Typographic Emphasis of Headings:

Methods of typographic emphasis to assist with search of unfamiliar and familiar text

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Abstract

Readers use headings to understand the structure and content of a text, and to locate information. Readers understand the structure of a text by building an understanding of the structure of the content through developing relationships between the sections of content. Headings assist readers with both their comprehension of text as well as assisting them with recall of the content. Headings provide signals to readers to aid navigation of a document by indicating the structure of topics. This helps readers to locate information both through signalling the content of text that may be unfamiliar or providing markers to assist with the recall of the location of information in a familiar text.

The importance of headings is known; however, little research exists to indicate how these important organisational features of text should be presented visually. This research was undertaken to fill this gap in our understanding of how headings can assist readers. Five studies were carried out to investigate which heading emphasis methods are most easily identified within a passage of text and which of these methods best assist readers with searching text.

An initial survey of current practice for emphasising headings revealed that there are six main methods for emphasising headings and these are often used in combination with each other to create stronger emphasis. It was also revealed that the presentation of headings in the same publication across print and digital formats is often inconsistent. This survey was used to help inform which heading emphasis methods were used in the paired comparison studies to test for ease of identification.

Three paired comparison studies were then undertaken to establish which methods of typographic emphasis are most easily identified within a passage of text. These studies

compared seven individual typographic emphasis methods with each other in print and on screen then compared five combinations of typographic emphasis methods in print and on screen. These studies found that emphasis methods with the greatest visual weight were the most easily identified.

The most easily identifiable heading emphasis methods were then evaluated in search tasks to evaluate which of the four heading styles provided the most assistance when searching for answers in a screen-based text. This research showed that when headings are emphasised using styles that combine two heading emphasis methods they are easier to distinguish from the body copy surrounding them. These more easily identifiable headings are more useful to readers when they are searching for information in a text, both when the text is unfamiliar and when it is familiar.

When bold is combined with either an increase in size or a sans serif typeface to create a heading, readers are able to more quickly and accurately find information within a document, whether that text is unfamiliar or familiar.

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Headings in this Thesis

The research presented in this thesis investigates the presentation of headings in documents. While this thesis focussed on a single level of headings in a document, there was a need to develop a hierarchy of headings for a document like this.

The lowest heading level was decided first, level 4 headings are distinguished from the body copy (10-point Palatino), through a change to a Bold Sans Serif typeface at the same size as the body copy, 10-point Helvetica Neue Bold.

The next level of headings was differentiated from the lower level of headings by introducing the typographic emphasis method of size. Level 3 headings are set in 12-point Helvetica Neue Bold.

Level 2 headings are given greater emphasis though a greater increase in size and are set in 16-point Helvetica Neue Bold.

Chapter titles, level 1, are set in 24-point Helvetica Neue Bold with the accompanying numerals 72-point Helvetica Neue Bold.

The spacing above headings is greater than the spacing below and is proportional to the line spacing of the document.

Hopefully all of the headings can be identified with ease and assist with searching the document whether it is unfamiliar or familiar to you.

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1 Introduction

The structure of a text can be conveyed by both implicit and explicit means. The visual presentation of a text structure is through the headings used to signal the content of the text. Headings as visual markers in text perform many functions: signalling the structure of a text, assisting readers with understanding the content and indicating the hierarchy of information. This research focuses on the impact that the typographic emphasis methods used for headings has on the search of documents. The visual appearance of typography influences the ease with which we read as well as how we perceive the structure of the content of the document. This thesis intends to develop a better understanding of how those headings should be presented to be useful for readers. The structure of a text should be effectively revealed through heading construction and presentation (Williams & Spyridakis, 1992).

Headings provide a visual hierarchy to the reader and the effectiveness of this hierarchy depends strongly on the degree of emphasis placed on the headings through typographic variation. Several methods can be used to create typographic emphasis, most commonly scale, weight, capitalisation, spacing, italicisation and position (Hill, 2010).

This chapter provides an overview of the research area and information about the motivation for conducting this research from both an academic and a real-world perspective. It then identifies the thesis statement and hypothesis, and explains the research questions and how they will be answered in the content of the thesis. The scope of the research is then explained and finally a summary of the structure of the thesis is provided.

1.1 The Need for Headings Research

Researchers have investigated how the visual signalling of text structure affects aspects of reading such as search, comprehension, and recall (Hartley, 1982; Jonassen & Kirschner, 1982; Klusewitz & Lorch, 2000a; Lorch & Lorch, 1996; Meyer, Brandt, & Bluth, 1980; Waller, 1979a). However, little research exists to examine how best to visually signal document structure through the visual presentation of textual information, specifically through the typographic presentation of the headings. Headings assist readers with locating information in text; Hartley and Jonassen (1985) describe this purpose as "one of the most obvious functions of headings" (1985, p. 246) and they speculate that this is the reason the area is least researched. The visual hierarchy provided through typographic emphasis of headings in a text provides clarity by making the structure easy to identify (Ambrose & Harris, 2010) and consequently assists with search and location of information within a document. The visual structure of a text supports navigation of the information and assists readers with locating information within that text. This thesis examines how best to present headings through typographic means to assist readers with search of text.

1.1.1 The Use of Headings

The task of searching a text is a type of strategic reading that is motivated by the need for specific goal-related information (Dreher & Sammons, 1994). Many workplace activities involve reading to locate specific information (Dreher, 1993) and in many workplaces this is the main purpose of reading (Dreher & Sammons, 1994).

Reading to locate information is different from reading for comprehension. When searching readers will often skip what appears to be irrelevant information and focus on where they think they are likely to fulfil their search goals (McGoldrick, Bergering, Martin, & Symons, 1992). As well as indicating the structure of a text, headings are a visual reference for readers to help direct them to content which they are looking for (Jennett, 1973). The appearance of these headings may have an influence on how effectively a reader's attention is drawn to those textual markers to direct them to content and assist them with their search goals.

Conventions for typesetting are ever changing as the technology used for typesetting develops and consequently the methods available to create variation and emphasis within the text also changes. The movable metal type of letterpress restricted printers as the weights and sizes available were limited to those that the printer had on hand. Hot metal typesetting followed, and then Phototypesetting, which provided a wider range of formatting opportunities. Digital typesetting and desktop publishing have now provided

an even more extensive range of methods for creating typographic variation in a document. These changes in convention have meant that a greater variety of methods for creating emphasis on headings are available to the typesetter.

1.1.2 Motivation

Until the late 1970s there was little research into the graphic organisation of text and its implications (Hartley & Trueman, 1985; Waller, 1982b). Since this research by Hartley and associates in the 1970s and 80s the most rigorous research into the implications of text structure signalling, especially headings, has focused on the implications that heading content and positioning have on comprehension related tasks. Hartley and Jonassen (1985) point out that that research into headings does not tell us which kinds of heading are most effective, how frequently headings should be used in different situations, where headings should be placed or how they should be presented typographically. In the 32 years since this article was published there are still few studies that have been conducted to provide adequate research to help guide text designers.

While some understanding about how headings and searching for information in texts may be able to be drawn from research involving headings and comprehension, "reading to comprehend and locating information are psychometrically distinct" (Symons & Pressley, 1993, p. 251). Dreher and Guthrie (1990) agree that cognitive processes required for reading comprehension seem to be different to those needed when searching for information. There is also little evidence regarding the effects of familiarity with a text on search effectiveness. "Although there are no reports of the effects of prior exposure to a text on text search, there is extensive literature on repeated reading of text" (Klusewitz & Lorch, 2000a, p. 667). However, much of the literature on repeated reading of a text measures the resulting recall or comprehension that a reader has, rather than considering how a reader's need for visual hierarchy of headings to assist with search may change as they become more familiar with a document. "Few studies have assessed the effect of different physical dimensions of headings" (Williams & Spyridakis, 1992, p. 65). Dreher and Guthrie (1990) acknowledge that text search is a distinctly different task to prose recall and has not been well researched. In their article "*Effects of headings on Text Recall and Summarization*" Lorch and Lorch claimed that "labelling and emphasising a familiar topic by use of a heading is unlikely to substantially increase the accessibility of the topic" (1996, p. 263); this statement was in regard to recall of information rather than the locating of information in a familiar text.

Waller (1979a) believes that there are strongly practical reasons for investigating the link between the behavioural aspects of the reading process, and formally analysing the way

that texts are structured. He advocates that since readers are active participants in the reading process then there needs to be investigation into methods of text presentation that support their selective sampling behaviour. The search of text requires easily identifiable markers to signal the content as readers use headings to locate information (Kools, Ruiter, van de Wiel, & Kok, 2008). Headings are just one of the typographic access structures that Waller (1979a) believes needs to be presented in a logical and consistent manner to best signal the structure of the text to readers. There are many complex factors, such as type size, line length, line spacing, typeface, text colour and the interaction between all of these factors, which contribute to the ease with which text is read (Winn, 1993).

1.2 Hypothesis and Research Questions

The primary aim of the research presented in this thesis is to understand which methods of typographic emphasis for headings best assist with search in unfamiliar and familiar texts.

It is hypothesized that headings which are more strongly emphasised are perceived by readers as being more easily identifiable from their surrounding text and therefore more effective in assisting with searching text. The importance of strong typographic emphasis will be more important for readers searching an unfamiliar text, than a familiar one. Bold, as a heading style, will be the most effective typographic method for emphasising a heading when used in combination with other emphasis methods.

In order to explore this hypothesis, three focusing questions were developed to understand which heading emphasis methods should be considered, whether multiple heading emphasis methods were more easily identified, and to what extent the methods of heading emphasis assist the search of text. These three research questions were:

1. Which methods of typographic emphasis make a heading easiest to identify within a passage of text?
2. Are headings that are emphasised by combining two methods of typographic emphasis more easily identified than single emphasis methods within a passage of text?
3. Do more-easily-identified headings increase the speed of searching in unfamiliar text and familiar text?

These three research questions and their contribution to this thesis are discussed in more detail below. The first two questions are intended to establish a basis for answering the third question and consequently the overall thesis question.

1.2.1 Which methods of typographic emphasis make a heading easiest to identify within a passage of text?

This question aims to gain an understanding of which forms of typographic emphasis are best used to assist with distinguishing a heading from the body copy surrounding them. While established typographic practice provides guidelines, few studies have investigated the relative merits of different typographic methods for identifying headings in text or signalling its structure. To determine which methods of typographic emphasis headings should be considered, a survey of current practice for emphasising headings is undertaken (see Chapter 4), and information about typographic practice and related research that was taken into account (Chapters 2 and **Error! Reference source not found.**). A paired comparison study of the most commonly used methods for emphasising headings creates a ranking, to understand which heading styles are easiest to identify within a passage of text, by a general population (see Chapter 5), and amongst those that have graphic design knowledge (see Chapter 6).

1.2.2 Are headings that are emphasised by combining two methods of typographic emphasis more easily identified than single emphasis methods within a passage of text?

This question extends the findings of Research Question 1 to ask whether creating stronger emphasis of headings by combining methods of typographic emphasis makes headings easier to identify. Creating stronger emphasis of a heading by using two typographic emphasis methods is likely to create headings which are more distinct textual markers, therefore more clearly showing the structure of the text (Black, 1990). Greater ease of identification is likely to better assist readers with using headings for search as clearer headings will mean they are faster and easier for readers to find. A paired comparison study is again used to rank headings for ease of identification where combinations of two methods of typographic emphasis are used to emphasise headings (see Chapter 7).

1.2.3 How does the degree of typographic emphasis for headings influence search of unfamiliar and familiar text?

The purpose of this question is to understand which methods of emphasising headings are most beneficial to readers when they are searching a text and whether that changes

depending on if the text is unfamiliar or familiar. Previous research regarding headings as indicators of structure generally focusses around their influence on comprehension or recall which requires distinctly different processes from the reader than searching for information (Symons & Pressley, 1993). Research by Klusewitz & Lorch (2000a) revealed that readers search differently and their search speed increases as they become more familiar with a text. To investigate Research Question 3, knowledge gained from the investigations to answer Research Questions 1 and 2 was considered, and information from Chapter 2 and **Error! Reference source not found.** was used to inform the design of the study. The final study, presented in Chapter 8, is a series of information search tasks in unfamiliar and familiar texts to understand whether the typographic emphasis methods which people find easiest to identify assist with search speed in texts that are unfamiliar and familiar.

1.3 Scope of This Thesis

The broad term of 'headings' is used in multiple contexts for devices which give the title of the document, introduce the content of a sub-section or provide orientation information in the top or bottom margin of the page. Headings are typographic cues provided in documents to act as devices for accessing or signalling information. The term 'heading' used in the context of this research is a textual marker dividing the text into sub-sections. The textual devices known as headings in this document, appear within the run of text between paragraphs and can serve multiple purposes for the reader. They provide visual references to indicate structure and provide contextual information to the reader about the content of the paragraphs that they preceed. Within other literature the device called a heading, as defined for this research, is often also referred to as; a crosshead (Ambrose & Harris, 2010), a sub-heading/subheading (Lewis, 2007; Mitchell & Wightman, 2005), sub-head/subhead (Bosler, 2012; Craig, Bevington, & Scala, 2006; Jennett, 1973) a section heading (Williamson, 1983), or an internal subhead or breaker head (White, 1999). For the purposes of this research the focus will be on documents with a single level of headings.

The two functions of headings that Hartley and Jonassen (1985) define are the purposes that this research is concerned with attempting to facilitate. The first function they describe, *encoding*, is headings assisting readers with organising and understanding the structure of the text to encode the information from the text into memory. The second purpose of headings, *access*, is assisting readers with locating information, both when they are searching text that is unfamiliar to them and when they are retrieving information from a text that is familiar. The encoding process involves headings helping readers relate the

content of the text to their prior knowledge, clarifying the text structure and creating contextual cues for future recall. The access function of headings assists readers with locating information in a new text by providing structural cues relating to the content. They then also assist with retrieval, both in locating information in a familiar text using the structural cues that headings provide and in recall, retrieving information stored in memory. The research in this thesis is primarily concerned with the access that headings provide, both the new, unfamiliar text and retrieval from familiar text.

Within the context of this research, the phrase 'typographic emphasis' is used to describe any change to the appearance of typography in order to increase the hierarchy of that portion of text over that which surrounds it. This hierarchy in typography can be created using a variety of different methods which Cullen (2012) divides into three categories of typographic emphasis which include eleven basic typographic variations. The first grouping of methods for variation is 'typographic' and this includes; point size, style (posture, weight, width), typeface combinations, case distinctions and baseline shifts. The second group of methods for creating hierarchy is 'spatial' and includes; spacing (kerning, tracking, leading), orientation and position. The third category is 'graphic' these methods for creating typographic emphasis are; line, shape and colour. Hierarchy in text acts as a visual guide to the organisation of the text content. Variation in point size and style are used to indicate degrees of importance. The complexity of the text hierarchy should not be overly complex as it can be distracting (Ambrose & Harris, 2005).

One of the aspects that this research seeks to understand is if there is a difference between the effect of heading emphasis method between a document that a reader has never seen before and a document that the reader has previously read. The distinction between these situations can be referred to as the text being unfamiliar to the reader, or familiar to the reader. Hartley & Trueman (1985), in relation to their own studies, discuss search as an activity where the reader has not previously read the text, and retrieval as an activity when the reader has previously read the text and is familiar with it to some extent. The nature of the task changes for the reader if they are searching for information within a text that they are unfamiliar with or whether they are retrieving information from a text they have previously sighted or read.

The degree of familiarity with a text or document is likely to have an effect on the search of a document and the appearance of headings may support this. However, it is not proposed that the degree of familiarity is addressed within the scope of this current research. Therefore, within this research a text that has not been sighted or read by the

reader will be referred to as an unfamiliar text, and a text that has already been read will be referred to as a familiar text.

1.4 Thesis Structure

The content of this thesis is structured into four main sections covered in nine chapters. Chapters 2 provides contextual and background information. Chapter 3 provides information about related research. Chapter 4 presents the information from a survey of current typographic practice. Chapters 5 and 6 give details of a series of two related studies run to understand which styles of typographic emphasis are easiest to distinguish for the body copy surrounding them. Chapter 7 then uses the findings from Chapters 5 and 6 to investigate whether combining two heading emphasis methods creates more easily identified headings than single methods of emphasis. Chapter 8 describes Study 3, the major study conducted for this thesis, examining different heading styles in a search situation. Chapter 9 then draws conclusions from all three studies and recommends future work. The content of these chapters is explained below.

Chapter 2: In this chapter, information about established typographic practice and recommendations for heading presentation are discussed in this chapter to provide background to the research. Explanation is given regarding how the legibility of typography influences reading and how typographic features can be used to create hierarchy and emphasis.

Chapter 3: This chapter discusses previously conducted research on document search and established typographic practice for headings. Specifically, the importance of visual cues for indicating document structure, how document structure is used to facilitate information search and how headings are used to highlight the structure of a text is discussed.

Chapter 4: This chapter presents a survey of current practice for typographic emphasis of headings in academic publications. Comparison is made between print and screen versions of identical publications to understand changes in the presentation of document structure between the two reading environments.

Chapter 5 & 6: The results of the first study are reported in these two chapters, looking at which typographic methods are easiest to identify within a passage of text. Seven different heading styles are compared in both print and screen by participants representing a general population. The same heading styles are also presented in print to a group of

participants with education and/or experience in graphic design. These chapters provide insight to answer Research Question 1.

Chapter 7: This chapter extends the findings of Chapters 5 and 6 by reporting the results of investigations into headings where two typographic emphasis methods are combined. Five heading styles are compared in print and screen presentations in the same study design as was used for the comparisons conducted in Chapters 5 and 6. The findings from this chapter provide answers to Research Question 2.

Chapter 8: This chapter reports on the major study that was developed to investigate which typographic methods are most useful to readers when searching for answers in texts that are unfamiliar and familiar. This study was conducted on screen, comparing four typographic styles of heading emphasis and provides answers to Research Question 3.

Chapter 9: This final chapter summarises the findings from the series of studies reported on in this thesis. This chapter presents conclusions regarding how typographic emphasis of headings assists in searching unfamiliar and familiar texts. The contributions that this thesis makes to research regarding the visual appearance of headings and their role in assisting readers is also discussed here. Finally, this chapter discusses potential future research to build on current findings.

2

Typographic Principles and Theory

The majority of the knowledge and recommendations for how headings should be presented in text has been developed by typographers over many years; it is primarily intuitive and concerned with the aesthetic aspects of the printed page; however, little of this is supported by empirical research. Despite typographic research and practice often providing different recommendations, both make a valuable contribution to advancing our understanding of typographic features and their relationships (Lonsdale, 2014).

In this section background is provided to give definitions and context for typographic ideas discussed in this thesis. An overview is given of the way the design and layout of typography influence the legibility of text and therefore, reading. This section also provides descriptions for terms specific to typography such as, typographic hierarchy and typographic colour/weight. It discusses the importance of typographic hierarchy and the emphasis methods that can be used to indicate that typographic hierarchy in a text, especially through the signalling of headings. The specific methods of typographic emphasis for headings that are discussed and the recommendations for their use are; changes in typeface, size, weight, italic, vertical spacing, capitalisation and horizontal position.

2.1 How Typography Influences Reading

Text layout for legibility is influenced by a wide number of factors that are all interrelated; "the ease with which text is read is affected in complex ways by such factors as type size, line length, the amount of space between lines, type and background color, and level of illumination" (Winn, 1993, p. 108). The characteristics of all typographic elements in a

document are interrelated and therefore, when we consider one aspect of typographic appearance, we must also consider the relationship it has to all other typographic elements. To create text with good legibility, decisions regarding the characters, spacing and configuration of the text all need to be considered in relation to each other (Lonsdale, 2014). By conducting thorough investigations into the legibility of typography, Burt (1959) found that many typographic characteristics interact to contribute to the overall legibility of text. These characteristics include; typeface design, size, line spacing, column width and margin size. His studies also found that adults with normal vision are tolerant of slight variations to what is optimal without adversely impacting efficiency of reading.

The x-height of a typeface largely determines the perceived size of a font (Mitchell & Wightman, 2005). The size of type may be the most important factor in determining legibility (Huey, 1908). In a typeface, the x-height is the distance between the baseline and midline, which is approximately the height of the lowercase 'x'. The relationship between the relative proportion of the x-height to the cap height and the ascender and descender height varies between typefaces (Bringhurst, 2004). Burt (1959) recommends that for general reading purposes the x-height of text should be approximately 1.52mm, which is approximately equivalent to 10-point Times New Roman and is most satisfactory with 2 points of leading , but the optimal column width and margins size can vary depending on the purpose of the writing. The extent to which this variation in text size influences legibility was discovered in speed of reading studies conducted by Paterson and Tinker (1940), where type that was 9, 10, 11 and 12 point was read the fastest, with 11 point type rated by readers as being the most legible, closely followed by 10 and 12 point.

Text for continuous reading should be set in lowercase as it is considered more legible than all capitals, and capitalised text is read 11.8 percent slower than lowercase text (Tinker & Paterson, 1928). Paterson and Tinker (1940) provide three reasons for why text set in all capitals has poor legibility. As well as taking up more printing surface, and people being more familiar with reading lowercase, text set in all capitals lacks the important cue of "word form". This means that readers see the shape that the word makes as a solid rectangle, rather than seeing the varied shape of a word that is created with lowercase with the ascenders and descenders providing greater variation in shape and making it easier to read the letters. Spiekerman (2003) explains that the primary identification of words comes from the reader scanning the shape made by the letters that compose the words, especially the ascenders and descenders. They combine this information with fixations on individual letters to 'read' the text.

2.1.1 Typographic Hierarchy

The hierarchical structure of a text and how this structure is shown is crucial for readers to easily get an overview and find information easily (Kools et al., 2008). Visual hierarchy assists the delivery of the message by indicating to the viewer the order which an arrangement of visual elements should be viewed. This order of visual importance can be created by varying the scale, placement, colour and spacing as well as other visual characteristics in relation to each other (Bosler, 2012; Lupton & Phillips, 2015). "A hierarchy helps to make a layout clear, unambiguous and easy to digest" (Ambrose & Harris, 2010, p. 130). Visual hierarchy assists with establishing the varying degrees of importance of objects (Bosler, 2012).

Hill (2010) suggests that visual hierarchy in text can be created through the use of several typographic devices. Position, weight, scale, case and italicisation are the forms of typographic variation that Hill recommends for creating visual differentiation between text elements to establish a hierarchy of information. Typographic hierarchy is created through changes in size, style, spacing, weight and alignment to assist readers in understanding the relative importance of different aspects of the text (Lupton & Phillips, 2015). Ambrose and Harris (2010) explain typographic hierarchy as a "logical and visual way to express the relative importance of different text elements by providing a visual guide to their organisation" (p.130). When creating a typographic hierarchy, the title is typically the largest and boldest typography to indicate it is the most important. The weight of the subtitle is then generally slightly lighter in weight to distinguish it as being subordinate to the title while ensuring it is still prominent (Ambrose & Harris, 2010).

Hierarchy within a document creates relationships between textual elements as well as providing focus and visual interest (Cullen, 2012). "In text, attention is drawn to words or passages that stand in contrast to the rest of the body of text" (Winn, 1993, p. 105). When considering perception in layout similar characteristics should be used to show that objects belong together. The amount of space between objects will also alter the perception of the relationship between them (Pettersson & Tullinge, 2010). "The designer can use spatial and graphic means… to assign qualities to and to display relationships between different components of the text" (Waller, 1982b, p. 137). According to Black (1990) it is recommended that the number of heading levels be limited as this will help to clarify the document structure; limiting the number of levels in a text hierarchy will also increase the speed for discerning the differences between heading levels.

2.1.2 Typographic Colour/Weight

In the introduction to Burt (1959), Stanley Morison explains that the density of the ink on the page (including the size and spacing of characters and words) can be as important to legality as any other typographic variable. The typeface style, size, spacing and the relationship between ink and the surrounding space all contribute to the perceived visual weight of the text (White, 2002). The visual weight or typographic colour of text is not the same as the hue, it is the relative density of the type when set, as opposed to the weight of the typeface, such as bold (Bringhurst, 2004). Variation in visual weight can be created through the use of different fonts within a family. A bold or black version of a typeface will have more visual weight than a regular or light font. Changes in typographic colour in a passage of text can draw attention to words or phrases as a method of emphasis (Bosler, 2012).

2.2 Typography for Headings

Headings serve two functions for readers; they primarily provide orientation for the reader, but also assist with organising content at a global level to assist readers with skim reading to gain an overview of the document (Waller, 1982b). Typographic elements such as headings and subheadings create a break in the rhythm of the text on the page. After the break however, the text should return to its rhythm. This break in rhythm should add life to the page (Bringhurst, 2004).

Headings are used to summarise ideas and are usually emphasised through the use of bold or an increase in size (Glynn, Britton, & Tillman, 1985). Black (1990) recommends that variations in the main text face should be the first choice for creating emphasis in text. But if there is a limitation on available typeface variants, vertical spacing can be controlled to create emphasis, as can adjusting the type size. In contrast to Black, Hartley (1982) advises space is often used as the main variable to clarify structure, and typographic variations (italic, bold, etc.) are used sparingly to enhance the structure and spacing. Heading treatments should be chosen by varying the fewest formatting dimensions to allow for all necessary heading levels (Williams & Spyridakis, 1992). The type of heading used should indicate the degree of importance of the text which follows (Jennett, 1973). Black (1990) explains that there is a fine balance in determining typographic appearance of headings. Emphasis is often necessary to differentiate the heading structure; emphasis should provide clear differentiation, but be as modest as possible and provide good clarity. Fewer formatting dimensions is more useful to readers, as using more variations is likely to lead to confusion (Williams & Spyridakis, 1992). As many levels of headings should be used as

necessary: no more, no less. The more that are used, the more care needs to be taken (Bringhurst, 2004). "Clear differences between elements are easier for readers to remember as they move from page to page" (Black, 1990, p. 28). Black explains this by stating that too many fine distinctions overload the reader. This is also supported by Pettersson & Tullinge (2010) who state that it is important for content to have a clear structure, but the number of levels in the structure should be limited.

To get attention in text using typography, headings can be set in different type versions or use italics, bold or colour to gain attention (Pettersson & Tullinge, 2010). Type that is set differently or has a changed appearance in size, style, colour or spacing will attract attention. The use of typographic variation should be limited however to avoid clutter (Winn, 1993). Using different fonts or colour increases distinction. Capitalisation can also be used (Ambrose & Harris, 2010).

The importance of headings and their place within the heading hierarchy can be indicated size, weight position, spacing and colour (Mitchell & Wightman, 2005). Within a text, hierarchy is usually signalled through incrementally increasing the weight and size of the typeface used for different heading levels (Ambrose & Harris, 2010). Hill (2010) suggests that the appropriate amount of emphasis placed on headings should be a decision based on both aesthetic and editorial considerations. "Emphasis relate[s] to the hierarchy of elements within the compositional structure" (Wallschlaeger & Busic-Snyder, 1992, p. 409). Adjustments can be made "without any change to type size or leading by using a heavier weight or capital form of the typeface used in the text, or another typeface of equal size" (Hill, 2010, p. 134).

The perception of headings was studied by Williams and Spyridakis (1992), where they sought to understand how a range of physical attributes of headings are perceived by readers. Their study focussed on four typographic emphasis methods (type size, underlining, case and position), that can be used for emphasising a heading and different combinations of these four attributes. For their study, they asked participants to sort index cards which were printed with paragraphs of dummy text and headings into an order which reflected the most important headings through to the least important. They found that when used alone, increasing type size was considered the strongest indicator of hierarchy for headings and that relative, rather than absolute, size difference provided the greatest indicators of hierarchy, with a difference of approximately 20 percent being the most useful. They suggest that to create headings the fewest formatting dimensions possible should be changed to create the necessary number of heading levels.

2.2.1 Typeface

Changes in typeface are an effective means of using typographic variation to create emphasis (Cullen, 2012). It is suggested by Black (1990) that a second typeface might be required for setting headings to be able to modestly differentiate all heading levels, or to accommodate longer headings with a more condensed font. "If you use a second typeface for emphasis you should play on the contrasts in style, scale, weight and width of the typefaces to make the distinctions between text elements obvious" (Black, 1990, p. 31). Jennett (1973) recommends that typographers should feel free to use a different typeface for headings. Examples of a serif and a sans serif typeface are shown in Figure 1.

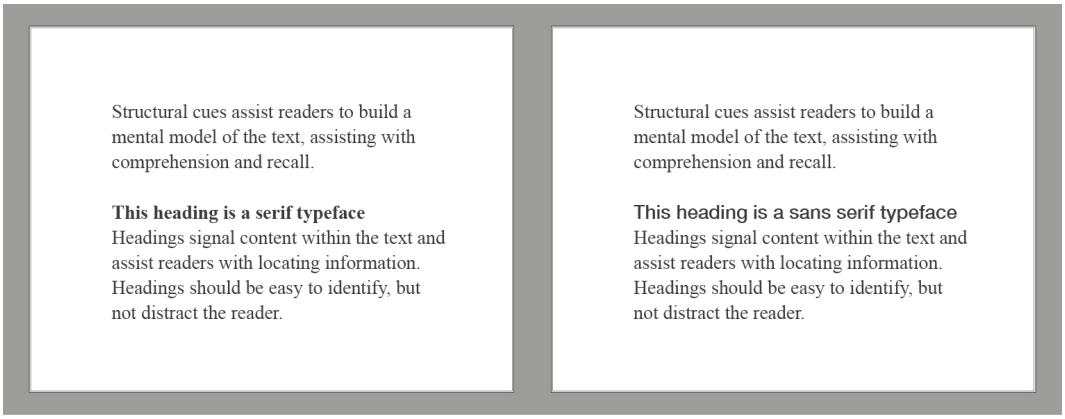


Figure 1: Heading typeface comparison example

Changes in typeface can be effective for providing hierarchy in a document (Ambrose & Harris, 2010) and is the method traditionally used by printers to create typographic emphasis (Lewis, 2007). When using two typefaces in a document for emphasis, such as with headings they should contrast each other enough for it to be seen as a deliberate change. Using a serif with a sans serif is often best (Craig et al., 2006). Mitchell and Wightman (2005) recommend that when a change in typeface is used for emphasising headings, all headings should be presented in variations of the same typeface to maintain a sense of unity throughout the document.

2.2.2 Size

Increasing the size of the typeface for a heading is a typographic variation which creates emphasis and is recommended by Ambrose & Harris (2005) for use when emphasising A and B level headings. Changes in size is considered to create dramatic emphasis, but the appropriate size increase will depend on the level of emphasis required and the line spacing available (Craig et al., 2006).

Hill (2010) and Williamson (1983) suggest that in general, changes in scale between heading text and body copy should be 2pt or greater so that the change looks like a deliberate decision. Mitchell and Wyman (2005) elaborate on this saying that a 2 point difference in typeface size at small sizes is enough to create discernible difference for readers, but at larger sizes an increase of more than 2 points is necessary to create a visual difference for the reader. Research by Williams and Spyridakis (1992) found that headings with a relative size difference of 20 percent larger than the text were more easily distinguished. It is proposed by Williamson (1983) that if roman caps or italic caps are used to visually emphasise the heading, the size of typeface need not be increased. However, he recommends that an increase of 2 sizes from the body text size should be used if the heading is set in upper or lowercase italics, or small caps. An example of a heading that is an increase in size is shown in Figure 2.

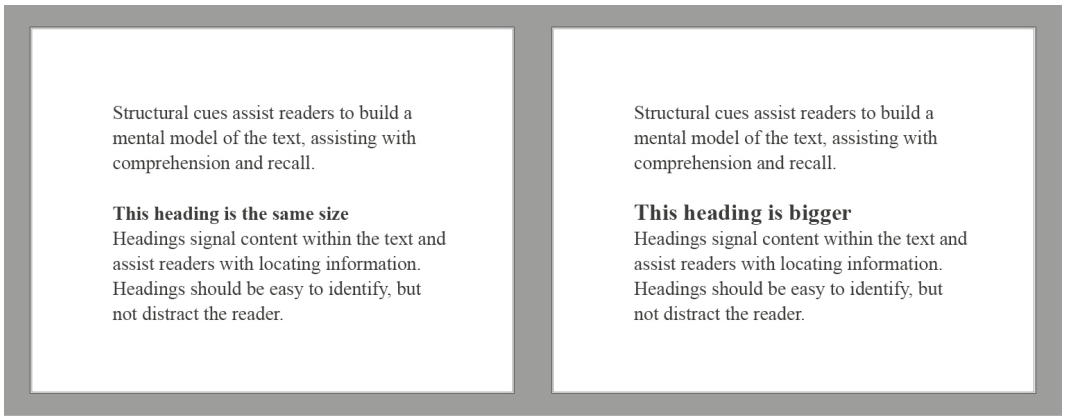


Figure 2: Heading size comparison example

Research conducted by Williams & Spyridakis (1992) asked participants to sort headings with different visual attributes according to their perception of the hierarchical importance of the headings. They found that type size was always considered to be the most important method for indicating hierarchy with position and case considered the next best indicators of hierarchy and underline considered to be the cue of least importance.

2.2.3 Weight

An increase in type weight is a typographic variation in style for emphasis (Cullen, 2012) which is useful for defining headings (Jennett, 1973). Increasing typeface weight creates greater emphasis than using Caps or italics and can be very effective while staying within the same size and typeface (Craig et al., 2006). However, if bold is used too much, the page can appear overly heavy. Ambrose & Harris (2005) suggest it is best used for emphasis in A and C heading levels, whereas Lewis (2007) recommends using bold for subheadings.

Jennett (1973) suggests that Times New Roman is a good typeface choice if heading emphasis is only through making the headings a bold version of the typeface used for the body text. An example of a bold heading is shown in Figure 3.

The use of bold typefaces is one of the most direct methods for creating emphasis (Hill, 2010), as it creates an obvious uniform hierarchy (Ambrose & Harris, 2010). The literature offers both positive and negative views on the use of bold for emphasising headings. Mitchell and Wightman (2005) explain that bold is good for easy identification of headings without using space; however, they also caution that bold can appear oppressive and suggest it should be printed as a tint. In contrast to this, bold can also be applied to make headings stand out. Williamson (1983) warns that bold tends to draw the reader's attention away from the text through over emphasis, but may be useful when there are multiple heading levels that need to be indicated.

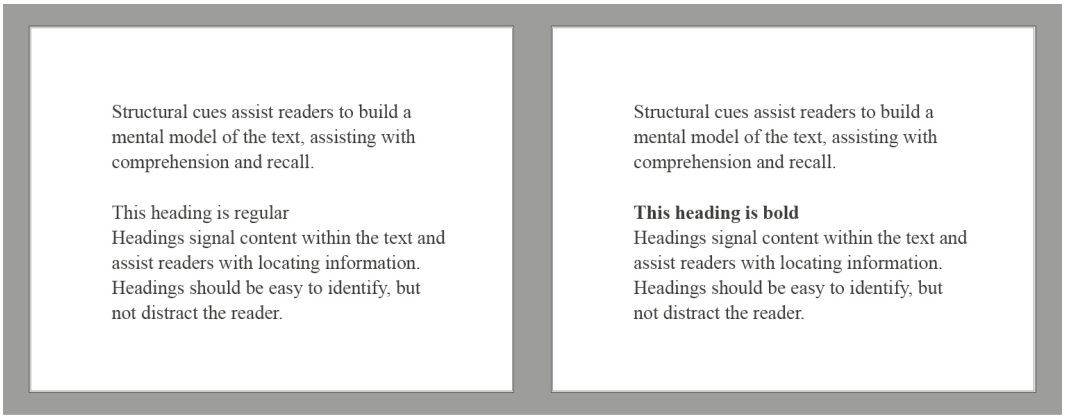


Figure 3: Heading weight comparison example

Paterson and Tinker (1940) found no difference in reading speed between text that is bold and that which is regular lowercase type. Readers in the same study though felt that it was less legible, but because it has greater visibility than regular text Paterson and Tinker recommend using bold for emphasis of text content such as section heading. "Although some designers may have a strong esthetic *(sic)* objection to boldface for headings, this does not mean that readers react the same way" (Tinker, 1966, p. 136).

2.2.4 Italic

Italic typographic variation creates emphasis through the change in style (Cullen, 2012). By convention, italics is usually used for assisting readers with identifying titles, proper nouns, foreign words or to indicate important terms in the text (Glynn et al., 1985). It provides subtle emphasis because it is the same size and weight as the roman, and some sans serif italics are not easy to distinguish from their roman (Craig et al., 2006). The use of

italic typefaces is more widely associated with in copy text (Hill, 2010) or is recommended to be used for C level headings (Ambrose & Harris, 2005). It is considered to be good for use with minor headings and is easy to distinguish from text at small sizes (Mitchell & Wightman, 2005). An example of an italic heading is shown in Figure 4. If italics are used though, Mitchell and Wightman (2005) suggest that it is better suited to being set in upper lowercase rather than capitalised.

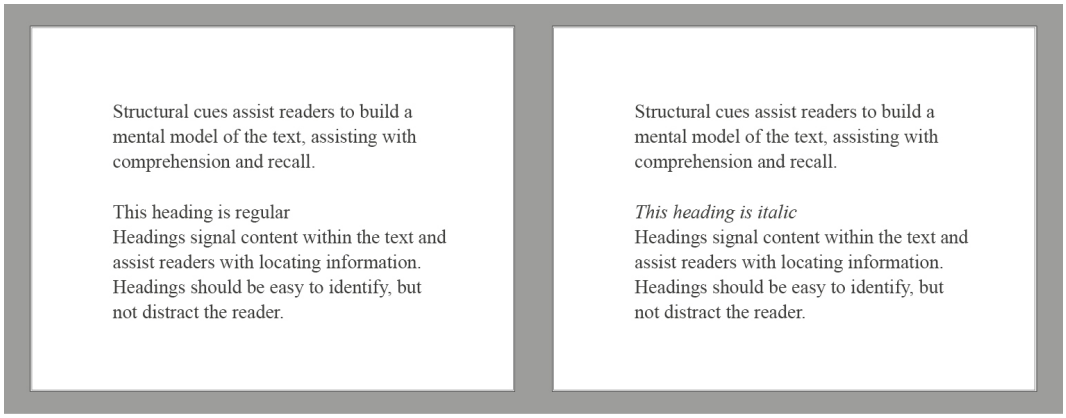


Figure 4: Italic heading comparison example

2.2.5 Spacing

Winn (1993) explains that line breaks and paragraphs give structure and aid comprehension of ideas. Making paragraphs more apparent than only indenting can further aid understanding (Winn, 1993). Space is often used as the main variable to clarify structure and typographic variations (italic, bold, etc.) are used sparingly to enhance the structure and spacing (Hartley, 1982). Waller (1982a) notes that other researchers have discovered that "the use of space to differentiate items was a stronger signal than the use of typographic variation (bold, italic)" (Waller, 1982a, pp. 341–2). Foster (1979) also recommends the manipulation of typographic space to convey the structure of a text. Hartley (1982) with his colleague Peter Burnhill explain that given a passage of text and the dimensions of the page the spatial arrangement of a text on the page can be manipulated to enhance the clarity, retrieval and comprehension. Foster (Foster, 1979) also recommends the manipulation of typographic space to convey the structure of a text. Black (1990) recommends to first choose variants of the main text face for emphasis. But if there is a limitation on typeface variants, vertical spacing can be controlled to create emphasis, as can adjusting the type size. When designing the spacing of text, Hartley (1982) recommends beginning with the smallest unit and increasing it proportionally.

There is general consensus among typographers regarding the use of spacing for headings. Aside from simply providing space to separate text blocks, there should be more space above a heading than below so that the heading is closer to the text it directly refers to and creates a semantic relationship (Mitchell & Wightman, 2005; Twyman, 1981; Williams & Spyridakis, 1992; Williamson, 1983). An example of using space to indicate a heading is shown in Figure 5. When changing typeface to indicate headings, the vertical spacing needs to be carefully considered to indicate the relationship to the text that follows them (Black, 1990). "There should always be more space above a heading than beneath it to separate the heading from the preceding text and link it to the following text" (Black, 1990, p. 33). This adheres to the general principles of sematic association, that an object will have a closer relationship to the items it is placed most closely to (Wallschlaeger & Busic-Snyder, 1992). The amount of vertical space on the page that a heading consumes, including the space above and below, should be equal to a whole number of lines within the main body of text (Bringhurst, 2004; Hill, 2010; Mitchell & Wightman, 2005; Williamson, 1983). Hartley (1982) recommends that vertical spacing should be proportional to type size of body copy and headings. In Methods of Book Design, Williamson (1983) advises that the ratio of spacing above and below a heading should commonly be approximate to ¾ over and ¼ under, or 1½ over and ½ under or 2 over and 1 under. He suggests that less of a difference might be unable to be perceived by the reader and more might be over-emphatic.

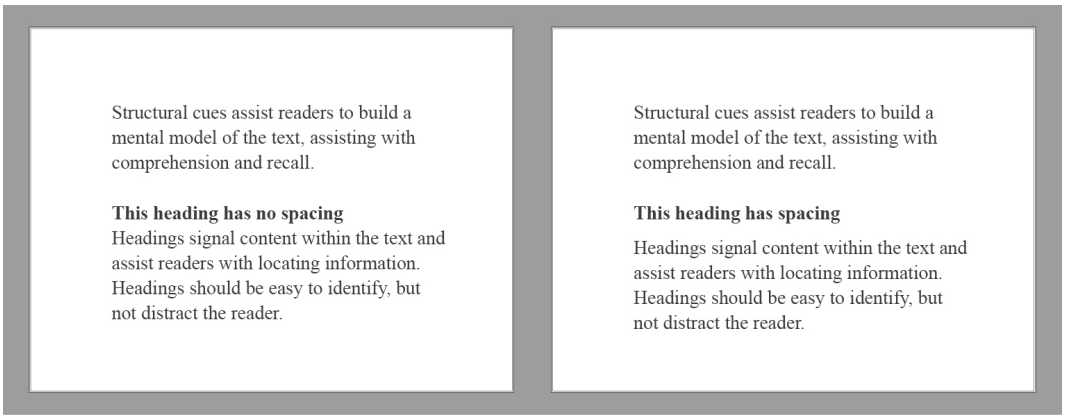


Figure 5: Heading spacing comparison example

Bringhurst & Marks (2004) provide several possible solutions for how the spacing of headings can be created in an effective way to maintain the base leading of the main text. A hard return, both above and below the heading can be used, though this does not provide the necessary semantic associations suggested by others. A division of a single line of leading can be used; the example provided divides 13-points of leading so that there is 8 points above and 5 points below. Spacing equivalent to two lines of text can be given

above the heading and one line below. Finally, they suggest that a division of two lines of leading can be used; the example provided divides 26 points of leading so that there is 16 points above the heading and 10 points below.

2.2.6 Capitalisation

Text set in all capitals is viewed by readers as being more important than lowercase text and needs to be carefully considered when used within a heading hierarchy (Mitchell & Wightman, 2005). An example of using capitalisation to indicate a heading is shown in Figure 6. The use of small caps, rather than full size capitals, for headings is recommended by Bringhurst (2004), who suggests using them at the same size as the body text that they are set within. Small caps are designed to be the same height as the x-height of a typeface, so are not as heavy as regular capitals (Lupton, 2004).

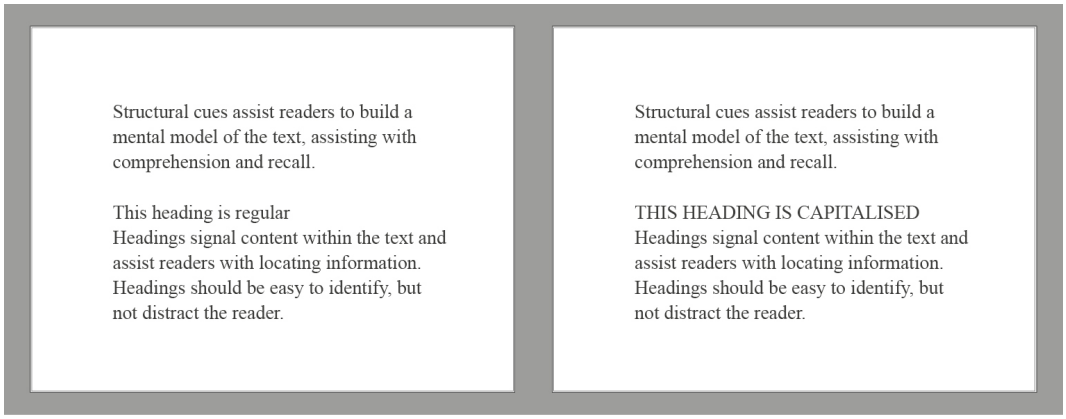


Figure 6: Heading capitalisation comparison example

Tinker and Paterson (1939) found when studying eye movements of readers that text set in all capitals caused a much larger number of fixation pauses when reading. Paterson and Tinker (1940) recommend that capitalised text should not be used for text where speed of perception is important. Their research found that capitalisation of text can slow reading speed by almost 12 percent. They therefore advise that text set in all capitals should not be used for headings, billboards, text copy and other types of printed text, except for occasional use. However, in one of the few studies comparing capital letters with lowercase in search tasks, it was found that on-screen text set in capitals was searched faster, and was rated as being preferred, over lowercase text (Vartabedian, 1971).

