that participants agreed as to which question and answer sheet layout made it easier to answer in both Experiment 2 (W=0.76,χ2=24.5, p<0.001) and Experiment 3 (W=O.66,χ2=21.1, p<0.001). Layout Q1, the one intended to be more legible, was preferred over layout Q2, the one intended to be of medium legibility (as is shown in Table 7).

Table 7. Ranking results for ease of answering – Experiments 2 and 3.

	Ease of answering			
	Exp 2		**Exp 3**	
Layout	*rankings*		*rankings*	
	1	**2**	**1**	**2**
Q1	30	2	29	3
Q2	2	30	3	29

Q1 – question and answer sheet layout intended to be more legible
Q2 – question and answer sheet layout intended to be of medium legibility

The reasons given for the preference of question and answer sheet layout Q1 over Q2 in Experiments 2 and 3 were as follows:

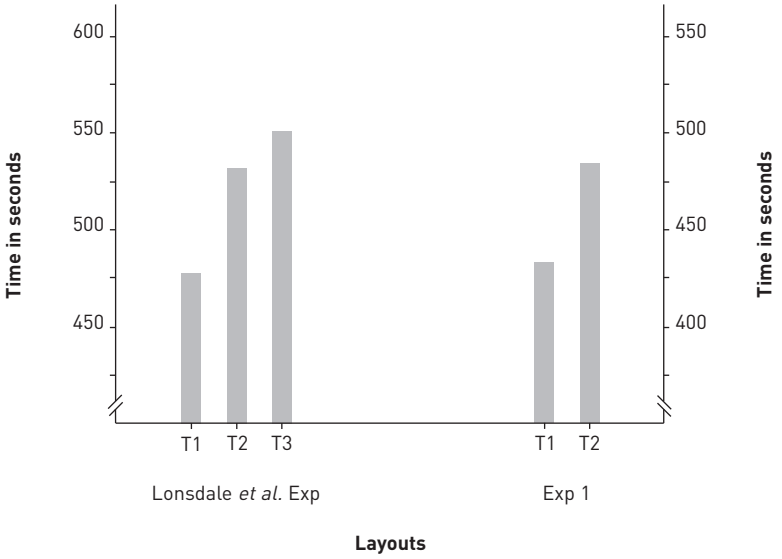
- Better organised.
- More space between questions.
- A space to write the answers
- Questions/answers clearly distinguished.
- Numbers closer to questions.
- Clearer and more relaxing/less stressing.
- Easier to read and write/fill in.
- Easier to find question and answer;
- Easier to remember text/words.
- Allowed more time to study the text.
- Faster to read and to match the question with the answer.
- Easier to confirm if the bit of text found/selected in the passage answered the question.
- Easier to see which question had already been answered.

4.5 Discussion of the results

The task time results for text layout in Experiment 1 appear to replicate those of Lonsdale et al.'s (2006) study, as illustrated in Figure 7. Participants performed faster when using text layout T1 (the one intended to be more legible) than when using text layout T2 (the one intended to be of medium legibility).

In relation to the question and answer sheet layout, the failure of Experiment 1 to show significant differences in performance was unexpected. However, although no statistically reliable evidence was provided, we can see from the data that there was a trend toward faster performance with Q1, the question and answer sheet layout intended to be more legible. Perhaps the absence of a significant result for the question and answer sheet layout was related to the short time participants needed to spend on the question and answer sheet when compared to the time spent on the text. This argument that the failure to find an effect was due to the short time spent using the document has been raised in other experimental studies, for example, Foster and Bruce (1982, p. 147). This issue was, therefore, investigated in Experiment 2.

The results of Experiment 2 were not exactly the same as Experiment 1. The most interesting finding in this experiment is the significant superiority in accuracy of both text and question and answer sheet layouts conforming to legibility guidelines – T1 and Q1 respectively. Furthermore, it seems that the nature of the task used in Experiment 2

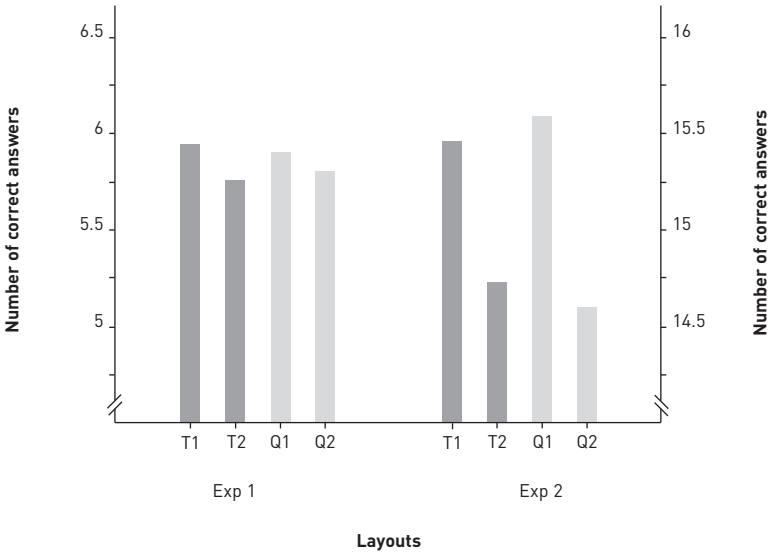


T1 – text layout intended to be most/more legible
T2 – text layout intended to be of medium legibility
T3 – text layout intended to be least legible

Figure 7. Comparison of the effects of text layout on performance across Lonsdale *et al.*'s (2006) experiment and Experiment 1. In the two experiments participants were asked to perform as quickly and accurately as possible. The significant differences in task time between text layouts T1 and T2 continue to be observed in Experiment 1. Note that in Experiment 1 the layout intended to be least legible – T3, was not included for comparison

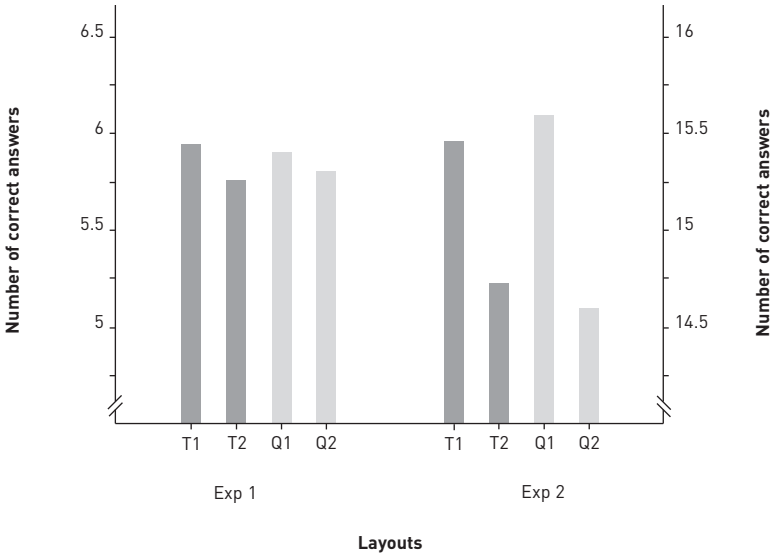
has revealed differences in performance between question and answer sheet layouts, probably by ensuring that participants spent more time on the question and answer sheet.

In Experiment 2, the superiority of the text layout conforming to legibility guidelines (T1) was in terms of accuracy and not speed, contrary to Experiment 1 (Figures 8 and 9). The superiority of the question and answer sheet layout conforming to legibility guidelines (Q1) was also in relation to accuracy and efficiency but not speed. It may be the case that the inclusion of a new set of matching questions, and the high number of questions, increased the possibility of revealing differences in terms of accuracy, which did not happen when there was only one set of seven matching questions. At the same time, when confronted with a high number of questions and two sets of questions requiring slightly different answering processes, participants may have decided to compromise on the time taken in order to read the text and answer the questions as accurately as possible. This may have lead them to spend a similar amount of time overall. Consequently, no significant differences in task time were shown for neither text layout nor question and answer sheet layout.



T1 – text layout intended to be more legible
T2 – text layout intended to be of medium legibility
Q1 – question and answer sheet layout intended to be more legible
Q2 – question and answer sheet layout intended to be of medium legibility

Figure 9. Comparison of the effects of text layout and question and answer sheet layout on task accuracy across Experiments 1 and 2. The figure shows that the inclusion of a new set of matching questions and an increase in the total number of questions did reveal significant differences in task accuracy between text layouts and question and answer sheet layouts.



T1 – text layout intended to be more legible
T2 – text layout intended to be of medium legibility
Q1 – question and answer sheet layout intended to be more legible
Q2 – question and answer sheet layout intended to be of medium legibility

Figure 9. Comparison of the effects of text layout and question and answer sheet layout on task accuracy across Experiments 1 and 2. The figure shows that the inclusion of a new set of matching questions and an increase in the total number of questions did reveal significant differences in task accuracy between text layouts and question and answer sheet layouts.