2.2.7 Position

One of the main problems with headings is where to put them. 'Cross headings' interrupt the text, but imply strong structure. 'Side headings' allow the text to flow and provide good overview/summarisation. 'Running headings' give content overview and context (Waller,

1982b). Headings can be set centred, left or right aligned. They can also be made more prominent by setting them in the margin, also called 'running shoulderheads' (Bringhurst, 2004) or marginal headings (Winn, 1993). An example of each of these heading positions is shown in Figure 7. Bringhurst (2004) use different terms for referring to headings in different positions: a centred heading is referred to as a 'crosshead' and a left aligned heading, whether slightly indented or not, is referred to as a 'left sidehead'. Headings within the flow of text are usually centred or left aligned (Williamson, 1983). Headings in justified text are generally centred rather than starting on the left (Hartley, 1982). The use of marginal headings and annotations can considerably improve organisation and aid skimming and review (Winn, 1993). Research conducted by William and Spyridakis (1992) found that centred headings were perceived as the most important, followed by indented headings and left aligned, which were not perceived as significantly different, and lastly 'embedded' or in-line headings.

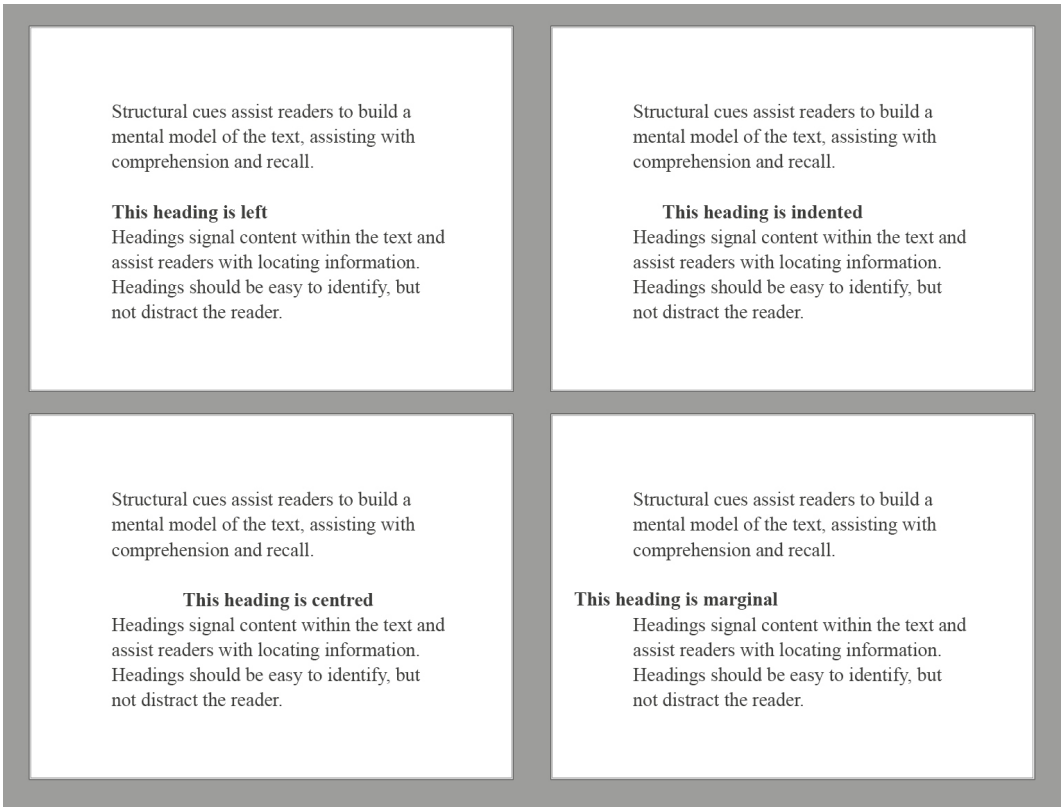


Figure 7: Heading position comparison example

Mitchell and Wightman (2005) suggest that position can be important for creating distinction between heading levels, with centred headings being better for chapter headings and top level headings. Williamson (1983) agrees with this, expressing that centred headings are considered more important than those which are left aligned. He cautions against indenting left aligned headings as this may lead them to appear off-

centred if the heading text continues too far across the page width. Headings should be consistent throughout a book of text. Either symmetrical (centred) or asymmetrical (left/right aligned) (Bringhurst, 2004).

Throughout a series of experiments conducted by Hartley & Trueman (1985), the effect of heading placement (margin or embedded in text) was found to provide no difference when searching in familiar or unfamiliar text. In research conducted by Klusewitz & Lorch (2000), designed to assess the effect heading information had on search strategies, the heading position changed between two of the four heading conditions being tested; however, the effect of the heading position was not intended to be tested in the study.

The relative horizontal positioning of headings will not be considered in this research however, as there is currently an existing body of knowledge addressing this area and it is considered to be the least influential method for creating typographic emphasis.

2.3 Summary

All aspects of typographic emphasis need to be considered when designing the layout of text. The relationships between the visual aspects of the typeface and the layout of the textual elements are all interrelated and help to develop a visual hierarchy of information that will assist the reader with reading and navigating the document.

This chapter discussed why the visual appearance of headings is an important feature within a typographic layout. All typographic features, and the relationships between them assist with creating legible text. One of these aspects contributing to legibility is typographic hierarchy which is used to signal the structure of a document through typographic emphasis. The methods used to emphasise headings within text include; changes in typeface, increase in size, change in weight, italicisation, vertical spacing, capitalisation and horizontal heading position. Readers perceive each of these typographic emphasis methods differently based on their appearance and how they differ from the surrounding text.

The typographic emphasis methods that have been identified in this chapter will be used in answering Research Question 1 and Research Question 2 (Chapters 5, 6 and 7), investigating the ease of identification of each of individual and combined typographic emphasis methods for headings.

3

Reading and Search Strategies

Headings provide a visual presentation of the structure of a text's content. The research discussed in this section approaches the topic of headings for the perspective of different disciplines including; psychology, instructional design, and information science. This section takes into consideration knowledge from these areas, as well as from established typographic practice (as discussed in Chapter 2) to develop an understanding of how headings can support the reading process through their visual appearance. The way people read and the role that headings play in that reading process; signalling structure, assisting with search and supporting comprehension and recall of information are discussed in this chapter.

This chapter begins by discussing reading strategies and how they relate to reading texts that are unfamiliar and familiar, how document structure aids the reading process and the differences in reading between print and screen environments. The chapter then discusses research into how readers search documents, before describing how structure is visually presented through the use of headings and the frequency of these headings.

3.1 Reading Strategies

The reading process can be divided into three aspects; motivation, strategy and outcome. Motivation is concerned with the reader's selection of relevant text; strategy relates to how the readers moves through the text, based on the purpose of their reading; and outcome concerns the meeting of their goals (Waller, 1979b). Generally we interact with text to satisfy our information needs (Jonassen & Kirschner, 1982). The location of information within a document is a common purpose for reading and requires the reader to selectively

sample the text (Symons & Pressley, 1993). Instructional text requires different design considerations to prose because of the very different way it is read and interacted with (Hartley, 1982). "Most learners do not interact with text by picking it up, reading straight through, putting it straight down, never to read it again" (Jonassen & Kirschner, 1982, p. 133). Therefore, textbook structure is more reliant on typographic features than prose (Waller, 1979b). In schooling, little direct instruction seems to be given to learning to locate information (Dreher, 1993).

Instructional text is often interacted with in an unpredictable manner as people pick it up, scan, read, re-read, put it down, then return to it again (Hartley, 1982). The manner in which a document is read cannot be dictated or predicted by the author. Books can be used by people the author is not aware of and read in an order that the author did not intend (Waller, 1979b). In a book, the author and editor develop the structure of the text and the graphic designer makes it visible (Pettersson & Tullinge, 2010).

3.1.1 Reading Unfamiliar and Familiar Texts

Previous studies have shown that the presence of headings is important for facilitating the search of text that are both unfamiliar and familiar, (Dreher, 1993; Dreher & Guthrie, 1990; Dreher & Sammons, 1994; Hartley & Trueman, 1985; Symons & Pressley, 1993); there is little evidence regarding how those headings might best be emphasised to facilitate search. The spatial or typographic cues that are encoded within the text act as retrieval cues, so the more explicit these are the more effective they should be for the retrieval of the prose that they signal (Jonassen & Kirschner, 1982).

A study conducted by Klusewitz and Lorch (2000) investigated the effect that heading type and familiarity with the texts had on search. Their participants were videotaped while searching for answers to questions within a text. The texts either had no headings, or one of three types of headings; structure headings, topic headings, or section headings. Participants in the study by Klusewitz and Lorch were asked to answer questions where key words in the headings were also included in the headings or subheadings and answers were contained in a single sentence in the paragraphs following the related heading. Participants were asked to locate the answer in the text even if they already knew the answer to the question. Results showed that when the participants were unfamiliar with the text they used an exhaustive page-by-page search strategy. As their familiarity increased and they had a better understanding of the context and text structure they were more likely to employ more selective strategies and page-skipping. They also found that when there were no headings, readers examined the text more closely, meaning they

actually learnt more about the content and structure of the text and therefore adopted page-skipping strategies that utilised this knowledge. "As searchers became increasingly familiar with the content and structure of the text, they were increasingly likely to use strategies that relied on the approximate page location of the target information" (p. 671). They found that readers who searched text that had structure of content headings, rather than section headings or no headings, found the information faster, indicating that the content of headings is important for improving search of familiar texts.

3.1.2 The Role of Structure to Aid Reading

A clear structure will facilitate perception, interpretation, understanding, learning and memory (Pettersson & Tullinge, 2010). Characteristics of the structure will be encoded into memory along with the content (Jonassen & Kirschner, 1982). Organisational text structures are used by readers to understand content and are also used as memory facilitators and potentially also work as visual cues to assist with retrieval of information (Jonassen & Kirschner, 1982). The hierarchical structure of a text and how this structure is shown may be crucial to get an overview and find information easily. A clear macro structure may help to find information at a micro level (Kools et al., 2008).

Readers of well organised text generally agree on the structure of importance of ideas discussed within (Williams & Spyridakis, 1992). Symons and Pressley (1993) found that when readers were aware of the text structure, their search success improved, but factors other than prior knowledge of the text that were not tested, such as the typographic appearance of the headings, are likely to have an effect on search success. These factors may include reinforcing the structure using the visual hierarchy created through typographic emphasis of headings.

Typographically structured text allows for more selective sampling (Waller, 1979b), which could be likened to non-linear reading methods. Much of the reading done in non-fiction contexts is conducted in a less linear manner with readers intentionally sampling selected aspects of a text. Access structures contribute to and facilitate retention and recall of knowledge as well as retrieval of information, by signalling to the reader where information may be contained (Jonassen & Kirschner, 1982).

Typographical structure is the difference between readability and legibility in many aspects of book design, especially in access structure items such as the contents page (Waller, 1979b). The readability of a layout involves the reader's ability to understand the style of text and pictures (Pettersson & Tullinge, 2010). Structural cues are explicitly shown

using linguistic, spatial, and typographic means through their form, function, sequence, content, and importance on the page (Jonassen & Kirschner, 1982).

3.1.3 Reading in Print and on Screen

Many research studies have been conducted over the years to understand differences between print-based reading environments and reading from screen (Dillon, 1992; Noyes & Garland, 2008). The range of studies have considered different reading situations and different aspects of the reading process (Askwall, 1985; Cushman, 1986; Gould & Grischkowsky, 1984; Muter, Latremouille, Treurniet, & Beam, 1982). Muter (1996) explains that the knowledge of optimal text layout for screen is limited. Dyson (2004) proposes that the reason for this is likely because the types of screen used in the studies has also varied and changed as technology has progressed, which may be a contributing factor to the slow progression of knowledge in the optimal screen layout for text. Research conducted by Osborne and Holten (1988) found no significant speed or comprehension differences between paper and screen.

Less text can be presented at a readable size on a computer screen at one time than on a printed page (Winn, 1993). Hartley and Jonassen (1985) also discuss that on screen the amount of text displayed at any given time can be limited and is often less than is shown in print. To reduce "wayfinding" difficulties associated with less text being shown on a screen users need to be shown where they are in a text and provide them with easy ways to get back to where they have been (Winn, 1993).

In an electronic text, Hartley and Jonassen (1985) describe within document information access as having two functions; for assistance with online information retrieval and for the online display of information. These two purposes, though seemingly similar to print functions of headings, are often treated differently by readers. "Gaining access to information in electronic displays presents a distinct set of problems that cannot be resolved by simply transferring a printed document into an online document" (Hartley & Jonassen, 1985, p. 253).

Hartley and Jonassen (1985) describe the function of headings in electronic text differently to in print as the nature of the media and how we interact with it is different. In electronic documents readers can usually search by entering key terms or strings into a search function, which changes the way readers think about searching for information.

Structural cues such as headings may have a greater impact on readers of on-screen information as Bartell, Schultz and Spyridakis (2006) discovered that print heading frequency had far less impact on comprehension than for online readers.

3.2 Searching in Documents

The term "access structure" (Waller, 1979a) refers to typographical structural cues that indicate the structure of a text and help readers with navigation and using selective sampling strategies. Access structures include, but are not limited to; tables of contents, indices, headings and glossaries. These devices can extend to features such as concept maps, questions, study notes and learning objectives. Common accessibility structures in texts are; contents lists, concept diagrams, indexes, glossaries, objective lists and summaries. These features, which provide global structures, give us summaries and an overview of concepts in the main text (Waller, 1982b). Typographically, access structures are indicated by creating visual hierarchy through emphasis. The research regarding access structures begins by assuming that "the nature of complex text and its underlying structure can be indicated to the reader by the way it is displayed on the page" (Jonassen & Kirschner, 1982, p. 124).

The effects that heading placement and familiarity have on search strategies was researched by Klusewitz and Lorch (2000a). Their hypothesis was that understanding of a text's organisational structure is critical, as this will guide the searcher in their location of target information using this internal access device. They found that readers appear to use headings to guide them when searching for content.

Symons and Pressley (1993) studied whether a searcher's efficiency is related to their semantic knowledge of the content, as prior knowledge plays a clear role in text processes other than searching. They postulated that, "prior knowledge might direct attention to appropriate sections of text or enhance recognition of sought-after information when it is encountered" (p. 252). Their study was conducted by providing participants with a text book, from which they were asked to locate the answers to questions presented to them. Participants were given a fixed length of time to find answers and the sequence of pages they visited to find the answers, as well the time taken were recorded. Their results support previous research that prior knowledge does have an effect on search success, improving location time when subjects were aware of the text structure. However, variability in their results for search success indicates that factors other than prior knowledge differences affect search time results.

In arguably the most comprehensive set of studies related to headings and their impact on readers, Hartley and Trueman (1985) systematically explored the position of content of headings and the effect that these factors have on recall and retrieval. Hartley's studies regarding search of familiar and unfamiliar text investigated the position of headings (marginal or embedded), whether questions were written as questions or statements. The participants in these studies were students (aged 14-15 years) divided into both high and low ability students.

In the search studies conducted by Hartley and Trueman (1985) participants were given either text with headings as statements, questions, or a control with no headings and positioned marginally or embedded (within the flow of text). Across all search tasks the only significant finding was that the presence of headings has an effect on readers search time; neither the type of heading, nor its position had an effect on participant search time. In the retrieval studies Hartley (1985) conducted, participants were given six minutes to read the text before being given the search task. Again, Hartley found that the presence of headings significantly aided readers in searching for answers, but neither the form of the question, nor the position had a significant influence on the speed with which readers found the answers in the familiar text.

3.3 Visual Presentation of Structure

The appearance of text conveys a great deal of information that is independent of the information conveyed in the words (Winn, 1993). The design of text is affected by three main factors: the way items are ordered and grouped on the page affects the syntactic structure; restrictions of the media, such as page size, have artefactual effects; and the way the text will be used affects design decisions (Waller, 1982b). Paragraph indentations show where new ideas start; headings give signposts to new sets of ideas and underlining, bold or italics draw attention to important words or phrases in the text, all before the reader had read a single word (Winn, 1993). Typographic elements such as headings, subheadings, footnotes and captions create a break in the rhythm of the text on the page. After the break however, the text should return to its rhythm (Bringhurst, 2004).

Typographic structure is important as it affects the mechanics and aesthetics of the reading experience as well as how the content is interpreted (Waller, 1982a). The appearance of text conveys a great deal of information that is independent of the information conveyed in the words (Winn, 1993). Visual cues are presented to the reader as changes in typographic appearance to aid in discriminating target items (Foster, 1979). "The typefaces and variations of typefaces that you choose to mark elements of text should be different enough

to make the text structure immediately visible to the readers and to leave no doubt that the differentiation is deliberate" (Black, 1990, p. 28). A variety of cues are used to help readers discern structure, one being headings. Headings are used to identify subject matter and clarify the structure of a text; they can also help focus attention on particular parts of the text and locate information (Kools et al., 2008). Headings assist readers with understanding the structure of the text (Williams & Spyridakis, 1992).

The hierarchical structure of a text and how this structure is shown may be crucial to get an overview and find information easily (Kools et al., 2008). Readers of well organised text generally agree on the structure of importance of ideas discussed within (Williams & Spyridakis, 1992). For creating accessible information an appropriate index or search feature should be provided as well as context for important information contents, regardless of the medium (Pettersson & Tullinge, 2010).

Visual cues are changes in typographic appearance to aid the reader in discriminating target items (Foster, 1979). In his review of previous experiments that used cueing, Foster (1979) found that cueing generally improves post-test scores. "The typefaces and variations of typefaces that you choose to mark elements of text should be different enough to make the text structure immediately visible to the readers and to leave no doubt that the differentiation is deliberate" (Black, 1990, p. 28). Hartley (1982) supports the notion that visual typographic cues in a document should be consistent, stating that "inconsistent spacing and multiple typographic cueing can only confuse the reader" (1982, p. 203). Text should be designed to facilitate mental processing and inconsistent typography should be avoided (Pettersson & Tullinge, 2010).

3.3.1 How Headings are Used

Early in the history of books, rules concerning the treatment of the page were developed and some of these have become fixed conventions with few differences in books printed today. Other conventions, such as page headlines and page numbering have arisen from the printing house (Jennett, 1973). Organisational text structures are used by readers to understand content and are also used as memory facilitators and potentially also retrieval cues (Jonassen & Kirschner, 1982). A variety of cues are used to help readers discern structure, one being headings. "One specific type of signal is headings, which occur as short phrases or topical labels and announce subordinate content before the reader encounters the actual content" (Williams & Spyridakis, 1992, p. 64). A heading can be an invaluable reference tool, directing the reader to the content which they are looking for (Jennett, 1973). Bosler (2012) explains that headings need to be noticeable as readers use

these to know where they are in the text. Headings assist readers with understanding the structure of the text. This structure can also reveal the author's perspective on the topic (Williams & Spyridakis, 1992).

Local accessibility structures are provided by headings, with their primary function being one of orientation. Headings label the text section so readers can locate information as well as provide context to what is being read (Waller, 1982b). "Paragraph headings help the reader to decode the hierarchical organisation of the ideas in the text" (Glynn et al., 1985, p. 197). Waller (1982b) explains that other local accessibility structures involve layout aspects and their styling (or appearance). Layout or appearance can make it easy to locate items through placement, size, colour or many other graphic means. A heading can be an invaluable reference tool, directing the reader to the content that they are looking for (Jennett, 1973). This overview of the text that headings provide can also be used to guide the reader to information about the text that has been stored in memory from previous readings of the text (Williams & Spyridakis, 1992).

Headings are important for categorising information and research indicates they can help readers to understand how a text is organised as well as navigate within it, retrieve information and assist with recall (Hartley & Jonassen, 1985). Headings are used to identify subject matter and clarify the structure of a text, they can also help focus attention on particular parts of the text and locate information (Kools et al., 2008). The important function of headings within the run of text is to "convert a browser into a reader" (White, 1999, p. 43).

There are at least three types of information that headings can provide to assist with searching, they can indicate distinct sections within the text, they can indicate the likely content of a section of the text and they can create hierarchy to provide structural and relationship information (Klusewitz & Lorch, 2000a). "Typography and layout will show the structure and the hierarchy of the content in the information material when important parts are emphasised" (Pettersson & Tullinge, 2010, p. 174). Hierarchy is the logical means for visually expressing "the relative importance of different text elements by providing a visual guide to their organization" (Ambrose & Harris, 2010, p. 130).

Waller (1982b) likens the use of text structuring to using punctuation, it increases the ability to understand the text. He describes typography and layout as macro-punctuation and uses four parameters to compare typography and punctuation; interpolation, delineation, serialization and stylisation. Headings are included under both 'delineation' and

'serialization'. Headings create delineation as they indicate where a unit of text begins, much like a capital letter does. Headings assist in the organisation of text into a clear structure, in much the same way a semi-colon would (Waller, 1982b). Researchers have proposed that text layout is important for organising ideas, and structuring techniques related to formatting affects comprehension (Winn, 1993). "Typography and layout will show the structure and the hierarchy of the content in the information material when important parts are emphasised" (Pettersson & Tullinge, 2010, p. 174).

3.3.2 Heading Frequency

The depth of research regarding the optimal frequency of headings within a document is limited; however, there are several studies that provide some insight. Too many headings however may slow the search process (Klusewitz & Lorch, 2000a). In their study of the effect that heading frequency has on comprehension in online text, Schultz and Spyridakis (2004) found differences in comprehension between student and adult participants, but overall a heading frequency of approximately every 200 words was best for facilitating comprehension. In a similar study by Bartell, Schultz and Spyridakis (2006) the influence that heading frequency had on comprehension was compared across print and online documents. It was again found that in online documents comprehension is negatively impacted by low-frequency headings (every 100 words), more so than in print documents. The online participants in this study achieved greatest comprehension scores with medium frequency headings in the online text. Heading frequency had much less impact on readers comprehension in print, than when reading on screen.

Increasing the frequency of headings and therefore creating text which is more segmented does not necessarily make a text more accessible for finding information (Kools et al., 2008). This is supported by Bartell, Schultz and Spyridakis (2006) who found that readers of online text with high frequency headings actually had lower comprehension than in text with no headings.

3.4 Summary

This chapter discussed research previously conducted in the areas of reading strategies, specifically those in unfamiliar and familiar text, how a well-defined structure can support reading and differences in strategy between reading in print and on screen.

The research draws on knowledge of the use of headings and their appearance that has been developed mainly in the area of psychology, which has considered cognitive effects of headings within texts, such as with comprehension or recall of information. This

research sits alongside understanding of established typographic practice for signalling headings and support legibility of text that was discussed in Chapter 0. In her survey of recommendations regarding the typographic factors influencing text layout, Lonsdale (2014) identifies that there are a combination of research studies with recommendations of the typesetting of headings that sit alongside practice based recommendations.

The clear structuring of text is acknowledged as being important for assisting readers with understanding, searching and navigating a document. Headings are one of the key indicators of the structure of a text, but there is little research regarding how typography is being used to create hierarchy for these headings. The related work reviewed in this chapter acknowledges that while there has been research into the role that headings play in documents, these studies have largely focussed on headings as aids for comprehension and recall rather than search, or heading content and placement rather than visual appearance.

Emphasising headings to assist with structural cueing can be achieved through their placement, typographic appearance, and the spacing around them. There are several suggestions for how typographic emphasis should be applied to headings, but much of this is not supported by empirical research and little is known about how these recommendations are being applied in the publication of academic journals. Recognised methods for creating hierarchy for headings is through the use of weight, size, italicisation, capitalisation, spacing and placement.

The research discussed in this chapter is important for understanding the role of headings in search, as well as other reading-related tasks. This information will be used in the design of Study 3 (Chapter 8) to answer Research Question 3.

4

Survey of Current Practice for Heading Emphasis in Documents

This chapter reports on a preliminary study that surveyed current practice in the typesetting of headings in non-fiction text. The survey focused on periodicals as these documents are frequently read, or searched by readers, to satisfy specific information needs. The content that appears in these periodicals is also published in both print and electronic formats; the print format of the content rarely has access structures, such as indexes, to assist with searching content. Significant differences were found between print/PDF and HTML versions of the same publications. By understanding what typographic characteristics are being used to emphasise heading typography within these journals, we can assess how hierarchy is being established within the text structure.

It is now the norm for publishers of periodicals to make their offerings available in both print and digital form. Each publisher usually has currently established standards for creating a typographic hierarchy in the text of journal articles that they publish. The nature of scholarly publishing is rapidly changing and the demands of publishers to keep up are increasing (Boyce, Owens, & Biemesderfer, 1997). The gap in knowledge that this chapter tries to fill is an understanding of what methods for creating hierarchy to signal text structure are currently being used, specifically those being used for emphasising headings. This chapter addresses the need for understanding how the structure in academic journal publications is currently being conveyed and a comparison of the treatments across print and digital versions. This is the first step towards understanding how the typographic methods used to create visual hierarchy can best support search for information within

both digital and print academic texts. The results of this survey will also be used to inform which typographic emphasis methods are tested in the paired comparison studies in Chapter 5, 6 and 7.

4.1 Method

A survey of current practice was undertaken to investigate how typography is currently used to create visual hierarchy within the text of academic journals. This was achieved through recording the typographic appearance of primary headings in a selection of journals that were available in both print and electronic format. The survey reported on in this chapter was undertaken to provide background information to assist with the design of the study to answer Research Question 1; *Which methods of typographic emphasis make a heading easiest to identify within a passage of text?* Understanding current practice is useful to assist in selecting which methods of emphasising headings should be compared to determine their ease of identification within a passage of text. Parameters that were of specific concern to this research were the relationship of the heading to the body copy, typeface choice, methods of typographic emphasis, heading positioning and spacing.

4.1.1 Sample

To research current typographic methods for emphasising headings from text within academic articles, 50 journals from the University of Waikato Library were surveyed (See Appendix A). These were chosen from a possible 1842 journals which were available in both print and electronic form through the university library. The journal titles were sequentially numbered in a spreadsheet in alphabetical order. To select the journals a random integer set generator was used to select 50 non-repeating numbers between 1 and 1842. The periodicals surveyed covered a wide range of subject areas including science, law, technology, language and literature. The most recent issue available both in print and electronic forms was chosen for analysis. The majority of the sample fell between 2004 and 2012, with a spread of years from 1994 to 2012.

4.1.2 Analysis Method

The typographic appearance of headings in each of the journals was measured and analysed and comparisons were drawn between both print and electronic versions of the same journal and between the journals surveyed within each of the media.

The following attributes were recorded for each document:

- Page size (millimetres)

- Typeface for heading and body copy
- Typeface style for heading and body copy (serif or sans serif)
- Typeface size for heading and body copy (measured in points)
- Methods of typeface emphasis for headings (italic, bold, caps, small caps, other)
- Heading position
- Spacing above and below headings (measured in points)

Type size and heading spacing were measured using the E Gauge provided in *Type Survival Kit* by Jill Yelland (Yelland, 2003). The E gauge is an analogue optical measurement device used by typographers for ascertaining the point size of a typeface through measuring the cap-height.

4.2 Results

The results from the survey of headings in the available journals in both print and electronic form are summarized in this section.

Of the sample of 50 journals, all were available both printed and digitally; however, the visual presentation of these varied across publishers and some depending on where they were viewed. The digital versions of journal articles surveyed were all available as PDF files to download, and a selection (approximately 10%) were available to view through in-browser PDF viewers. Of the 50 journals sampled, 30 (60%) were also available as an HTML version as well as a PDF.

Eight journals (16%) were available as an HTML version through more than one depository. This meant that for some journals there were multiple variations in the typographic presentation for the document and the headings for the same edition of the journal across several formats. In each of these instances the two (or more) HTML presentations of the journal were significantly different in the presentation of the headings with variation in size, typeface and elaboration, such as bold or italicisation. The nature of HTML documents also means that sacrifice in consistency across users and browsers is also made, as personal or browser settings can influence the final presentation of the text on a viewer's screen.

In all cases of the surveyed sample, the PDF version of the journal was a direct representation of the same articles in print, making a direct comparison of these formats redundant. For that reason, this paper will discuss the results of analysing the print and

PDF versions of the journals and compare this to the HTML experience for those journals where an HTML version was available.

None of the 30 journals available as HTML documents had the same typographic properties applied consistently between both the print/PDF version and the HTML version/s. Differences in document presentation were also seen in the text being presented in a single or multiple columns, the visual appearance of graphs and tables, and the layout of images.

4.2.1 Heading Typeface

Nineteen different typefaces appeared as headings across the 50 journals surveyed. The majority of journals combined a serif typeface for the body copy with a serif typeface for the headings, 36 (72%), the same as the body copy in the publication (Figure 8). A sans serif heading was combined with a serif body copy in 12 (24%) of journals and just 2 of the sampled journals used a sans serif body copy, which in both instances was combined with a sans serif heading. The combination of a serif heading with a sans serif body did not occur in any of the journals sampled in this study.

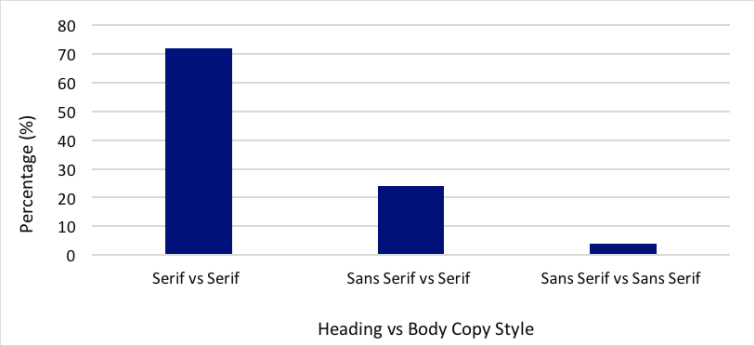


Figure 8: Heading and body copy style pairings (n=50)

The most commonly used heading typeface was Times New Roman, 26 (52%). All of the journals that used Times New Roman for headings also used Times New Roman for the body copy; 8 other journals (16%) used Times New Roman for the body copy, but another typeface for their headings. Four other typefaces were used in more than one of the sampled journals; 3 used Minion Pro (6%), 3 used Helvetica (6%), 2 used Calibri (4%), and 2 used Optima (4%). The remaining 14 (28%) journals all used a typeface for headings that was not used in any of the other journals surveyed. In 34 (68%) cases the typeface used for the heading was the same typeface used for the body copy. In the 16 cases where the heading and body copy were different typefaces, 12 of these combined a heading in a sans serif typeface with a serif typeface for the body of text.

Emphasising the heading was most commonly created by means other than using a change in typeface style, as the majority of headings were a serif typeface, the same as the body copy in the publication (Figure 8). This dominance of Times New Roman leads to the serif heading with the serif body copy combination being the most commonly occurring combination for heading and body text typefaces. The combination of a serif heading with a sans serif body did not occur in any of the journals sampled in this study.

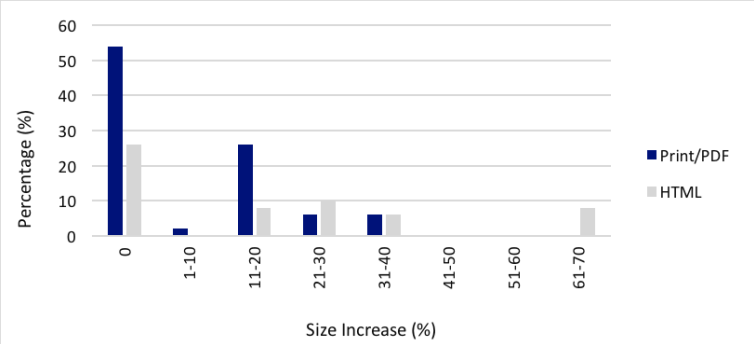


Figure 9: Size difference between heading and body copy (n=50)

The majority of headings, 45 (90%) had a point size of between 9 and 11-point. The difference in point size between the heading and the body copy text can be seen in Figure 9. It was interesting to discover that 50% had no difference at all between the two type sizes and relied on other methods such as styling and spacing to create emphasis on the heading.

In 12 of the sampled journals (24%), the same or similar typeface was used for the body copy and heading between print and HTML versions. A larger proportion had kept with a consistent use of the same relative style (serif versus sans serif) for the relationship between heading and body copy typefaces. 21 journals (42%) used the same style of typeface for the heading and body copy in HTML version as was used for the print publication.

The nature of the electronic environment with viewing HTML documents, and the size and resolution of viewing on screen, means that the comparison of size between print and electronic versions is limited to analysing the relative difference. In the HTML version, 24 (48%) of the sample had a greater relative size difference between the heading and body copy than was seen in print.

Across the sample of journals, a range of methods were used to differentiate headings from the body copy. Emphasising the heading was most commonly done by methods other than using a change in typeface style, as 34 (68%) of journals used the same typeface for both the body copy and the headings. Of the 26 journals using Times New Roman for headings,

seven different methods were used to emphasise the heading from the body copy using different combinations of emphasis methods.

When summarizing the methods of emphasis used for each heading, an increase in type size of less than 1 point or 10%, was disregarded because an increase by such a small increment would be difficult for a reader to discern. All of the emphasis methods were a combination of one or more of: an increase in size of 1 point or more, bold, capitalisation, small caps, and italics. Figure 10 shows that exactly half of the sample (25 publications) used just one method of emphasis to differentiate the heading from the copy, 23 (46%) combined two emphasis methods, and 2 journals (4%) used three emphasis methods to differentiate headings. The two journals that used three typographic emphasis methods combined an increase in size with bold and capitalisation. The most common combination used to differentiate headings was bold, 15 (30%), closely followed by a combination of bold and an increase in size, 14 (28%).

Of the 26 of journals (52%) using Times New Roman for headings, seven different methods were used to emphasise the heading from the body copy using different combinations of emphasis methods. These emphasis methods included: an increase in size of more than 1 point, bold, capitalisation and small caps. When both the heading and body copy were Times New Roman the most common change in typeface appearance was the use of bold for emphasis, 18 (36% of the sample).

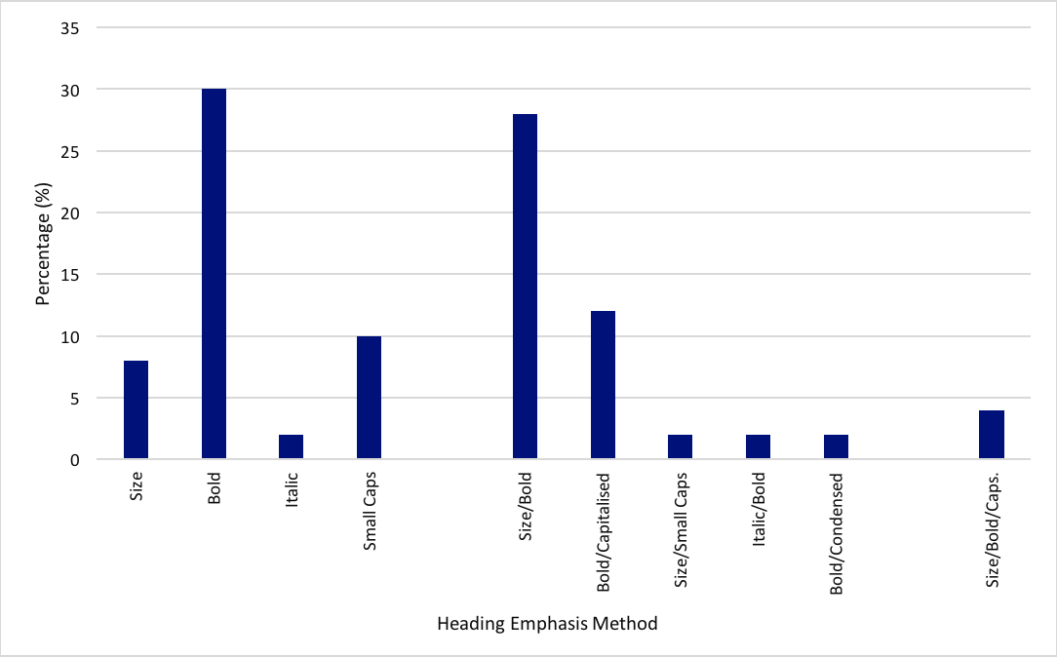


Figure 10: Heading emphasis method combinations used (n=50)

To emphasise the headings in the HTML versions of the journals bold was more commonly used with 28 (56%) having headings that were bold. Fewer also used italic and capitalisation or a combination of these three to emphasise the headings.

4.2.2 Heading Spacing

The amount of space above and below each heading was measured, from baseline to baseline, and was considered proportionally to the amount of line spacing (leading) in the body copy of the text. There was wide variation in the spacing provided above and below the headings. Only three headings had the same amount of spacing above and below them and none had less spacing above them than below. The greatest difference in spacing was a space of 28 points below the heading and 52 points above, where the leading was 14 points.

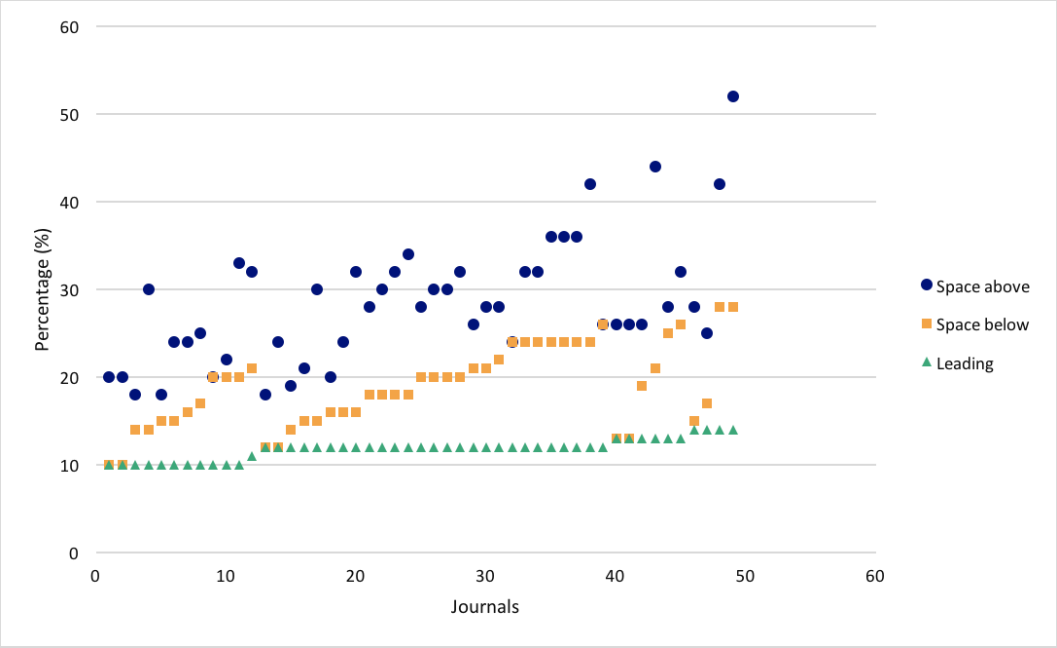


Figure 11: Heading spacing as a proportion of body copy leading (n=50)

One journal in the sample had inconsistent spacing for most of the headings that were present in the volume that was surveyed, and therefore was omitted from the data reported in Figure 11. Five other journals (10%) had inconsistencies in the spacing around the headings. In most instances, this was due to additional full lines of spacing being included, usually before the heading.

Six journals had inconsistent spacing above and below their headings throughout the sampled articles, despite the typographic treatments for emphasising the headings being

consistent throughout. One example also had no spacing below the heading, as it was in the same line as where the content started.

The amount of space above and below each heading was more consistent across HTML documents, and was not equivalent between print and HTML in any of the instances that we sampled.

4.2.3 Heading Horizontal Position

A total of three different heading positions were found across the selected journal sample. Figure 12 shows the most common heading position was aligned to the left margin, 35 (70%), with the next most common being a heading that was centred in the column of text, 18 (36%). Two (4%) of the surveyed journals positioned headings indented in from the left-hand margin.

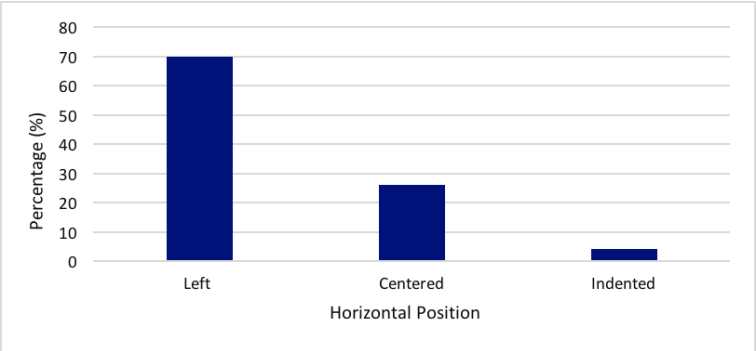


Figure 12: Horizontal position of headings (n=50)

There were common trends in the combination of horizontal position and other emphasis methods used. The majority of headings combined bold and left alignment, whereas the typeface for centre aligned headings was most commonly capitalized or in small caps. In print 13 (26%) had a centred heading, but in the HTML presentation only 6 (12%) of the journals used a centred heading. All other headings in the HTML versions of documents were left aligned.

4.3 Discussion

The ability to differentiate a heading relies on it being emphasised through it having sufficient contrast in appearance from its surrounding text. A survey of current practices for creating this visual hierarchy in academic journals reveals that a variety of methods are being used for this purpose. Serif typefaces appear to be generally favoured in journals, both for body copy and headings. In the 33 instances where the same typeface was used

for the heading and the body copy, the importance of utilising other methods for emphasising the heading is increased.

The majority of journals used left alignment for the positioning of headings and scale, bold, italic and capitalisation to create hierarchy for headings within the texts. Emphasis methods such as bold or capitalisation seemed to be preferred over changes in point size, with a large percentage of journals using relatively small point sizes for headings (9 - 11pt).

Hill (2010) recommends that any change in typeface scale should be 2 points or more as anything less that this may not be distinguishable to the reader, or may appear to be an error rather than a conscious decision. In all but 8 of the surveyed publications, headings were less than 2 points larger than the body of text. The finding that changes in the scale of text is a lesser used method of emphasis, especially on its own, goes against research by Williams & Spyridakis (1992) who showed that readers considered an increase in the size of text as the most important cue for indicating text hierarchy. In the same research by Williams & Spyridakis (1992) they found that position and capitalisation were perceived as the next most important cues for indicating text hierarchy. Their research however, did not consider the use of bold for headings; the testing of this emphasis method against size, position, spacing, case and underline may have revealed that bold is perceived as even more important than scale as readers often prefer what they see most.

One finding from the survey was that spacing above headings was almost always greater than the space below. This is positive because it helps create a visual relationship for users so they link the heading to the content placed below. The element of spacing is a helpful tool for guiding readers to important information. The space around headings can help draw attention and create hierarchy as a means of emphasis to assist with showing the document structure. However, the proportionate difference in spacing was not always as large as has been recommended. Williamson (1983) recommends that the spacing either side of a heading should be proportionate to the line spacing of the rest of the document and the spacing should be equivalent to three times greater above the heading as below it. Of the surveyed journals, most had spacing that was equivalent to an increase of just 20-60% above the heading.

The spacing applied above and below headings was inconsistent in 12% of the sample. This inconsistency occurred either within articles, or across several articles within the same issue of the journal. Inconsistent treatment of the same level of access structure can impede processing of the text structure. It is recommended that text should be designed to facilitate

mental processing and inconsistent typography should be avoided (Pettersson & Tullinge, 2010). Hartley (1982) supports this recommendation, stating "inconsistent spacing and multiple typographic cueing can only confuse the reader" (Hartley, 1982, p. 203).

In this survey, several factors were considered when limiting the scope of the research, especially comparison between print and digital versions of the journals. All journals in the sample were available both in print and digital forms, but for many of the digital versions, the only available format was a downloadable PDF. A small selection of five journals (10%) was also available in online readers for the PDF version. In all instances found in this research, the PDF versions were identical to the hard copy. The role that headings play as functions for assisting readers with search are different in print and electronic documents (Hartley & Jonassen, 1985). However, if an electronic search function is not available, as with many of the journal articles that are only available as PDF versions of the print article, the types of strategies that readers would employ in print documents come into play.

As an alternative to the PDF, some journals also offered an HTML version of the journal (60%). The visual hierarchy of headings used in these HTML offerings were inconsistent with the print and PDF versions of the document that were available. These inconsistencies in document presentation were often across all of the typographic variables that this research was focusing on, resulting in documents that bore little visual relationship to each other.

In no instance was the visual appearance of headings the same in the PDF and HTML versions, and for some publications that offered HTML versions through more than one digital source (8 of 50) the visual presentation of the document structure differed between digital repositories. This may mean that readers, even if previously familiar with an article in a differing visual presentation, may lose many of the benefits that come with having an understanding of the structure and content of the text because of the change in visual appearance of the text's hierarchy. Research conducted by Klusewitz and Lorch (2000) found that as a reader's familiarity with a document increased, their strategies for locating information within that document changed. Participants who were more familiar with a document relied more heavily on their knowledge of the document structure and utilizing their memory of approximate page location of the information they were searching for. If it is known that readers rely on their previous knowledge of the visual layout of a document to locate information, a change in the typographic appearance of that document

between media is likely to negate the benefits of familiarity with the document in another media.