In addition, in Experiment 2 effects were found for more of the measures with the question answer sheet layout than with the text layout. For question and answer sheet layout there were significant differences in both accuracy and efficiency, but for text layout the significant differences found were just in accuracy. A question and answer sheet with two different sets of matching questions instead of one is structurally more complex than a text passage, which places greater demands of time and concentration upon participants. Therefore, if more time and concentration is required on the question and answer sheet than on the text, it is more likely that effects are found for more of the measures with the question and answer sheet layout than with the text layout.

As for Experiment 3, the significant difference in accuracy between the two question and answer sheet layouts, and the lack of a difference between text layouts, were as expected. Participants performed best with the question and answer sheet layout conforming to legibility guidelines – Q1. Moreover, there was no interaction between text layout and question and answer sheet layout.

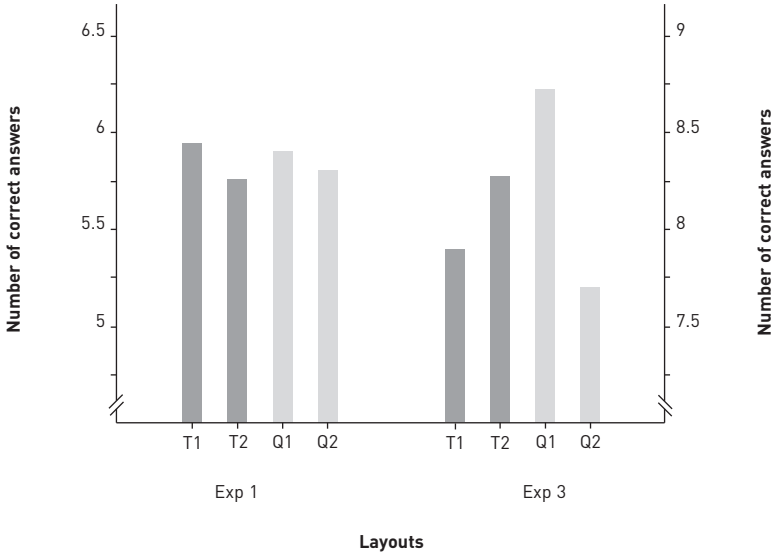
It is possible that with a very short time allowed for the task, together with the complexity of the question and answer sheet, a lot more time was spent on the question and answer sheet than on the text. Therefore, this might account for why only question and answer sheet layout showed a significant effect. In fact, during the experiment it was observed that in each individual session participants spent a considerable amount of time on the question and answer sheet, leaving little time to go through the text.

In conclusion, it seems that the greater the number of questions and the more stringent the time pressure, the greater the likelihood of finding an effect of question and answer sheet layout on accuracy, but not an effect of text layout (Figure 10).

Moreover, it appears that similar results are found whether imposing a time limit or asking participants to read as quickly and accurately as possible. Therefore, the method used to impose time pressure in the previous experiments (i.e. an instruction to perform as quickly and accurately as possible) can be considered a valid method.

It is also of interest that there was no interaction between text layout and question and answer sheet layout in any of the three experiments. This means that one did not affect the other, i.e. they were independent.

Therefore, in the particular context of these experiments, combining text and question and answer sheet layouts conforming to legibility guidelines did not result in better performance than when combining the same text layout with a question and answer sheet layout of medium legibility. Moreover, combining a text of medium legibility with a question and answer sheet layout conforming to legibility guidelines did not result in better performance than when combining the same text layout with a question and answer sheet layout also of medium legibility.



T1 – text layout intended to be more legible
T2 – text layout intended to be of medium legibility
Q1 – question and answer sheet layout intended to be more legible
Q2 – question and answer sheet layout intended to be of medium legibility

Figure 10. Comparison of the effects of text layout and question and answer sheet layout on task accuracy across Experiments 1 and 3. In Experiment 3 the number of questions and time pressure were greater than in Experiment 1. When these two variables were changed, the only significant difference in task accuracy was in the question and answer sheet layout.

In Experiment 1 participants favoured text layout T1, the one intended to be more legible, because of the generous interlinear space and clear separation of paragraphs. This reinforces Lonsdale et al.'s (2006) suggestion that the effect of text layout on performance is most likely to be caused specifically by these two typographic features. Moreover, in all three experiments participants agreed that layout Q1 (the one intended to be more legible) made it easier to answer the questions than

layout Q2 (the one intended to be of medium legibility). Participants described layout Q1 as being clearer and easier to read and fill in, mainly because of the generous space between the questions and the existence of a space to write the answers. This suggests that the manipulation of interlinear space and the inclusion of an answer space in the question and answer sheet are the features most likely to account for differences in performance.