There are many typographic and other factors that affect the reading experience in print compared to on screen, because of the vast number of variables involved. There is little evidence through replicated studies to show that certain visual cues for structuring documents are preferable in printed versus digital documents. While the visual hierarchy needs of readers may change between digital and printed media, maintaining a consistent typographic appearance of a journal article between print and screen may assist with retaining some of the understanding of the document structure. This is an area that requires further investigation to establish exactly how readers' search as document structure perception may be affected by changes in the typographic appearance of a document.

4.4 Conclusions and Implications for Study 1a & 1b

The survey of periodicals in this chapter was undertaken to gain insight into current practice for emphasising headings in print and electronic non-fiction documents. From this survey of the treatment of headings in journal publications, it has been shown that the most commonly used methods for emphasising a heading within a passage of non-fiction academic text was either the use of bold or use a combination of bold and an increase in size from the body copy surrounding it.

From the surveyed sample of journals, it is evident that many publishers need to better consider how document structure can be created through the typographic hierarchy of headings. Methods of typographic emphasis used to assist readers with differentiating headings in academic journals are currently varied and potentially lack the necessary hierarchy required to convey the text structure to the reader. The use of scale and spacing as a means for creating emphasis is currently being under-utilized by journal publishers. A clearly conveyed structure is important in documents where readers are conducting search activities as is likely in an academic journal article.

Conversely, many journals are also using typographic methods that overemphasise the headings within the text. Creating headings that are over emphasised or have greater spacing around them than is necessary, may interfere with the reader's continuous reading of the text. There needs to be a balance between headings that are sufficiently emphasised to support readers in building an effective understanding of the structure of the text for search and comprehension, without detracting from continuous reading.

However, current recommendations for the treatment of headings to create hierarchy within a document are seldom based on empirical research. Methods for creating hierarchy using typographic emphasis within journal articles need to be investigated to determine which methods assist with greatest ease of identification for readers. Once there is an understanding of which methods of typographic emphasis for headings best assist with indicating a text structure, journal publishers can make more informed decisions to benefit their readers.

The percentage size increase that is recommended for headings by Williams and Spyridakis (1992) is an increase of 20% from the size of the body copy. This allows enough difference for the reader to be able to distinguish the heading as being larger in size, without creating a heading which is overly large and creating over emphasis and distracting the reader from the natural flow of reading.

There were eight main factors that were found to be used for emphasising headings in the survey that was conducted. These were; type size, bold, italic, small caps, vertical spacing, sans serif (in contrast to a serif body copy), and horizontal position. The first seven of these typographic emphasis methods will be carried forward and compared in Study 1a and 1b (see Chapters 5 and 6), to answer Research Question 1; *Which methods of typographic emphasis make a heading easiest to identify within a passage of text?*

The horizontal position of headings will not be investigated further for two reasons. This method of typographic emphasis was only seen in combination with other methods for emphasising the heading, usually capitalisation. It was also only used in a small percentage of the documents presented in HTML versions of the documents. Horizontal positioning has also been explored by Hartley & Trueman (1985), who found that the horizontal position of headings did not have a significant effect on the search of familiar or unfamiliar text.

The survey also revealed that the text for the same publications can differ greatly between print and screen-based versions of the same document. For this reason, the next study will consider both print and screen presentation of documents to compare whether there are differences in the ease of identification between the two media.

5

Identification of Headings using Typographic Emphasis (Study 1a)

There are a seemingly infinite number of typographic variations that can be made when setting a heading within the run of a passage of text. Changes to the typeface, its weight, appearance and size can be combined with its horizontal placement and vertical spacing to generate an extensive number of variations to create contrast between the heading and the text that precedes and follows it. The viability of these typographic variations as emphasis methods for headings is investigated in the study reported on in this chapter.

The results of the survey reported in Chapter 4 showed that across just a small sample of academic publications there was a diverse range of methods for emphasising headings within the texts; and the methods of emphasis were frequently inconsistent between print and screen versions of a publication. With regard to typography, it has been observed that people find easiest to read that with which we are most familiar (Gill, 2013). Chapter 4 provided insight into which methods of typographic emphasis for headings readers are likely to see most frequently; this assists in establishing a set of typographic variations for headings which can be used in this study to answer Research Question 1.

Research Question 1: Which methods of typographic emphasis make a heading easiest to identify within a passage of text?

The study presented in this chapter attempts to answer Research Question 1, by comparing seven heading emphasis methods in both print and screen presentations of text. A paired comparison study is used to test which of the seven heading emphasis methods are easiest to identify in a passage of text, both in print and on screen. This chapter first outlines the

method used and describes the materials used in the study. Then the results are presented with analysis giving an overall ranking of ease of identification as well as examination of differences between demographic groups. The discussion section then explains why some heading styles were easier to identify than others and finally recommendations are made for using these results to inform Study 1b and Study 2.

5.1 Method

This study, designed to answer Research Question 1, used a balanced paired comparison procedure to evaluate which methods of typographic emphasis created headings that were more easily distinguishable from the surrounding body copy.

A paired comparison is a useful method for establishing a ranking for a group of items when either there are too many objects for judges to be able to make a fair comparison of all items at the same time or when the perceived differences between items may be less distinct. This study employed a paired comparison, rather than a card sorting or ranking study, as the differences between the items being compared was potentially more subtle and therefore more difficult for participants to create an accurate ranking of the items being compared. Cattelan (2012) observed that individuals find it easier to make direct comparisons between pairs of items than directly creating a ranking of a set of items. This is especially the case when the differences between the items being compared may be perceived as minor. Employing a paired comparison methodology typically leads to participants making choices based on preference rather than arbitrary factors (David, 1988).

The study reported in Chapter 4 found that the most common typographic methods for emphasising headings was typesetting the heading in a bold version of the same typeface as the body copy, or making the heading bold as well as increasing the size. Other methods commonly found in the surveyed sample were the use of italic, capitalisation, and the use of a sans serif heading with a serif typeface for the body copy, as well as spacing between headings and the body copy.

5.1.1 Stimuli

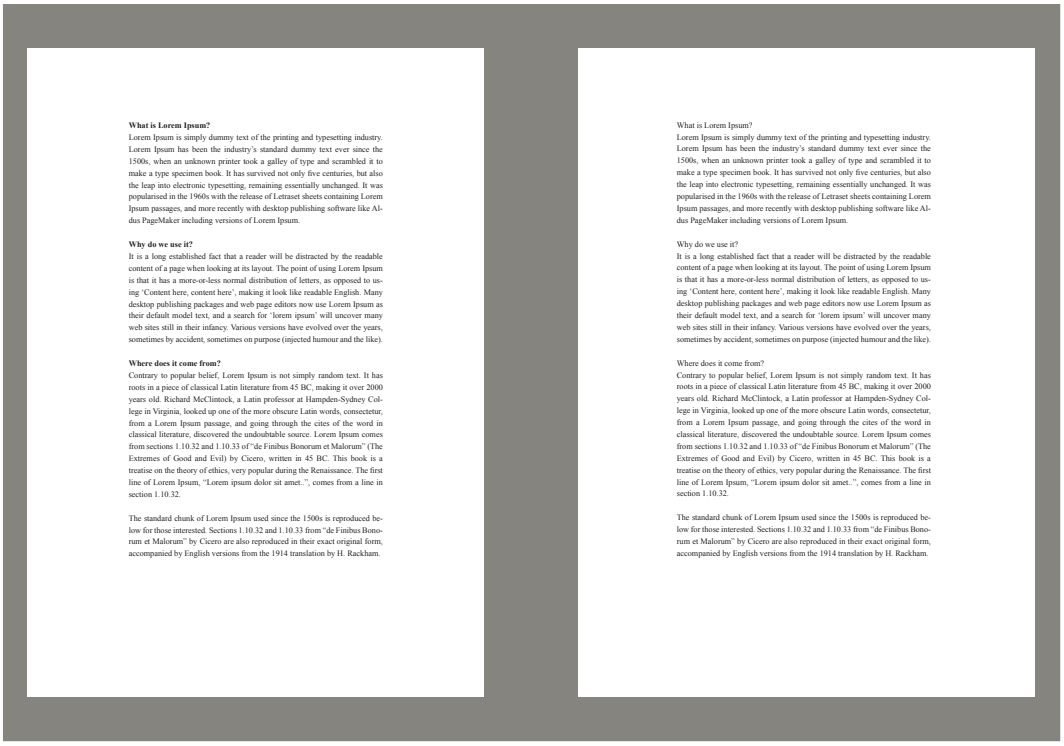
Participants were asked to indicate in which passage of text they found the heading easiest to distinguish from the body copy in a pair of texts. The study material consisted of the same passage of text (one page long) with three headings spaced throughout the page. No changes were made to the body copy of the text between each heading style. The body copy was set in Times New Roman at a size of 9 points with 13 points of leading. The

column width was 98mm wide and 175mm high on a page that was 176mm wide and 250mm high, allowing for generous margins and presented side-by-side.

Seven heading emphasis methods (styles) were chosen:

Co	Control (no difference between the heading and body text)
B	Bold
I	Italic
Sp	Increased spacing between the heading and the body copy
Sa	Sans Serif (Helvetica)
C	Capitalisation
Si	A size increase 20% larger than the body copy

Participants were shown pairs of text passages that each had a different heading style. For example, Figure 13 shows the pairing of the Bold style (left) and Control style (right).



What is Lorem Ipsum?
Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Lorem Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Lorem Ipsum.

Why do we use it?
It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout. The point of using Lorem Ipsum is that it has a more-or-less normal distribution of letters, as opposed to using 'Content here, content here', making it look like readable English. Many desktop publishing packages and web page editors now use Lorem Ipsum as their default model text, and a search for 'lorem ipsum' will uncover many web sites still in their infancy. Various versions have evolved over the years, sometimes by accident, sometimes on purpose (injected humour and the like).

Where does it come from?
Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum" (The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum" by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

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Figure 13: Example of test material (Bold and Control)

Each of the heading styles was shown paired with every other style, resulting in a total of 21 paired comparisons being shown to each participant. This resulted in each participant making six choices about each heading style as it was compared to all other styles being evaluated. Four sets of study materials were developed in which the 21 pairings were set in a different random order. The side of the page that each example of a pairing was presented on was also alternated to attempt to eliminate bias for a particular side of the

page, as well as the order the pairings were shown. In Sets 2 and 4 the pairs were presented in the opposite left to right orientation as they were in Sets 1 and 3 in an attempt to eliminate any bias that may have arisen from which side of the page each of the stimuli were presented on. Both items within each pairing were presented an equal number of times on each side of the page across all participants. Details of the order of the pairings in each Set and the orientation of those pairings is given in Table 1.

The materials used in both the print and screen presentations of the study were identical. The order and orientation of each of the four 'Set' conditions were the same in both print and screen versions of the study. The study material for the print version was prepared as a booklet where each pairing was presented side-by-side on an A3 page with a grey border around the pages, as seen in Figure 13. The screen material for the study presented each pairing on a screen no smaller than a standard tablet with the whole of both passages of text within the window.

Table 1: Presentation order and orientation for pairings in Study 1a

	Set One	Set Two	Set Three	Set Four
1	Sa / Si	Ca / Co	Co / I	Ca / Co
2	Co / B	Si / Sp	B / Si	Ca / Sa
3	Sa / Ca	Ca / Sp	B / Sp	Sa / Sp
4	B / Sp	Sp / B	Co / B	Si / I
5	Co / Sa	Ca / Sa	B / I	I / Co
6	Sp / Sa	Sa / B	B / Ca	I / Ca
7	I / Sa	Sa / Sp	I / Si	Si / Co
8	Ca / Si	Si / I	I / Sa	I / B
9	I / Si	Si / B	Sp / Ca	Sp / I
10	Sp / Si	Ca / B	Sa / Ca	Si /B
11	B / Sa	Ca / I	Sp / Sa	Si / Sa
12	I / Sp	Si / Sa	Sa / Si	Sa / Co
13	I / Ca	I / Co	Sp / Si	Sp /Co
14	B / Si	I / B	I / Ca	Ca / Si
15	B / I	Si / Ca	Ca / Si	B / Sp
16	Sp / Ca	B / Co	B / Sa	Sa / B
17	Co / Ca	Si / Co	Co / Si	Ca / B
18	Co / Sp	Sa / Co	Co / Sp	Ca / Sp
19	B / Ca	Sp / I	Co / Sa	Sa / I
20	Co / Si	Sa / I	Co / Ca	B / Co
21	Co / I	Sp / Co	I / Sp	Si / Sp

Overall, 200 participants took part in the study, 100 each for the print and screen version. Participants for the print version were sourced through approaching potential participants on the University of Waikato grounds and through personal contacts. This resulted in participants for the print version being a combination of students and staff from the University of Waikato, as well as from the wider community. For the screen version, participants were sourced through Amazon's Mechanical Turk and were self-selecting, though had to meet specified criteria as can be stipulated within the system. All participants through Amazon Mechanical Turk had to have the system's assigned qualifications of a HIT (Human Intelligence Task) Approval Rate (%) for all Requesters' HITs greater than or equal to 98 and the Number of HITs Approved greater than or equal to 5000. These qualifications were stipulated to ensure that the participants were likely to be competent at completing the study and would provide reliable data. Potential participants were excluded from participating in Study 1a if they were defined as being "graphic designers". They were defined as "graphic designers" if they had more than one year of visual design or typographic education at a tertiary level or if they had more than six months experience working in the visual design industry. These participants were excluded as it was hypothesised that their knowledge of typography may change the responses that they gave in this study.

5.1.2 Procedure

Prior to the commencement of the study each participant was randomly assigned a participant number. Then each participant number was randomly assigned one of the four sets of test materials.

The study began by asking participants for basic demographic information; their gender, age range and highest completed level of education (See Appendix B for a copy of the participant information sheet and study recording sheet). Participants were asked to consider each pairing and decide in which of the two passages of text the headings were easiest to distinguish from the body copy surrounding them. They could also indicate whether they did not perceive a difference in their ability to distinguish the headings from the body copy. Participants could move through the pairings at their own pace as there was no limit to the length of time they could take to complete the study. Participants' responses were recorded by the researcher in the print version of the study and by selecting a radio button in the Amazon Mechanical Turk interface for the screen version ("Left", "Right" or "No Difference").

5.2 Sample

Before commencing the study, all participants were asked three demographic questions; their gender, age range and highest completed qualification.

The gender balance differed between the two samples. For the print study, 38% of participants were male and 62% were female. Whereas for the screen study 53% of participants were male and 47% were female.

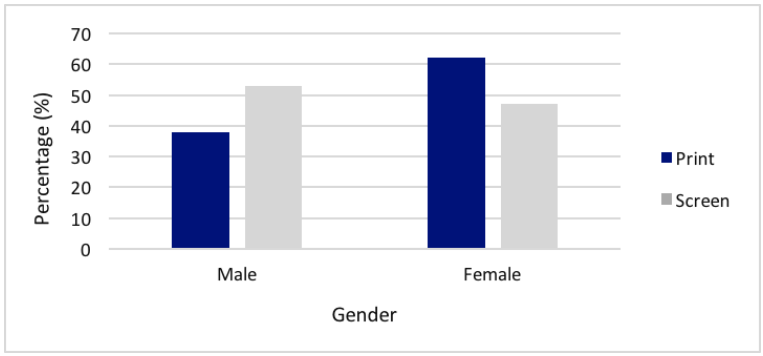

Figure 14: Gender of participants in Study 1a for print (n=100) and screen (n=100)

In print, the print version of the study 46% of participants were aged 17-25 and 23% were aged between 26 and 35 years. In the screen based study 19% of the participants were aged 17-25, 47% were aged 26-35, and 19% were aged 36-45 years. The majority of participants were aged between 17 and 35 years across both conditions of the study. The age of participants in the screen condition was slightly older than in the print condition.

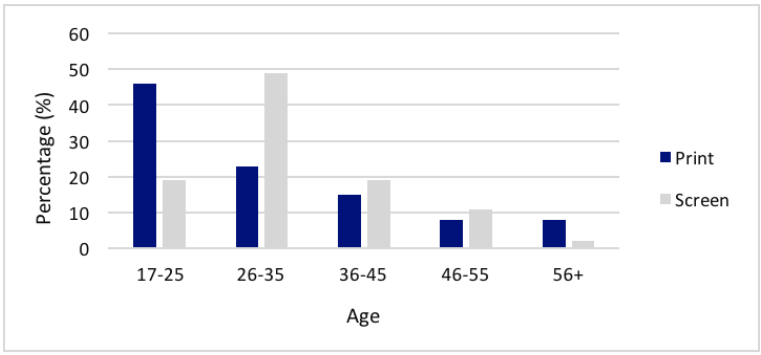

Figure 15: Age of participants in Study 1a for print (n=100) and screen (n=100)

Overall, the level of education across the two samples was similar. In the print study 50% of participants had a pre-degree qualification, 29% had a bachelor degree. For the screen version of the study 44% of participants had a pre-degree qualification, 39% had a bachelor degree and 16% had postgraduate degrees. In each of the conditions, one participant had a qualification classed as 'other'; they did not specify what this qualification was.

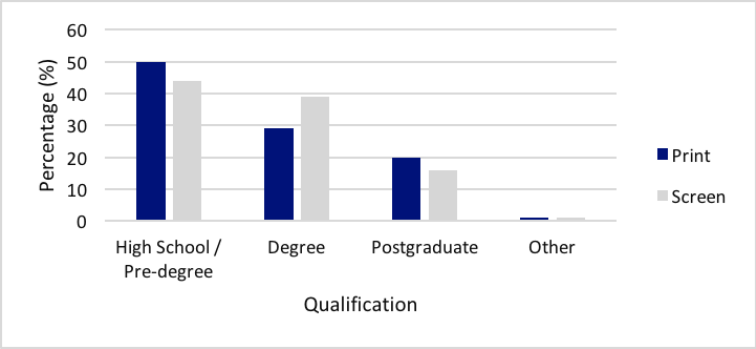

Figure 16: Highest qualification of participants in Study 1a for print (n=100) and screen (n=100)

5.3 Results

Here we discuss the results of the paired comparison study and analyse this data to generate an overall ranking of ease of identification for the seven heading styles based on participants choices in the paired comparison study.

A ranking of ease of identification for the heading styles that were compared was conducted using two methods. The first method for ranking the emphasis methods can be created by considering the overall number of times an emphasis method was chosen in each head-to-head comparison and using this to generate an order of preference (David, 1988). The second method for analysing the choices of the participants was also analysed using the Bradley Terry model in R using the 'prefmod' package (Dittrich & Hatzinger, 2009; Hatzinger & Dittrich, 2012).

5.3.1 Head-to-head Comparison

According to paired comparison methods described by David (1988), the ranking for this study can be created from interpreting it as a Round Robin tournament where every 'player' is paired with each other 'player'. Table 2 and Table 3 show the frequency of choices made by participants for each of the heading styles in a pairing in print and on screen. Where a heading emphasis method in the column was chosen over that in the row, '1' was assigned, where a tie, or neutral response was split evenly between the two heading styles, '0.5' was recorded for each. The reference totals for each heading style are shown out of a maximum 600 possible times each style could have been chosen across all 100 participants.

Table 2: Study 1a head-to-head results for print

	Control (Co)	Bold (B)	Italic (I)	Spacing (Sp)	Sans (Sa)	Caps (Ca)	Size (Si)
Control (Co)	---	99	74.5	86.5	90.5	90	91
Bold (B)	1	---	11.5	25.5	26.5	27	27
Italic (I)	25.5	88.5	---	65	68	68	72
Spacing (Sp)	13.5	74.5	35	---	65	63	74.5
Sans (Sa)	9.5	73.5	32	35	---	35.5	66.5
Caps (C)	10	73	32	37	64.5	---	46.5
Size (Si)	9	73	28	25.5	33.5	53.5	---
Total	**68.5**	**481.5**	**213**	**274.5**	**348**	**337**	**377.5**

In results from the print version of the study (Table 2), Bold was chosen over the Control in 99 instances out of 100, Bold was chosen most frequently when paired with all other styles (481.5). In comparisons with Bold; Spacing, Sans Serif, Capitalisation and Size all had a similar number of choices made in favour of them (27 – 25.5). Meaning that more than a quarter of people found one (or more) of these three heading styles easier to identify than the most commonly chosen heading emphasis method in this study. The pairing of Size and Capitalisation was the closest in the number of choices for each of the two heading styles in the pairing. This is likely due to the two being perceived as carrying a similar visual weight. Aside from the Control, Italic was the least frequently chosen heading emphasis method at just 213 choices made in favour of it for its ease of identification. In the results of the on-screen study (Table 3), Bold was again most often chosen as the heading style that was easier to identify, though not by as much as in print. The only inconsistency that arises in the ranking of choices in the on-screen version of the study is between Capitalisation and Sans Serif. Capitalisation was chosen more frequently than Sans Serif as the heading emphasis method that was easiest to identify over all paired comparisons; however, Sans Serif was the heading emphasis method more frequently chosen when Capitalisation and Sans Serif were compared to each other.

Table 3: Study 1a head-to-head results for screen

	Control (Co)	Bold (B)	Italic (I)	Spacing (Sp)	Sans (Sa)	Caps (C)	Size (Si)
Control (Co)	---	93	59.5	77	86	92.5	89.5
Bold (B)	7	---	29	22	30	37.5	38.5
Italic (I)	40.5	71	---	66	65	76.5	77
Spacing (Sp)	23	78	34	---	66	60	66.5
Sans (Sa)	13.5	70	35	34	---	47	63.5
Caps (C)	7.5	62.5	23.5	40	53	---	53
Size (Si)	10.5	61.5	23	33.5	36.5	47	---
Total	**102**	**436**	**204**	**272.5**	**336.5**	**360.5**	**388**

On screen, the number of choices in favour of Bold was less distinct than in the print version of the study, and the number of choices made for Capitalisation and Size was greater overall. The Control was also chosen more frequently on screen, but Spacing was chosen almost the same number of times between the two versions of the study.

5.3.2 Neutral Choices

Neutral choices, or ties, were recorded when a participant felt that the heading emphasis methods in a paired comparison were of equal value. Recording a tie was given as a third choice to participants if they felt that two heading emphasis methods were equally easy or hard to identify as headings within the text, or if they felt that there was no perceivable difference between the two heading emphasis methods. The number of neutral choices for each of the pairings in print is shown in Table 4 and for screen in Table 5. For the majority of pairings, the number of neutral choices was reasonably consistent. Between three and nine ties (3-9% of responses) were recorded for most pairings across all 100 participants, this was the same for both print and screen. The number of neutral choices (ties) made for an individual heading emphasis method was greatest for Sans Serif headings on screen (72) as well as having the most neutral responses in print (48). The high number of neutral choices for the Sans Serif heading style may also be a reflection of it being chosen a similar number of times to other heading styles in the overall choices. The fewest number of neutral choices was made for Bold, 29 in print and 26 on screen, from all 600 choices made. This supports the finding that participants found the Bold heading style to be more easily distinguished in both print and screen versions of the study.

Table 4: Neutral choices in print

	Control (Co)	Bold (B)	Italic (I)	Spacing (Sp)	Sans (Sa)	Caps (Ca)	Size (Si)
Control (Co)	---	0	11	11	7	4	6
Bold (B)	0	---	3	5	9	8	4
Italic (I)	11	3	---	6	8	8	4
Spacing (Sp)	11	5	6	---	4	4	3
Sans (Sa)	7	9	8	4	---	7	13
Caps (C)	4	8	8	4	7	---	7
Size (Si)	6	4	4	3	13	7	---
Total	**39**	**29**	**40**	**33**	**48**	**38**	**37**

The total number of neutral choices across all heading emphasis methods in print was 264. The 100 participants made 2100 choices in total; therefore 12.6% of responses in print were neutral. The greatest number of neutral choices across a single heading emphasis method in print were made for the Sans Serif headings (48), with the greatest number of neutral responses for Sans Serif/Size (13). The larger number of neutral choices of this pairing may be due to the two heading styles having a similar perceived size, as they both have a similar x-height. Bold had the fewest number of neutral responses in print (29) and the single pairing that respondents were least likely to feel was equivalent was Control/Bold for which no one had a neutral response. This is in line with the overall finding of Bold being chosen most frequently and the Control being chosen least frequently.

Table 5: Neutral choices on screen

	Control (Co)	Bold (B)	Italic (I)	Spacing (Sp)	Sans (Sa)	Caps (C)	Size (Si)
Control (Co)	---	6	11	24	15	3	9
Bold (B)	6	---	4	6	6	3	1
Italic (I)	11	4	---	14	8	5	2
Spacing (Sp)	24	6	14	---	8	6	5
Sans (Sa)	15	6	8	8	---	12	19
Caps (C)	3	3	5	6	12	---	8
Size (Si)	9	1	2	5	19	8	---
Total	**69**	**26**	**48**	**63**	**73**	**37**	**44**

Overall there were a greater number of neutral choices made in the on-screen condition. On screen the total number of neutral choices across all heading emphasis methods was 360, therefore, on screen 17.1% of responses were neutral. Combinations containing a Sans Serif heading were most commonly thought of as neutral (73); this reflects what was also found in print. A large number of neutral choices were also made in the paired comparisons with the Control as one of the heading emphasis methods (69). In the comparison of Control and Spacing, which were most frequently thought to be equal of any of the combinations of heading styles on screen, there was the greatest number of neutral choices. The combinations that participants were most likely to feel were equivalent, were the comparison of Control/Spacing (24) on screen. The fewest number of neutral choices on screen were made for paired comparisons where Bold was one of the heading emphasis methods (26), with only one person feeling that Bold and Size were tied. This supports Bold being the most frequently chosen heading style on screen. Size was the second most frequently chosen headings style on screen but this did not mean that it was more frequently chosen as a neutral combination with Bold.

5.3.3 Analysis Using the Bradley Terry Model

The Bradley Terry model is a log-linear model that is used to predict the probability that object A will be preferred over object B. The paired comparison data was modelled in R using the prefmod package, as described by Hatzinger and Dittrich (2012) as this package allows for ties. The prefmod package for R provides a range of functions for analysing paired comparison data according to Bradley Terry models. Results were entered into R and were compared with the Control used as a reference object, so that all other headings are judged relative to that (Dras, 2015).

The plots (Figure 17 to Figure 26) were generated to provide a visual presentation of relative ranking based on the worth estimates of each of the six heading emphasis methods, Bold (B), Italics (I), Spacing (Sp), Sans Serif (Sa), Capitalisation (Ca), Size (Si) and the Control (Co). The plot provides a scale which defines the probability that any item would be preferred over any other in the paired comparison (Hatzinger & Dittrich, 2012).

5.3.3.1 Paired Comparison in Print

The overall results for the print version of the study when analysed using the Bradley Terry model support the findings of the head-to-head comparison. The plot of the relative

ranking of the seven heading styles is shown in Figure 17. The distance between the points on the plot indicate the relative preference of each of the heading styles.

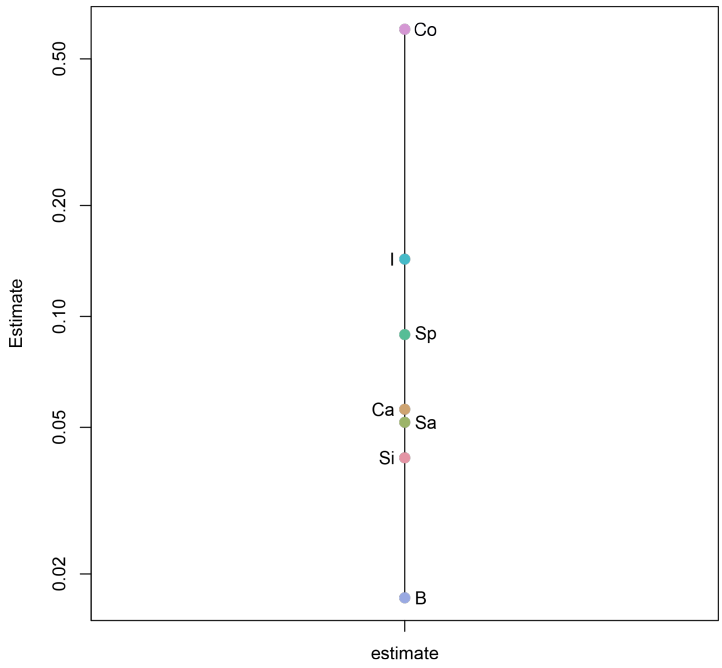

Figure 17: Heading emphasis ranking in print

Overall, the results for paired comparisons made in the print condition show a significant preference for Bold above all other methods of emphasis for headings, this is supported by the Pr(>|z|) value in Table 6. The plotted points for Size, Sans Serif and Capitalisation are much closer, indicating that the ease of identification for these heading styles is much closer and are therefore considered by participants to be more equal in value. Spacing and Italic were considered even less easily identified ahead of the Control.

Table 6: Coefficients of interest for print results

	Estimate	Std. Error	z value	Pr(>|z|)
Si	-1.33900	0.08239	-16.253	<2e-16 ***
Ca	-1.18736	0.08105	-14.650	<2e-16 ***
Sa	-1.22817	0.08138	-15.092	<2e-16 ***
Sp	-0.95400	0.07948	-12.003	<2e-16 ***
I	-0.71831	0.07840	-9.162	<2e-16 ***
B	-1.77638	0.08851	-20.070	<2e-16 ***
Co	0.00000	NA	NA	NA
g1	-1.76576	0.09086	-19.434	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '

All surveyed methods of emphasising headings were found to be preferred over using no emphasis (Control) as detailed in Table 6. This result is found to be statistically significant, given Pr(>|z|). The negative value of g1 indicates that there was a strong tendency for participants to make a decision between the two options shown in each pair. The further this number is from 0, the stronger their tendency for making a decision. This result is also statistically significant.

5.3.3.2 Paired Comparison on Screen

Overall, the results for the relative ranking of heading emphasis styles on screen, as analysed using the Bradley Terry model, are shown in Figure 18. This visual plot of the results reflects the findings from the head-to-head comparison.

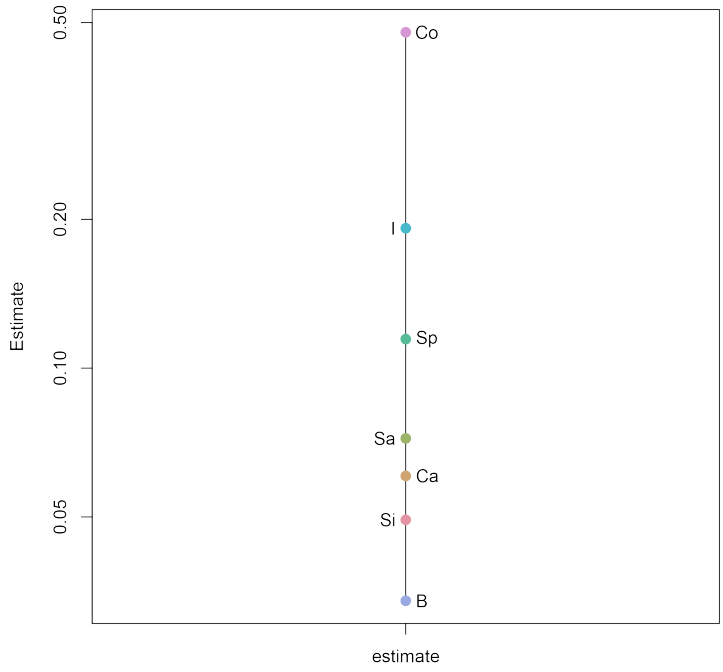

Figure 18: Heading emphasis ranking on screen

The order of ranking for heading emphasis methods on screen is similar to the order of ranking in print. However, the relative ease of identification for Bold that is seen in print is not as strong on screen. The results on screen indicate that Bold is the heading emphasis method that is easiest to identify, followed by an increase in the Size of heading. As was the case for the print results, the screen results show that all heading styles are significantly preferred over the Control, as shown in

Table 7 with the Pr(>|z|) value. The negative value for g1, again shows that there is a tendency for making a decision, though not as strong as with the print version of the study, as the value is closer to 0.

Table 7: Coefficients of interest for screen results

	Estimate	Std. Error	z value	Pr(>|z|)
Si	-1.13549	0.07360	-15.428	< 2e-16 ***
Ca	-1.03324	0.07257	-14.238	< 2e-16 ***
Sa	-0.94586	0.07183	-13.168	< 2e-16 ***
Sp	-0.71462	0.07043	-10.146	< 2e-16 ***
I	-0.45636	0.06986	-6.532	6.47e-11 ***
B	-1.32399	0.07603	-17.414	< 2e-16 ***
Co	0.00000	NA	NA	NA
g1	-1.50849	0.07923	-19.040	< 2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

5.3.3.3 Comparison of Presentation Order

All participants gave their choices for all of the 21 pairings, however, they saw them in one of four possible orders. Here the results for each of the four sets are compared to see if the order of presentation influenced results.

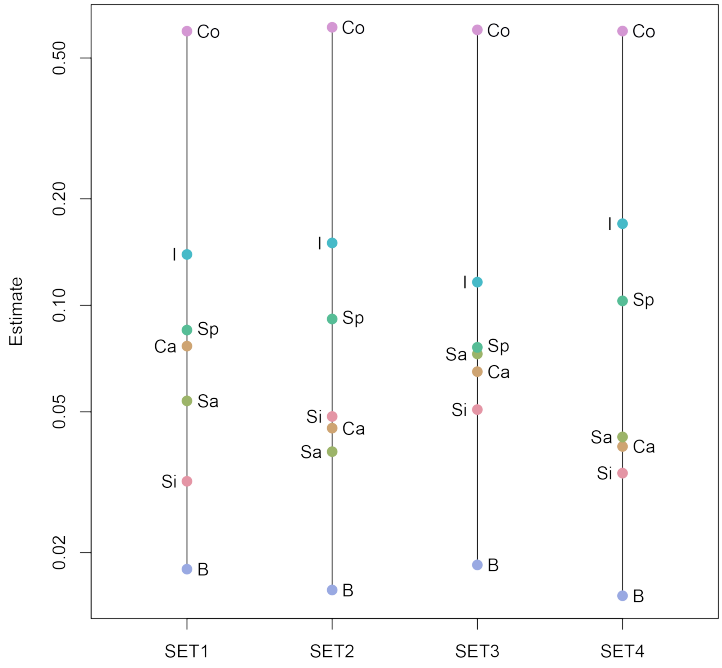

Figure 19: Comparison of print results by set

As seen in Figure 19, Bold was still the preferred heading method across all four presentation conditions in print and Italics was still the least preferred method of emphasis in all four presentation conditions. There was, however, some movement between Size, Sans Serif, Capitalisation and Spacing between the four 'sets'. In three of the four sets, Size was still ranked as being the next most preferred, but in 'Set 2' the Sans Serif typeface condition was the most preferred with Size being ranked fourth of the six heading emphasis methods.

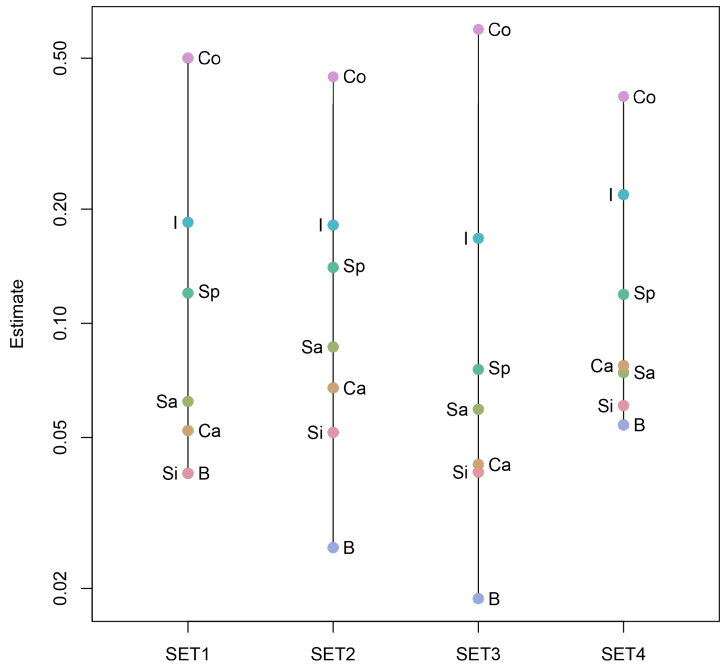

Figure 20: Comparison of screen results by set

When compared across the four presentation conditions which participants were shown the on-screen results (Figure 20) are far more varied. Bold is still the heading style that participants find easiest to identify for participants who viewed Sets 2 and 3, but this is not the case for Set 1 and Set 4. In Set 1, Bold and Size were tied as most preferred and in Set 4, Bold was only marginally preferred over Size.

In all conditions, Spacing was the fifth ranked heading style, but there was wide variation in its relative ranking between sets. Capitalisation and Sans Serif were ranked third and fourth, but their ranking in relation to the other heading emphasis methods varied greatly.

5.3.3.4 Left Versus Right Side of the Page

In the presentation of each paired comparison, passages were presented alternated from the left-hand side of the page to the right-hand side between Sets 1 and 3, and Sets 2 and 4

with each heading style being shown an equal number of times on each side of the page. Analysis of the responses was conducted to try to determine whether participants were biased towards either the left or right-hand side of the page. Neutral choices were excluded, and the total number of times that the passage on each side of the page was chosen was calculated.

In print, the passage on the left-hand side was chosen 986 times (47.0%), and the heading style on the right-hand side was chosen 982 times (46.8%), of a total 2100 choices. On screen the difference was slightly greater; of the 2100 choices, 1004 (47.8%) were for the heading style on the left-hand side of the page and 916 (43.6%) for the heading style on the right. Many of the pairings were balanced left to right within 1 or 2 choices of each other, while others had a stronger bias to one side of the page.

Table 8 lists the heading style pairings where the greatest differences occurred between the number of times the left and right page was chosen. The results are listed in order from greatest to least difference.

Table 8: Study 1a left and right-side page biases in print (left) and on screen (right)

Print			Screen		
	Left	**Right**		**Left**	**Right**
Size/Spacing	60	37	**Sans Serif/Capitalisation**	59	29
Capitalisation/Size	35	58	**Bold/Italic**	61	35
Italic/Capitalisation	55	37	**Sans Serif/Size**	30	51
Sans Serif/Capitalisation	39	54	**Spacing/Capitalisation**	41	53
Normal/Capitalisation	55	41	**Spacing/Sans Serif**	52	40
Sans Serif/Size	38	49	**Italic/Sans Serif**	49	39
Italic/Sans Serif	51	41			

Overall there appears to have been a slightly greater bias to the left-hand page on screen than there was in print. Sans Serif/Capitalisation appears in both lists, but has a bias each way for left and right between print and screen. Sans Serif/Size appears in both lists and has a bias to the right in both print and screen. Italic/Sans Serif appears in both lists and has a bias to the left in both print and screen. While there appears to be biases to one side of the page or the other for some pairings, there seems to be no consistent trend. The

differences overall across all heading styles are not significant and biases within pairs of headings do not appear to be consistent.

5.3.3.5 Comparison of Ranking by Gender

Here the results in both print and screen versions of the study are considered by gender to understand if there were differences between genders for which heading styles are easiest to identify.

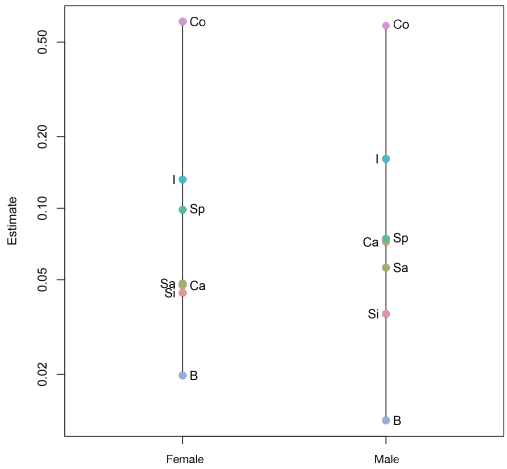

Figure 21: Comparison of print results by gender

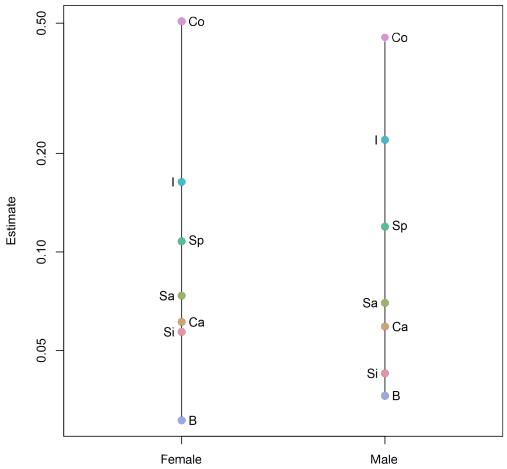

Figure 22: Comparison of screen results by gender

Gender differences had some influence over the choices made for heading emphasis methods in both print and screen conditions. Size, Sans Serif and Capitalisation were all ranked very closely by female participants in the print condition. Capitalisation was less preferred by male participants in print, though this was not the case on screen. In print, female participants felt that the Italics heading style was easier to identify than the male participants did; though both were still the heading style that the participants found least easy to identify. On screen, the male participants had a relative ranking for Size and a lower relative ranking for both Bold and Italics, though otherwise their overall ranking for ease of identification was largely similar to the female participants.

5.3.3.6 Comparison of Ranking by Age

For the analysis in this section the age bracket '66+ years' was combined with '56-65 years', as there was only one participant in this category across all 200 participants in both print and screen conditions.

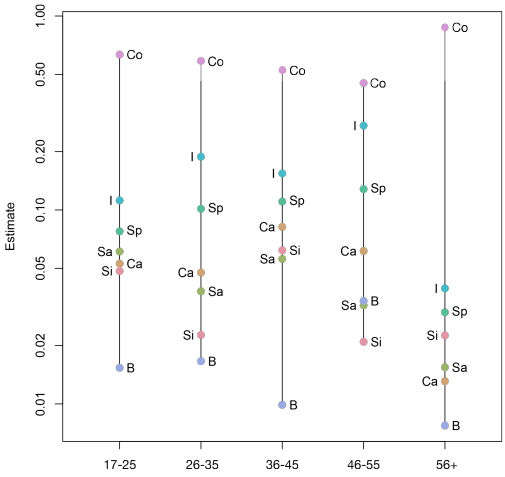

Figure 23: Comparison of print results by age

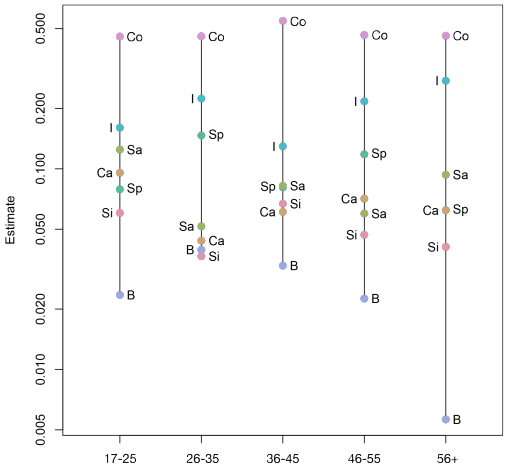

Figure 24: Comparison of screen results by age

In print, Bold was still the most preferred heading emphasis method across all age brackets (Figure 23), other than for 46-55 where size was favoured. Bold was ranked third for the 46-55 age group, closely behind Capitalisation. Size was the second most preferred in just two of the age brackets, 17-25 and 26-35, the two youngest brackets. Italics and Spacing were still the two least preferred methods of emphasising the headings.

On screen (Figure 24), Bold was again the preferred heading emphasis method across all ages other than one; 26-35 where size was marginally preferred and Capitalisation was ranked a close third. Size was ranked second in three of the other four age brackets, and third in the age bracket of 36-45. Italics was again the heading style that was thought to be least easy to identify in each age bracket; however, Spacing had a higher relative ranking in some age brackets than it did in print, being ranked third with 17-25 year olds and being third equal with Capitalisation with participants in the 56+ age bracket.

5.3.3.7 Comparison of Ranking by Qualification

Here we consider the results in both print and screen versions of the study to see whether the level of qualification that a participant held influences their choice of heading style which is easiest for them to identify.

When considering the results in print (Figure 25), broken down by the highest attained qualification of the participants, Bold is generally still the most preferred heading emphasis method and Italics is still the least preferred. Size is the second most preferred in each of the qualification categories and Spacing was the second least preferred. Amongst the postgraduate participants, Spacing is only marginally preferred over Italics. Capitalisation and Sans Serif are very similar in ranking for the high school/pre-degree and Bachelor

categories, but in the groups of participants with postgraduate degrees, Sans Serif is considered more easily identified than Capitalisation, where it is almost equal with Size.