5 Conclusion

Looking at the results of the three experiments reported in this paper, together with the results of Lonsdale et al.'s (2006) experiment testing the effects of text layout on performance, it is possible to conclude that:

- Significant differences in performance between typographic layouts were always found (in at least one measure), despite the fact that time pressure, number of questions, type of questions, individual or group testing, differed across experiments.
- When there were differences, performance was always better with the layouts conforming to legibility guidelines.
- Participants' judgements on the ease of locating the answers and the ease of answering the questions reflected their performance.
- Participants favoured the text and question and answer sheet layouts conforming to legibility guidelines.
- In their judgement on the layouts, participants mentioned space more than any other typographic feature as contributing to a clear typographic structure and aiding the completion of the task (e.g. interlinear space, space between paragraphs, space within the list of questions, space within the list of answers).

Therefore, the general conclusion is that text and question and answer sheet layouts displaying a combination of typographic features intended to improve legibility, support efficient search reading and answering of questions, and are preferred by readers. Participants' comments further suggest that the interlinear space, separation of paragraphs, and space to write the answers are the typographic features most likely to be causing the effect of text layout and question and answer sheet layout on performance. To elucidate this suggestion further systematic investigation needs to be conducted.

It is also interesting to note that participants frequently underlined key words in the text and questions to help them locate the information and

complete the task efficiently. Such evidence reinforces the suggestion made in the beginning of this paper that the effect of typographic layout on performance might occur at the perceptual level of reading. Specifically, typographic layout might affect performance when candidates: 1) read the questions and instructions; 2) locate specific information in the text; 3) check back with the question being answered; 4) write down the answer; 5) double check back with the text. At these five stages of the reading and answering process, a less legible examination layout (text and question and answer sheet) can make it difficult for candidates to complete the reading tasks quickly and accurately.

In sum, the study reported here, together with Lonsdale et al.'s (2006) study, provide useful information in relation to an important aspect of education, that of examinations. Even if there is not yet sufficient evidence to design 'ideal' typographic layouts for English language reading examinations, the results of these studies encourage a more rational approach. Once more there is evidence showing that performance in a reading examination can be affected by the text and question and answer sheet layouts used. Consequently, the validity and reliability of the examination can be compromised since the measurement of performance is confounded with typographic legibility. Designers of examinations should, therefore, take this into consideration in order to construct valid and reliable examination materials. Moreover, such evidence makes examination boards aware of the importance typography has for a fair and efficient assessment.

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Her research is notable in the field of typography and graphic design, as it involves experimental studies to test design solutions to particular problems encountered in real-life materials. It focuses on the effects of typographic and graphic design on user's performance.

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Appendices

Appendix 1. Example of a passage and corresponding 'matching-questions' used in the experimental study.

READING PASSAGE

*You should answer **Questions 1-20**, which are based on the reading passage below, as quickly and accurately as possible.*

Handedness in humans – What causes it?

Why do humans, virtually alone among all animal species, display a distinct left or right-handedness? Not even our closest relatives among the apes possess such decided lateral asymmetry, as psychologists call it. Yet about 90 per cent of every human population that has ever lived appears to have been right-handed. Professor Bryan Turner at Deakin University has studied the research literature on left-handedness and found that handedness goes with sidedness. So nine out of ten people are right-handed and eight are right-footed. He noted that this distinctive asymmetry in the human population is itself systematic. 'Humans think in categories: black and white, up and down, left and right. It's a system of signs that enables us to categorise phenomena that are essentially ambiguous.'

Research has shown that there is a genetic or inherited element to handedness. But while left-handedness tends to run in families, neither left nor right handers will automatically produce off-spring with the same handedness; in fact about 6 per cent of children with two right-handed parents will be left-handed. However, among two left-handed parents, perhaps 40 per cent of the children will also be left-handed. With one right and one left-handed parent , 15 to 20 per cent of the offspring will be left-handed. Even among identical twins who have exactly the same genes, one in six pairs will differ in their handedness.

What then makes people left-handed if it is not simply genetic? Other factors must be at work and researchers have turned to the brain for clues. In the 1860s the French surgeon and anthropologist, Dr Paul Broca, made the remarkable finding that patients who had lost their powers of speech as a result of a stroke (a blood clot in the brain) had paralysis of the right half of their body. He noted that since the left hemisphere of the brain controls the right half of the body, and vice versa, the brain damage must have been in the brain's left hemisphere. Psychologists now believe that among right-handed people, probably 95 per cent have their language centre in the left hemisphere, while 5 per cent have right-sided language. Left-handers, however, do not show the reverse pattern but instead a majority also have their language in the left hemisphere. Some 30 per cent have right hemisphere language.