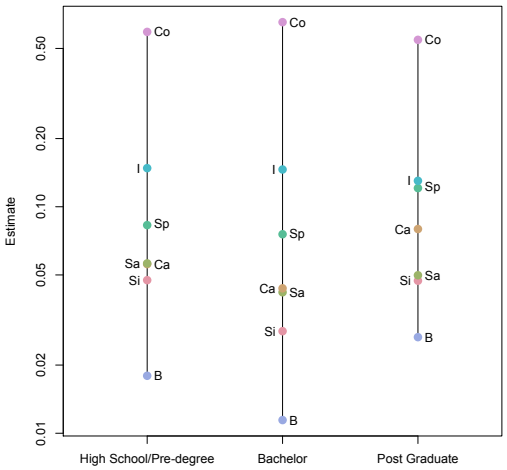

Figure 25: Comparison of print results by qualification

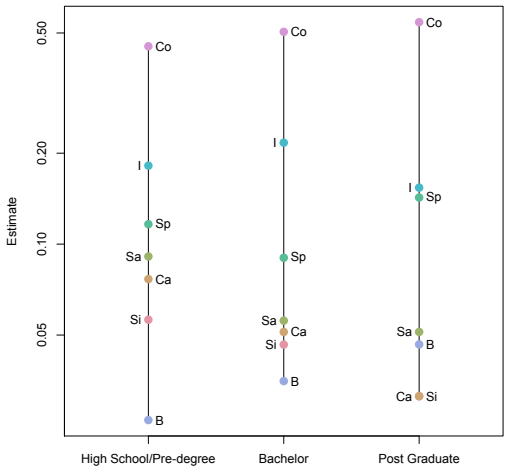

Figure 26: Comparison of screen results by qualification

As shown in Figure 26, on screen the relative ranking of Bold decreases as the level of qualification increases. Bold is the most easily identified heading emphasis method in the high school/pre-degree and bachelor groupings, but for participants with a postgraduate qualification, Bold is ranked third for ease of identification. Size and Capitalization are tied equally as most easily identified heading emphasis methods. These two heading emphasis methods were ranked second and third for ease of identification on screen with both the participants whose highest completed qualification was a high school/pre-degree and bachelor qualifications. Italics and Spacing were the two least easily identified heading emphasis methods, though in the postgraduate grouping the relative ranking of Spacing falls to being only slightly easier than Italics.

5.3.4 Participant's Comments

Participants were not asked to provide comment or reasoning for the choices they made during the study. However, during the print version of the study many participants volunteered information to the researcher about their thoughts on the heading styles shown to them or the reason for their choices. No comments were recorded about the screen version as this facility was not made available in Mechanical Turk. Some participants provided factual information as comments, identifying the heading emphasis methods being used, whereas others offered their reasoning for their choices. It was common for participants to note that they felt there was minimal difference between the two options, and often pointed to one of the headings, along with a statement like "This

one, just" to indicate that they only slightly preferred one heading over the other. Other participants also pointed out the differences between the headings, such as one being a sans serif and the other being larger than the body copy. Here the relevant comments made by participants are presented.

5.3.4.1 Bold

Many comments were made regarding the general ease for identifying Bold headings, "can't go wrong with bold" and another comment in favour of Bold was that it "stands out". The overall observation made by one participant was that they preferred Bold, "others just look like they are part of the text." One participant identified that context was important when considering which typographic emphasis method was most appropriate, discussing that Bold creates more distinct items, but Italics is better to "indicate more fluid content." When considering their choice for either Bold or Size, one participant mentioned that they liked the Size better, but the Bold was 'just' easier to identify. When making the same comparison, a participant in the 56-65 age group felt that "size and bold are probably better for old people." However, another participant in the 17-25 age bracket also commented on their choices in favour of Bold and Spacing.

5.3.4.2 Capitalisation

Comments regarding Capitalisation generally centred on their dislike for capitalised headings. Two participants simply commented that they do not like 'caps' and one commented that they did like it. When choosing Capitalisation as their preferred heading type they pointed to the choice saying, "that one, but I don't really like capital letters as a heading." Noting its relative size one participant thought that it was bigger (than Sans Serif) but "ugly", and another participant did not like that a capitalised heading was bigger in comparison to the italicised headings. Another participant made a comparison between Capitalisation and Spacing saying that 'caps' was more obvious as a heading than Spacing. An insightful comment was made by a participant who felt that Capitalisation was harder to read but easier to identify as a heading from the copy surrounding it when looking at the pairing of Capitalisation and Size. The most interesting comment made in relation to Capitalisation was by a participant in the 17-25 age bracket the first time they saw a capitalised heading they said that it's "yelling at me", the same participant continued to refer to caps as 'yelling' the whole way through the study.

5.3.4.3 Size

Two participants commented on Size when comparing it with the Control, one saying that the increase in size was more readable because it was more different, and the other

mentioning that they thought the space felt larger when the size was bigger. The only other person to comment on Size was on individual who felt that Size was only just better than Spacing.

5.3.4.4 Italic

When one person was choosing Italics, they stated that it was a close decision over the Control heading and for another it was a close choice when choosing Italics over Size, even though they liked Size. An insight provided by another participant was that the Italics just looked like highlighted copy rather than a heading, with another participant stating that they are "not a fan of cursive."

5.3.4.5 Spacing

The perception that some participants had of some heading styles seemed to change depending on which pairing they were viewing. An example of this is one participant who in the pairing of Spacing and Capitalisation felt that the Spacing heading style just made the heading look like a short sentence (paragraph) and then later in the study when comparing Spacing and Sans Serif, they commented that they liked the Spacing. In another instance, a different participant also mentioned that Spacing alone was not enough to indicate a heading "When there's a gap I don't think of it as a heading". From a positive perspective, one participant felt that vertical spacing was good and another commented that Spacing provided better flow than Capitalisation, which interrupted the page and flow of reading too much. Others were torn, and seemed to prefer it in some situations and not others, "I like the gap", when comparing Spacing and Size, then later, "Ok, I don't like the gap now" when comparing Spacing and Capitalisation.

5.3.4.6 Ties

Comments were made frequently by participants when they thought a pairing was very close, this happened several times with pairings involving italics (Italic/Spacing, Italics/Sans Serif and Italics/Capitalisation). One participant commented that they thought Bold and Capitalisation were close and two people commented on the combination of Italics and Spacing, one saying that they were close and the other expressing that they felt Spacing was only just better than Italics. Another commented that Sans Serif and Size were close; this may be due to the Sans Serif having a relatively larger x-height that can make the type appear to be larger, even at the same point size (Lupton, 2004). One participant commented that they felt that Sans Serif and Spacing were "equally awful".

5.3.5 Consistency of Choices

Brown and Peterson (2009) explain that 19th Century psychologists studied inconsistency in binary choices, finding that the more similar items are, specifically physical stimuli, the less accurate the individuals comparative judgment becomes. In the case of there being just one judge (or even a small number) the judge/s could be seen as guessing (because of incompetence) or it may also indicate that the objects being judged are considered to be very similar (David, 1988). With 100 'judges' in this study, the latter is the most likely explanation. The difference between the overall 'scores' of Capitalisation and Size is very small, Capitalisation (50) and Size (43), and therefore these two could be equally preferred.

5.3.5.1 Circular Triads

In a paired comparison study, if the items being judged are seen by a participant as being similar, inconsistencies can occur in the responses provided. This can result in a clear ranking of preference order not being able to be established within the responses of an individual participant. For example, if A is preferred over B, B over C, and C over A, this inconsistency in preference creates a circular triad between the three heading emphasis methods (David, 1988), or a tetrad or 'polyad' (Kendall, 1970) if four or more items are ranked inconsistently. Inconsistency in choices may be the result if a participant does not have a clear preference for certain choices or if there is not a significant difference between the examples being compared.

In the print version of the study we see a circular triad in the overall results. After Bold, a Size increase was the heading emphasis method with the next greatest number of choices made for it. Size had the next greatest number of choices made in favour of it, 377.5 (of a possible 600). Other than Bold, the only other heading emphasis method to be more frequently chosen, was Capitalisation (53.5 to 46.5). However, excluding Bold, Capitalisation was more frequently preferred over all other heading emphasis methods, besides, Sans Serif (64.6 to 35.5). Other than Bold, Sans Serif was more frequently preferred over all other heading emphasis methods, apart from Size (66.5 to 33.5).

In the screen version of the study the anomaly seen in print was not repeated. A circular triad between Size, Sans Serif and Capitalisation was not created as Size was more frequently chosen as the more easily identified heading when paired with Capitalisation.

5.3.5.2 Coefficient of Consistence

When making paired comparison choices the responses of a single participant may be inconsistent and may not reflect a perfect ranking of preference. The greater the number of circular triads, or inconsistent responses, within a participant's set of choices, the less consistent a participant is considered to be. The degree of consistency for a single participant, given an odd number of styles, in this instance seven different heading emphasis methods, can be calculated using the formulae described by Kendall (1970), (see Appendix C for a full description of the calculations and formulae).

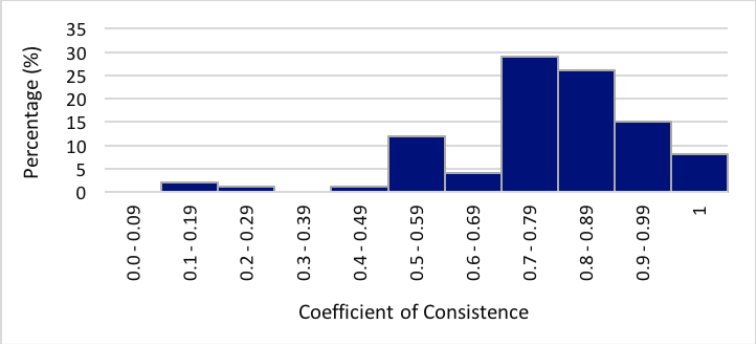

Figure 27: Coefficient of consistence scores in print (n=100)

The coefficient of consistence was calculated for each of the 200 judges in both print and screen versions of the study. From Figure 27, where the coefficient of consistence calculations for all print judges are plotted, we can see that the majority of judges had a coefficient of consistence between 0.7 and 0.89. For the screen-based version of the study (Figure 28) the majority of judges had a coefficient of consistence score higher than 0.7. A coefficient of consistence score of 1 for an individual participant, indicates that their responses were consistent across all their 21 choices in the paired comparison study.

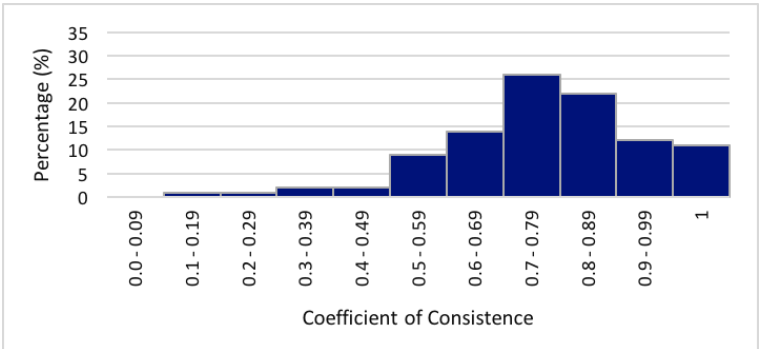

Figure 28: Coefficient of consistence scores on screen (n=100)

Only 8 judges in print and 11 judges on screen had no circular triads and therefore had a coefficient of consistence of 1. While multiple judges may have a coefficient of consistence

of 1, they may not be in agreement about the judgments that were made and their rankings of the 7 heading emphasis methods may not all be the same.

A single circular triad in the responses by a participant resulted in their coefficient of consistence score reducing by 0.071. For a participant with a single neutral response, their coefficient of consistence reduced by 0.0179, equivalent to one quarter of the effect a circular triad would have on their coefficient of consistence score.

The mean coefficient of consistence score for print was 0.775, which corresponds to an average of approximately three circular triads within each participant's responses. For the screen based study the mean coefficient of consistence was slightly lower, 0.764, which translates to approximately 3.25 circular triads. The participants whose coefficient of consistence scores were the lowest were the least consistent and frequently had circular triads within their rankings. Some of these participants also had a high number of neutral responses, but most had very few.

For both the print and screen versions of the study 96% of the participants had a Coefficient of Consistence of 0.5 or higher. A coefficient of consistence of 0.5 translates to seven circular triads within the responses of a participant. From the tables provided by Kendall (1970), this gives a P value of approximately 0.67, meaning that while the majority of participants were not perfect in the consistency of their responses, the number of circular triads within their responses was not significantly large and choices were unlikely to have been made at random.

5.3.5.3 Coefficient of Agreement

The coefficient of agreement developed by Kendall (1970) gives a measure, for determining the extent to which a group of judges agree on the comparative judgments they have made for a set of stimuli in a paired comparison study (Edwards, 1957). To calculate the coefficient of agreement for the print and screen responses, the calculations provided by Kendall (1970) can be followed, (see Appendix C for a full description of the calculations and formulae).

The coefficient of agreement is calculated using only the entries below the diagonal in Table 2 and Table 3. For the print study, the coefficient of agreement is 0.294 and for the screen version of the study, the coefficient of agreement is 0.221. A value of "1" for a coefficient of agreement indicates perfect agreement among all judges, as the coefficient of agreement approaches "0" the agreement between judges approaches a response

agreement closer to random. Any positive value for u indicates that there is agreement between the judges.

The resulting significance (χ^2) for the coefficient of agreement of the print judges is 644.85 and the significance for the screen judges is 490.88.

Rounded to the nearest whole number the degrees of freedom (*df*) for both the print and screen results is 21.21. Our result for the degrees of freedom can then be used to determine that the significance of the agreement between the print participants is approximately p=0.1 and the significance of the results for the screen judges is approximately p=0.25. This result indicates that the probability that any two judges will agree is reasonably good, though there is greater probability of agreement in print than on screen.

While there were a large number of inconsistencies in the data with circular triads, we can still conclude that there was a reasonable amount of agreement between the judges.

5.4 Discussion

This section discusses the findings from the paired comparison study conducted to find which style of typographic emphasis for headings is easiest to identify in a passage of text. The same study was run in print and on screen.

5.4.1 Ease of Identification

The results and overall rankings gained by analysing the data using a head-to-head comparison and using the Bradley Terry model showed little variation in results between the two methods. The overall rankings for both environments of the study, print and screen, for both methods of analysis are shown in Table 9. The only change in overall ranking among the seven heading styles was the change between Sans Serif and Capitalisation between print and screen versions of the study. No change was found in the relative ranking between the two analysis methods.

Table 9: Study 1a summary of ranking

	Print		Screen	
	Head-to-head	**Bradley Terry Model**	**Head-to-head**	**Bradley Terry Model**
1	Bold	Bold	Bold	Bold
2	Size	Size	Size	Size
3	Sans Serif	Sans Serif	Capitalisation	Capitalisation
4	Capitalisation	Capitalisation	Sans Serif	Sans Serif
5	Spacing	Spacing	Spacing	Spacing
6	Italics	Italics	Italics	Italics
7	Control	Control	Control	Control

Bold was consistently chosen by participants as the heading style which was most easily identified. Of the seven heading styles compared in this study Bold is the heading style with the greatest visual weight and therefore has the greatest visual contrast with the body copy text used in this study.

In both the print and screen versions of the study Size was ranked second, based on choices made by participants in the paired comparison. The increased Size of the text gives a greater visual weight by increasing the overall height of the letters, including their x-height. As the size of the characters increases, the width of the strokes of the letters also increases. This also adds to the sense of the text having greater visual weight. These features combined create a heading which was perceived by participants to be the second easiest to identify.

Figure 29: Comparison of Size (left) and Control (right) headings

Through the choices made by participants Sans Serif was ranked as the third most easily identified heading style in print, and the fourth on screen. The Sans Serif typeface chosen, Helvetica, is a common typeface for distinguishing a heading, as was discovered in Chapter 4. Helvetica has an even stroke weight and no serifs, in comparison to the uneven stroke weight and bracketed serifs which are characteristics of Times New Roman. The differences between the style of the two typefaces can be seen in Figure 30 where the two

typefaces are overlaid with the text at the bottom shown with blue lines to indicate the cap height, x-height and baseline. The image shows the relative sizes when Times New Roman is 11pt and Helvetica is 9pt, the same as the comparison between Size and Sans Serif in Study 1a.

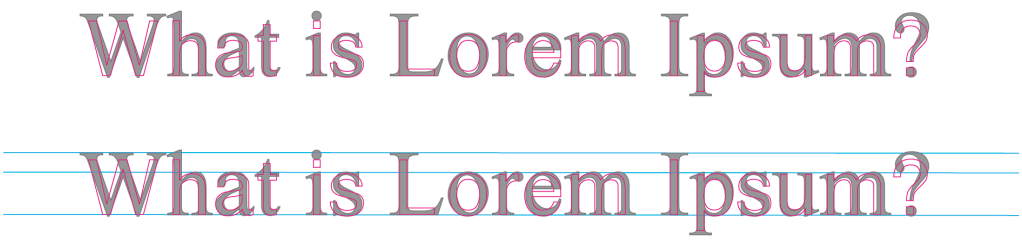

Figure 30: Comparison of Times New Roman (11pt) and Helvetica (9pt)

As well as style of letterform being in contrast to the body copy, the x-height is also a characteristic of Helvetica that gives the sans serif heading distinction from the serif body copy typeface. The differences in the characteristics of the typefaces can be seen in Figure 31, which shows Times New Roman (left) and Helvetica (right) as they appeared in the Sans Serif and Size increase headings.

Figure 31: Comparison of x-heights of Size (left) and Sans Serif (right) headings

Capitalisation used to indicate a heading was more strongly preferred on screen, being ranked third, ahead of Sans Serif, but in print was ranked fourth behind Sans Serif. While the choices of participants indicate that as a heading it is easier to identify than many other heading styles of heading emphasis, comments by participants often centred around their dislike for Capitalisation. Several participants explained that even though they chose the capitalised heading as being easier to identify, they did not like it. While no one articulated the reason for their dislike, this may be due to Capitalisation being harder to read as the form of the word is not as easily distinguishable (Tinker, 1966). See Figure 32 for an example. The stronger choice for Capitalisation on screen may be due to research by Vartabedian (1971) finding that text in all capitals on screen is searched faster than lowercase text. So, while Capitalisation as a heading emphasis method creates a distinct heading, readers may find it harder to read in print and less visually appealing.

Figure 32: Comparison of Control (left) and Capitalised (right) headings

The use of Spacing as a heading emphasis method seemed to divide readers, with some feeling that it is ineffective as when it is used as the only form of typographic emphasis for a heading it can appear to be a paragraph which is a single line. Other participants appear to find it a useful method of typographic emphasis for easily identifying headings in text. The use of space creates a visual break between the heading and paragraph, rather than relying on text that has a stronger visual weight. With no change in the visual appearance of the typeface for the heading, emphasis relies on the visual emphasis created by the negative space surrounding the headings.

The perceived size of a typeface is influenced by its x-height, as well as line weight and the width of the individual characters (Lupton, 2004). The typeface, Helvetica, which was used for the Sans Serif headings, has an x-height larger than that of Times New Roman, which was used for the body copy and other headings. Helvetica also has slightly wider character widths and the strokes are heavier. The combination of these factors may have resulted in participants feeling that the headings that were set in the Sans Serif, Helvetica, were also increased in size. A neutral choice was made in 19 out of 100 comparisons on screen of Sans Serif/Size, and was the most common neutral choice in print (13%). The high number of neutral choices for this pair could be attributed to the Sans Serif heading being perceived as having an increase in size as well as a change in typeface style, as shown in Figure 30 and Figure 31.

Comments were made that the headings with the Spacing felt like a single line of a paragraph. This may be due to the amount of spacing before and after the heading not being distinctly different. If the space between the preceding paragraph and heading had been clearly identifiable as being larger than the space between the heading and the paragraph following it, this may not have been the case. The greatest number of neutral choices on screen were made in the comparison of Control/Spacing (24). The high number of neutral choices for Control/Spacing may be attributed to vertical spacing being the only distinguishing factor, meaning the only difference between the two heading appearances was in layout, rather than there being any typographical variation in the typefaces of the two headings being compared. One participant did volunteer that the Spacing did not distinguish the heading enough on its own and only made the heading look like a one line paragraph.

Aside from the Control, Italics was the heading style which participants chose least often as the easiest to identify. Italics is the subtlest style of typographic emphasis included in this study and it is usually recommended for use as emphasis within the run of text

(Hochuli, 2015). The italic version of a typeface will usually have a similar visual weight as the regular, often only differing in the angle of the letterforms and in some instances, a slight variation in the width of the individual characters, depending on whether it is a true italic, or if it is an oblique or sloped version of the roman. Therefore, it is unsurprising that italics did not provide easy identification for a large number of the participants in the study.

Control was only chosen as the more easily identifiable heading style by a small number of participants. In the Control situation, the only distinction between the heading and the surrounding text was that it was on a separate line before the paragraph began, the headings not extending the full width of the text column. The lack of emphasis and visual difference therefore means readers are unlikely to be able to identify the headings at all.

5.4.2 Neutral Choices

Neutral choices were most commonly made with pairings that contained Sans Serif headings. In each condition, each of the 100 participants saw a Sans Serif heading in a pairing six times, giving a total of 600 total possible instances where a Sans Serif could have been chosen in both print or screen. On screen a neutral response (tie) was given 72 times (12%) and in print 48 times (8%).

More neutral choices were made on screen than in the print condition; 17% of all choices on screen were neutral, compared to just 7.9% in print. Factors contributing to this difference may include that in the screen version of the study the researcher was not present with the participant, meaning that the participants on screen may have felt less inclined to make a decision. The greater number of neutral choices being made on screen may also be due to it being a more obvious choice. In the print version of the study, participants were told at the start they could make a neutral choice if they felt two heading emphasis methods were tied, and they were reminded by the researcher about this option if they looked to be struggling with a decision, or if they expressed that they did not know which to choose. In contrast, for the screen version of the study, when recording their responses to each pairing, participants were presented with three radio buttons, 'left', 'right', and 'no difference'. This meant that the neutral choice was a more obvious option for participants as they saw it every time they made a choice, rather than just being faced with two passages of text, on either the left or right side of the page.

The comparison of Control/Italic received the same number of neutral choices in both print and screen with 11 neutral choices. The large number of neutral choices for this pairing

may be attributed to the lack of contrast between the two typographic variations. Italic is more commonly recommended for minor or subheadings, within the flow of text to emphasise individual words, for titles, or for indicating words in a foreign language (Mitchell & Wightman, 2005). Because of these conventions for the use of italics, readers may not consider them to be appropriate for indicating a major heading.

In print, the four most common neutral choices – Sans Serif/Size (13), Control/Spacing (11), Control/Italic (11) and Bold/Sans Serif (9) – Control/Italic was the only pairing where the two heading emphasis methods appeared next to each other in the overall ranking of the six methods of emphasis. Of the four most common neutral choices on screen – Control/Spacing (24), Sans Serif /Size (19), Control/ Sans Serif (15) and Italic/Spacing (14) – Italics/Spacing was the only pairing where the two choices appeared next to each other in the overall ranking of heading emphasis methods. The number of neutral choices for any pairing does not seem to be related to their relative ranking. The number of neutral choices made between heading styles which ranked next to each other in the overall rankings for ease of identification were not larger than those that were further away.

5.4.3 Influence of Demographic Factors

Gender appears to have little overall influence on participants' choices for the heading styles which are easiest for them to identify. For females, the rank order between print and screen-based conditions was unchanged, however, the relative ranking between the heading emphasis methods changed between Sans Serif, Size and Capitalisation.

In print, the differences between male participants and the general population are restricted mainly to changes in the relative ranking for Capitalisation, and Sans Serif. While the overall ranking does not change, Capitalisation was considered to be less easily identified in print, only marginally ranked above Spacing and the relative ranking for Sans Serif decreases also.

When the results from the paired comparison study are considered by age and qualification, there is a greater variation within the segmented populations, compared with the larger sample. The most significant variations seem to occur in the sub-groups, which contain a smaller proportion of the larger population. This is because the smaller sample size is more likely to be skewed if the responses of a single participant differ from the responses commonly provided.

When we consider the print responses with regard to age, the greatest shift in relative ranking is in the 46-55 age bracket, a group of eight participants. For this group, Bold was ranked third of the six heading emphasis methods, for ease of identification.

There does appear to be a trend in choices towards and away from certain heading styles as the age of participants increases. However, if we discount the highest age bracket of 56+, which in print had 7 participants, then we see a slight decrease in the relative ranking of Spacing and also a slight decrease in the relative ranking of Italics.

For the screen results, the 56+ age group had a strong relative ranking for Bold over all other heading emphasis methods and the 26-35 age group ranked the heading style of Size higher than Bold. On screen, age appears to have even less influence than in print, over changes in ease of identification of heading styles as the participant age increases, except for a potential slight increase in relative ranking for Bold and slight decrease in relative ranking for Italics.

Level of education, or highest completed qualification, that a participant had attained did not seem to have a significant influence on the heading styles that participants found easiest to identify in either print or screen. There did not appear to be an increase or decrease in choices for any of the heading emphasis methods as the level of qualification increased. Those who identified as their highest qualification being post graduate may have had greater deviation from the overall population's results due to a significantly smaller sample size, there were just nine Post Graduate participants in print and three for on screen.

Investigation into whether any demographic factors influenced the willingness to make a decision about ease of identification revealed no significant trends. In print, 52 of the 100 participants made no neutral choices and only 13 made 4 or more neutral decisions. The proportions of ages, gender and qualifications within this group closely reflect those of the overall group. While there were a greater number of neutral responses on screen, with only 42 of the 100 participants giving no neutral choices, there still appears to be no correlation between the number of neutral responses given and any of the demographic factors that were recorded in this study.

5.4.4 Print vs Screen

The presentation order for the study materials was consistent between the print and screen versions of the study to try to ensure that a direct comparison could be made between the results from the two environments. On screen the relative ranking for Bold was lower than

in print and there was a greater relative ranking of Size and Capitalisation, though they were both still considered to be inferior heading emphasis methods to Bold. The relative order of the six heading emphasis methods and the Control was almost identical across the two conditions, other than Capitalisation being more preferred to Sans Serif on screen. Spacing and Italics, the two least preferred heading emphasis methods were considered to be of relatively similar worth between the two conditions. Studies have shown that Sans Serif typefaces may be read more fluently, with fewer regressions, than text set in a serif typeface (Josephson, 2008).

5.4.5 Pairing Order and Viewing Orientation

Presentation order seemed to have a greater influence on screen than it did in print. In print, the greatest difference between the overall ranking and 'Set 2' where there was an increase in relative ranking for Sans Serif, as it was ranked second overall, before Size which fell to fourth, and Capitalisation which was ranked third. In both 'Set 3' and 'Set 4' there was a slight variation in the ranking from the overall results, with Sans Serif and Capitalisation swapping positions. However, the relative difference in ease of identification between these two heading emphasis methods is minimal.

For the screen condition, there was far greater variation in results across the four presentation orders. The overall relative ranking for any one heading emphasis method was greatly reduced in 'Set 1' and 'Set 4'. The relative ranking of the Control, Italic and increased Spacing headings remained reasonably consistent, with the greatest variation occurring with the relative ranking for Bold.

While there were biases towards one page or the other between the left heading style presented on the left or right, there was no consistent bias towards one side of the page over the other.

5.4.6 Limitations of the Design of Study 1a

Throughout this study only one style of text was used for the body copy, Times New Roman at 9 points with 13 points of leading. This typesetting decision was made based on the findings from the study reported in Chapter 4 as well as best practice for creating legible text for reading both in print and on screen. Despite the typesetting used following common practice, the body copy that the headings in this study were seen in comparison to may have influenced the perception of the headings being presented.

The Sans Serif headings were set in Helvetica, to contrast with the Times New Roman body copy. While both were presented at the same point size (9 point) Helvetica has a significantly larger x-height than Times New Roman and therefore may have been perceived by the participants as being slightly larger in size (Lupton, 2004). This may have had an influence on participants' perception of the relative importance or visibility of the Sans Serif headings set in Helvetica as the Helvetica headings would have not just appeared to be a different style, but also be larger. Choosing a sans serif typeface with an x-height equivalent to Times New Roman, may have yielded different results.

Even though participants were not asked for their degree of preference when making their decisions between heading emphasis methods in the paired comparison, many still offered this information. Many participants offered comments such as "only just" when they felt that there was little difference between the two heading emphasis methods being compared, or would make statements such as "definitely this one" to indicate that one heading emphasis method was clearly preferred over the other. Abbas, Aslam and Hussain (2011) discuss the issues associated with judges in a paired comparison not being able to indicate their degree of preference and pose methods for doing this using the Bradley Terry Model. Providing information about the degree of preference could also help with resolving circular triads within participants responses.

5.5 Conclusions and Implications for Study 2

In Study 1a reported on in this chapter, a paired comparison study was conducted to compare seven heading styles in print and on screen, to answer Research Question 1. Research Question 1 sought to understand which methods of typographic emphasis make a heading easiest to identify within a passage of text. The paired comparison study presented participants with each of the heading styles paired with each other and asked them to identify which of the heading styles in the pair was easier to identify. The results of this study will be used to inform the design of Study 2 (Chapter 7), which will investigate whether combining two heading emphasis methods creates more easily identifiable headings than using a single typographic variation for emphasis, as explored in Study 1a.

The results of the initial paired comparison study, that used a single variation in typographic appearance to emphasise a heading, shows that certain methods of emphasis are more effective for ease of identification. In this study, it was found that the headings emphasised with the greatest visual weight (Bold, followed by Size) were considered easiest to identify. Therefore, it is recommended that in choosing heading styles to be compared in Study 2, combinations which include Bold and Size should be used. Sans Serif

was the third most easily identified heading style in print, therefore this heading style should also be considered when developing heading styles for Study 2. Capitalisation was the third most easily identified heading style on screen; however, there is research to show that capitalised text is harder to read and has slower word recognition. For this reason, it is unlikely that this heading emphasis method will be continued to compare as a headings style in Study 2. Based on the findings of this chapter, it would now be beneficial to explore whether emphasising a heading using two variations in typographic emphasis of heading text will create a heading which has greater ease of identification, than using a single typographic emphasis method.

Study 1a excluded graphic designers from the population of participants as it was thought that they may perceive headings differently to the general population. Before considering how two methods of typographic emphasis can be combined to create a heading style that has greater visual weight, or visual distinction from the body text, Study 1a will be repeated with a sample of graphic design participants, Study 1b. Spacing is a typographic method for creating hierarchy frequently used by designers and is commonly thought of as being an important factor in the layout of text. It may be that some readers are familiar with this as a method of emphasis, while others are less familiar. It would be useful to investigate whether readers with graphic design education or experience perceive space differently to those who do not. This will be investigated in Chapter 6 along with comparing the perception that graphic designers have for all other heading styles that have been studied so far. After investigating if there are differences between the general population and graphic designers in Chapter 6, the results of both Study 1a and Study 1b will be discussed in more detail and further implications for the design of Study 2 (Chapter 7) will be outlined.

6

Identification of Headings for Graphic Designers (Study 1b)

In the design of Study 1a and 1b, individuals who were graphic designers were excluded from participating in the study as it was hypothesised that education in the field may alter the judgments made in the study. A comparison study, reported in this chapter, was undertaken with 40 graphic design students and professionals to determine whether the ease of identification of headings for graphic designers was the same as for the rest of the population. This study was conducted with those whose experience and knowledge excluded them from participating in Study 1a, Chapter 5.

The responses of the graphic designers to the paired comparison study investigating the ease of identification of headings were studied separately to determine whether those with greater knowledge of typography and design would find different heading emphasis methods easier to identify. It was hoped that by examining the group separately it would be found that the ease of identification for heading emphasis methods of graphic designers would be similar to that of the general population and could therefore be included as part of the larger sample of participants for future studies. The results of this study are used to further support and expand on the answering of Research Question 1.

Research Question 1: Which methods of typographic emphasis make a heading easiest to identify within a passage of text?

The study reported in this chapter investigates whether people with greater typographic understanding find the same heading emphasis methods easiest to identify as the general population. A paired comparison study was conducted in the same manner as Study 1a.

This chapter first describes the method used for the study and gives details of the participants. Then the results are presented with comparison to the results of the general population reposted in Study 1a (Chapter 5). The results are then discussed and recommendations given for the design of Study 2, based on the finding of Study 1a and 1b.

6.1 Method

The paired comparison study with graphic designers was conducted in an identical manner as the print version of Study 1a with the general population (see Section 5.1). Again, the same seven heading variables were presented; a Control, Bold, Italic, Sans Serif, Size increase, Capitalisation and increased Spacing were presented in a paired comparison. The booklets with the test materials were the same booklets used previously with the general population, meaning the passage of text and the headings, page layout and randomized orderings of pairs was identical for the group of graphic design participants. Again, participants were randomly assigned one of the four sets presented in an A3 booklet. Participants were asked to indicate in each of the 21 pairings they were presented with, in which passage of text they found the headings easiest to identify.

6.2 Sample

Demographic information was collected from participants at the commencement of the study, including gender, age and highest completed qualification (See Appendix B for a copy of the participant information sheet and study recording sheet). In addition, the graphic design participants were also asked to indicate their background; student, industry professional or design educator.

Potential participants were defined as "graphic designers" if they had more than one year of visual design or typographic education at a tertiary level or if they had more than six months experience working in the visual design industry. A total of 40 graphic design participants took part in the study. They fell into 3 main groups; students, industry-based professionals and design educators.

Twenty (50%) of the graphic design participants were design students, 15 (37.5%) were industry-based professionals and 5 (12.5%) were design education professionals.

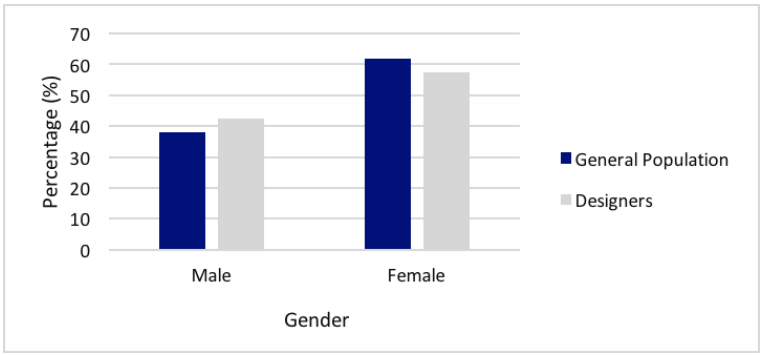

Figure 33: Gender of participants in Study 1b, general population (n=100) and designers (n=40)

In the sample of participants from the general population 38% were male and 62% were female. In the group of designers, a similar gender balance was seen, with 17 (42.5%) of the participants being male and 23 (57.5%) female.

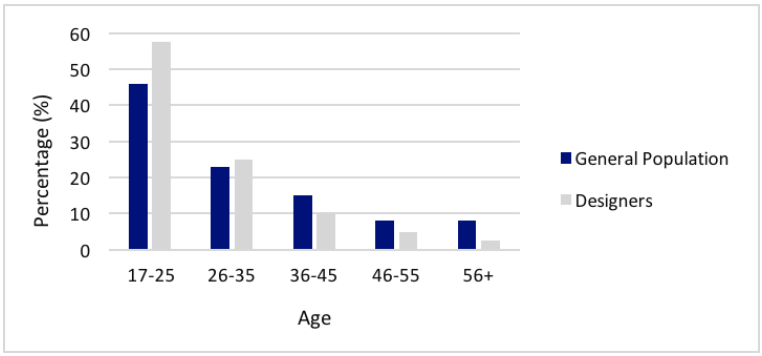

Figure 34: Age of participants in Study 1b, general population (n=100) and designers (n=40)

The spread of ages in both populations was also similar. Participants in the 17-25 age bracket made up 46% of the general population and 57.5% of the designer participants. In the general population 23% of the group were 26-35, whereas 25% of designers fell into the same age bracket. The general population was made up of 14% 36-45 year olds compared to 10% of the designers. Participants in the 46-55 age bracket made up 8% of the general population and 5% of the designers. The remaining 8% of the general population was over 56 years old and 2.5% of the designers were above 56 years.

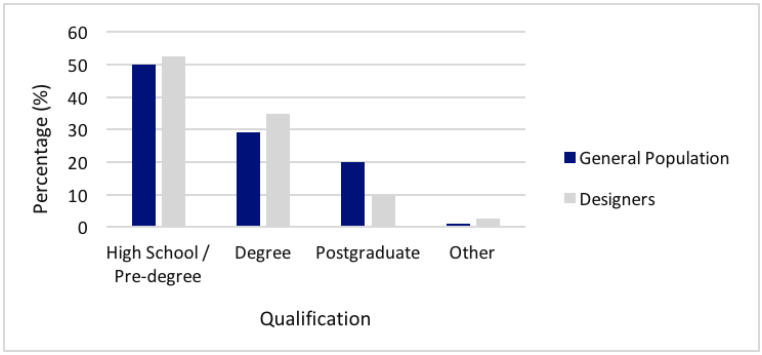

Figure 35: Highest qualification of participants in Study 1b, general population (n=100) and designers (n=40)

The majority of participants in the general population and graphic design samples had a High School diploma or a pre-degree qualification as their highest completed qualification; general population 37% and designers 40%. The higher proportion of designers with a high school diploma as their highest qualification may be due to 20 (50%) of the participants being students. In the general population 25% had a Bachelors degree and 35% of designers held this qualification. In both sets of participants there was one person who listed their highest completed qualification as "other".

6.3 Results

The data collected from the paired comparison was analysed using the same two methods as used for Study 1a (see Section 5.3); head-to-head comparison to create preference totals to generate an order of preference (David, 1988), and using the Bradley Terry Model in R (Hatzinger & Dittrich, 2012).

6.3.1 Head-to-head Comparison

As with the results from the previous paired comparison study (Chapter 5), totals were generated for each heading style in a head-to-head comparison to create an overall ranking of the seven heading styles being compared. The number of times each heading emphasis method was preferred, compared to each other heading emphasis method for the graphic design participants (Table 10) is recorded; numbers are out of 40 for the graphic designers. A total number of choices is given at the bottom of each column in the table for each of the heading emphasis methods (out of a possible 240 in the graphic design population), as well as a percentage of times each heading emphasis method was chosen across all of it's paired comparisons with the other heading emphasis methods. Table 11 gives a summary of the responses for the general population (as given in Table 2 in Section 5.3.1) the total number of times each heading style was chosen out of a possible 600, as well as the percentage of times each style each was chosen.

Table 10: Head-to-head results for graphic designers

	Control (Co)	Bold (B)	Italic (I)	Spacing (Sp)	Sans (Sa)	Caps (Ca)	Size (Si)
Control (Co)	---	38	30.5	40	38.5	37	39
Bold (B)	2	---	7	10.5	6	6.5	5
Italic (I)	9.5	33	---	29	22.5	26	21
Spacing (Sp)	0	29.5	11	---	15	12	18.5
Sans (Sa)	1.5	34	17.5	25	---	16	26
Caps (C)	3	33.5	14	28	24	---	20
Size (Si)	1	35	19	21.5	14	20	---
Total	**17**	**203**	**99**	**154**	**120**	**117.5**	**129.5**
Percentage (%)	**7.08**	**84.58**	**41.25**	**64.17**	**50.00**	**48.96**	**53.96**

Table 11: Summary of head-to-head results for the general population (see Table 2)

	Control (Co)	Bold (B)	Italic (I)	Spacing (Sp)	Sans (Sa)	Caps (Ca)	Size (Si)
Total	**68.5**	**481.5**	**213**	**274.5**	**348**	**337**	**377.5**
Percentage (%)	**11.42**	**80.25**	**35.50**	**45.75**	**58.00**	**56.17**	**62.92**

Within the population of 40 designers there are some changes to preference from the general population for the frequency each of the heading emphasis methods were chosen as being the most easily identifiable in a paring. As with the general population, Bold was most frequently chosen as the more identifiable heading emphasis method in a pairing, being chosen 84.58% (203) of situations. The second most frequently preferred heading emphasis method amongst designers was Spacing, chosen 64.17% of the time, more frequently than the second ranked heading emphasis method with the general population, Size (62.92%). Size was the third most frequently chosen heading emphasis method being chosen by designers in 53.96% of instances, followed by Sans Serif being chosen overall in 50% of pairings. Capitalisation was chosen by designers in less than half of its paired comparisons, at 48.96%, followed by Italic which was chosen 41.25% of the time. The Control was again the least frequently chosen heading emphasis method with just 7.08% preference choices, scoring 17 out of a potential 240.

The most surprising result seen in the head-to-head comparison is that all 40 of the participants chose Spacing over the Control, this was the only perfect agreement between

all participants in any of the pairs across all of the studies conducted. Also of note is that in the pairing of Capitalisation and Size, each was chosen an equal number of times (20).

6.3.2 Neutral Choices

Neutral choices by participants were recorded when an individual either could not discern the difference between the two heading emphasis methods being shown to them in a paired comparison, or if they felt the two heading emphasis methods were equally easy or equally difficult to identify as headings from the surrounding text. Table 12 shows the total number of times each pairing was given a neutral response by a graphic design participant, with Table 13 providing a summary of the general population from Table 4 in Section 5.3.2 for comparison.

Table 12: Neutral choices for graphic designers

	Control (Co)	Bold (B)	Italic (I)	Spacing (Sp)	Sans (Sa)	Caps (Ca)	Size (Si)
Control (Co)	---	0	1	0	1	0	0
Bold (B)	0	---	2	1	1	2	2
Italic (I)	1	2	---	2	3	2	0
Spacing (Sp)	0	1	2	---	0	0	1
Sans (Sa)	1	1	3	0	---	2	2
Caps (C)	0	2	2	0	2	---	2
Size (Si)	0	2	0	1	2	2	---
Total	**2**	**8**	**10**	**4**	**9**	**8**	**7**
Percentage (%)	**0.83**	**3.33**	**4.17**	**1.67**	**3.75**	**3.33**	**2.92**

Table 13: Summary of neutral choices for the general population (see Table 4)

	Control (Co)	Bold (B)	Italic (I)	Spacing (Sp)	Sans (Sa)	Caps (Ca)	Size (Si)
Total	**39**	**29**	**40**	**33**	**48**	**38**	**37**
Percentage (%)	**6.50**	**4.83**	**6.67**	**5.50**	**8.00**	**6.33**	**6.17**

In the general population, 5.42%, approximately 1 in every 18 choices made, were neutral. In the sample of designers who participated in this study, neutral choices were made less frequently than in the general population. Overall, only 2.86% of choices made by the designers were neutral. The greatest number of neutral choices occurred with the Italic

heading condition (4.17%), and the greatest number of neutral choices between a single pairing being the comparison of Italic and Sans Serif. Many pairings had no neutral choices made for that pairing of heading emphasis methods including; Bold/Control, Spacing/Control, Sans Serif/Spacing, Capitalisation/Control, Capitalisation/Spacing, Size/Control and Size/Italic. There were just two instances of 840 (0.83%) of choices made regarding pairings containing the control heading emphasis method that were neutral.

6.3.3 Analysis using the Bradley Terry Model

As discussed previously in Section 5.3.3, analysis of the paired comparison data was conducted in the software package R using the Bradley Terry model with the prefmod package. This modelling of the data allowed a relative ranking for each of the heading emphasis methods to be generated, to give a better understanding of the relative ease of identification for each of the heading emphasis methods. The visualization of this ranking also enabled better comparison of the relative preferences for the two groups of participants.

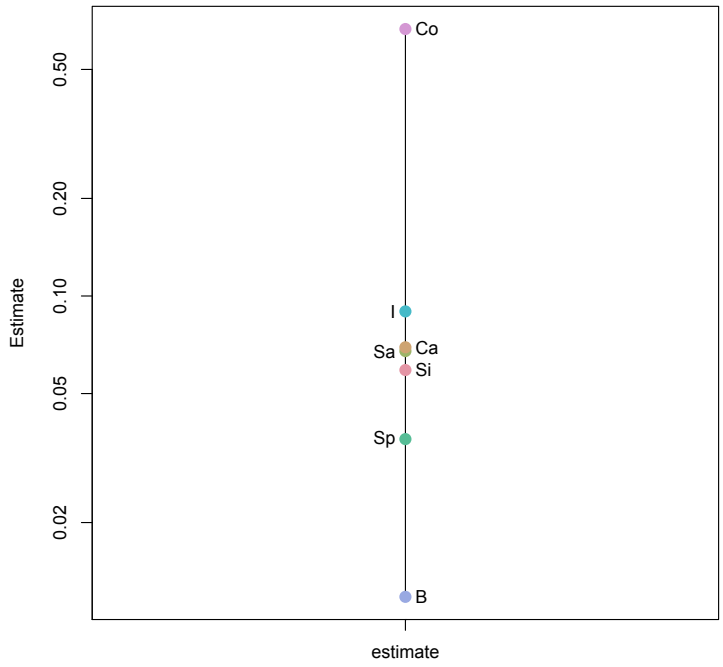

Figure 36: Heading emphasis ranking for graphic designers

Results for the general population are discussed in greater detail in Section 5.3.3.1, Bold was the most preferred heading emphasis method. This was followed by size, ranked as the second most easily identified heading emphasis method. Sans Serif and Capitalisation were ranked close together at third and fourth respectively, increased Spacing was the fifth

most easily identified heading emphasis method in rank order, with Italics the least easily identified of all six heading emphasis methods.

Table 14: Coefficients of interest for graphic designer results

	Estimate	Std. Error	z value	Pr(>|z|)
Si	-1.2111	0.1385	-8.743	< 2e-16 ***
Ca	-1.1304	0.1377	-8.206	< 2e-16 ***
Sa	-1.1439	0.1379	-8.297	< 2e-16 ***
Sp	-1.4565	0.1415	-10.291	< 2e-16 ***
I	-1.0029	0.1366	-7.340	2.14e-13 ***
B	-2.0167	-0.1552	-12.992	< 2e-16 ***
Co	0.00000	NA	NA	NA
g1	-4.6686	0.5791	-8.062	< 2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The model of the preference ranking of graphic designers (Figure 36) supports the findings of the head-to-head comparison. The results (Table 14) also show that graphic designers have a highly significant preference for Bold and Spacing over the Control presentation of headings. The strong negative value for g1 supports the low number of neutral choices seen, indicating that there was a strong tendency for graphic designers to make a decision. For the graphic designers, the overall rank of most to least easily identified heading emphasis methods differs from that of the general population (Figure 17). Bold is also ranked as the heading emphasis method that was most easily identified within the passage of text, but increased Spacing is then ranked as the second most easily identified, which was ranked fifth in the general population. The ranking of the four remaining heading emphasis methods follows in the same order as the general population, Size in third, Sans Serif in fourth, Capitalisation in fifth, Italic in sixth and the Control ranked least easily identified. The relative preference for Size, Sans Serif and Capitalisation was closer together for the group of graphic designers than for the general population. In Table 14 the negative result for g1, indicates that there was a strong tendency for participants to make a decision for each pairing. The higher number for g1 with the graphic designers, than with the general population is a reflection of the lower proportion of neutral choices made by the designers.

6.3.4 Comparison of Presentation Order

As was the case with the general population, the graphic design participants were presented the paired comparisons for the study in one of four possible random orders (Sets 1-4). As well as being presented to participants in different orders, the stimuli were also switched between the left and right sides of the page. Sets 1 and 3 and Sets 2 and 4 had the same left/right page orientation of the pairs. The four presentation orders for the paired comparisons were identical for both the general population and the graphic designers.

Across all four Sets, Bold was still the most preferred typographic emphasis method for both designers and the general population.

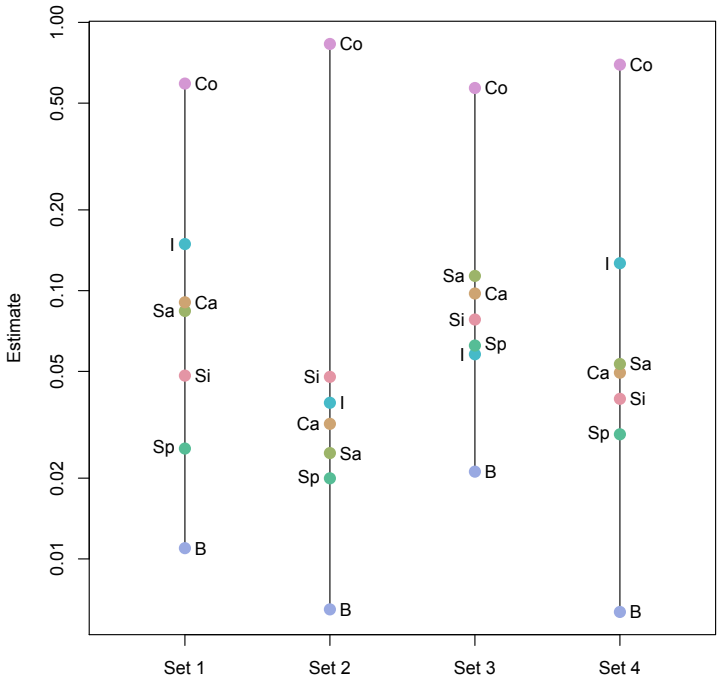

Figure 37: Comparison of graphic designer results by set

For the group of graphic designer participants there was greater variation across the four presentation conditions (Figure 37). This may be due to the sample size being smaller, as only 10 design participants saw each of the four presentation orders. Spacing was the second ranked across all four sets, except in Set 3 where Italics was narrowly ranked higher than Spacing. The relative ranking of all other heading styles saw shifts in ranking between all four presentation orders. In Set 1 there is a considerable preference for Spacing over the next ranked typographic emphasis method, Size. Whereas, in Set 3 there is little difference between Spacing, and Italics in third and Size ranked fourth. The ranking of Set 4 most closely reflects the ranking of the full group of graphic design participants. Sans Serif and Size were most inconsistently ranked across all four sets, ranging from third to sixth.

Capitalisation was consistently ranked fourth or fifth by the graphic designers across all four sets. Italics found greatest preference with the participants who responded to Set 3, where it was ranked third of the six typographic emphasis methods. In the presentation of Set 3, four of the six pairs with Italics were in the first eight comparisons, though this may not be a factor that effected the choices of the participants.

6.3.5 Left Versus Right Side of the Page

When parings were presented for the paired comparison, one was presented on each side of the page. Sets 1 and 3, and Sets 2 and 4 were alternated from each other as to which passage was seen on the right and which was seen on the left side of the page. This was done in an attempt to eliminate bias for a particular side of the page. The responses of the graphic designers were analysed to determine if there was a bias towards one side of the page when making choices. One graphic design participant commented that they "Will sit right in the middle so I'm not biased."

Table 15: Graphic designers left and right side page biases

	Left %	Right %
Italic/Spacing	60	35
Sans Serif/Capitalisation	35	60
Sans Serif/Size	37.5	57.5
Capitalisation/Size	37.5	57.5
Size/Spacing	55	42.5
Italic/Sans Serif	40	52.5
Spacing/ Capitalisation	55	45

In the study conducted with graphic designers, 840 choices were made across the 40 participants. The heading style presented on the left was chosen 410 times (48.8%) and the right was chosen 406 times (48.3%). The balance of the choices made were neutral, therefore having no preference for a particular side of the page.

The majority of pairings had a difference between the number of choices for the left and right sides of the page by just two or three choices. However, for those pairings shown in Table 15, there was a stronger bias towards a particular side of the page. Italic/Spacing and Sans Serif/Capitalisation were the two pairings with the strongest bias towards a specific side, though they were biased towards opposite sides. Italic/Spacing to the left side and

Sans Serif/Capitalisation to the right side. Sans Serif/Capitalisation was also highly biased in the general population, to the right in print and to the left on screen. Italic/Spacing was the only pairing to have a strong bias with graphic designers that did not have a strong bias in the general population. Of those that also had a strong bias towards one side of the page in the general population, the four that also appeared in print were all biased towards the same side of the page. Of the four that were also most biased on screen, three were for the opposite side of the page to the designers and one was for the same side. As with the general population, the designers seemed to not show a consistent bias towards a particular side of the page despite there being an imbalance in the number of choices made on a particular side of the page in the same pairings.

6.3.6 Preference by Gender

The results were analysed based on the gender of the participants. In the general population, 38% of participants were male and 62% of the participants were female. Whereas, the gender balance of the graphic design participants was 42.5% male participants and 57.5% female participants.

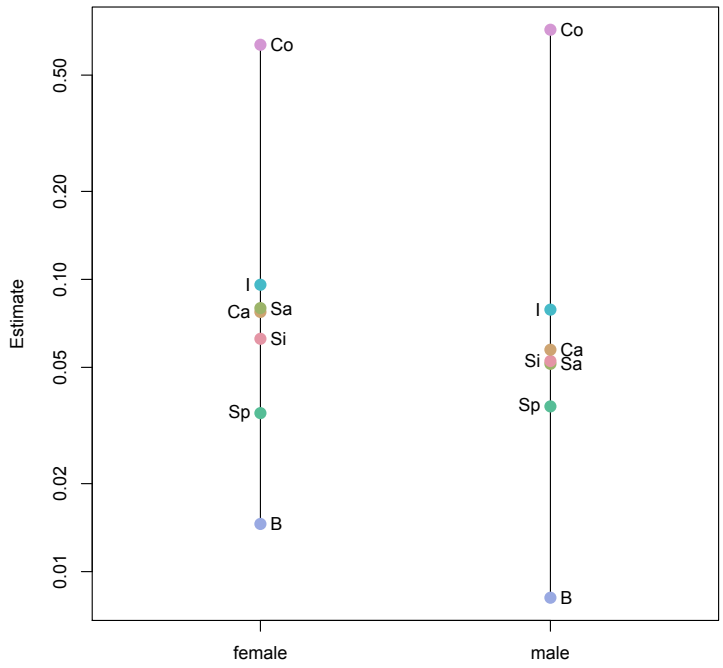

Figure 38: Comparison of graphic designer results by gender

Figure 38 shows that for the group of graphic designers the relative preference ranking was largely unchanged for female participants compared to the overall group, whereas the male participants had a slightly decreased preference for Size and a greater relative preference for Bold.

6.3.7 Preference by Age

Age may have had some influence over the relative preference for typographic emphasis of headings in the sample of designers; however, the small number of participants across three of the five age bands means that the plot produced to represent the relative rankings does not assist with useful analysis of the data.

6.3.8 Preference by Qualification

Less than half of the graphic designer participants had a qualification higher than a High School diploma or a pre-degree qualification, therefore for the analysis using the Bradley Terry model responses from participants with a Degree or postgraduate qualification were combined.

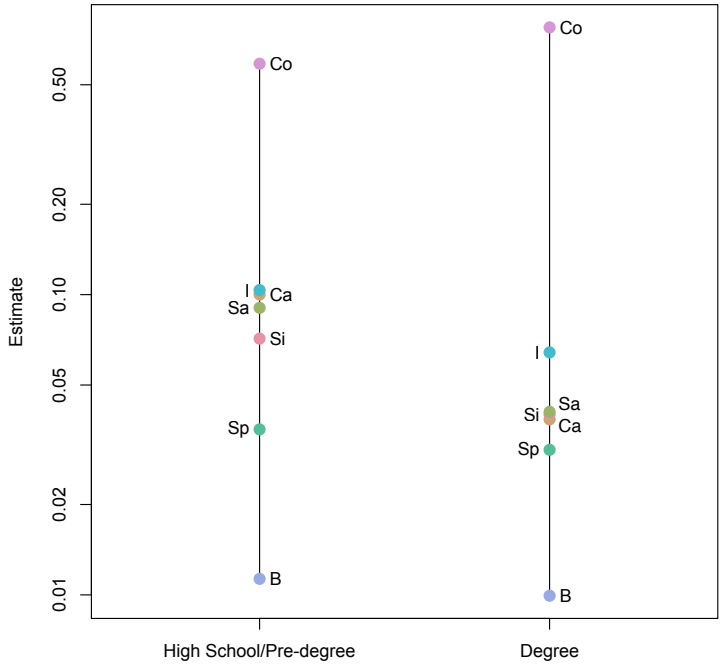

Figure 39: Comparison of graphic designer results by highest completed qualification

The overall rank created for designers by qualification (Figure 39) is similar to the combined group of graphic design participants, but with some variation in relative preference. The resulting ranking shows that those with a degree have a stronger preference against the Control for ease of identification. The relative ranking of the heading styles differs only slightly with Capitalisation, Size, Sans Serif and Italic all being closely clustered.

6.3.9 Preferences of Student and Professional Graphic Designers

The graphic design participants were asked whether they were students or professionals (industry and educators). Exactly half of the sampled population were students, and exactly half the sampled population were professionals. A comparison of the relative preferences of each of these two groups within the graphic design population shows both similarities and differences.

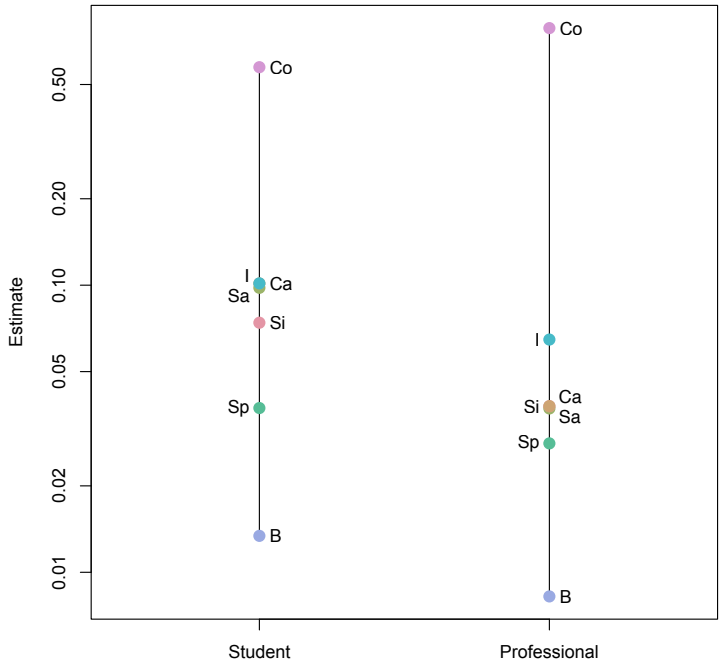

Figure 40: Comparison of graphic designer results by students with professionals

As seen in Figure 40, there is little difference between the plots for students compared with professionals, to Figure 39, showing rankings according to qualification. The participants in these two groups are largely the same, differing by only two students with degrees and three industry professionals who have pre-degree qualifications. Both groups had a clear preference for Bold, followed by Spacing. The professionals then showed little difference between Sans Serif, Size and Capitalisation, followed by Italic and lastly Control. Whereas, the students had a stronger preference for Size and ranked Sans Serif, Capitalisation and Italics all closely grouped, with the Control by far the least preferred.

6.3.10 Comments

Full comments from the participants in the general population are presented in Section 5.3.4. Pertinent to the comparison with the graphic design population though are those comments from the general population that relate to the reasons for preference (or lack thereof) for Bold, Spacing and Size. The designers seemed less inclined to make comment

when participating in the study, with far fewer comments overall being recorded. In print, many general population participants commented that Bold stood out more and created "more distinct" items, rather than indicating "more fluid content". Another participant also recognized the need for headings to not be so distinct or obtrusive that they interrupt the flow of reading; this positive perspective on Spacing was that Spacing provided better flow than Capitalisation, which interrupted the page and flow of reading too much. Several participants felt that Spacing alone was not enough to indicate a heading as it may be mistaken for a single line paragraph, "When there's a gap I don't think of it as a heading". One participant in the general population commented on their preference for both Bold and Spacing, which was against the trend of the general population, but aligns with the designers' choices. Other participants liked Spacing in some situations and not others.

The graphic designers' comments on Spacing reflected practical considerations; analysis by one participant suggested that light conditions might dictate which is better, in low light conditions space might be more effective than methods such as Bold. One participant commented that he liked both Bold and Spacing and felt they were both important and this was brought to his consciousness when seeing the two compared.

6.3.11 Consistency of Choices

The consistency of responses from the graphic design participants was analysed to understand how consistent participants' responses were in the paired comparison study. Despite the 40 participants who were categorised as graphic designers all having education and/or experience in the area, there were still inconsistencies in the headings which they felt were easiest to identify.

6.3.11.1 Circular Triads

The overall preference results were considered to determine whether there were inconsistencies in participants' responses resulting in circular triads (Circular triads in paired comparison studies are explained in Section 5.3.5.1).

Within the results of the graphic design participants there were no distinct circular triads; however, there was a slight inconsistency with the responses regarding Capitalisation and Size. This was the result of an even split of responses to the pairing of Capitalisation and Size. Size had the third greatest number of choices made in favour of it (129.5), followed by Sans Serif (120) and Capitalisation (117.5) in fifth. Of the 40 responses, Size was chosen over Sans Serif 26 times; Sans Serif was chosen over Capitalisation 24 times, but the choices between Capitalisation and Size were evenly split (20-20). In each of the pairings of Size,

Sans Serif and Capitalisation, the results included two neutral choices made in each of the pairings.

6.3.11.2 Coefficient of Consistence

In a paired comparison study, the choices made by an individual participant may not always be consistent, resulting in circular triads. The degree of consistency within a participant's choices can be calculated as a coefficient of consistence, (see Appendix C for a full description of the calculations and formulae).

The coefficient of consistence was calculated based on the formulae given by Kendall (1970) for the 40 graphic design participants. Figure 41 shows the distribution of coefficient of consistence scores for the graphic design participants.

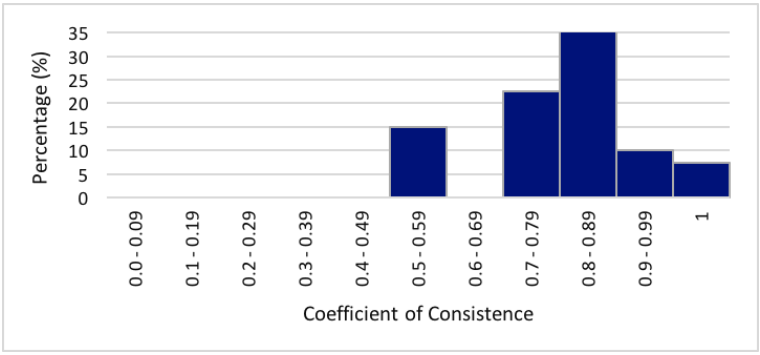

Figure 41: Coefficient of consistence for graphic design participants (n=40)

The lowest coefficient of consistence score for a designer was 0.5 with all but six (15%) having a coefficient of consistence of 0.7 or higher. Three designers (7.5%) had a coefficient of consistence of 1, meaning that they were completely consistent across all of their choices to create a perfect ranking of the seven heading styles. For the 40 graphic design participants, the average coefficient of consistence was 0.804, equating to approximately 2.7 circular triads within their responses. The lower number of neutral choices made by the designers in this study is also reflected in the higher coefficient of consistence calculated for this group.

In the general population, 96% of participants had a coefficient of consistence of 0.5 or higher (see Section 5.3.5.2), which in this study is equivalent to seven circular triads in a participant's responses and a P value from Kendall (1970) of approximately 0.67. All of the design participants had a coefficient of consistence of 0.5 or higher. Therefore, with the graphic design participants, as with the general population, the choices made were unlikely to be made at random, despite not exhibiting perfect consistency.

6.3.11.3 Coefficient of Agreement

The coefficient of agreement provides a measure for the extent to which a group of participants agree on the choices made in a paired comparison study (Edwards, 1957). The coefficient of agreement for the graphic designers responses was determined using the calculations of Kendall (1970), (see Appendix C for a full description of the calculations and formulae). The values above the diagonal in Table 10 are used for calculating the coefficient of agreement.

Perfect agreement amongst all participants results in a value of "1" and the closer to "0" the coefficient of agreement is the closer the responses are to being random. A positive value indicates agreement between participants. For the paired comparison study with the graphic designers the coefficient of agreement was 0.335. The significance (χ^2) for the coefficient of agreement of the graphic design participants is 311.79.

The degrees of freedom (*df*) for both the graphic design participant result is 21.58. The degrees of freedom can then be used to determine that the significance of the agreement between the graphic design participants is approximately p=0.6. The significance of the agreement between the graphic design participants is not high, but there is still a degree of agreement. This result for the significance of the agreement is likely to be a reflection of the close clustering of Sans Serif, Capitalisation and Size.

6.4 Discussion

This section discusses the results of the paired comparison study conducted with graphic designers to understand which styles of heading emphasis they find easiest to identify in a passage of text. The results from this study are compared to those of the same study (Study 1a) undertaken with a general population (Chapter 5).

6.4.1 The General Population Compared to Designers

A summary of the ranking for ease of identification for the graphic designers and the general population for each of the heading styles when analysed according to the head-to-head method (David, 1988) and the Bradley Terry Model in R (Hatzinger & Dittrich, 2012) can be seen below in Table 16. Analysis according to both methods gave the same overall rankings.

Table 16: Study 1b general population and graphic designers summary of ranking

	General Population	Graphic Designers
1	Bold	Bold
2	Size	Spacing
3	Sans Serif	Size
4	Capitalisation	Sans Serif
5	Spacing	Capitalisation
6	Italics	Italics
7	Control	Control

As was the case amongst the general population, Bold was also considered the most easily identifiable of the seven heading styles. The only change in rank order between the two groups of participants was the placing of Spacing within the ranking, all other heading styles remained in the same order. Spacing moved from being ranked fifth with the general population, to being ranked second with the graphic design participants. The leap in ranking of Spacing is the only distinct difference between the results of the two groups.

The reason for graphic designers viewing Spacing so differently to the general population is likely due to the use of space as a method for creating emphasis and indicating headings; graphic designers are therefore more attuned to its use and purpose. The gestalt principle of proximity is a key idea in regard to visual organisation and grouping of information. The proximity of two objects influences the perceived relationship of those objects and can assist with creating emphasis in combination with other visual organisation or gestalt grouping laws (Wallschlaeger & Busic-Snyder, 1992). To make something that is important stand out from surrounding objects it can be placed away from the content surrounding it (White, 2002). Objects that are placed closer together are viewed as being more closely related to each other and those that are further apart are viewed as less closely related (Wallschlaeger & Busic-Snyder, 1992).

Bringhurst (2004) discusses the importance of spacing in the typographic layout of headings and provides recommendations for the effective use of space when defining a heading style of hierarchy of headings. These recommendations include ensuring that any

additional spacing is in multiples of the leading of the text. However, he does not recommend the use of Spacing as the sole indicator for a heading in text.

Design education and an assumed better understanding of typography was shown to mean that participants are more certain about their choices regarding identification of headings and choices that are more consistent than the general population. The Coefficient of Consistence scores were on average far higher in the group of graphic design participants, then the general population. Likewise, the Coefficient of Agreement for the graphic design participants was closer to 1, and perfect agreement than the general population.

In his discussion of Bold as an ideal method for emphasising headings, Tinker (1966) suggests that although designers may or may not prefer certain methods of typographic emphasis, these preferences may not always be what is preferred by readers.

6.4.2 Neutral Choices

For the graphic design participants, neutral choices made up a smaller proportion of the overall number of choices that they made than the general population.

In the general population, pairings that included the Sans Serif heading style had the highest proportion of neutral choices made regarding them. However, amongst the graphic design participants. Pairings containing the Italic heading style (10) had one more neutral choice for them than pairings with a sans Serif heading style (9). The Sans Serif/Italic pairing had the greatest number of neutral choices for it (3). With the low number of neutral choices across just 40 participants, it is hard to draw any strong conclusions from those pairings or heading styles that had more neutral choices than others.

The other point of interest is the instances where no neutral choices were made for a pairing, indicating that participants were more certain about the choices they were making about these pairings. No neutral choices were made in four of the six pairings with the Control heading style as well as with Sans Serif/Italic, Spacing/Sans Serif and Spacing/Capitalisation. These were not necessarily the pairings in the general population that had the fewest neutral choices. This also resulted in just two neutral choices being made for pairings with the Control heading style. Combined with the Control only having a total of 17 choices for it in all pairings this indicates that designers were certain about the Control heading style not providing satisfactory typographic emphasis to provide ease of identification for the heading.

What can be commented on is the lower proportion of neutral choices made by the designers compared to the general population. Graphic designers made almost half as many neutral choices as the general population when posed with the same decisions. The smaller proportion of neutral choices could be attributed to the designers being more aware of the stylistic changes in typographic appearance and more attuned to subtle design changes based on their education and industry experience.

6.4.3 Limitations of the Design of Study 1b

The collection of data from the two populations of Study 1a and 1b, the general population and the graphic designers, were run in parallel so the limitations discussed in 5.4.6 are also relevant to the results discussed in this chapter.

The population of designers surveyed was smaller than that of the general population and therefore the smaller sample size may mean that despite the demographic parameters of the two groups being similar, the results are not as easily compared to the general population. The selection of the population of graphic designers for the study could also have been refined to limit the number of students and focusing on only recruiting participants who had a minimum of three years of graphic design education or more than a year of industry experience. This may have produced more distinct differences between the two groups of participants.

6.5 Conclusions and Implications for Study 2

This chapter reported on the results of the paired comparison study from Study 1b repeated with a group of participants who were categorized as being graphic designers to further answer Research Question 1. The purpose of repeating Study 1a with designers was to understand if those with knowledge and experience in design find the same heading styles easiest to identify. With this different group of participants, Bold, as was also the case with the general population, was found to be the heading style that was most easily identified within a passage of text. The heading style that was second easiest to identify with this group of participants was Spacing, which differed to the general population.

The results of Study 1a and 1b, as reported in Chapter 5 and 6 respectively, are used to inform the design of Study 2, Chapter 7. The heading styles with the greatest ease of identification from Study 1a and 1b will be used to decide which headings should be investigated to answer Research Question 2, in Study 2. Research Question 2 asks whether headings that are emphasised by combining two methods of typographic emphasis more

easily identified single emphasis methods within a passage of text. To determine which heading styles should be used to determine this, combinations of the most easily identifiable heading styles from Study 1a and 1b were created.

Across both groups of participants and in both print and screen, Bold was the most easily identifiable heading style of the seven compared. Based on the findings of Study 1a and 1b, Bold will be used on its own in Study 2 as a heading emphasis method as a means of comparison with the results from Study 1a and 1b. Bold will also be combined with other heading emphasis methods with the intention of creating heading styles with greater visual weight than using Bold alone.

Size was ranked the second most easily identifiable heading style with the general population. Size as a heading emphasis method in Study 1a had greater visual weight than most other heading styles that were compared, but was not as easily identifiable as Bold for indicating a heading. The heading emphasis method of Size will be combined with two other heading emphasis methods in two different heading styles for Study 2. Size will be combined with Bold to create a heading style that uses the two most easily identifiable heading emphasis methods from Study 1a and 1b to create a heading with strong visual weight. Size will also be combined with Spacing to create a heading style that has greater visual weight than space alone, but does not utilize Bold to emphasise the heading. This heading style will create a point of comparison to the other four heading styles to be compared in Study 2, as it does not use Bold as a heading emphasis method. The other reason to consider increasing the spacing following the larger heading size is to counter the perceived decrease in Spacing between lines of text that occurs when the size of the text is increased. As Dyson (2004) explains, no typographic variable can be viewed in isolation and any change in typographic appearance will influence the perception of all other surrounding text.

Spacing was ranked fifth overall in both print and screen by the general population, but second overall by the graphic designers. Spacing is considered by designers to be an important consideration in typesetting, allowing for ease of reading and definition of relationships between aspects of the text. In contrast, this typographic feature does not seem to be viewed by the general population with the same level of importance when it comes to ease of identification for headings. Comments made by the general population seem to indicate that when Spacing alone is used to indicate a heading to readers, it can be perceived as a paragraph which is a single line of text – it does not create enough visual distinction to be used alone.

Based on the results in Study 1a and 1b, increased Spacing between the heading and body copy will be studied as a heading emphasis method in Study 2. For Study 2, increased Spacing will be combined with the heading emphasis method of Bold to create a heading style which has the same visual weight as the heading with the single emphasis method of Bold, but has a greater visual distinction from the paragraph following it. Spacing will also be combined with Size, explained above, to combine the two heading styles that were ranked second by each of the populations in Study 1a and 1b.

The final heading emphasis method that will be carried forward from Study 1a and 1b to be compared in Study 2 is Sans Serif. The use of Sans Serif gives a greater visual weight without the use of Size or Bold and also uses a change in style to create further difference to the appearance of a heading. This heading emphasis method gives the greatest visual change between the heading and body copy in this study, but does not have the same visual weight as Bold. Therefore, the fifth heading style to be compared in Study 2 will combine the use of bold and a Sans Serif typeface.

Italics was consistently ranked sixth of the seven heading styles in all environments and across all populations in Study 1a as it does not provide sufficient visual weight compared to the body copy text when used alone. The relative ranking of Capitalisation changed considerably between environments and populations. With the general population, it was ranked fourth in print and on screen it was ranked third. In comparison, it was ranked fifth by the graphic design participants. Due to the inconsistent ease of identification by readers and because it lacks ease of reading it will not be used as a heading emphasis method in Study 2.

The coefficient of agreement for the designers (0.335) was higher than that for the general population (0.294) in Study 1a. This means that there was greater agreement between the paired comparison choices of the designers than in the general population. Greater agreement does not necessarily mean a higher level of consistency; there can still be a high level of agreement between inconsistent responses.

The results of the study reported in this chapter, comparing graphic designers' preference for heading emphasis methods, mean that they cannot be included in the general population sample. Overall, they ranked Bold as the easiest heading emphasis method to identify, but their perception of Spacing, ranked second compared to fifth in the general population, means that their perception of headings is different to that of the general population

7

Identification of Headings with Two Methods of Typographic Emphasis (Study 2)

A single variation in the visual appearance of a heading typeface significantly improves the ability for a reader to easily identify that heading from the surrounding text. In Study 1a and 1b, reported in Chapter 5 and Chapter 6, we found that increasing the visual weight of a heading using a single heading emphasis method creates headings which are more easily identified. Heading styles with greater visual weight were chosen as being more easily identified than the headings with a lighter visual weight. It was also found that those who have visual design education or experience found different methods of heading emphasis easier to identify than the general population.

To further the findings of Chapter 5 and Chapter 6, this chapter presents a second paired comparison study that investigates whether creating headings with increased strength of visual emphasis would increase ease of identification. This was achieved by combining two heading emphasis methods to produce heading styles with greater visual weight than using a single method of typographic emphasis, and will answer Research Question 2.

Research Question 2: Are headings that are emphasised by combining two methods of typographic emphasis more easily identified than single emphasis methods within a passage of text?

The study presented in this chapter answers Research Question 2 by comparing four heading styles created by combining two heading emphasis methods and a control heading with a single heading emphasis method, in print and on screen.

This chapter begins by providing detail of the method and materials used to conduct the paired comparison study, it then gives detail of the participant sample. The results of the study are then presented with analysis before discussing the findings of the study. Finally, the chapter provides a conclusion and outlines the implications of the findings of this study on Study 3 (Chapter 8).

7.1 Method

This study followed the same methodology as the previous study, Study 1a and 1b. In the previous study six typographic emphasis methods for headings and a control were ranked in a paired comparison study. The methods of emphasis that were ranked in the first study were Bold, Italic, Sans Serif (in contrast to the serif body copy), Size increase of 20%, Capitalisation, increased Spacing between the heading and the body copy, and a Control (where there was no difference between the heading and body text). From Study 1a and 1b it was found that Bold was the preferred typographic method for emphasising a heading both in print and on screen. With general readers (Chapter 5) an increase in size was the second most preferred heading emphasis method and with graphic designers (Chapter 6), the second most preferred heading emphasis method was an increase in Spacing between the heading and the following paragraph.

This study again used a balanced paired comparison method to create an order of relative preference from the set of five typographic heading emphasis methods chosen based on the findings of Study 1a and 1b. Participants were shown pairings of the heading styles set within a passage of text and asked to indicate in which of the passages of text they found the headings easiest to identify.

7.1.1 Stimuli

The study materials were also developed with as many consistencies with the material from Study 1a and 1b as possible. The same passage of text, with the same three headings was used for all five heading presentations in this study, as in Study 1a and 1b. Again, the body copy was set in 9 point Times New Roman with 13 points of leading. The text was set in a single column measuring 98mm wide and 175mm high, on a 176mm wide and 250mm high page, allowing for a generous margin to separate the two pages. Both

passages of text were placed side by side on an A3 page with a mid-grey background as can be seen in Figure 42.

The combination of heading emphasis methods to create the heading styles to be compared in Study 2 were chosen based on the results of Study 1a and 1b. Bold, as the most frequently chosen heading in Study 1a and 1b, was combined with Size as the second most frequently chosen heading style by the general population, Spacing as the second most frequently chosen heading style by designers, and Sans Serif as the next most frequently chosen heading style across print, screen and designers in Study 1a and 1b. The combination of Size and increased Spacing was chosen as a comparison to a heading which included Bold to understand if a heading can be as effectively emphasised using two heading emphasis methods without the use of Bold. Bold, as a single variation heading style was included as the fifth heading style to compare in Study 2 to provide a direct comparison to the results of Study 1a and 1b. Capitalisation was not carried forward, despite its relatively strong ranking in Study 1a. This is because despite its visual weight, and subsequent ease to identification, text set all in capitals is harder to read due to the word shape being unrecognisable. This is explained in research by Paterson and Tinker (1940).

Five heading emphasis methods (styles) were chosen:

B	Bold
B-Si	Bold combined with increased type size by 20%
B-Sp	Bold and increased Spacing between the heading and the body copy
B-Sa	Bold Sans Serif (Helvetica Bold)
Si-Sp	Size increase of 20% and increased Spacing below the heading

The paired passages of text with the headings to be compared were shown to participants next to each other on the same A3 size page. An example of a pairing is shown in Figure 42, with the Bold and Sans Serif combination (B-Sa) on the left and Size and Spacing combination (Si-Sp) on the right.

The paired comparison study was a block design where every heading emphasis method was shown to participants alongside every other heading emphasis method variation. Each participant was shown the 10 pairings, meaning that each participant made 4 choices about each heading style when compared with each of the other heading styles.

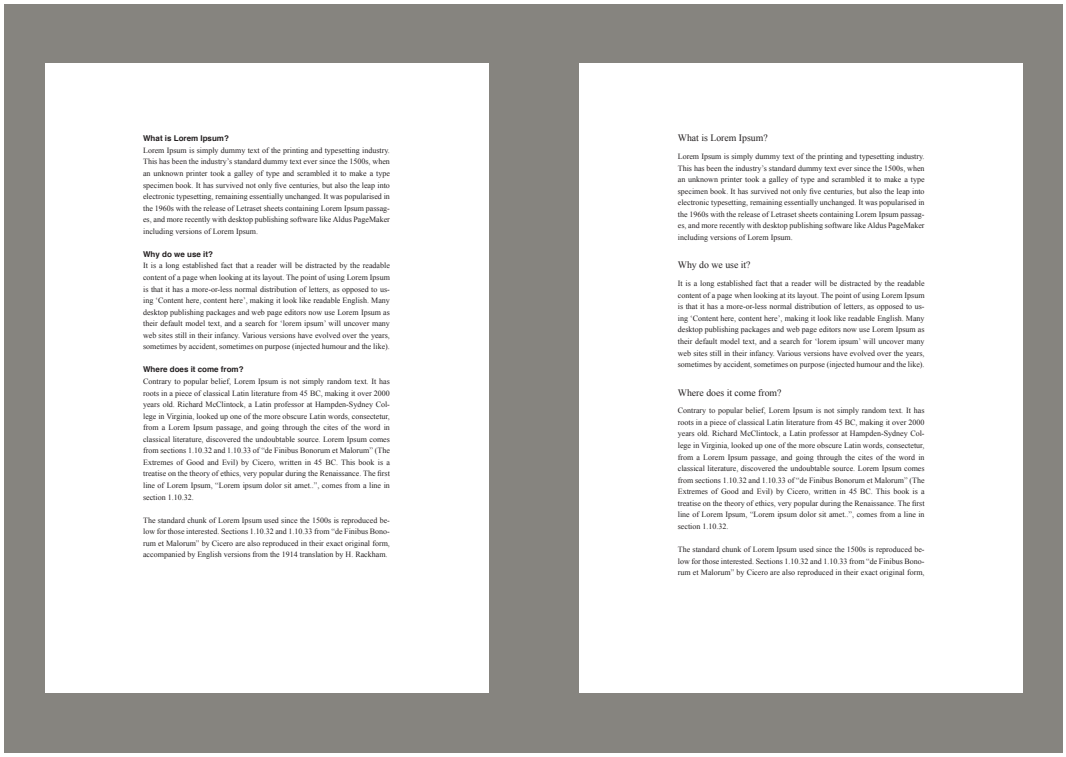

Figure 42: Example of test material (Bold-Sans Serif and Size-Spacing)

The set of 10 pairings was presented to participants in one of four random orders. The side of the page that each example was presented on was alternated left to right in an attempt to eliminate any possible bias for presentation on a particular side of the page.

Table 17: Presentation order and orientation for pairings in Study 2

	Set One	Set Two	Set Three	Set Four
1	B-Sa / Si-Sp	Si-Sp / B-Sp	B-Sp / B-Sa	Si-Sp / B-Sp
2	B / B-Sp	B-Si / B	B / Si-Sp	B-Sa / B-Si
3	B-Sp / Si-Sp	Si-Sp / B-Si	B-Sa / Si-Sp	B-Sp / B
4	B / B-Sa	B-Sp / B	B-Si / B-Sp	Si-Sp / B-Si
5	B-Sp / B-Sa	B-Sa / B-Sp	B-Si / B-Sa	Si-Sp / B-Sa
6	B / B-Si	Si-Sp / B-Sa	B-Si / Si-Sp	B-Sa / B
7	B-Si / B-Sp	B-Sa / B	B / B-Sa	Si-Sp / B
8	B-Si / B-Sa	Si-Sp / B	B / B-Sp	B-Sa / B-Sp
9	B / Si-Sp	B-Sp / B-Si	B / B-Si	B-Si / B
10	B-Si / Si-Sp	B-Sa / B-Si	B-Sp / Si-Sp	B-Sp / B-Si

The materials used in both the print and screen versions of the study were identical. In the print condition, participants were given an A3 sized bound booklet containing all 10 pages of study material. In the screen condition, participants were asked to open a PDF on their own computer screen containing all 10 pages. Participants on screen were asked to view

the pairings on a screen no smaller than a tablet, with both passages of text being compared visible on the screen at the same time.

Participants were randomly assigned one of the four sets of materials before the commencement of the study. Before participants began the paired comparison, they were asked for some basic demographic information, including their gender, age and highest completed qualification.

There was a total of 200 participants that took part in this study across both print and screen conditions, 100 in each condition. Participants for the print and screen versions of the study were collected through two different methods. Participants for the print version of the study were recruited by approaching potential participants on the University of Waikato campus or in the wider community through personal contacts. This meant that participants in the print version of the study were students or staff at the University of Waikato as well as from the wider community. The participants for the on-screen version were self-selecting through Amazon's Mechanical Turk, so long as they met the specified criteria for participation in the study. The participants sourced through Amazon's Mechanical Turk were required to have the system's assigned qualifications of a HIT (Human Intelligence Task) Approval Rate (%) for all Requesters' HITs greater than or equal to 98, and the Number of HITs Approved greater than or equal to 5,000. The reason for specifying these criteria was to have greater certainty that the participants would provide reliable data (See Appendix B for a copy of the participant information sheet and study recording sheet). Participants who had previously participated in Study 1a were allowed to participate in Study 2.

7.1.2 Procedure

For the study, participants were asked to compare each pairing of text passages and to indicate in which of the two passages of text they found the headings easiest to identify as headings compared to the body copy surrounding them. Participants were also able to respond that they felt that the two headings were of equal value. There was no time limit placed on completing the study and participants were able to move through the pages of paired comparisons at their own pace.

In the print version of the study the responses given by participants were recorded by the researcher. In the screen version participants selected a radio button in the Amazon Mechanical Turk interface ("Left, "Right", or "No Difference").

7.2 Sample

Information about the participants' age range, gender and highest completed qualification were sought before they commenced the study.

The gender balance of participants had a shift in balance between the print and screen conditions. In print, 46 males and 54 females made up the sample of 100. In the screen condition, 64 males and 35 females made up the population of participants, with one participant recording their gender as 'other'.

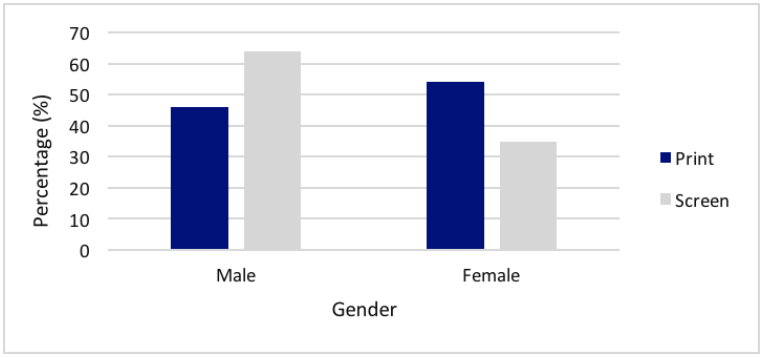

Figure 43: Gender of participants in Study 2 for print and screen (n=100)

In the print condition, 29% of the participants were aged 17-25; this was the age bracket with the greatest number of participants. The 26-35 year age bracket had 16% of participants, and 15% were 36-45, 19% were 46-55 and 13% of participants were aged 56 or older. Participants in the on-screen condition were aged between were mostly aged 26-35 years at 47%, 14% of participants were 17-25 years old, 22% were 36-45 years old, 14% were 46-55 and just 3 were aged over 56 years.

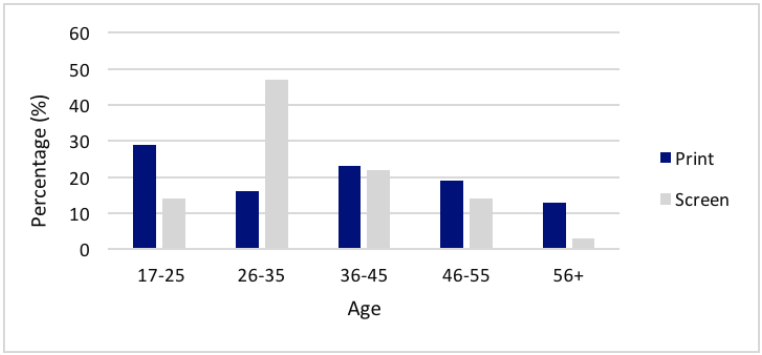

Figure 44: Age of participants in Study 2 for print and screen (n=100)

Participants were asked for their highest completed qualification. This was divided into three main categories; high school or a pre-degree qualification such as an Associates degree or Certificate, a Bachelors degree (including a Bachelors with honours), and Postgraduate (including Postgraduate Diploma, Masters and PhD qualifications). In the

print condition the participants were divided relatively evenly between the three categories; 36% pre-degree, 28% Degree and 36% Postgraduate. On screen the distribution of qualifications was less even, with 38% of participants having a pre-degree qualification, 43% having a degree and only 18% have a postgraduate qualification. One participant recorded their qualification as 'other'.

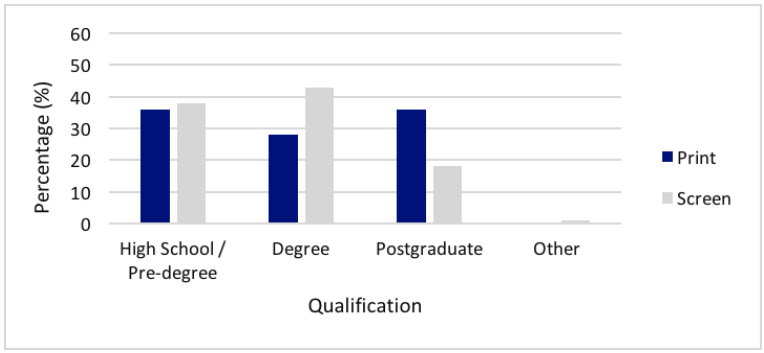

Figure 45: Highest qualification of participants in Study 2 for print and screen (n=100)

7.3 Results

The data collected from the two paired comparison studies conducted in print and screen was analysed to try to understand which heading emphasis methods are most easily identified from the body copy surrounding them. The first method of analysis is through counting the number of times each of the heading emphasis methods was chosen as the preferred heading emphasis method n a head-to-head comparison. This creates a total number of times each heading emphasis method was considered to be the most easily identifiable (David, 1988).

The second method of analysis was using the Bradley Terry model in R. Modelling of the collected data was done using the 'prefmod' package. David (1988), explains that when a large number of items are being ranked it is not always possible to find an absolute order. Using the Bradley Terry model it is also possible to compare results across different demographic groupings as well as compare results according to the different presentation orders, to see if ordering of stimuli had any effect on the results.

7.3.1 Head-to-head Comparison

The analysis method of calculating preference totals for Study 1a and 1b as described in Section 5.3.1 was used again for this study to analyse the overall number of times each heading emphasis method was preferred. David (1988) explains how a ranking of

preference can be determined from the results gathered from a paired comparison study. Each time a heading emphasis method was chosen as being the more easily identified heading emphasis method in a pair it was given '1', with the other heading emphasis method being given '0'. If a tied or neutral response was recorded for a paired comparison, both heading emphasis methods were allocated '0.5'. Table 18 gives the total number of times each heading style stated in the column was chosen over the heading emphasis method started in the row. The total number of times each heading emphasis method was preferred, out of a maximum total of 400, is shown at the bottom of each column.