Dr Brinkman, a brain researcher at the Australian National University in Canberra, has suggested that evolution of speech went with right-handed preference. According to Brinkman, as the brain evolved, one side became specialised for fine control of movement (necessary for producing speech) and along with this evolution came right-hand preference. According to Brinkman, most left-handers have left hemisphere dominance but also some capacity in the right hemisphere. She has observed that if a left-handed person is brain-damaged in the left hemisphere, the recovery of speech is quite often better and this is explained by the fact that left-handers have a more bilateral speech function.

In her studies of macaque monkeys, Brinkman has noticed that primates (monkeys) seem to learn a hand preference from their mother in the first year of life but this could be one hand or the other. In humans, however, the specialisation in function of the two hemispheres results in anatomical differences: areas that are involved with the production of speech are

usually larger on the left side than on the right. Since monkeys have not acquired the art of speech, one would not expect to see such a variation but Brinkman claims to have discovered a trend in monkeys towards the asymmetry that is evident in the human brain.

Two American researchers, Geschwind and Galaburda, studied the brains of human embryos and discovered that the left-right asymmetry exists before birth. But as the brain develops, a number of things can affect it. Every brain is initially female in its organisation and it only becomes a male brain when the male foetus begins to secrete hormones. Geschwind and Galaburda knew that different parts of the brain mature at different rates; the right hemisphere develops first, then the left. Moreover, a girl's brain develops somewhat faster than that of a boy. So, if something happens to the brain's development during pregnancy, it is more likely to be affected in a male and the hemisphere more likely to be involved is the left. The brain may become less lateralised and this in turn could result in left-handedness and the development of certain superior skills that have their origins in the left hemisphere such as logic, rationality and abstraction. It should be no surprise then that among mathematicians and architects, left-handers tend to be more common and there are more left-handed males than females.

The results of this research may be some consolation to left-handers who have for centuries lived in a world designed to suit right-handed people. However, what is alarming, according to Mr Charles Moore, a writer and journalist, is the way the word 'right' reinforces its own virtue. Subliminally he says, language tells people to think that anything on the right can be trusted while anything on the left is dangerous or even sinister. We speak of left-handed compliments and according to Moore, 'it is no coincidence that left-handed children, forced to use their right hand, often develop a stammer as they are robbed of their freedom of speech'. However, as more research is undertaken on the causes of left-handedness, attitudes towards left-handed people are gradually changing for the better. Indeed when the champion tennis player Ivan Lendl was asked what the single thing was that he would choose in order to improve his game, he said he would like to become a left-hander.

Geoff Maslen

Questions 1-11

The Reading Passage describes a number of persons and their opinions. Match each person (A-F), with his/her opinion (1-11).

Write the appropriate letter **(A-F)** *next to the numbers 1-11 below.*

NB *There are fewer persons than opinions. So, you may use some persons more than once.*

1 Human beings started to show a preference for right-handedness when they first developed language.
2 Society is prejudiced against left-handed people.
3 Boys are more likely to be left-handed.
4 After a stroke, left-handed people recover their speech more quickly than right-handed people.
5 Our attitudes to left-handed people are changing gradually for the better.
6 Asymmetry is a common feature of the human body.
7 Monkeys do not show a species specific preference for left or right-handedness.
8 It can be the case that forcing left-handed children to use their right hand provokes problems of speech like stammer.
9 Left-handed people have undergone hardship for years.
10 People who suffer strokes on the left side of the brain usually lose their power of speech.
11 The two sides of the brain develop different functions before birth.

PERSONS
A Dr Broca
B Dr Brinkman
C Geschwind and Galaburda
D Charles Moore
E Professor Turner
F The writer

Appendix 2. Example of the second set of 'matching-questions' used in the expermental study.

Questions 12-20

Complete the sentences below. Choose your answers from the box at the bottom of the page and write them in the spaces provided in each question.

NB *There are more words than spaces. So, you will not use them all.*

12 Left-handers tend to be more common among ..... and architects.
13 Left-handed people can quite often recover speech better because they have a more ..... speech function.
14 Different parts of the brain ..... at different rates.
15 Nine out of ten people are right-handed and eight are .....
16 The majority of left-handed people have their language centre in the ..... hemisphere.
17 Every brain is initially ..... in its organisation.
18 Areas of the hemisphere connected to the production of speech are usually ..... on the left side than on the right.
19 A boy's brain develops somewhat ..... than that of a girl.
20 Among identical twins,..... in six pairs will differ in their handedness.

LIST OF WORDS

unilateral	right	female
mature	male	left
faster	narrower	one
right-footed	slower	left-handed
two	physicians	think
mathematicians	larger	bilateral