Table 18: Study 2 head-to-head results for print

	Bold (B)	Bold-Size (B-Si)	Bold-Spacing (B-Sp)	Bold-Sans Serif (B-Sa)	Size-Spacing (Si-Sp)
Bold (B)	---	89.5	64	92	65.5
Bold-Size (B-Si)	10.5	---	21.5	38	25
Bold-Spacing (B-Sp)	36	78.5	---	77.5	52
Bold-Sans Serif (B-Sa)	8	62	22.5	---	31.5
Size-Spacing (Si-Sp)	34.5	75	48	68.5	---
Total	89	305	156	276	174

The preference table for the responses in the print condition are shown in Table 18. The heading emphasis method of Bold and Size (B-Si) was chosen the greatest number of times as the more easily identifiable heading emphasis method in a paired comparison, 305 times. The second most frequently chosen heading emphasis method across all pairings was the Bold-Sans Serif (B-Sa) combination at 276. The headings combining Size-Spacing (Si-Sp), 174, and Bold-Spacing (B-Sp), 156, had a similar number of preference choices each and the Bold (B) heading emphasis method was chosen the fewest number of times, 89, as the heading emphasis method that was easiest to identify in a paired comparison. The strongest preference for one heading emphasis method over another in print was in favour of Bold-Sans Serif over Bold. Bold-Sans Serif scored 92 out of a possible 100, being chosen as the more easily identifiable heading emphasis method 89 times and Bold just five times, with six neutral choices between them (see Table 20). Bold-Spacing and Size-Spacing had the most evenly split number of preference choices, with Bold-Spacing scoring 48 and Size-Spacing scoring 52, this included just four neutral choices, as shown in Table 20.

Table 19: Study 2 head-to-head results for screen

	Bold (B)	Bold-Size (B-Si)	Bold-Spacing (B-Sp)	Bold-Sans Serif (B-Sa)	Size-Spacing (Si-Sp)
Bold (B)	---	87	56.5	79.5	64
Bold-Size (B-Si)	13	---	20	34.5	29
Bold-Spacing (B-Sp)	43.5	80	---	73	57.5
Bold-Sans Serif (B-Sa)	20.5	65.5	27	---	28.5
Size-Spacing (Si-Sp)	36	71	42.5	71.5	---
Total	113	303.5	146	258.5	179

Table 19 shows the overall preference results for the screen-based condition of the study. As with print, Bold-Size was preferred the greatest number of times (303.5), again followed by Bold/-Sans with 258.5 preference choices. Using this analysis method, the order of preference remains unchanged in the screen condition to what it was in print; Size-Spacing was third preferred (179), followed by Bold-Spacing (146), with Bold, the only single heading emphasis method in this study having the lowest preference total, 113. On screen the two closest preference total scores were between Bold-Spacing (56.5) and Bold (43.5), though Size-Spacing (57.5) and Bold-Spacing (42.5) scored almost as closely. The Bold-Spacing and Bold paired comparisons included a large number of neutral responses, 45 (as shown in Table 21), meaning that Bold-Spacing was only chosen outright 34 times and Bold only chosen 21 times in the paired comparisons of the two heading emphasis methods. In contrast, the paired comparison of Size-Spacing and Bold-Spacing had just nine neutral responses in their comparison (see Table 21), meaning that Size-Spacing was chosen as being more easily identifiable, 53 times, and Bold-Spacing was chosen 38 times in total. The paired comparison of the Bold-Size and Bold heading emphasis methods on screen had the most distinct preference for one of the two heading emphasis methods being compared, with Bold-Size being preferred in 87 instances and Bold preferred in just 13 instances. This paired comparison attracted 14 neutral responses (see Table 21), giving Bold-Size 80 outright choices, and Bold only six outright choices of the 100 comparisons between these two heading emphasis methods.

7.3.2 Neutral Choices

When participating in the study, participants had the option of expressing no preference for one of the stimuli in the paired comparison over the other. Their neutral choices were recorded when a participant felt that the two heading styles in a pairing were equally easy

or difficult to identify within the text, or if they felt that there was no perceivable difference between the two heading styles. The number of neutral choices made for each style in a pairing, along with the total number of neutral choices for each heading style are shown in Table 20 and Table 21 for screen.

The greatest number of neutral choices was given in response to the pairing of Bold (B) and Bold-Spacing (B-Sp), with 14 neutral responses in print and 45 on screen. This result is likely due to the only difference between these two headings being a single line of extra vertical space between the heading and the body copy below. As was found in the previous study, within the general population Spacing was not considered to be a strong method for creating visual emphasis in headings. In print, the fewest number of neutral choices was given for the pairing of Size-Spacing (Si-Sp) with Bold-Sans Serif (1). On screen, the pairing of Bold-Size with Size-Spacing (Si-Sp) had just two neutral choices made, and Bold-Sans Serif (B-Sa) and Size-Spacing (Si-Sp) had only three neutral choices in total.

Table 20: Study 2 neutral choices in print

	Bold (B)	Bold-Size (B-Si)	Bold-Spacing (B-Sp)	Bold-Sans Serif (B-Sa)	Size-Spacing (Si-Sp)
Bold (B)	---	3	14	6	5
Bold-Size (B-Si)	3	---	3	8	4
Bold-Spacing (B-Sp)	14	3	---	5	4
Bold-Sans Serif (B-Sa)	6	8	5	---	1
Size-Spacing (Si-Sp)	5	4	4	1	---
Total	28	18	26	20	14

The number of neutral choices in print (106) made up 10.6% of the total number of responses from all participants. The greatest number of neutral choices for a heading style in print was Bold (28), this was largely due to the high number of neutral choices for the pairing of Bold-Spacing.

Table 21: Study 2 neutral choices on screen

	Bold (B)	Bold-Size (B-Si)	Bold-Spacing (B-Sp)	Bold-Sans Serif (B-Sa)	Size-Spacing (Si-Sp)
Bold (B)	---	14	45	13	8
Bold-Size (B-Si)	14	---	6	19	2
Bold-Spacing (B-Sp)	45	6	---	8	9
Bold-Sans Serif (B-Sa)	13	19	8	---	3
Size-Spacing (Si-Sp)	8	2	9	3	---
Total	80	41	68	43	22

For the screen version of the study, the total number of neutral choices (254) accounted for 25.4% of the total number of responses from all participants. As was also seen in Study 1a, there was a greater number of neutral choices made in the screen version of the study with more than twice as many neutral choices made than in print. As well as a high number of neutral responses in print for Bold (B) and Bold-Spacing (B-Sp), which were seen as equivalent 45 times, Bold-Size (B-Si) and Bold-Sans Serif (B-Sa) also received a larger number of neutral responses (19).

7.3.3 Analysis in R

The Bradley Terry model was used to analyse the paired comparison data, as was done in Study 1a and 1b, as well as the head-to-head method. The results were modelled in R, as explained in Section 5.3.3. The plots generated provide a visual representation of the relative ranking of the five heading styles being studied in the paired comparison conducted for this study.

7.3.3.1 Paired Comparison in Print

When analysed using the Bradley Terry model, the results for the print version of the study show differences in the overall ranking compared to the head-to-head comparison. The plot of relative ranking for the print version of the study is shown in Figure 46.

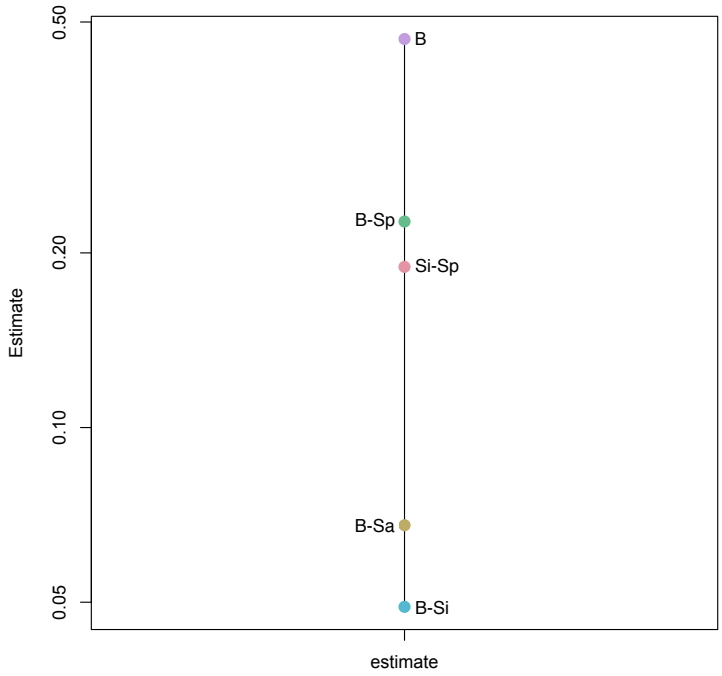

Figure 46: Heading emphasis ranking for print

The plot in Figure 46 shows that in print, the headings which were overall considered to be most easily identified were headings that were a bold version of the body copy typeface, Times New Roman, but with an increase in size of 2 points compared to the body copy (B-Si). This was closely followed, however, by headings which were Bold-Sans Serif (B-Sa), the same size as the body copy. The third most easily identified heading emphasis method was the heading which was the same typeface as the body copy (Times New Roman), but was 2 point sizes larger and had increased Spacing between the heading and the body copy following it (Si-Sp). The heading style which was a Bold heading, the same size as the body copy, but with an increase in Spacing between the heading and the body copy following it (B-Sp) was ranked as the next most easily identified. The Bold heading (B), which was the same size as the body copy with no vertical spacing below it, was considered to be the Control in this study. Bold had been the most preferred heading emphasis method in the first study, so was used here as a point of comparison. It was considered the least easily identified heading emphasis method.

Table 22: Coefficients of interest for print results Study 2

	Estimate	Std. Error	z value	Pr(>|z|)
Si-Sp	-0.45213	0.07601	-5.948	2.71e-09 ***
B-Sa	-0.96482	0.08235	-11.716	<2e-16 ***
B-Sp	-0.36219	0.07562	-4.789	1.67e-06 ***
B-Si	-1.12669	0.08580	-13.132	<2e-16 ***
B	0.00000	NA	NA	NA
g1	-2.01150	0.14273	-14.093	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '

Table 22 shows the results from Study 2 in print and the significance of the results (Pr(>|z|)). All four of the heading styles that were a combination of two heading emphasis methods were considered significantly easier to identify than Bold. However, the degree of significance for Bold-Spacing and Size-Spacing was lower than for Bold-Size or Bold-Sans Serif. The strong negative value for g1 indicates that participants had a strong preference for making a decision and a greater tendency to make a decision than in print in Study 1a.

7.3.3.2 Paired Comparison on Screen

The relative ranking results of the screen version of Study 2 are shown in Figure 47 where the results of the paired comparison of the five heading styles reflects the findings of the head-to-head analysis.

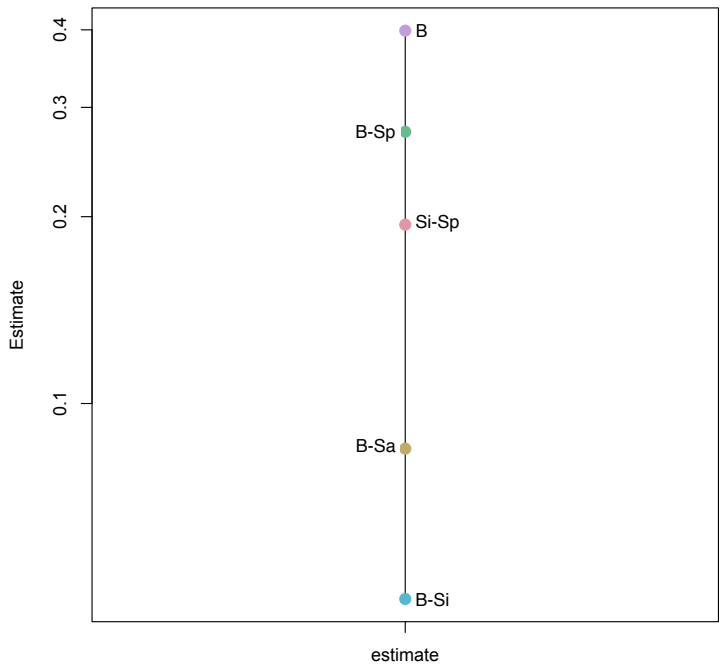

Figure 47: Heading ranking for screen

There was some change in the relative preference of the five heading variations that were used in the paired comparison, between print and screen conditions, but the overall preference rank order was the same. For the screen-based condition, the Bold with Size increase headings were the heading emphasis method which were most preferred, being ranked marginally higher than the Bold and Sans Serif heading. The heading which was ranked third was Bold with a Spacing increase; the fourth ranked was the Bold only heading and the heading considered to be the least easily identified was the heading with the increase in both Size and Spacing.

Table 23: Coefficients of interest for screen results study 2

	Estimate	Std. Error	z value	Pr(>|z|)
Si-Sp	-0.36121	0.07572	-4.770	1.84e-06 ***
B-Sa	-0.78271	0.08024	-9.755	<2e-16 ***
B-Sp	-0.18553	0.07548	-2.458	0.014 *
B-Si	-1.04639	0.08571	-12.208	<2e-16 ***
B	0.00000	NA	NA	NA
g1	-1.07394	0.09720	-11.049	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '

The results for the screen version of the study show that ease of identification for Bold-Size and Bold-Sans Serif heading styles were again highly significant (Table 23). However, the significance of results for Size-Spacing was lower, though still highly significant, but the Bold-Spacing result had a much lower significance. As was seen in Study 1a, the g1 value is lower in the on-screen version of the study than in print, meaning that participants on screen were less inclined towards a decision.

7.3.3.3 Comparison of Presentation Order

Participants saw the 10 pairings of heading styles in the paired comparison study in one of four different orders (Sets 1-4). The results from each of the four sets were compared and are shown in Figure 48 (print), and Figure 49 (screen).

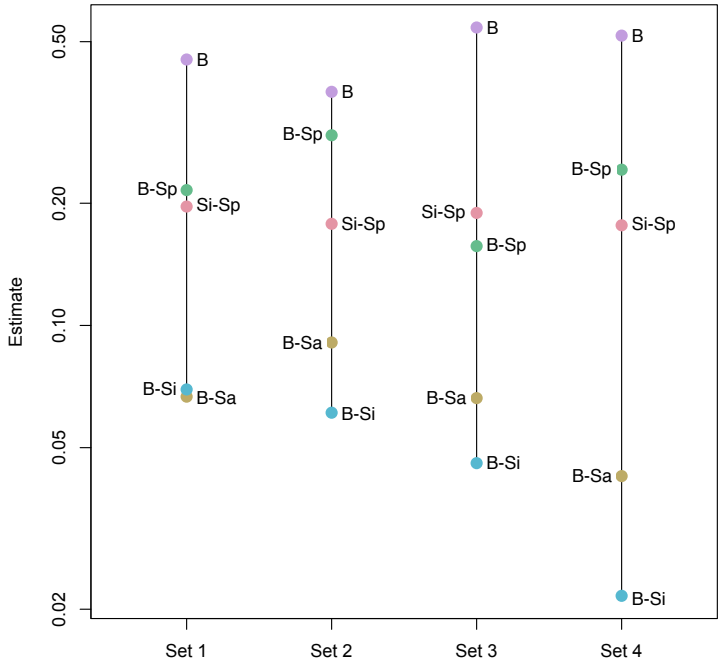

Figure 48: Study 2 print results by set

Between the four presentation orders in print there was little change in the relative ranking based on ease of identification of the five heading emphasis methods that were being compared. Bold-Size was judged the most easily identified in three of the four presentation orders with Bold-Sans Serif being ranked second in all but Set 1 where it was ranked first over Bold-Size by a small margin. The greatest gap between the first and second most easily identified heading emphasis methods occurred in Set 4. The greatest variation between the relative rankings in the four sets was between Bold-Spacing and Size-Spacing, these two heading styles were ranked third and fourth in all four sets, but moved in terms of their relative preference.

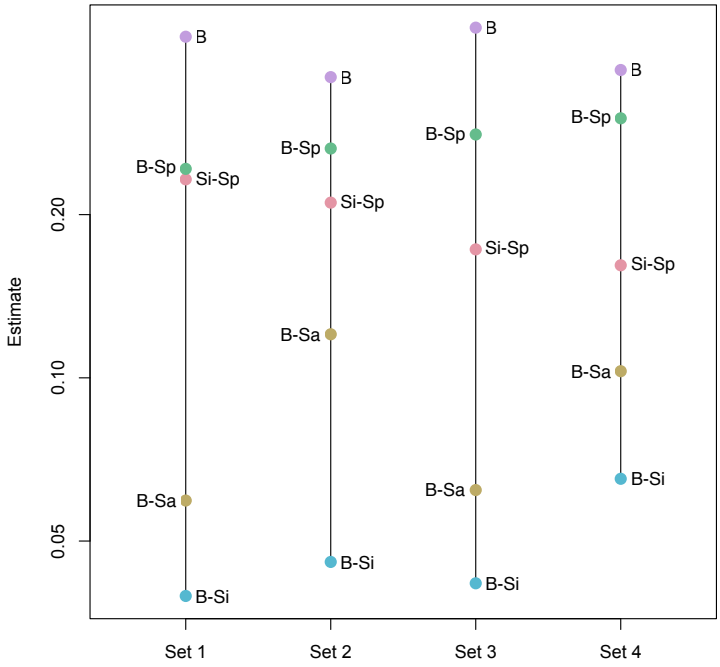

Figure 49: Study 2 screen results by set

In the on-screen results there was greater consistency in the rankings between the five heading styles, but the relative preference varied between the four sets, especially between Bold-Spacing and Size-Spacing. The relative ranking between the two heading emphasis methods considered to be most easily identified showed the greatest shifts between the four presentation orders.

7.3.3.4 Left Versus Right Side of the Page

The side of the page on which each heading style in a pairing was presented to participants was alternated between Sets 1 and 3, and Sets 2 and 4 of the booklets of randomly ordered pairings. The purpose of this was to attempt to eliminate any influence a bias for a particular side of the page may have made on the participants' choices.

In print, the total number of times the heading style presented on the left side of the page was chosen was 467 out of a possible 1000 and the right heading style was chosen 480 times. The remaining 53 choices were neutral. On screen, the heading style presented on the left side was chosen 433 times and the right side was chosen 440 times, with the remaining 127 being neutral choices. Across both print and screen the balance of choices for the heading style presented on either the left or right side was close to evenly split. In both print and screen the number of choices for the heading style presented on the right is slightly higher, by 13 in print and by 7 on screen. However, some pairings had a bias towards the left side of the page and others had a bias towards the right side.

A list of the pairings with the largest discrepancies between the number of choices between each heading style presented on the left or right is given in Table 24.

Table 24: Study 2 left and right side page biases

Print			Screen		
	Left	Right		Left	Right
Bold/Bold-Spacing	36	50	Bold-Sans Serif/Size-Spacing	58	39
Bold-Spacing /Bold-Sans Serif	53	42	Bold-Size/ Bold-Sans Serif	36	45
Bold-Size/ Bold-Spacing	43	54	Bold/Bold-Spacing	23	32
Bold-Size/ Bold-Sans Serif	41	51	Bold/ Bold-Size	39	47
Bold/ Bold-Size	52	45	Bold-Size/ Bold-Spacing	50	44

The pairings with the greatest discrepancies tended to favour the heading styles presented on the right, though preference for the left was also seen. Four of the five heading style pairings with the strongest biases appear in the list for both print and screen. Bold/Bold-Spacing showed a bias for the right in both print and screen, though in the screen version of the study 45 of the 100 choices were neutral, higher than for the heading style presented on either the left or right. Bold/Bold-Sans Serif appeared in both lists and also had a bias to the right in both print and screen. Bold-Size/Bold-Spacing and Bold/Bold-Size were the other two pairings that appeared in both lists in Table 24, but were biased to the left in one version of the study and to the right in the other version.

There were two pairings in print that had an almost equal number of choices for each side of the page, Bold/Size-Spacing and Bold-Sans Serif/ Size-Spacing, where there was only a difference of one choice between the two page sides. On screen, there was no difference at all between the number of times the heading style on the left or right was chosen for the pairing of Bold-Sans Serif/Size-Spacing.

There appears to be a slight bias towards the heading style presented on the right side, though as in Study 1a, a bias toward the heading style presented on a particular side of the page does not appear to have influenced the result.

7.3.3.5 Preference by Gender

The results were analysed broken down by the gender of the participants to see if there was variation in results. The results for both males and females on screen and males in

print were all reasonably similar; however, the results for females in print saw a shift from the results of the total population.

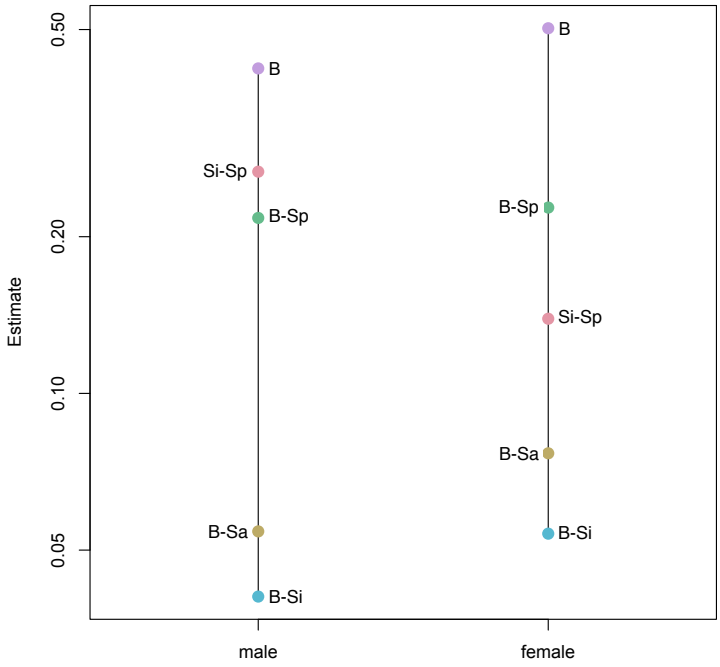

Figure 50: Study 2 print results by gender

When results in print are considered by gender, the males have a far wider spread in preference ranking than the females in the study, as shown in Figure 50. In both gender groups, Bold-Size was ranked as the most easily identified heading emphasis method. The only difference in overall ranking between males and females was the shift between Bold-Spacing and Size-Spacing between third and fourth. Females had a greater relative preference for Size-Spacing than males. Bold-Size and Bold-Sans Serif were clearly more frequently chosen by male participants in print with a wide gap between Bold-Sans Serif and Bold-Spacing.

The wide spread of preference that was seen for males in the print condition was not replicated in the screen version. For both genders, there was little difference in the overall rank order of the five heading styles. The only variation came in the relative preference. Bold-Size was again ranked the most easily identified heading emphasis method on screen for both males and females, as it was in print, though by a larger margin with females. The Bold heading style was ranked as the least easily identified heading style by both males and females on screen. As with print, Size-Spacing was relatively less preferred by males compared to Bold-Sans Serif.

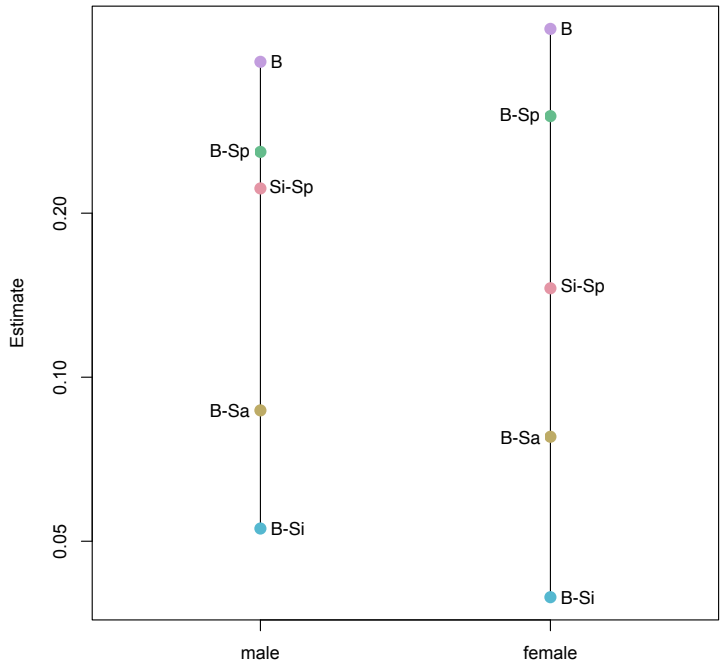

Figure 51: Study 2 screen results by gender

7.3.3.6 Study 2 Ranking by Age

Results of the paired comparison were analysed according to the age of participants across five age brackets.

In print, the variation in rank across age brackets, as seen in Figure 52 is minimal, with only changes in rank order occurring between Bold-Spacing and Size-Spacing in third and fourth. In print, Bold-Size was considered the most easily identified heading style with Bold-Sans Serif following in second, a similar distance behind in respect to relative preference.

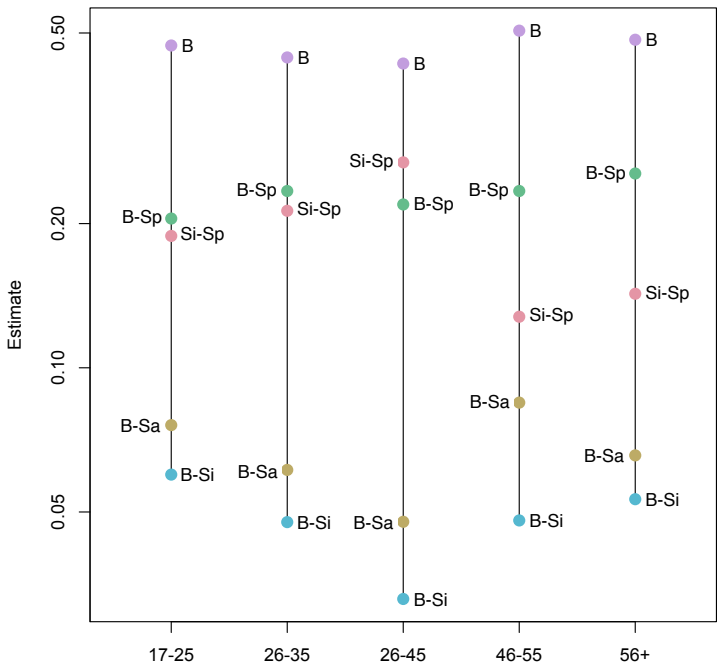

Figure 52: Study 2 print results by age

A small number of participants in the 56+ age group (n=3) in the on-screen version of the study gave a visual presentation that was hard to view for the younger age groups and a different scale to the print version of the study. Figure 53 combines two plots with different scales, the plot combining all five age brackets can be found in Appendix D.

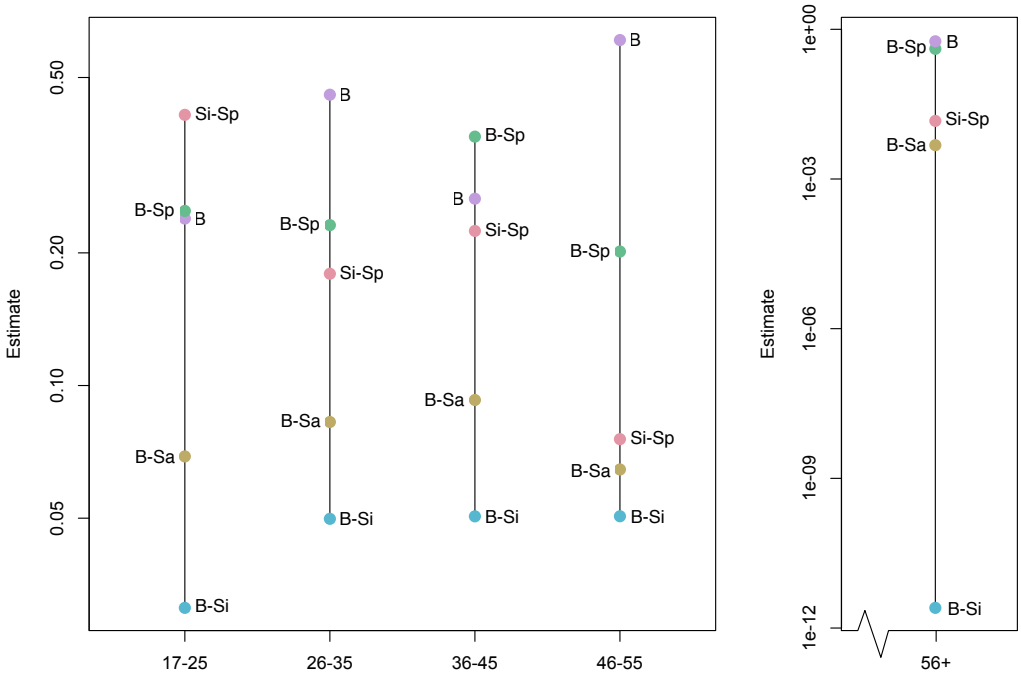

Figure 53: Study 2 screen results by age

Greater variation is seen in the on-screen version of the study when considered by age bracket. As with print, Bold-Size was ranked first and Bold-Sans Serif second. The relative preference of the remaining three heading styles shifts between the three remaining heading styles. In the youngest age bracket (17-25 years), Bold is ranked far higher, in third ahead of Bold-Spacing and Size-Spacing. The 26-35 age bracket is close to the relative ranking of the overall population and then the 36-45 age bracket with Bold being ranked fourth and Bold-Spacing in fifth. Size-Spacing is viewed by the 46-55 year age bracket as far more easily identifiable than any of the others, coming in a close third behind Bold-Sans Serif.

7.3.3.7 Preference by Qualification

The highest completed qualification of participants was collected and the result of the choices made by participants were divided into three categories according to whether the participant had completed pre-degree, Bachelor or Postgraduate qualifications. Some variation was seen between the groups and between print and screen versions of the study.

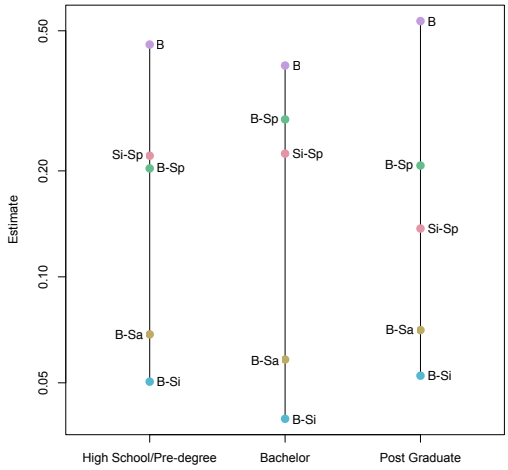

Figure 54: Study 2 print results by highest completed qualification

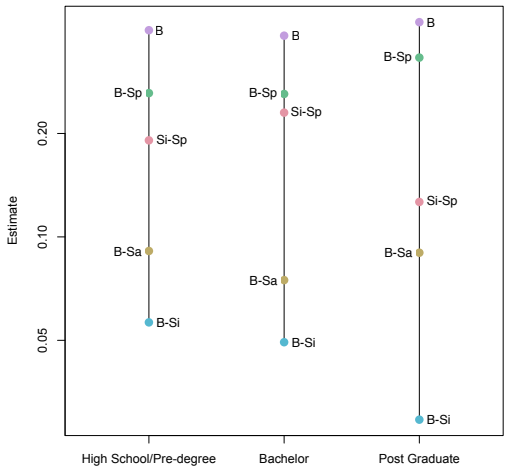

Figure 55: Study 2 screen results by highest completed qualification

The results in print showed only slight shifts in the two most frequently chosen heading styles; Bold-Size and Bold-Sans Serif, as seen in Figure 54. The main shifts in relative preference were again between Bold-Spacing and Size-Spacing. The greatest difference came in the screen version of the study (Figure 55), where those with a Postgraduate qualification had a relatively low preference for Bold-Spacing and a comparatively higher preference for Bold-Size.

7.3.4 Comments

As was common with the first study, many participants commented about their preferences as they made their choices in the paired comparison. Sometimes this was an observation about what the headings were, or if they felt that the difference between the two heading styles was hard to make a choice about, or that one was only just easier to identify than the other. Many participants were very perceptive about what the differences were between two different heading styles.

7.3.4.1 Bold

One participant commented that they felt they preferred Bold headings. A different participant commented that a Size-Spacing heading would be even better if it was “black” (It is assumed that they meant ‘Bold’). In the comparison of Bold and Bold-Sans Serif, one participant noted that the Bold alone was bolder than the Bold-Sans Serif. And another participant preferred Bold alone as is was clearer to read. When comparing Bold and Size-Spacing, one participant felt the heading styles were very similar, but chose Bold.

7.3.4.2 Bold-Size

Several comments were made by participants regarding the pairing of Bold-Size and Bold-Sans. Many of these felt that the two heading styles were similar, or only just preferable over the other. In most of the cases the choice was made for the Bold-Sans Serif heading style, accompanied by comments such as “Only just”. Reasons given for choosing the Bold-Sans Serif were that it was easier to read or they felt the other was too big. The one participant who gave a reason for making a choice the other way was that they felt that Times New Roman was easier to read. A participant who gave a neutral response to this pairing expressed their dislike of both. Only one comment was made regarding the pairing of Bold and Bold-Size, with the participant feeling that Bold-Size seemed blacker. Two participants expressed that the choices they were making in regard to the pairing of Bold-Size and Bold-Spacing were counter to what they thought they would find easier. One choosing Bold-Size “even though it's together” and the other who felt that Bold-Spacing was better even though they felt that logically they should be choosing Bold-Size.

7.3.4.3 Bold-Spacing

When making a decision between Bold-Spacing and Bold-Sans Serif, a participant chose the Bold-Spacing, commenting that it was more suitable, but did not specify exactly what they felt it was more suitable for. When choosing Bold-Spacing over Bold, a participant commented that "size and space make more difference than bolding for me." In comparison, another participant felt that it takes extra time for the eye to look at the space.

A comment was made by a participant that felt they preferred the Bold-Spacing over the Bold alone as they felt it was more centred. It was not clear whether they were referring to the vertical or horizontal space.

7.3.4.4 Bold-Sans Serif

When trying to make a decision between Bold-Size and Bold-Sans Serif, a participant expressed what they were thinking, noting that Bold-Size was bigger but Bold-Sans was easier to read, their final choice was for Bold-Sans Serif. The dislike of Bold-Sans Serif was the motivation for one participant choosing Bold rather than the change in typeface. In the comparison of the same heading styles another participant felt that the Bold-Sans Serif was preferred over Size-Spacing, but "not by much" and another pointed out that the Bold-Sans Serif was bolder. Another participant chose the Bold-Sans heading style over Spacing, but also stated that "Bold is not always best."

7.3.4.5 Spacing

While comparing Bold/Size and Size/Spacing a participant commented that they felt Spacing is better, Bold is too crowded, "The bold feels too claustrophobic" it looks like less content when there is Spacing. Several participants felt that the space made the heading easier to read, especially when comparing Bold-Sans Serif and Spacing, commenting that the space was good. Space was also the factor for Spacing being chosen over Bold by a participant who thought that space was good. When comparing Bold-Sans Serif and Spacing, two participants gave different reasons for choosing Spacing. The first believed that the larger text makes it better and easier to read, and a second participant felt that the size made it preferable.

7.3.4.6 Neutral Choices

In the comparison of Bold-Size and Spacing, the participant commented that they were equally pleasing, and chose a neutral response for that pair. A participant who made a neutral choice about Bold-Spacing and Bold-Sans Serif did so because they disliked both, saying that the change of font "bugs" them and Spacing makes it too awkward.

7.3.5 Consistency of Choices

The responses of the paired comparison conducted for Study 2 were analysed to understand how consistent the responses of each participant were (Coefficient of Consistence) and how close the participants were in their choices (Coefficient of Agreement).

7.3.5.1 Circular Triads

Circular Triads occur in the results of paired comparison data when participants provide inconsistent responses within their choices. Within the combined results of Study 2, no circular triads were present within the collated results. The lack of circular triads in the combined data means that a ranking of the heading styles is more consistent and there is likely to have been greater agreement between participants. However, this does not mean that circular triads were not present within the responses of individual participants.

7.3.5.2 Coefficient of Consistence

The coefficient of consistence is used to calculate the degree of consistency a participant has when making their choices in a paired comparison. The coefficient of consistence also reflects the number of circular triads that may be present within the responses. An explanation for the calculation of the coefficient of consistence is given in Appendix C. The coefficient of consistence was calculated for each participant in print (Figure 56), and on screen (Figure 57). A coefficient of consistence of 1 indicates that the responses given by a participant were consistent across all choices they made and they gave no neutral responses.

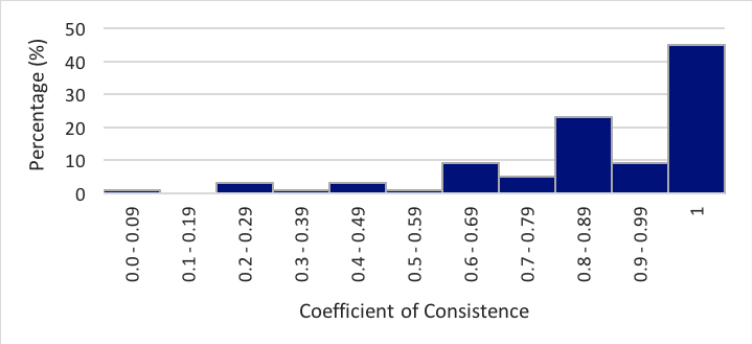

Figure 56: Study 2 coefficient of consistence in print

In the print version of the study, the majority of the 100 participants had a coefficient of consistence between 0.8 and 1 (78%), and only four had a coefficient of consistence below 0.3. A total of 45 participants had a coefficient of consistence of 1, meaning their responses had no circular triads or inconsistencies.

For the responses to the on-screen version of the study 24 participants had a coefficient of consistence of 1 and 72% had a coefficient of consistence of 0.7 or higher.

The mean coefficient of consistence in print was 0.844, equivalent to less than 1 circular triad; this supports the findings from the head-to-head comparison (Section 7.3.1), where no circular triads were found. The mean coefficient of consistence on screen was 0.787, approximately 1.25 circular triads per participant.

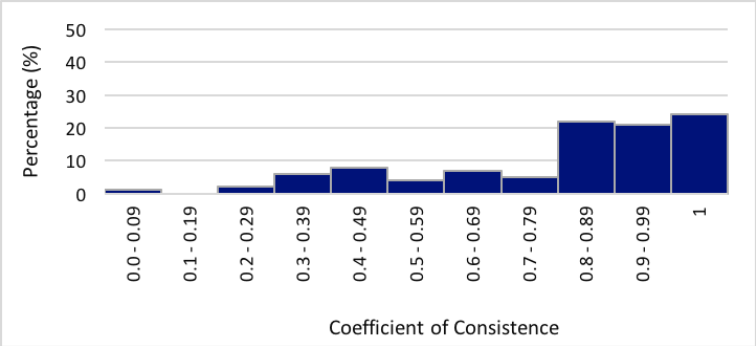

Figure 57: Study 2 coefficient of consistence on screen

In print, 92% of participants had a coefficient of consistence of 0.5 or higher, which, with five heading styles being compared, translates to approximately 2.5 circular triads. Using the tables provided by Kendall (1970), this gives a P value of approximately 0.707. On screen, 91% of participants had a coefficient of consistence of 0.4 or greater, or the equivalent of three circular triads. From the tables provided by Kendall (1970), this gives a P value of 0.531. While both of these results show that there was not a perfect consistency of responses, it is shown that the choices were unlikely to be made at random in either print or screen and the number of circular triads is low in the majority of participants' responses.

7.3.5.3 Coefficient of Agreement

In analysing the results of a paired comparison, the calculation of the coefficient of agreement can be used to help understand the degree to which the participants agree on the choices they have made (Edwards, 1957). The formulae used to make these calculations are given by (Kendall, 1970) and are detailed in Appendix C. The values in Table 18 and Table 19, above the diagonal were used to calculate the coefficient of agreement.

If there is perfect agreement between participants, the coefficient of agreement is '1', and as the coefficient of agreement approaches '0' the closer the responses are to random. For the print study the coefficient of agreement was 0.294 and for screen the coefficient of agreement was 0.221.

The resulting significance (X^2) for the coefficient of agreement of the print judges is 644.85 and the significance for the screen judges is 490.88. Therefore, the degrees of freedom (*df*) for the X^2 value is 10.10 for both the print and screen results.

Given the results of the degrees of freedom, we can therefore determine that for the responses given to the print version of the study, the approximate significance of agreement between participants is p=0.05, and for the screen results p=0.1. This indicates that there is a good chance that any two participants in the study will agree on the responses given and that the participants in print were more likely to agree with the responses they have given.

7.4 Discussion

This section discusses the results for Study 2, a paired comparison study designed to help understand which combinations of two methods of typographic emphasis create heading styles which are most easily identified within a passage of text. The overall ranking of ease of identification is considered for both print and screen versions of the study and results for ease of identification are compared to Study 1a and 1b, which considered headings emphasised using a single variation in typographic appearance.

7.4.1 Ease of Identification

Analysis of the results from this paired comparison study using the head-to-head (David, 1988) and Bradley Terry models (Hatzinger & Dittrich, 2012) provided consistent rankings. The overall rankings of ease of identification are given in Table 25 for both print and screen.

Table 25: Study 2 summary of ranking

	Print		Screen	
	Head-to-head	**Bradley Terry Model**	**Head-to-head**	**Bradley Terry Model**
1	Bold-Size	Bold-Size	Bold-Size	Bold-Size
2	Bold-Sans Serif	Bold-Sans Serif	Bold-Sans Serif	Bold-Sans Serif
3	Size-Spacing	Size-Spacing	Size-Spacing	Size-Spacing
4	Bold-Spacing	Bold-Spacing	Bold-Spacing	Bold-Spacing
5	Bold	Bold	Bold	Bold

The combination of Bold-Size was ranked as the most easily identified heading style in this study. In Study 1a Bold and Size were ranked the most easily identified heading styles

and could be considered to be the two heading emphasis methods with the greatest visual weight.

Bold-Sans Serif was ranked as the second most easily identified heading style in this study. Sans Serif had been ranked third with the general population, behind Bold and Size in Study 1a in print, and fourth on screen (with Capitalisation, not used in Study 2, being third). It was therefore unsurprising that combining Bold with Sans Serif would be closely ranked behind Bold-Size for ease of identification.

The combination of Size-Spacing was ranked third for Study 2. Individually the two methods of typographic emphasis were ranked second and fifth respectively in Study 1a. Size-Spacing was ranked ahead of Bold-Spacing in the overall ranking in both print and screen versions of the study, but when the data was analysed according to some demographic parameters, their order was reversed. Size-Spacing generally being considered more easily identified than Bold-Spacing indicates that when Spacing is introduced, heading styles may be perceived differently than when there is no Spacing. This finding supports the statement Dyson (2004) who presents the statement widely known by typographers, that no element in a typographic layout can be altered without it influencing the perception of other typographic elements in the composition. When Spacing is introduced between the heading and the following paragraph which it signals, Size may be more effective than Bold at emphasising the heading.

In the general population in Study 1a, Bold was clearly considered by the participants easier to identify in print over Size with 73 choices for Bold and just 27 for Size when they were compared directly. However, once Spacing was introduced the split of choices was in favour of Size-Spacing with 52 choices, compared to 48 for Bold. In both Study 1a and Study 2 there were just four neutral choices in each of the pairings. On screen, the ease of identification was similar when Bold and Size were compared in Study 1a, Bold was considered easier to identify, with 61.5 choices for it and 38.5 choices for Size, including just 1one neutral choice between them. Study 2 again saw a stronger preference for Size-Spacing than Study 1a with 57.5 choices for it and 42.5 choices for Bold-Spacing. This pairing received nine neutral choices.

Figure 58 provides a comparison of Bold, Bold-Spacing, Size and Size-Spacing headings for the study. The survey of current practice in Chapter 4 found that 28% of the publications surveyed used Bold and Size combined for emphasising the headings, and 24% of publications created emphasis using a heading that was Sans Serif when the body copy

was Serif. Mitchell and Wightman (2005) explain that the appropriate amount of space above and below a heading will depend on its importance within the hierarchy of heading styles being used, but there should always be more space above a heading than below it.

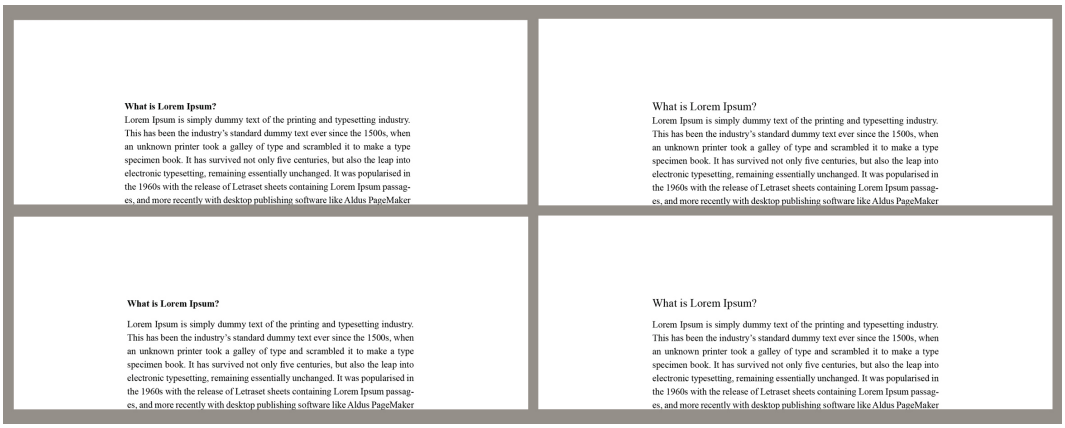

Figure 58: Comparison of Bold (t-l), Size (t-r), Bold-Spacing (b-l) and Spacing (b-r)

Of the five heading styles compared in Study 2, Bold was considered the least easily identifiable heading style, using a single method of typographic emphasis compared to the other four heading styles in the study, which all used two. Bold as a single heading emphasis method was used as a heading style in both Study 1a and 1b and Study 2. In Study 1a and 1b Bold was considered the easiest to identify and in Study 2, Bold was considered the least easily identified. This was the case in both print and screen. Based on this result it would seem that Research Question 2 can be answered; headings that are emphasised by combining two methods of typographic emphasis are more easily identified than single emphasis methods within a passage of text.

7.4.2 Print versus Screen

Subtle differences in the relative ranking of the five heading styles in this study were seen between the print and screen versions. The greatest difference between print and screen was the slightly larger number of choices in favour of Bold on screen. Half of the 24 extra choices for Bold on screen came when it was paired with Bold-Sans Serif (12.5). As was also seen in Study 1a the number of neutral choices was greater on screen than in print. This is again likely to be due to the "neutral" choice being a more obvious answer for participants than in print as on screen they were presented with a radio button for this option alongside each choice for one or the other. In comparison, in print the participant needed to either remember that a neutral choice was acceptable, or be prompted by the researcher if they made comment that they were unsure which to choose.

7.4.3 Pairing Order/Orientation

The order that the pairings were presented to participants and the position of each heading style on either the left or right side of the page seems to have not had an influence on the results of the paired comparison study. As with the earlier paired comparison studies, some pairings had a bias towards the heading style presented on either the left or right side of the page, but again there appears to be no specific reason for this. Bold/Bold-Spacing had a very high number of neutral choices on screen and a bias towards the heading style presented on the right side of the page both on screen and in print. If these two heading styles were viewed by participants as being very equal then the bias towards the right may be due to the participants who were unsure choosing the second passage as we read from left to right.

7.4.4 Neutral Choices

A large number of neutral choices were made in both the print and screen versions of Study 2 for the pairing of Bold and Bold-Spacing. In the screen version of the study more neutral choices were made for this pairing (45) than was made for either of the heading styles, and in print nearly twice as many neutral choices were made for this pairing than any other pairing. The high proportion of neutral choices for this pairing indicates that the use of spacing as a second method for further emphasising a heading does not improve the ability to identify the heading from the surrounding body copy and create adequate distinction from another heading that is also using the first method of typographic emphasis without spacing. This would especially be important if a secondary emphasis method was to be chosen to create two levels of heading. Black (1990) states that changes in typography should be visibly intentional and, "leave no doubt that the differentiation is deliberate" (1990, p. 28). The distinction between Bold and Bold-Spacing may be too subtle for readers, especially as they move from page to page.

The ineffectiveness of Spacing as a secondary method of emphasising a heading is even more pronounced on screen. As was found in Chapter 4, Spacing can often be applied inconsistently, even within a single document for the same level of heading. As well as providing little visual distinction, it also may not be viewed by readers as a method of emphasis that is being used intentionally, based on their past experience of viewing documents. Study 1a found that increasing visual weight improves ease of identification of headings, the lack of ability for participants to distinguish between a Bold and a Bold-Spacing heading supports this finding, giving further evidence that Spacing alone is not enough emphasis for a heading.

In Study 1a with the general population, the heading style with the fewest number of neutral choices had been the use of Bold in both print and screen situations, the heading style considered to be easiest to identify. In this study however, the heading style with the fewest neutral choices was Size-Spacing, a heading style which was not considered to be the easiest to identify. Therefore, it seems that neutral choices were made when headings were perceived as having similar visual weight, whether that was because they were equally easy or equally difficult.

7.4.5 Demographic Influences on Preference

Demographic factors appear to have had minimal influence on the results of Study 2.

Males had a stronger preference in print for Bold-Size and Bold-Sans Serif, while females had a stronger preference over the other heading styles on screen. On screen, there was also greater variation between different age brackets than seen with any of the other demographic factors that were considered. In the youngest age bracket, (17-25 years) and the age bracket of 36-45 years, the relative preference for Bold, Bold-Spacing and Spacing were varied; however, the bracket between these two varied little from the ranking of the overall population. The 46-55 year age bracket also reflected the choices of the overall population, except for a stronger preference towards Size-Spacing.

There was also some movement in the relative rankings for both print and screen when the results were considered according to participants' highest completed qualification. The ranking with each of the qualification groups only had a change in order for print participants with a High School/Pre-degree qualification. In this situation Size-Spacing and Bold-Spacing were swapped in the rank order.

Based on these observations, it seems that demographic factors have not had a strong influence on participant's perception of their ease of identification for heading styles. It appears that demographic factors have had less of an influence when two heading emphasis methods are combined to create a heading style than when single heading emphasis methods were compared in Study 1a and 1b.

7.4.6 Limitations of the Design of Study 2

The limitations discussed for Study 1a (Section 5.4.6) are also relevant to Study 2. Limitations regarding the typographic decisions for Study 1a and 1b were not changed for Study 2 to ensure that as many of the variables as necessary that were not being tested were consistent between the two studies. This was done so that direct comparisons could

be drawn between the results of each of them. Asking participants to indicate their degree of preference for a heading style in a pairing was also not changed between studies, but is likely to be introduced in future related investigations.

7.5 Conclusions and Implications for Study 3

The study reported in this chapter was a paired comparison study which built on the results of Study 1a and 1b to answer Research Question 2. Research Question 2 asked if headings emphasised by combining two methods of typographic emphasis are more easily identified than using a single method of emphasis. Five heading styles, four of which combined two methods of typographic emphasis were tested in a paired comparison study. From the ranking of these five heading styles we found that when two methods of typographic emphasis are combined to indicate a heading, it is more easily identified than if a single method of typographic emphasis is used.

Bold-Size was the most frequently chosen heading style and therefore was ranked as the heading style which was most easily identified from the text surrounding it. The combination of the two most easily identifiable heading styles from Study 1a and 1b created a heading style with the strongest visual weight in Study 2. As the visually strongest heading from this study, it is recommended that this heading style is used in Study 3 to understand whether the heading styles with the greatest visual weight best assist with search.

The heading style consistently ranked second in regard to ease of identification in Study 2 was Bold-Sans Serif. The visual weight of this heading style is slightly less than the Bold-Size combination. The combination of Bold with a change in typeface style to a Sans Serif, which has a slightly higher x-height than the Serif typeface used in this study, gives a heading which is widely considered easy to identify. As discussed in Study 1a (see Section 5.4.1), the larger x-height of the Sans Serif contributes to the appearance of the Sans Serif being larger in size. As the second most easily identified heading style in Study 2, and because it utilises a change in typeface style to create emphasis, it is recommended that this heading style is used for comparison in search tasks in Study 3.

Size-Spacing was the heading style ranked third overall in Study 2, the only heading style not to use Bold as an emphasis method in this study. This result demonstrates that while Bold is generally considered the typographic emphasis method that best assists headings to be easily identified, Size is also effective for creating typographic visual weight. Size-Spacing was ranked above Bold-Spacing in this study, meaning that the introduction

of spacing with a heading style changes the perception of ease of identification. Bold was ranked ahead of Size in Study 1a without spacing between the heading and body copy, but Size was ranked over Bold when Spacing was introduced between the heading and body copy. It appears that spacing may have a strong influence over how easily headings are identified in text. The influence of spacing over the effectiveness of headings needs further exploration, for this reason neither Size-Spacing nor Bold-Spacing will be used as heading styles for Study 3.

The fifth heading style used in this study was Bold; it was ranked as the least easily identified in both print and screen versions of the study and with almost all demographic groups. In Study 1a and 1b it had been ranked the most easily identifiable heading style, when single emphasis methods were compared. This indicates that combinations of two easily identifiable typographic emphasis methods are more easily identified than single typographic emphasis methods used for headings. Bold was used in both Study 1a and 1b and Study 2 that that comparison can be more directly made between the two studies. It is recommended that Bold again be used in Study 3 as a point of comparison, being a single typographic emphasis method which is still easily identifiable.

Minimal differences were seen between print and screen results in regard to overall rankings. The order of the ranking was the same and only slight variations in the relative ranking were seen. Bold-Sans Serif was slightly less preferred than Bold-Size and the gaps in relative ranking between Size-Spacing and Bold-Spacing was slightly greater on screen. Differences between the results of print and screen ranking for Study 2 may partly be due to a higher number of neutral choices being made on screen because of the method provided to participants for giving their responses.

The heading styles that were most easily identified in Study 1a and 1b and Study 2 will be used in Study 3 to understand if headings that are more easily identified increase search speed in text that is unfamiliar and text that is familiar.

8

Typographic Emphasis of Headings for Search (Study 3)

In Study 1a and 1b and Study 2, we found that heading styles which have stronger visual weight are more easily identified within a passage of text. Study 2 (Chapter 7) showed that by creating heading styles which are bolder, or larger than the surrounding body copy, they can be identified more easily. We also found that heading styles which combine two methods of typographic emphasis to create a single heading style are more easily identified than heading styles which utilise just one method of typographic emphasis.

This chapter answers Research Question 3 to find out if headings that are more easily identified are therefore also more useful to readers when they are searching for specific information within a passage of text. This study considers the influence the ease of identification of headings would have on readers of both a text that they have not seen before, an unfamiliar text, and a passage of text that they have read or searched previously, a familiar text.

Research Question 3: How does the degree of typographic emphasis for headings influence search of unfamiliar and familiar text?

This chapter seeks to answer Research Question 3 by presenting participants with a series of search tasks in texts with different heading styles, each as an unfamiliar and then as a familiar text. In this study, the knowledge gained regarding the easiest headings to identify is applied to a series of search tasks where the effectiveness of easily identified headings is tested in unfamiliar and familiar text.

This chapter begins by describing the method used for Study 3, with detail of the considerations that were made in designing the materials and the procedure for administering the study. Detail of the participants is then given before presenting the results from the search task, comparing the heading styles tested in regard to search time, search accuracy and reading speed. The implications of these results are then discussed before a summary of the findings is given.

8.1 Method

This study was run as a series of search tasks in unfamiliar and familiar texts with four different heading styles. Participants were presented with questions to search for the answers to within each of the articles and the time taken to find each of those answers was recorded. Considerations needed to be made in designing Study 3 with careful attention given to a number of factors to ensure that decisions regarding the design of the study did not negatively affect the results.

8.1.1 Heading Emphasis Methods

Four heading conditions were chosen for the study; the combination of Bold-Sans Serif and the combination of Bold-Size were chosen as heading emphasis methods in this study based on them being considered the two most easily identified heading presentations in Study 2 in both print and screen conditions. Bold, as a single heading emphasis method, was chosen as the third variation for testing in study 3 as it was considered the most easily identified single heading emphasis method in Study 1a and 1b, across both print and screen, and it was also presented in Study 2, where it was one of the least preferred. The fourth heading style used in this study was a Control, where the text was presented with no headings. The Control was introduced as a baseline for two reasons; to what extent the presence of headings had an influence on search time, and whether familiarity with text had an influence on search speed.

8.1.2 Search

Visual search is used by readers in situations where software supplied search box options are not available, such as in a print environment or where the text is presented as an image rather than characters, as well as when an index is not available. Readers in these situations instead use typographic cues, such as headings, for locating information. Headings are used by readers to guide them when searching for information in a text, either by assisting them with an overview of the text content in an unfamiliar text or in a familiar text assisting

them with accessing information about the text that is stored in memory (Williams & Spyridakis, 1992).

This research focuses solely on the visual search rather than searching using software search boxes that digitally search text. Visual search of text ensures that readers are using the document's structural indicators and typographic navigation features, such as headings, to assist them in locating the target information within the text.

The search tasks which participants were asked to complete was to locate the answers to a series of five questions within a passage of text. The answers to the questions were related to the headings found within the passage. Questions were supplied to the participant one at a time, after completing the preceding task, so they cannot be intentionally searching for more than one answer at any time. The time taken to accurately answer each question was recorded. If a participant proposed an answer that was incorrect they were given the opportunity to keep searching for the correct answer. If a participant felt that they could not find the correct answer to any particular question they could pass that question and move on to the next question.

The two measures for the study are speed and accuracy. Because speed of locating answers is being used as a measure, participants were also asked to complete a reading speed test as part of the series of studies to understand how reading speed may have influenced the results in speed of finding answers when comparing results between participants.

The IReST (International Reading Speed Texts) reading test was used as it was specifically designed as a set of standardized paragraphs of text to be used for measuring reading speed (Trauzettel-Klosinski & Dietz, 2012). The test booklet contains 10 standardised texts all containing approximately the same number of characters and five 'performance categories' based on the mean reading speed of the passage. These passages are intended to measure reading speed under natural conditions for normally sighted individuals aged 18-35 years. The passages are available in 17 languages and are standardised across all languages in length, difficulty and linguistic complexity so that they are comparable between languages. For this study only the texts in English were used. The developers of the texts recommend that if one passage is to be used as a testing measure, then passage number 6 should be used. Passage 6, in performance category E, is 136 words long with a mean reading time of 42.1 seconds and a standard deviation of ±5.3 seconds.

A second passage of text was also used so that each participant had two reading speed measures to compare. The developers of the reading test recommend that if more than two

passages are going to be used and compared then both of the passages should be from the same or similar reading performance categories. Within the set of 10 passages, passage 6 is the only passage in performance category E, therefore the next closest passage was passage 10, in performance category D. The second passage chosen from the IReST texts was passage 10. This passage is 141 words long and is stated as having a mean reading speed of 40.7 seconds and a standard deviation of ±5.8 seconds.

8.1.3 Unfamiliar Versus Familiar Text

Both unfamiliar and familiar text will be compared to help understand whether a certain heading emphasis method is better for facilitating search in one or other of these searching situations. Each of the two search situations requires a set of skills to be implemented. In unfamiliar text, readers rely more strongly on orientation cues and typographic structural indicators to help them find information as they have yet to establish an accurate mental map of the document they are reading. By comparison, in a familiar text readers have already built an understanding of the structure and content of the text using structural cues as well as spatial orientation indicators such as location on the page.

Unfamiliar text should be a passage of text which the participant has not previously read. However, what defines a text as familiar is not as straightforward. Hartley and Trueman (1985) defined a familiar text as one which the participant had been given an allocated amount of time to read before being given the questions for the search task. This approach does not take into account a participant's reading speed. The approach used in this study was to scaffold the search sessions so that participants used the same articles for both the search of an unfamiliar text and the search (retrieval) in a familiar text. In this study participants will gain familiarity with a text through a series of three activities that address different aspects of memory. First, they will perform a series of search tasks with it as a passage of unfamiliar text (there is no limit to how long this may be allowed to take). The participant will then be given the opportunity to read or browse the passage in whatever manner they please for 5 minutes. This gave the participant two opportunities to read the passage under different types of reading conditions (searching and continuous reading or browsing) to familiarise themselves with the text, so that both short and long-term memory can be considered as factors that have been accounted for to some degree. Introducing a delay between the first search task with an article and the second search task meant that it was not just the participant's short-term memory for the text and the presentation of its structure that was considered, but also a longer term memory by having the participant revisit the text 1 to 3 days later. While this research did not primarily look at memory, it

needs to be acknowledged that both short and long-term memory play a part in retrieval; memory for the structural cues related to the content as well as for the content and its location on the page.

8.1.4 Print Versus Screen

There was a choice of three possible media environments for this study; print, on screen paging and on screen scrolling. In both Study 1a and 1b and 2 there were not distinct differences between the print and screen results for the most easily identified heading emphasis methods. However, Bartell, Schultz and Spyridakis (2006) identified that headings may have a greater impact on online readers than print readers. Therefore, an on-screen environment was chosen as the searching environment for this study as a variety of screen sizes are becoming more dominant as our reading environments for information discovery needs.

There are several reasons for not choosing to conduct the study using scrolling text on screen. When scrolling on screen there are the most differences between this type of document presentation, compared with the format of a printed document. In the scrolling environment, there are no spatial references like those that are provided by a paginated document in either print or screen. Scrolling is likely to weaken the memory that people have for the location of information, as this is often associated with a physical position on a page (Dillon, 2004). Further strengthening the argument against using a scrolling document on screen is that when the survey of current practice was conducted (Chapter 4), it was found that all journals had a print and a pdf version available, but not all publications had an HTML, scrolling version of the text. Most books, magazines and textual documents that are available digitally through eBook repositories, or readers are also paginated rather than scrolling. Paginated text also provides an environment that combines aspects of print-based reading with on-screen.

Making a choice between paginated documents in print and screen comes down to there being only minor differences between the results in Study 1 and Study 2 in the two environments. Further justification for choosing not to conduct the study using a scrolling on screen text, is that most scrolling on screen is digitised, and therefore searchable using a search box within the software that the text is presented. It can therefore be argued that visual search of such text is seldom the most efficient search method available. Support for conducting the study with paginated text also comes from research by Rothkopf (1971) who found that the physical location of information on a page was frequently remembered by readers when recalling information.

The final reason for choosing to study paginated text rather than scrolling is that in an academic setting we are still bound to pagination through referencing methods, as pagination remains important for referring to articles and their content.

8.1.5 Selection of Text

The passages of text chosen for this study were carefully considered in terms of content, length and reading difficulty. The content and subject matter of the articles used were non-fiction and aimed at a general audience, without necessary prior knowledge of technical ideas or jargon which is subject specific. In contrast, the content also needed to be specific or recent enough that it was not considered to be general knowledge or already understood in detail by a wider audience, meaning the answers to specific questions may already be known by the participant. The issue of prior subject knowledge was also be addressed by the participant not just needing to know the answer, but they must also locate the answer within the passage of text.

The lengths of the four texts were as close as possible, ranging in length from 4,157 to 4,753 words. Details of the four chosen texts are given in Table 26.

Table 26: Details of Study 3 texts

Article	Title and Author	Source	Word Count without headings	Average reading grade level	Number of Headings	Heading Frequency (words /headings)
One	Don't Blame Fat By: Bryan Walsh	Time. 6/23/2014, Vol. 183 Issue 24, p28-35. 8p.	4,157	11.0	13	319.77
Two	A Star is Born By: Lev Grossman	Time. 11/2/2015, Vol. 186 Issue 18, p30-39. 10p	4,467	10.8	15	297.80
Three	One and Done By: Lauren Sandler	Time. 7/19/2010, Vol. 176 Issue 3, p34-41. 8p	4,753	10.8	14	339.50
Four	The Code War By: Lev Grossman, Massimo Calabresi & Sam Frizell	Time. 7/21/2014, Vol. 184 Issue 3, p18-25. 8p.	4,304	11.0	15	286.93

The frequency of headings within the texts was kept consistent across all four articles. There is little information regarding how frequently headings should be presented within a non-fiction text of approximately 4,000 – 5,000 words to best signal the structure of the content and assist with navigation. The goal of the headings within the text was to

summarise the main content of the paragraph or paragraphs directly following the heading and provide a structure for readers to assist them in creating an understanding of the structure of the information contained in the article. Headings were spaced in the texts approximately every 250-350 words, this was generally 2 or 3 paragraphs. Research by Bartell, Schultz and Spyridakis (2006) deemed this level of heading frequency to be medium-low. This frequency of headings meant that there was, on average, one heading on each page within the on-screen layout.

The reading difficulty of the chosen passages was assessed using the Flesch Reading Ease (FRE) score and the Flesch-Kincaid Grade Level (F-KGL). Detail is provided in Table 26, for all four passages of text, including an average reading grade level. The average grade reading level for all passages was between 10.8 and 11.0.

8.1.5.1 Heading Content

Headings can take the form of statements or questions and can vary greatly in length, from one word, to a whole sentence. The content of the headings used in this study were all statements to maintain a consistent form throughout. Headings as statements were also found by Hartley and Trueman (1985) to be faster for retrieval of information than headings written as questions. The headings used in this study were intentionally designed to fulfil two of the three types of information that headings provide when searching; indicating distinct content, and providing an indication of the likely content following them (Klusewitz & Lorch, 2000a).

Hartley and Jonassen (1985) and Swarts et al. (1980), explain that a good heading should be user-oriented and predict the readers needs so they are effective at assisting a reader with their specific needs. While in any standard text, this is hard to achieve, in this study the needs of readers were able to be predicted with headings and questions having strong associations. The content of the headings intentionally created a semantic relationship or direct link between the question and the answer that could be found under that heading. Semantic headings are better for organising information than markers of content (Hartley & Jonassen, 1985). All headings were between 2 and 7 words long and were developed to express the sentiment of the following content as well as to help indicate the structure of the text. A list of the headings developed for each article as well as the questions and answers can be found in Appendix E.

8.1.6 Procedure

Participants were required to participate in four sessions where they were asked to perform a series of search and reading tasks with four different passages of text with different typographic methods used for emphasising the headings within each of the passages.

The four different heading presentations were; a Control with no headings, Bold, Bold and 2 point sizes larger than the body copy, and Bold and a Sans Serif typeface (compared to the serif typeface of the body copy). All texts were presented to participants on screen as a paginated document.

Four heading emphasis methods (styles) were chosen:

C	Control (No headings present in the article)
B	Bold
B-Sa	Bold Sans Serif (Helvetica Bold)
B-Si	Bold combined with increased type size by 20%

In the design of the reading material for Study 3, as many parameters, typographic and layout considerations, as possible were maintained from the design of the first two studies. The page size and margins were identical to Studies 1 and 2, as well as the width, height and position of the column of text on the page. As with Studies 1 and 2 the body copy was Times New Roman, and appeared at the same size on screen as the screen versions of Studies 1 and 2, meaning the body copy had a Cap-height of approximately 25 pixels high and approximately 45 pixels between baselines. The sans serif typeface used for the Bold-Sans Serif headings was Helvetica Neue, as was used in Study 1a and 1b. The increase in Size for the Bold-Size headings was also the same as the increase in previous studies and appeared on screen at approximately 30 pixels high.

In order to minimise bias due to the order which participants were presented with all of the variables, the presentation order of these variables was controlled. Each participant saw all four heading styles and all four chosen articles, but the combination of which heading type was applied to which article was randomized among participants. This was done so that an equal number of participants saw each article paired with each heading style.

The four different heading emphasis conditions, four different passages of text, and two sets of questions for each text produced 32 unique combinations where each heading emphasis method and passage of text were presented to participants an equal number of

times in each of the four possible positions. The two sets of questions for each of the texts were then divided so that each question set was seen an equal number of times with their text as a familiar or unfamiliar text and with each heading emphasis method. Before commencing the study, the 32 combinations of the study materials were randomly assigned to the participant ID numbers.

Every heading style and every article was seen by all participants, but not all participants saw the same heading style with the same article. Participants could see any one of the four heading styles combined with any of the four articles. They would see the same heading style and article paired together in both the unfamiliar and the familiar reading sessions.

Before commencing the search and familiarization tasks, the participant was asked to complete the reading speed test (IReST). For the IReST participants were shown passage 6 from the set of standardised tests on the screen, approximately 40cm away from where they were seated. Participants started the timing of their reading speed text by clicking a "start" button on the screen. They then read the passage of text before pressing the "Done" button on screen. The time that participants took to read the passage was recorded. It was explained to participants that this was a reading 'task' and was never described to them as a 'reading speed test'. The documentation for the IReST test explains that the passage should be read from the cards supplied with the text at a size of approximately 1.7mm (x-height). The IReST text presented for this study was shown to participants on screen at the same size as the text would be presented to them in search tasks for this study, in Times New Roman, which is approximately equivalent to the text appearance on the printed IReST cards. The line breaks in the passage of text were consistent with those in the original IReST test material. The use of the testing passage deviated from the recommended procedure, on screen and read silently, so that the conditions of the reading speed test more closely resembled those of the actual study.

The study was carried out over four sessions for each participant, as shown in the diagram in Figure 59. In the first session, participants began by completing the Reading Speed Test which involved reading two short passages of text. The participants then began the search task for their first article which was followed by time for the participants to read and further familiarize themselves with the article. Once they had completed the search task for that article they then continued on to the second article for the session. The second search task was conducted with a different article with the headings presented with a different one of the four heading styles. In the second session, 1-3 days later participants saw the same two articles they had seen in session 1 with the headings presented in the

same styles, but the search task had the question set they had not answered in the previous session. The second session had the participant complete the search tasks with two articles, and no time allocated for reading or familiarisation.

Session 3 ran in the same manner as Session 1, with two unfamiliar articles with the two heading styles that were not seen in the first two articles and reading/familiarisation time for each article after completing each search task. They were not required to read the IReST texts again. Session 4 was conducted in the same manner as Session 2, with participants searching for the answers to the second set of questions for each of the two articles, familiar from Session 3.

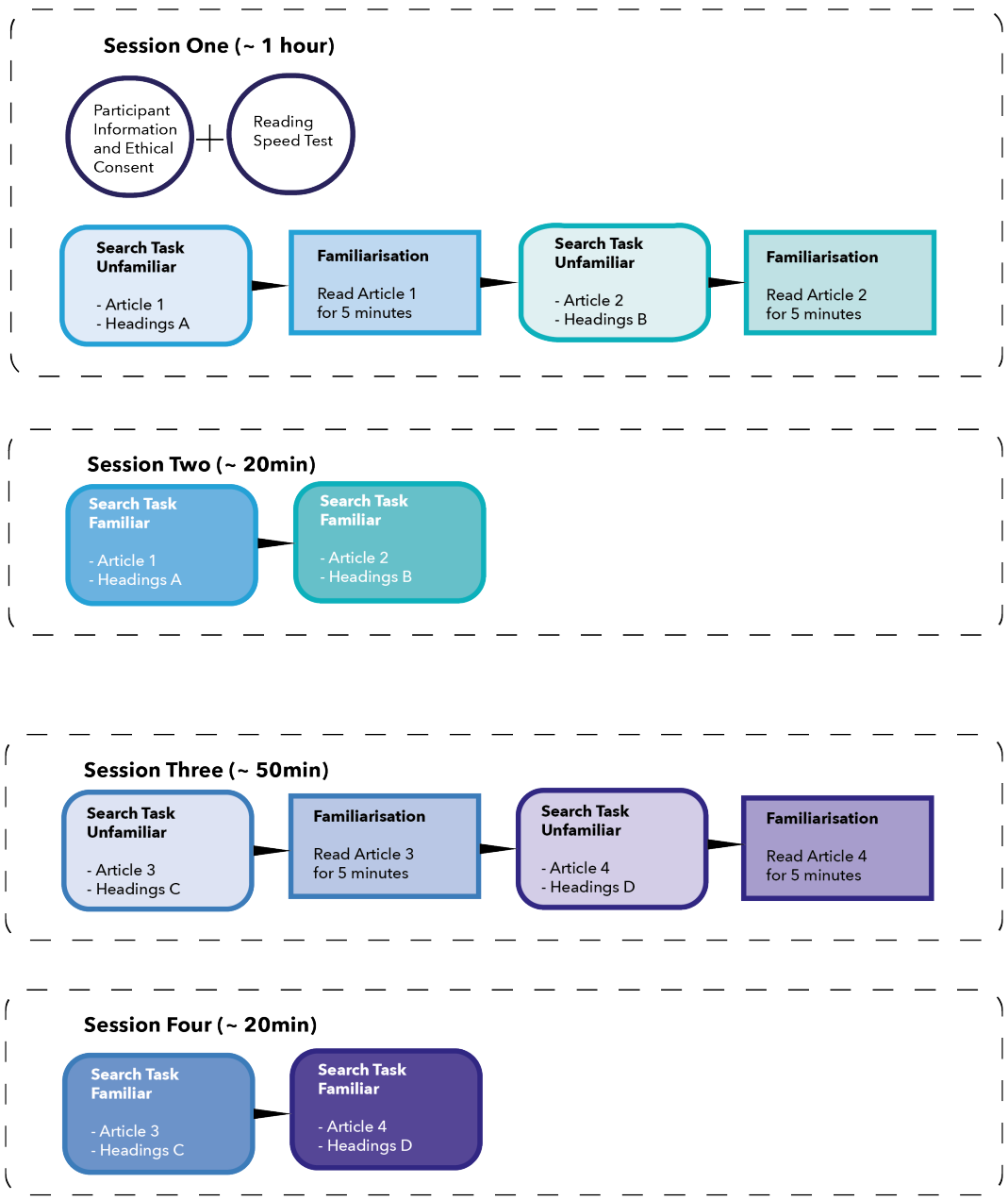

Figure 59: Flow diagram of Study 3 set-up

With each passage of text the participant was asked to search for the answers to five questions within that passage of text. The participant had never seen that passage of text before and they had not been given an opportunity to read it through before starting their search tasks. Participants were timed how long it takes them to find the answer to each of the questions and they were not given the next question until they had successfully found the answer to the previous question. Once the participant had found all answers they were given 5 minutes to read or browse through the passage as they wished to assist familiarisation with the text. The purpose of this was so that they could familiarize themselves with the document. In the next session, 1-3 days later, the participant was presented with the same article where they were presented with a second set of questions sequentially to search for the answers to in the now familiar passage of text.

The questions for the familiar and unfamiliar tasks were alternated so that for each passage, half of the participants were given question set 'a' for the familiar text, and question set 'b' for the unfamiliar text; the other half were given question set 'b' for the familiar text and questions set 'a' for the unfamiliar text.

To answer a question, participants were asked to click on the word or any word in the phrase that answered the question. Participants were required to locate the answers to the questions within the passage of text, even if they knew the answer when they first read the question. They were also required to find the specific answer contextually within the text, rather than just any instance of the word or phrase that answered the question.

In any of the search tasks, if a participant found an answer that was incorrect they were given the opportunity to continue searching for the correct answer. If they felt they would no longer like to search for a particular answer, they were able to skip that question and move on to the next. They were not allowed to return to previously skipped questions.

The study was conducted in an office dedicated to the delivery of the study and had four separate computer work stations where participants could sit to complete the study. The study material was presented on an Apple iMac 27-inch with a retina display (5120 x 2880), running the El Capitan operating system. The researcher was always present in the room with the participants to offer guidance if requested or answer queries from participants.

8.1.7 Design of Program for Administering Study

A program was developed to administer and record the results of the study. It was developed to assist with administering the study in a controlled manner and for the accurate recording of time. The program presented the study as well as providing dialogue

boxes with information to assist participants through the study and provided a means of navigating the articles. The article was presented centred on the screen with the question in a box to the right. Below the question box was a "Skip Question" Button. At the bottom of the screen to the right of the article space, there were two buttons "Previous Page" and "Next Page" for navigating forwards and backwards though the pages of the article. Below the navigation buttons there was an orientation indicator to show the participant what page number they were on out of the total number of pages in the article. An example of a screen from the program can be seen in Figure 60.

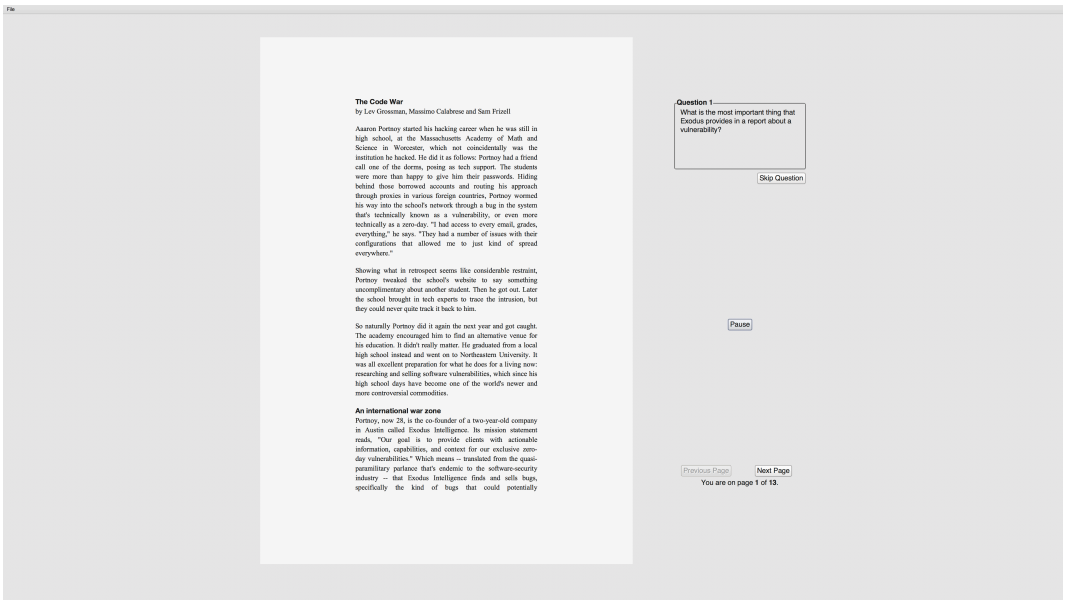

Figure 60: Search task example screen (Bold-Sans Serif headings)

Participants could navigate through the pages of the articles either using the arrows at the bottom right of the screen, or using the keyboard arrows. Dialogue boxes provided participants with information such as if they had answered a question correctly or incorrectly, or when their reading/familiarisation time was finished. Examples of the screens and dialogues that the participant saw can be found in Appendix E. Development of the program was outsourced to an external programmer.

8.2 Sample

The criteria for participation in Study 3 was in line with the criteria that was also used for Study 1 and Study 2. Participants should have completed their High School education and be a competent reader. Participants for whom English was a second language were not excluded from participating so long as they were considered to be competent readers of English. Participants for the study were recruited on the University of Waikato campus and through personal contacts. Also, an email was sent to all participants who had

completed Study 1a and Study 2, who had indicated that they were happy to be contacted about future related studies.

Extrinsic motivation to participate in the study was provided in two ways. Students enrolled in COMP258-17A at the University could participate in this study as an assessed component of the paper. The assessment was worth 5% of the total grade for the paper and required the student to complete participation in all four sessions of the study and submit to their lecturer for assessment a one-page evaluation of their experience of participating in the study. Participants in the study who are not enrolled in COMP258-17A were offered a contingent incentive of NZ$30 for participating in and completing all 4 sessions of the study. The contingent incentive amount of $30 was intended to be a sum which provides incentive, but not be so high that it would be a primary motivator for participation.

It should be noted that the participants in this study had no extrinsic motivation for finding the answers to the questions or to understand or remember the texts they were reading.

Participants were asked to provide relevant demographic information before commencing the study; which included their age, gender and highest completed qualification. A total of 96 participants completed the study.

The balance of gender tended towards females with 54 female participants and 42 male participants in the total group. This balance between genders is similar to earlier studies.

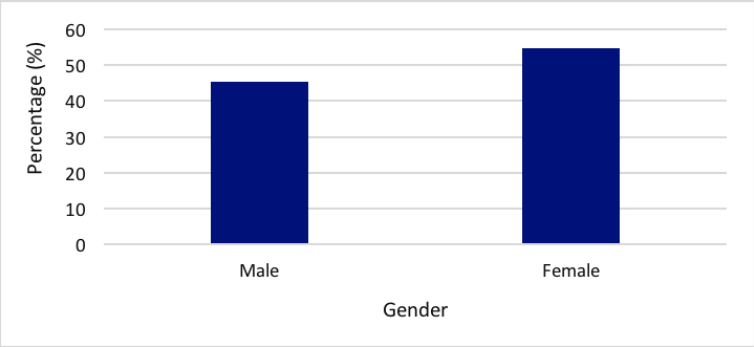

Figure 61: Gender of participants in Study 3 (n=64)

The majority of participants were aged 18-25 years; 53 of 96, slightly more than 55% were within this age range. There were 15 participants aged 26-35 years and 14 were aged 36-45 years. A further 12 participants were aged 46-55 years and 2 participants were 56 years or older.

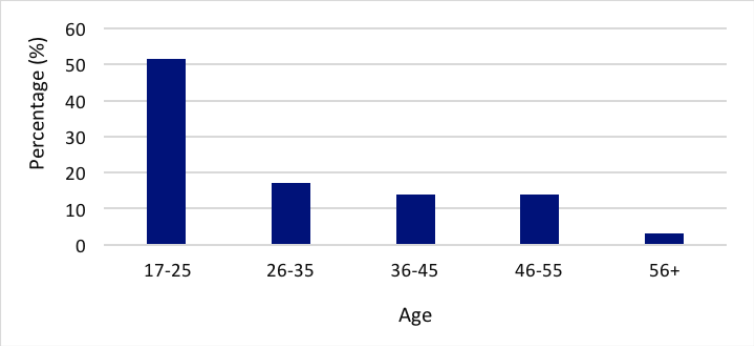

Figure 62: Age of participants in Study 3

As with earlier studies, participants were asked to provide their highest completed qualification. The majority of participants had a high school diploma or pre-degree qualification (40). There were also 29 participants with a Bachelors degree and 26 participants with a Postgraduate degree (eg. Postgraduate diploma, Master or Ph.D.). The proportion of participants with a High school or pre-degree qualification was lower in this study than in the two previous studies.

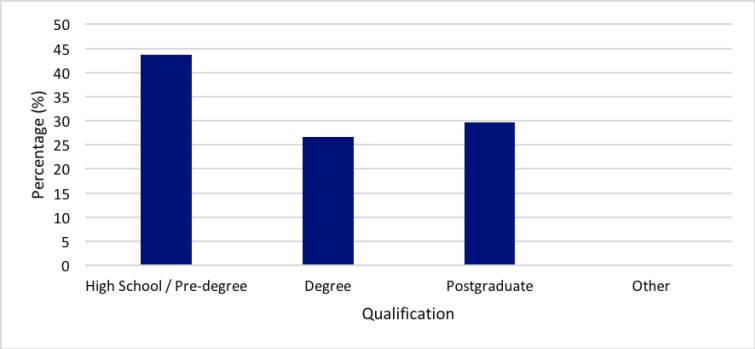

Figure 63: Highest qualification of participants in Study 3

8.3 Results

Here the results of Study 3 are reported where the results of the search tasks in both unfamiliar and familiar texts for both the general population and graphic designers are considered as a single population of participants. All times reported in the section are given in seconds.

8.3.1 Reading Speed

Participants reading speeds were established at the start of the first search session. At the start of their first session, each participant was asked to read two short passages of text to get an approximation of their reading speed. The two passages were chosen from the IReST Reading Speed test. The first passage (RS1) that participants read was text number 6. It was 136 words, with a mean reading time of 42.2 seconds, SD ± 5.3 seconds. The second passage

of text (RS2) was text number 10. It was 141 words and has a reading time of 40.7 seconds, SD ± 5.8 seconds.

Table 27: Reading speed results across all participants

	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
RS1	46.985	20.163	18.400	34.100	40.650	53.625	133.500
RS2	44.547	19.634	2.000	33.675	40.500	49.350	112.400

The mean reading speeds for the total population for both of the test passages are approximately 4 seconds faster than the mean reading speeds given by the IReST documentation. This may be due to the participants having to click a button on the screen with the mouse to start and end the reading session timing, adding slightly to the overall reading times.

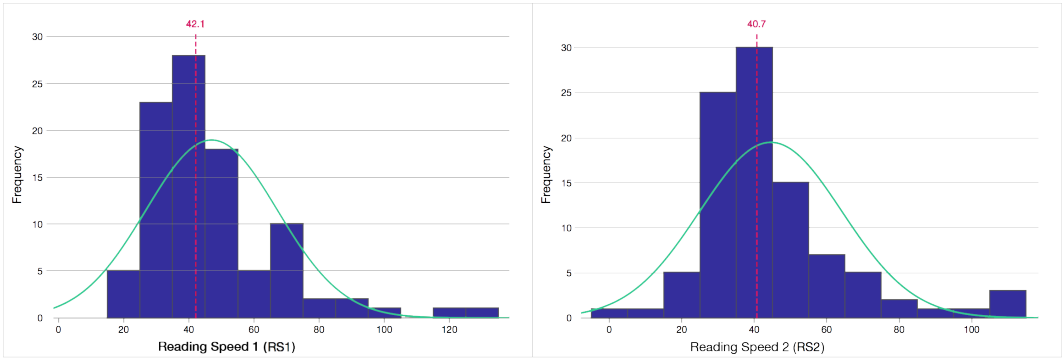

Figure 64: Reading speed test results both texts (RS1 and RS2) for all participants

The distribution of reading speed times for each of the two passages can be seen in Figure 64, with results of reading speed text 1 (RS1) shown on the left, and reading speed test 2 (RS2) shown on the right. The mean reading speed given by IReST is shown by the vertical red dotted line. In both of the graphs, the distribution of times peaks around the mean provided by IReST, with the greatest number of participants reading slightly faster than the mean time and a long tail of participants reading slower than the means.

8.3.2 Comparison of General Population and Designers

In the running of Study 3, along with the 64 participants, another 32 graphic design participants (as defined in Section 6.2) took part in the study. Analysis of the results of the graphic design participants compared to the general population show that there were not significant differences in the results from the two groups. This is in contrast to the results

of Study 1b (Chapter 6), where it was found that there are differences between graphic designers and the general population in regards to which heading style they find easiest to identify in a passage of text. The results of Study 3 for the two groups were analysed to see if there were significant differences between the search times for the four heading styles and in familiar and unfamiliar texts. The level of significance in the difference between the two groups (P), as determined by a One-Way ANOVA, is shown in Table 28.

Table 28: Significance of difference between general population and graphic designers

	Unfamiliar Mean Search Time			Familiar Mean Search Time		
	General population	Graphic designers	P Value	General population	Graphic designers	P Value
Control	1460.9	1398.6	0.6154	843.06	1006.17	0.0909
Bold	1261.41	1209.4	0.7133	641.63	1196.6	0.5584
Bold-Sans Serif	1213.42	1196.6	0.8980	544.34	533.35	0.8499
Bold-Size	1287.36	1118.5	0.2178	568.52	517.65	0.42474

Despite the differences in their ease of identification, this does not have a significant effect on how the headings affect their search speed in both familiar and unfamiliar text. Based on the lack of significance in the difference between the results of designers and the rest of the population, the results of the two groups were combined for further analysis, giving a total of 96 participants for Study 3. Reading speed results were also compared for the two groups of participants to determine if there were significant differences in the reading speeds of the two populations. The reading speed results of the general population are shown in Table 29 and graphic designers in Table 30.

Table 29: Reading speed results for general population (seconds)

Variable	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
RS1	48.33	20.44	18.40	35.55	43.10	54.00	133.50
RS2	46.57	21.21	13.30	33.68	40.65	53.93	112.40

Table 30: Reading speed results for graphic designers (seconds)

	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
RS1	44.29	19.66	21.18	32.94	35.95	52.22	121.34
RS2	41.75	13.86	16.92	34.34	40.62	44.80	88.78

The mean reading speed of designers for both of the standardised passages is slightly faster than the general population. The difference between the means of the general population and designers is 4.0 seconds for RS1 and 4.8 seconds for RS2. However, the fastest times for designers were slower for both reading speed test passages and the slowest times that designers took were both faster than the general population in each of the test passages.

The differences between the two groups of participants are not significantly different enough to warrant maintaining two separate populations for the analysis of the data for this study.

8.3.3 Heading Search Time

The mean search time was calculated across all participants for each of the four heading styles in both unfamiliar and familiar search tasks. A summary of the results for all participants when searching both unfamiliar and familiar texts is shown in Table 31.

Table 31: Overall results in unfamiliar texts and familiar texts (seconds)

		Mean	St. Dev	Minimum	Median	Maximum
Control	Unfamiliar	1440	569	446	1280	2942
	Familiar	897	446	172	834	2408
Bold	Unfamiliar	1244	649	263	1129	3687
	Familiar	624	409	167	508	2721
Bold-Sans Serif	Unfamiliar	1208	601	228	1144	2598
	Familiar	541	266	155	497	1304
Bold-Size	Unfamiliar	1231	631	282	1099	4032
	Familiar	552	294	151	487	1633

In all heading styles, the mean search time was longer in the unfamiliar presentation of the article than in the familiar. This was also the case for the maximum and minimum times

within the sample of participants. Overall, the slowest time for a participant to find the answer to all five questions was 4032 seconds (64 minutes, 12 seconds), this was in the unfamiliar article with Bold-Size headings. The shortest time a participant took to search for all five answers in an article was 151 seconds (2 minutes, 31 seconds), again this article was presented with Bold-Size headings, but was familiar to the participant. Bold-Sans Serif had far fewer outliers with the maximum search times being far lower than in the three other heading styles and the lowest standard deviation by almost 30 seconds. The greatest variation in search time was for text with Bold-Size headings when the text was unfamiliar.

The difference between the mean search times for each of the heading styles compared in this study shows that the presence of headings has a more pronounced impact on search time in familiar texts than in unfamiliar texts. The difference in search time between the Control, with no headings, and each of the other three heading styles in the familiar articles was significant, both in unfamiliar and familiar texts. A two sample t-test was conducted to compare each of the heading styles with the Control. In the Unfamiliar texts, Bold-Sans Serif had the most significant difference from the Control (P = 0.0065), this was followed by Bold-Size (P = 0.0168), and Bold alone had the least significant difference (P=0.0272). In the familiar texts all three heading styles were significantly faster for searching than the Control with a significance of P =< 0.0001.

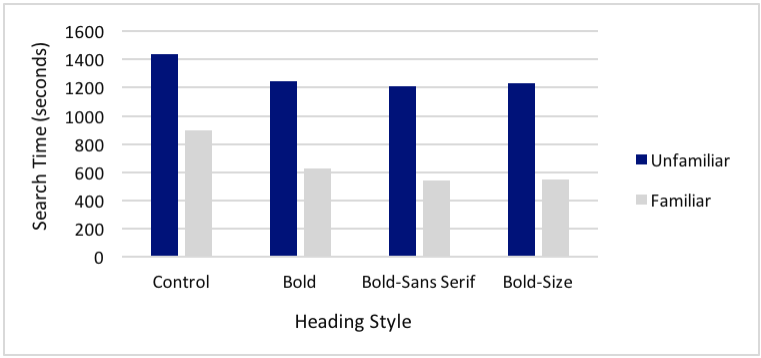

Figure 65: Mean search time (seconds) in each heading style, unfamiliar and familiar

In all instances, the mean search time for a heading style was longer when the article was unfamiliar, than when it was familiar, as shown in Figure 65. The improvement in search time between the unfamiliar and familiar was significant (P=<0.0001). In the Control, with no headings, familiarity with the article resulted in participants finding the answers just over one third (37.7%) faster than when the article was unfamiliar. When the headings were presented as a Bold version of the body copy, the improvement in search speed with familiarity almost halved the mean search time (49.8%). Both Bold-Sans Serif and Bold-Size heading styles increased the mean search speed in the familiar text by more than 50% over

the unfamiliar text. With Bold-Size headings, the search speed decreased by 55.2% between when the article was unfamiliar and when it was familiar. The greatest improvement in mean search time was with Bold-Sans Serif headings with an improvement of 57.7%.

A two sample t-text was conducted to compare each of the heading styles, both in the unfamiliar and the familiar text presentations. In the unfamiliar search tasks, there was little difference between the mean search times of Bold, Bold-Sans Serif and Bold-Size and therefore the difference in search times between these heading styles was not significant in unfamiliar text. The significance of the difference between Bold and Bold-Sans Serif was just P=0.6885 and for Bold and Bold-Size, the difference was even less significant (P=0.8883). The significance of the difference in search times between Bold-Sans Serif and Bold-Size was also not significant (P=0.7939). The most significant difference was between Bold and Bold-Sans Serif in the familiar text, P=0.0957. The difference between Bold and Bold-Size was less significant, P=0.1598. In the familiar text, the difference between the search times for Bold-Sans Serif and Bold-Size was not significant (P=0.7884).

8.3.4 Search Time by Question

The search time for each of the five questions was recorded for each text. The first question in an unfamiliar text always took significantly longer to find in all heading styles, the mean time being more than twice the time of the second question in all instances other than the Control.

Table 32: Mean search time for each question (seconds)

		Question 1	Question 2	Question 3	Question 4	Question 5
Control	Unfamiliar	581	326	210	196	127
	Familiar	218	225	164	167	123
Bold	Unfamiliar	603	236	179	137	89
	Familiar	151	172	114	113	73
Bold-Sans Serif	Unfamiliar	569	253	142	167	77
	Familiar	98	145	105	123	69
Bold-Size	Unfamiliar	568	236	179	145	104
	Familiar	113	133	122	121	62

When the article was unfamiliar, the difference in mean search times for Question 1 between the four headings styles was relatively small, between Bold (603 seconds) and

Bold-Size (568 seconds), there was a difference of just 35 seconds. The difference between these two search times is not significant based on the results of a two sample t-test, P=0.5554. In comparison, when the articles were familiar, the difference between the slowest and fastest mean search times was significant, where in the Control participants took an average of 218 seconds to find the answer to Question 1 and just 98 seconds to find the answer to Question 1 in the article with Bold-Sans Serif headings (a difference of 120 seconds), P=<0.0001.

The widest gap between the fastest and slowest mean search times for a question was for Question 2 where there was a difference of 80 seconds between the Control (317 seconds) and Bold (237) seconds.

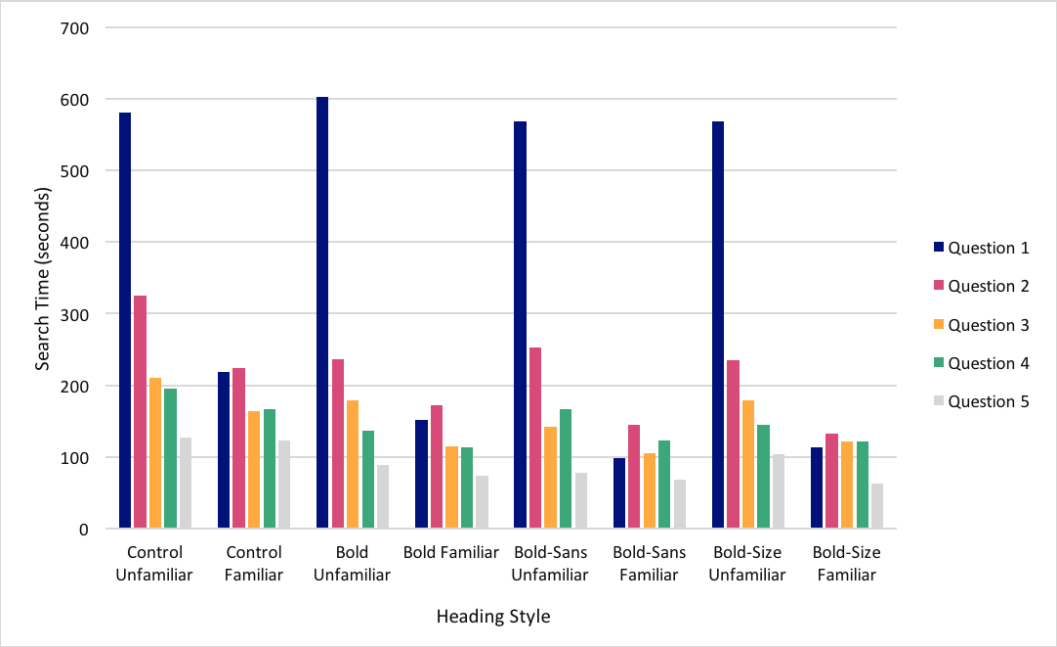

Figure 66: Mean search time for heading style by question number

Figure 66 provides a chart comparing the mean search times across Questions 1 through 5 when texts were both unfamiliar and familiar. When the article was unfamiliar to participants, the mean search time always improved as they progressed through the five questions. The only exception to this was with the Bold/Sans Serif heading where the mean search time for Question 3 was slightly faster than Question 4, by 16 seconds. The reason for the gradual decrease in mean search time is likely to be due to participants becoming increasingly familiar with the article content and structure as they search.

The same continual improvement in mean search time is not seen when the article was familiar to participants, as was seen when it was unfamiliar. This is likely to be because there is already a degree of familiarity with the article and its structure before beginning

the second search task. There was no consistent pattern across the four heading styles in the familiar text, as there was in the unfamiliar text. In the Control text, there was a similar pattern in the familiar text as there was in the unfamiliar, a trend of improvement in search time as participants progressed though the five questions, again, likely a reflection of the participants increasing familiarity with the text and improved memory for the location of information in the article. For the Bold heading, when the article was familiar, the Question 1 mean search time was slightly faster than Question 2, but otherwise a progressive decrease in mean search time was seen across the five questions. A gradual improvement in mean search time was not seen with the Bold-Sans Serif heading. Question 5 was still found the fastest, reflecting an increasing familiarity with the article and a stronger understanding of the structure of the content. However, Question 1 had the second fastest mean search time, followed by Question 3. Questions 2 and 4 had the slowest mean search times and had similar mean search times, with just 3 seconds difference between them. Bold-Size had an overall progression of improvement in mean search time as the questions progressed, but again, as with Bold and Bold-Sans Serif in the unfamiliar articles, Question 1 had a faster mean search time than Question 2.

Question 1 when the article was familiar when headings were presented in the Bold-Sans Serif heading style was found most quickly. This indicates that the Bold-Sans Serif heading may best assist readers with retaining an understanding of the structure of a document in memory.

The improvement in mean search times across questions shows that some heading styles, with greater ease of identification appear to better facilitate the building of an accurate understanding of the structure of the article. Gaining a better understanding of the structure of the article more quickly results in faster search times occurring more quickly in an article.

8.3.5 Skipped Questions

The number of questions that each participant skipped was recorded. Each participant was presented with 40 questions in total, of the 3,840 questions, 338 (8.8%) were skipped. Of the skipped questions, 202 were skipped in unfamiliar articles and 136 when the articles were familiar. There were only 13 of the 96 participants who accurately answered all 40 questions presented across all heading variations and articles without skipping. A further 25 participants only skipped one of the 40 questions. A summary of the number of questions skipped in each of the four heading styles, in both unfamiliar and familiar texts is shown in Figure 67.

The greatest number of skipped questions was in the Control texts with no headings, where a total of 130 questions were skipped, 70 when the text was unfamiliar to the participant and 60 when the participant was familiar with the article.

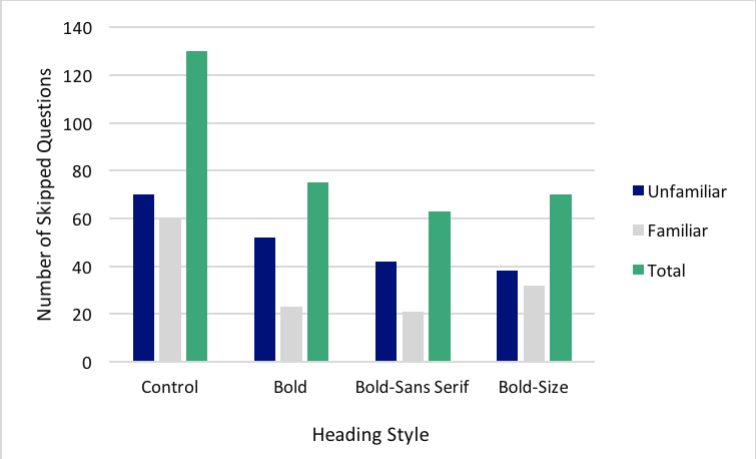

Figure 67: Number of skipped questions for each heading style

In both the texts with the Bold heading style and the Bold-Sans Serif headings, familiarity with the text approximately halved the number of skipped questions. For the Bold heading, the number of skipped questions dropped from 52 when the text was unfamiliar, to 23 when the text was familiar. The drop in number of skipped questions with the Bold-Sans Serif heading was from 42 with an unfamiliar text, to 21 with a familiar text. This was not the case in the Bold-Size condition (from 38 to 32), where there was only a slight reduction in the number of questions skipped, a similar proportion drop to that in the Control texts (from 70 to 60).

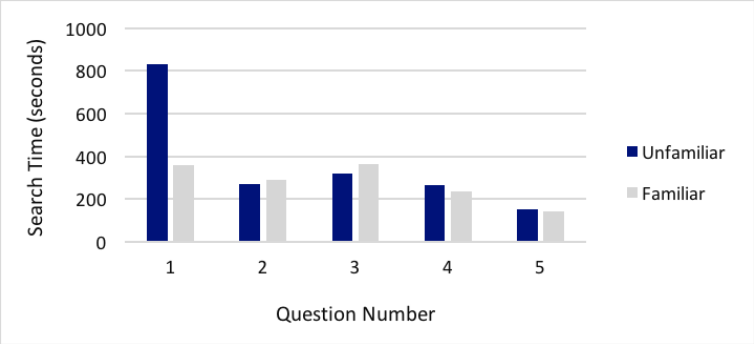

Figure 68: Mean search time before skipping a question

The mean length of time a participant spent searching before skipping a question was 368 seconds in an unfamiliar article and 278 seconds in a familiar article. Figure 68 shows the mean search time for participants before they skipped a question when the article was either unfamiliar or familiar. In an unfamiliar text, if a participant eventually skipped Question 1, they spent more than twice as long searching for the answer than with any

other question 831 seconds. In comparison, when the text was familiar, the mean search time of a skipped question was just 357 seconds. When an article was familiar, the longest mean time for searching for a question before skipping it was in Question 3 (364 seconds). The shortest mean search times before skipping were both for question 5, 152 seconds in an unfamiliar article and 142 seconds once the article was familiar.

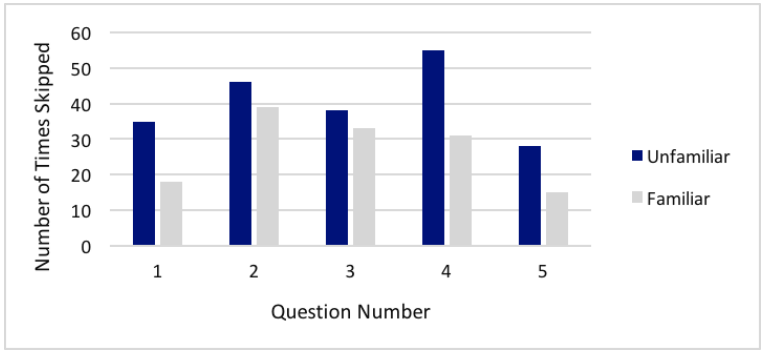

Figure 69: Number of times each question was skipped.

The number of times each of the five questions were skipped across all four articles is shown in Figure 69. The question number that was most commonly skipped was number 4 in an unfamiliar article and 2 in a familiar article. Question 5 was the least skipped question in either an unfamiliar article or a familiar article.

8.3.6 Search Time According to Reading Speed Band

Reading speed bands were calculated based on the mean reading time in seconds given for each of the IReST texts used to establish a participant's reading speed. In Table 33, the time in seconds for each of the reading speeds bands is given. The three bands were determined from the statistics given for each of the IReST passages. The medium band was determined by taking one standard deviation either side of the mean reading time given for each passage. Slow readers were then deemed to be those that were more than one standard deviation slower than the mean reading time and fast readers were those that were more than one standard deviation faster than the mean reading speed for that passage. A mean of the two passages could then be taken to be directly compared to the mean of the two readings times of the two passages for each participant. These calculations determined that participants whose mean reading speed over the two passages is greater than 47 seconds will be classed as 'slow' readers. Those whose mean reading time is between 35.8 and 46.9 will be considered 'medium' readers and those whose mean reading time for the two reading speed tests is 35.7 seconds or less will be categorised as 'fast' readers.

Table 33: Calculation of reading speed bands

	IReST Text 6	IReST Text 10	Mean
IReST reading time in seconds (mean ± SD)	42.1 ± 5.3	40.7 ± 5.8	
Slow	> 47.5	> 46.6	> 47.0
Medium	3.6 – 47.7	34.9 – 46.5	35.8 – 46.9
Fast	< 36.7	< 34.8	< 35.7

Based on the mean reading speed from the two test passages, participants were categorised as either, fast, medium or slow readers. The category with the fewest number of participants was fast readers (29), 33 readers were categorised as medium readers and the remaining 34 readers were slow readers.

Table 34 shows the mean search times for fast, medium and slow readers in each of the heading styles for both unfamiliar and familiar articles. The mean search times for both the fast and medium readers when the articles were unfamiliar were faster than the overall mean search time.

Table 34: Mean search times (seconds) by heading style for reading speed bands

	All Participants		Fast		Medium		Slow	
	Unfamiliar	**Familiar**	**Unfamiliar**	**Familiar**	**Unfamiliar**	**Familiar**	**Unfamiliar**	**Familiar**
Control	1440	897	1203	880	1163	863	1475	1218
Bold	1244	624	1008	558	1099	693	1056	1132
Bold-Sans Serif	1208	541	1001	529	987	589	966	940
Bold-Size	1231	552	980	500	983	521	1157	935

For those that were categorised as fast readers, there was little difference between the four heading styles when the text was unfamiliar, the Control having the slowest mean search time by 194 seconds (3 minutes, 14 seconds). The mean search times with each of the heading styles for the unfamiliar texts for the participants categorised as medium speed readers were similar to the fast readers. For both the medium and fast readers there was no significant difference in mean search times between all four heading styles based on a paired t-test. The main difference between the fast and medium speed readers was with the Bold heading style where the mean search speed for the medium readers was closer to

that of the Control heading style than with the fast readers. For the slow readers, the mean search times were slower than the medium readers by between 400 seconds for the Bold-Sans Serif headings and 509 seconds for the Control. For the slow readers, the mean search times decreased the most between the unfamiliar and familiar searches with the Control and Bold-Size heading styles. While the slow readers benefited the most with the Bold-Sans Serif heading style when the article was unfamiliar, the improvement in search time when the article was familiar was minimal (26 seconds). For the Bold heading though, slow readers had a longer mean search time in the familiar text than they did in the unfamiliar, meaning this heading style provided no benefit for them.

A graph of mean search times for each of the heading styles when participants were divided into fast, medium and slow readers is shown in Figure 70. The mean search times for the Control were the slowest for both unfamiliar and familiar articles for readers of all speeds. The mean search speed for articles with the Bold heading style was next slowest for all reading speeds in all heading styles and in unfamiliar and familiar articles, other than for slow readers searching an unfamiliar article where Bold-Size was seconds slowest. Bold-Size had the fastest mean search times of the four heading styles across all reading speeds, other than for slow readers searching an unfamiliar article. Bold-Sans Serif was consistently beneficial to readers of all speeds, only being fractionally slower than Bold-Size in most instances.

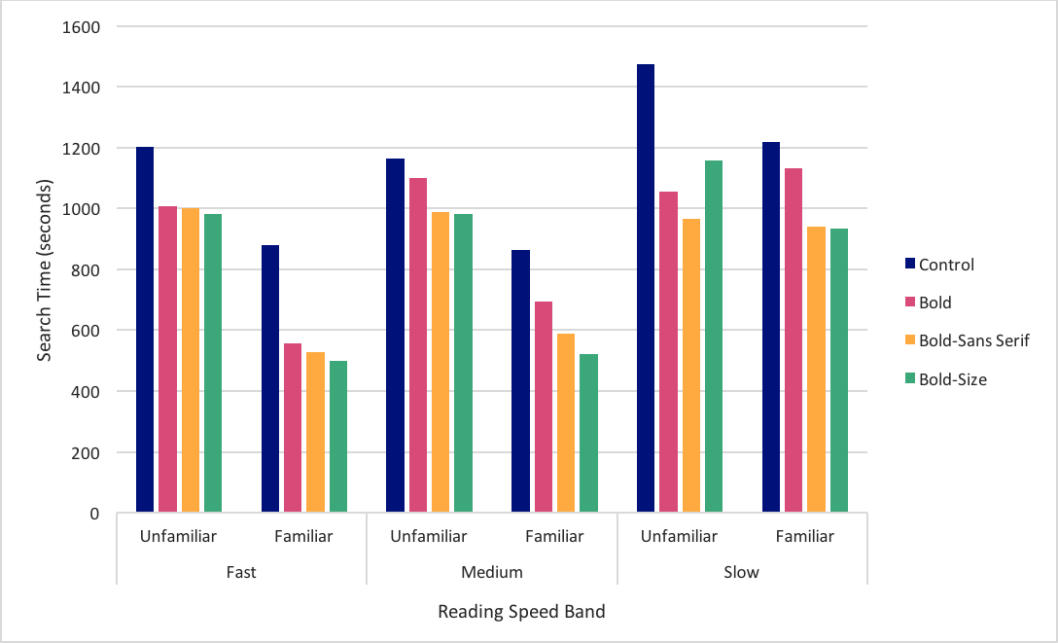

Figure 70: Mean search times by heading style for reading speed bands

Across all heading styles and when texts were both unfamiliar and familiar, fast readers found the answers to all of the questions faster than the overall mean search times. For those participants categorised as medium readers, the only heading style in unfamiliar texts where their mean search time was slower than the mean search time of the mean of the total population was with the Control, no headings. When the article was familiar to medium speed readers, in most heading styles, their mean search speed was slower than the mean of the overall population. Bold-Size was the only heading style where medium reading speed participants had a faster mean search time than the overall population. For slow readers, their mean search speed in all heading styles with unfamiliar texts was slower than the mean of the overall population. However, when the articles were familiar to the slower readers, their mean search speed was slower than the overall population for the Control and Bold-Size heading styles, but faster with the Bold and Bold-Sans Serif. In unfamiliar text, when slow readers were searching articles with Bold and Bold-Sans Serif headings, they actually had a faster mean search time than medium readers.

Amongst the 29 participants categorized at 'fast' readers they skipped 54 questions in total, a mean of 1.9 questions per participant. 'Medium' readers skipped 112 questions between the 33 of them, a mean of 3.4 questions skipped per participant. The 34 participants who were categorised as 'slow' readers skipped 174 questions between them, a mean of 5.1 skipped questions per participant.

8.3.7 Article Search Time

When designing the study, the texts used for the reading search tasks were kept as even as possible in terms of length, reading difficulty and heading frequency. The content of the articles was also chosen carefully to give a range of topics to be of interest to different readers. Despite the attempt to control the articles used for the study so that they would have as little impact as possible on the outcome of the study, there was some variation in search time of the articles in both unfamiliar and familiar search situations. All four articles were seen as the first, second, third or fourth article an equal number of times and with each heading style across all 96 participants.

For search in the articles when they were unfamiliar, Article 3 had a longer mean search time than the other three articles, 1551 seconds (25.9 minutes). In comparison, Articles 1, 2 and 4 had mean search times between 1200 and 1249 seconds (20.0 to 20.8 minutes). The mean time it took for participants to find answers for all of the questions in each article is shown in Figure 71.

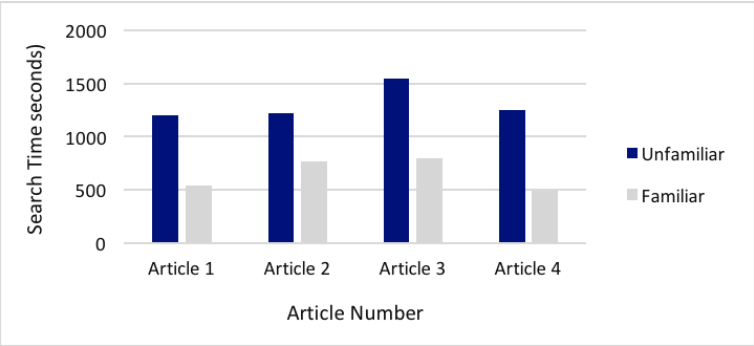

Figure 71: Mean unfamiliar and familiar search times for each article

In the familiar search situation, there was greater variation between the four articles. Again, Article 3 had the longest mean search time of 798 seconds (13.3 minutes), closely followed by Article 2, with a mean search time of 764 seconds (12.7 minutes). Articles 1 and 4 have the fastest search times, being 544 seconds (9.1 minutes) for Article 1, and 491 seconds (8.2 minutes) for Article 4.

Each article also had two questions sets, 'a' and 'b'. Participants saw both question sets, either when the article was unfamiliar of when it was familiar. If participants saw question set 'a' when an article was unfamiliar, then they would see question set 'b' when it was familiar, and vice versa. Figure 72 shows the mean time taken for participants to find the answers to all five questions in each of the question sets, when seen with either the article when it was either familiar or unfamiliar.

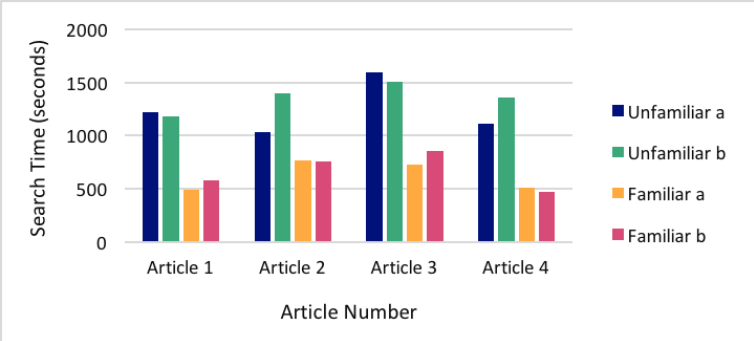

Figure 72: Comparison of Question Sets

Figure 72 shows a comparison of the mean time to search for all five answers in question set 'a' and question set 'b', when the text was either familiar or unfamiliar in each of the four articles. Article 1 shows little difference between the two questions sets when the article was unfamiliar (1,217 seconds and 118 seconds), but a slightly larger difference in mean search time when the texts were familiar (494 seconds and 584 seconds). With Article 2 the mean search time is very different between the two questions sets when the article was unfamiliar (1,029 seconds and 1,392 seconds), but when the same questions were

searched for when the article was familiar the mean times were very similar (769 seconds and 759 seconds). A similar pattern to Article 1 is seen with the mean search times of Article 3 when comparing the two question sets. In article 3 the mean search speed was longer for participants who were searching for the set 'a' questions (1,594 seconds), than set 'b' questions (1,508 seconds) when the text was unfamiliar to the participants. With the same two question sets when the articles were familiar, participants found the answers faster in set 'a' (729 seconds) faster than in set 'b' (855 seconds). The two question sets for article 4 again show a slight variation between the two question sets in the unfamiliar and familiar instances. With question set 'a' in the unfamiliar article, the mean search time was 1110 seconds, and with question set 'b' the mean search time was 1360 seconds. When the article was familiar, question set 'a' was slower, with a mean search time of 515 seconds and question set 'b' was 468 seconds.

Based on the analysis of the article, mean search times and considering the mean times of each of the questions sets, 'a' and 'b', it is unlikely that the chosen articles and questions had a significant influence on the search times of the articles.

8.3.8 Observations

While participants were undertaking the reading search tasks for Study 3 some observations were made regarding how they interacted with the study materials. Some participants also engaged with the researcher after one or all of their sessions, providing insight into their experience when undertaking the study. Before the study commenced participants were made aware that they were allowed to ask the researcher present in the room questions at any time throughout the study. This opportunity was usually taken up by participants to clarify the task that was being asked of them, however, others used this opportunity to provide insights into their experience of the task.

8.3.8.1 Search Strategy

After completing their sessions several participants commented that with the first passage they read it right through before searching for any answers. However, in subsequent texts, they have adjusted their strategy to the task and have been more focused on utilising the headings to assist them with searching for the answers, only reading what they felt was necessary to answer a question. At the end of their first session one participant queried whether they should be reading deeply or skim reading. They felt that they had been reading too deeply, as they were interested in the content of the article.

Some differences were observed in the page navigation and searching strategies employed by individual participants. While many participants simply clicked forward and backward through pages searching for each answer, one participant was observed to return to page one after answering each question to recommence their search from the start of the document. This strategy may have been employed by other participants, but was not noticed at the time.

A comment was made by one participant at the end of a session that this could be a strenuous task for someone who was not used to this type of reading activity. The search tasks may be easier for those who are more familiar with this type of activity.

An insightful observation was made by a participant after the completion of the search task for the Control text. They felt that when they were reading the Control text they were trying to build a mental model of the text, but this was easier to achieve in a text with headings. They thought this was most apparent when getting a question on a topic they did not recall from the article and they would have to start reading from the beginning of the article to search for the answer. Another participant offered further insight, saying that when an article had headings, they would recall the presence of a relevant heading and go back to find the answer, but they could not do that in the Control text that had no headings. In contrast, the comment of another participant was that, "Headings make it harder; I look for things under the wrong headings."

A range of strategies appeared to be employed by participants when undertaking the familiarisation with the text at the end of their search sessions. Some participants appeared to take more time reading through each page, progressing through the text slowly, often not viewing all pages within the allocated five minute familiarisation time. In contrast, other participants appeared to skim through pages having time to view each page more than once within the reading time. There were also a small number of participants who were seen checking their personal mobile phone for either short, or extended, periods during their reading time. The reason for this may be a reflection of how deeply they felt they read the text during their question search time. Several participants asked whether they needed to complete the familiarisation reading time, as they felt they had already read the article deeply while they were searching for the answers to the questions.

8.3.8.2 Question Answering

A general observation was made regarding participants attitudes towards answering questions; some participants were more determined to find the answer to questions than

others. While some participants would persevere to find an answer no matter how long it took them, others would be quite willing to skip a question if they had not found it as quickly as they would have liked. This observation was supported by the comment of one participant who said, "Ok, I'm going to skip this question. I've tried twice."

After completing a session several participants made comments that they had felt frustrated by having to find the exact instance of an answer within the text. This frustration seemed to be due to different reasons depending on the participant. For some participants, it was due to them having some prior knowledge of the article's topic and they knew the answer to the question before reading the article, however, the task required them to locate the answer within the text. For other participants, the frustration stemmed from them being in the correct portion of the text, but clicking on the wrong phrase. At times the issue seemed to be due to incorrect comprehension of the question, as the questions were quite specific. The third reason was because a participant knew they had read the answer to the question either when searching previously, or in the reading familiarisation phase, but could not recall the location of the answer in the context of the current question.

The design of the programme for administering the study meant that participants were required to click on the target answer within the text. One participant felt that the target answer phrases were too short and should have included the whole sentence rather than just a portion of it.

There were several observations by participants regarding both the positive or negative impact that their level of interest in an article seemed to have on their searching. Some participants noticed that when searching an article, they found interesting their search time slowed, as they were distracted by reading the content they were interested in. In contrast, some participants made comment that they felt they were more motivated and engaged to take in the content of articles that were of interest to them, meaning they felt they read it faster, whereas they read slower in articles that were less interesting or less familiar.

8.3.8.3 Individual's Interactions

The lack of headings in the Control text was noticeably more challenging for some participants and this was often revealed through their body language. These participants seemed more unsettled when completing the Control text, some visibly looking frustrated or shifting position in their seat more frequently. The data of one participant needed to be withdrawn from the study and replaced with another participant when they appeared to

get frustrated when completing the Control text and the computer she was working on 'mysteriously' turned off.

One participant was observed frequently looking at what the participant sitting next to them was doing. These two participants had come together and clearly had an established relationship. It is not known what the participant was looking at or checking, as the two participants were reading different texts with different questions, however, the participant may not have been aware of this. There were also other instances where a participant would make a comment to another participant in the room; this occurred more frequently during the familiarisation reading time, but occasionally also occurred during search times.

The observations made help to provide some insight into the experiences of the participants and how individuals approached the task differently. These insights also provide guidance for potential future studies.

8.4 Discussion

The results of Study 3 are discussed in this section with regard to how the typographic emphasis of headings assists readers with searching in unfamiliar and familiar text.

8.4.1 The Importance of Headings

The presence of headings, as opposed to no headings, has a significant effect on the time it took participants to find the answers to five questions. The importance of headings to assist with search is supported by other studies (Hartley & Trueman, 1985; Symons & Pressley, 1993; Waller, 1982b). Having no headings in a text means that for someone searching a text the benefits of being familiar with a text is less pronounced. While the time to search a familiar text with no headings is decreased, the decrease is not as great between an unfamiliar and familiar text, as it is in a text with headings. This demonstrates that while repeated reading of a text can create greater familiarity and increase search speed, having headings which are easily identifiable within the text further increases the speed of locating information. This builds on the research of Klusewitz and Lorch (2000a) who found, when studying the influence heading content has on search strategies, that search speed improves with familiarity and page-skipping increases. While this thesis did not investigate search strategy and page turning behaviour, it is likely that participants were employing page-skipping search strategies with the faster search speeds in texts with headings.

8.4.2 Search Speed

The presence of headings improves search speed, but the use of certain heading styles provides greater improvement in search speed with some heading styles more than others. Minimal difference was found between the mean search times of Bold, Bold-Sans Serif and Bold-Size in the unfamiliar articles, but there was a significant difference between each of the three heading styles and the Control, with no headings. This finding supports that the presence of headings is important when searching a text which is unfamiliar to the reader. The style of heading mostly becomes important once the article is familiar to the reader.

Bold and a typeface change is a more significant visual change than other methods of typographic emphasis for headings and seems to provide improvements in assistance with searching in the widest range of situations for the largest proportion of participants in this study. This is based on the heading style of Bold-Sans Serif being similar to Bold-Size in many situations, especially search speed in both unfamiliar and familiar texts. However, for participants who were slow readers, Bold-Sans Serif assisted participants far more in an unfamiliar text than Bold-Size. Participants were also much less likely to skip questions in a familiar article when Bold-Sans Serif headings were used.

The heading styles of Bold-Sans Serif and Bold-Size increase the improvements that familiarity brings to search speed. If familiarity accounts for an improvement in search speed of approximately one third, then heading style can account for between 12% and 20% improvement in search speed.

The decrease in time between the time to find the answer to the first question and the time to find the answer to the second question is greatest in the text with Bold-Sans Serif as a heading. In the unfamiliar text, the search time for the third question is approximately the same as the search time for the first and second questions in the familiar text. It took participants approximately two questions before they gained an accurate understanding of the structure of the text to assist them with their search tasks. The only exception to this was with the Bold-Size heading style where the mean search time in the unfamiliar text does not approach that of the search time in the familiar text until the fourth or fifth question. This seems like a strong indicator that readers struggle to build an accurate understanding of the structure of a text when the headings are Bold-Size. In the articles where participants had Bold headings, or the Control, there is also a larger increase in search time between the search time for Question 5 in the unfamiliar text and Question 1 in the familiar text. This increase may be an indicator that the understanding of the structure of a document with these heading styles that are developed by the reader are not

retained as well as with Bold-Sans Serif and Bold-Size headings which demonstrate a much smaller increase between the unfamiliar Question 5 and Question 1 in the familiar text.

People find answers to questions faster in a familiar text and skip fewer questions than in an unfamiliar text, no matter what the heading style. This could be due to either reading more deeply or the influence of memory for the content through multiple readings.

8.4.3 Search Success

The headings which best assist search in familiar and unfamiliar text do not just improve search speed, but also improve accuracy of finding answers. This is based on participants being less likely to skip an answer in an article with Bold-Sans Serif headings, especially when the article was familiar.

Bold improves identifiability of headings, but when combined with an increase in size, a heading which is Bold-Size, does not improve question skipping or search speed in slower readers as much as Bold alone or Bold-Sans Serif. Hartley and Jonassen (1985), based on their survey of headings research speculate that learners who are less capable of creating their own structural understanding of a text may gain more from the structural cues that headings provide. While readers who are less-capable of understanding a text's structure may not be the same group as those that were categorised as 'slow' readers in this study, there may be a strong overlap in needs between these two groups of readers.

When the text had no headings (the Control), there was more skipping of questions and participants took longer to find answers. When the texts had headings in Bold-Sans Serif participants skipped questions less frequently and took less time to find the answers to the questions.

If a short reading time were to be given before the first or subsequent search tasks, for participants to build an understanding of the structure of the text, would the sharp decrease in continual improvement in search time of unfamiliar articles still be seen in the questions?

8.4.4 Limitations of Study 3

In the design of Study 3, there were many factors that needed to be controlled: heading frequency, heading content, heading length, question difficulty, reading level of articles and the article topics. Each of these variables, although controlled as best as was possible, may have influenced the results of the study.

The time taken to search for each answer and then the accuracy of that answer were the measures used for this study. The time taken to find each answer however, also includes the time taken to manipulate the document, and the amount of time this added may have varied between participants. The articles were presented on screen, and as Dillon (2004) discusses the skills required to manipulate an electronic document are not as transferrable as those for print documents. One reason for participants taking so long to answer Question 1 in the unfamiliar article, as well as building a understanding of the structure and familiarity with the document structure, may be that they were also having to familiarise themselves with navigation of the programme. Two methods were provided to participants for moving through the pages of text: using the mouse to click 'next' and 'previous' buttons, and using the arrow keys on the keyboard. Many of the participants seemed to choose the mouse over the keyboard. Participants were asked to locate the answers in the text, even if they already knew the answer when they read the question, whether it was because they had previous knowledge of the topic, or because they were familiar with the answer from earlier in the study. Several participants commented on the frustration of having to locate the answer to a question they already knew the answer to, especially when the text was familiar in sessions 2 and 4. Unfortunately, it was not recorded which session participants were currently undertaking or what questions they were answering when participants made these anecdotal comments. A future study run in a similar manner, but with multiple answering options (for example; text input, click on any answer instance, click on the exact answer instance), may yield interesting results in regards to how participants would understand or respond to questions and answers.

The two reading speed tests were always shown in the same order to participants. Alternating whether participants saw passage 1 or passage 2 first may have helped to eliminate any bias that could have arisen from always showing them in the same order.

It was not recorded if a participant had English as a second language, rather than being their native language. This may have influenced search times as those for whom English was a second language may have struggled more with comprehension of questions or had slower reading speeds. The effect of this was hopefully minimal though as all participants completed all articles and heading styles. All participants who are likely to have been second language English speakers would have been admitted to study at University in English and therefore could be considered to have a competent level of English sufficient for a study such as this.

In the third study, there was a larger proportion of younger participants, aged 18-25 (55%), this may have had an impact on the final results as there were differences seen in Study 1a and in Study 2 with the headings that participants in this age bracket found easiest to identify compared to participants in other age brackets. However, the differences in ease of identification were generally limited to the heading styles which were lower in the overall ranking, rather than those which were easiest to identify.

There were also external factors that may have had an impact on results. Some participants were distracted during their sessions by various external sources. On more than one occasion, participants were found to be looking at their mobile phone despite being asked to turn them off. Others were distracted by others in the room or were simply observed to be daydreaming. While some used the pause function available in the interface of the programme, others needed to be prompted to do so.

8.5 Conclusions

The study presented in this chapter answered Research Question 3, '*Do more easily identified headings increase the speed of searching in unfamiliar and familiar text?*'. To answer this research question, we conducted a study in which participants were asked to search for answers to questions in articles when they were unfamiliar to the readers and when they were familiar. Each article was presented with one of three different heading styles, or with no headings.

Familiarity with a text improves search time even when no headings are present; however, in texts with headings the search speed improves more significantly when headings are present. This effect was even more pronounced if the headings are more easily identifiable from the surrounding body copy. Both Bold-Sans Serif and Bold-Size headings provided this advantage in the study that was presented in this chapter.

The heading styles of Bold-Sans Serif and Bold-Size were the easiest to identify when compared in Study 2. These two heading styles (Bold-Sans Serif and Bold-Size) were found in Study 3 to provide the greatest assistance to participants in the speed of search when locating the answers to questions. Additionally, Bold-Sans Serif provided the greatest improvement in search speed when the article was familiar to participants.

When headings were presented as Bold-Sans Serif, search times in familiar texts were faster than with other heading styles, search time for individual questions decreased more quickly, the number of questions skipped was lowest, and slower readers were best assisted when searching. Based on these findings, Bold-Sans Serif seems to best assist

readers across all reading speeds. Bold-Sans Serif assists with quickly building an understanding of the structure of the text to assist them with searching in text that is unfamiliar and then also continue to provide benefits when that text is familiar.

The importance of the heading style when searching becomes most pronounced for slower readers. Results in this group show that creating visually distinctive headings with a change in typeface style (Bold-Sans Serif) is more effective than just adding visual weight (Bold-Size).

The effectiveness of Bold-Sans Serif headings is further supported by considering the number of times a participant skipped a question they felt they could not find the answer to. Overall, the number of skipped questions was lowest for Bold-Sans Serif, especially when the text was familiar. So, while the advantage that Bold-Sans Serif provides over Bold-Size is minimal in some instances, there are several factors that provide an advantage for the Bold-Sans Serif style of heading emphasis over a heading which uses Bold-Size for emphasis. The use of Bold-Sans Serif as a heading emphasis method is also supported by Craig et al. (2006) who suggest that the use of sans serif for headings creates a dramatic change which feels intentional. The combination of a deliberate change in typeface to sans serif and increasing the weight of the type to bold creates heading emphasis that provides search speed and search accuracy benefits for readers in both unfamiliar and familiar text.

9

Conclusions and Future Work

This thesis aimed to answer the question: "which methods of typographic emphasis for headings best assist with search in unfamiliar and familiar texts?" It was hypothesised that headings which are more strongly emphasised will be more easily identified and therefore provide greater assistance to readers when searching for information. To prove this hypothesis, three research questions were developed to build a picture of what methods of typographic emphasis best assist with search in unfamiliar and familiar texts. The first research question asked which methods of typographic emphasis are the easiest to identify in a passage of text. Research Question 2 built on the findings of Research Question 1 to establish whether combining two methods of typographic emphasis created a more easily identifiable heading than using a single method of emphasis. The information gained from these first two studies, informed the choices made for the design of Study 3. The final study was conducted to find out which of the heading styles that are easily identified best assist with search for information in unfamiliar and familiar texts.

This chapter provides a summary of the contents of the thesis along with a summary of the findings relating to each of the three research questions. The contributions that the research has made are then discussed, followed by an overview of the future research that can be conducted to extend the findings of this thesis.

9.1 Summary

This thesis began by providing background information in Chapter 2 regarding how typography influences reading, and discussing best practice recommendations for the typographic emphasis of headings. It is widely understood that all aspects of a typographic

layout in regards to typeface choice and layout are interrelated and changes to the visual presentation in one aspect of the text can change how the other aspects are perceived. The choices made in the typographic layout of the text also influence many aspects of the reading process. Bold and Size are widely considered through established typographic practice to be the best methods of typographic emphasis for headings, yet there is little empirical evidence to support this understanding. Chapter 3 presented related work on how documents are structured, the strategies people use for searching documents, the ways that the structure of a document is visually presented through headings and the typographic methods that are used to create emphasis in text.

A survey of current typographic practice in academic publications was undertaken and the findings of this survey were presented in Chapter 4. The survey of the heading emphasis methods used in 50 randomly selected journals revealed that there is wide variety in the types of emphasis methods used to indicate headings, but they are often presented inconsistently, especially between print and digital formats.

The findings of the survey of current practice and then the background and related work were then used to inform the first study contributing to this thesis. The six heading styles found in the survey to be most commonly used were compared, along with a Control, in a paired comparison study which was conducted with a general population, Chapter 5, and with graphic designers, Chapter 6. The same material was presented in both print and screen versions of the study. Participants were asked to choose in each pairing, which passage of text the headings were easiest to identify. A second study, reported in Chapter 7, was then conducted to establish whether heading styles that combine two methods of typographic emphasis are more easily identified. Again, this study was presented in both print and screen-based environments, but just five heading styles were compared. The heading styles chosen were combinations of the most easily identifiable heading emphasis methods from the first study.

For the design of the final study (Chapter 8), to investigate how the typographic emphasis used for headings influences search when text is unfamiliar and when it is familiar, we drew on the results of the first two studies. The most easily identified heading styles from the paired comparison studies (Chapters 5, 6 and 7) were selected as the heading styles to be compared in the search of texts. These four heading styles were compared for their ability to assist with the search of unfamiliar and familiar text. Participants were asked to search for answers to four different articles, each with the headings presented using a different method of emphasis. Each article was searched twice; the first time when it was

unfamiliar to the participant, and then a second time when they were more familiar with the article and had been able to build an understanding of the structure of the text. The results of this study showed that heading styles that are more easily identified provide greater benefits to readers when searching for information.

9.1.1 Answers to Research Questions

This section presents the answers to each of the three research questions found through the research presented in this thesis.

9.1.1.1 Research Question 1: Which methods of typographic emphasis make a heading easiest to identify within a passage of text?

Research Question 1 established which of the most commonly used methods for emphasising headings were easiest to identify within a passage of text. The study conducted to answer Research Question 1 was a paired comparison study where seven heading styles were presented in a block design, with each compared to each other. This study was conducted both in print and on screen. Headings with the greatest visual weight were the easiest to identify and headings with the least visual weight were seen to provide little advantage over headings which were not emphasised at all. The paired comparison study design meant that a ranked order of ease of identification was found for the seven heading styles that were compared. Bold was the heading style considered to be most easily identified, followed by Size. The paired comparison study found that both in print and on screen, and for graphic designers, Bold headings are easiest to identify.

9.1.1.2 Research Question 2: Are headings that are emphasised by combining two methods of typographic emphasis more easily identified than single emphasis methods within a passage of text?

This question built on the answers found to Research Question 1 to find that if two heading emphasis methods are combined to create a heading, it is easier to identify in a passage of text than if a single method of emphasis is used. Four heading styles were developed for Study 2; Bold-Size, Bold-Sans Serif, Bold-Spacing and Size-Spacing. These combinations of emphasis methods were chosen based on the heading styles that were easiest for the general population and graphic designers to identify as single variations of heading emphasis. A fifth heading style with a single method of typographic emphasis, Bold, was also used in this study. Study 2 was also a paired comparison study run as a block design with the five heading styles all being compared to each other. It was again run as both a print and a screen study. From this study, it was found that Bold-Size is the most easily identifiable heading style that combines two methods of typographic emphasis. It was also

found that combining heading emphasis methods that are easily identified into heading styles creates headings that are easier to identify than headings using a single method of emphasis. Bold-Size and Bold-Sans Serif were the two heading styles that were easiest to identify in Study 2 and Bold was the easiest to identify in Study 1.

9.1.1.3 Research Question 3: How does the degree of typographic emphasis for headings influence search of unfamiliar and familiar text?

Study 3 found that headings are important for assisting readers with searching for information in text, especially text that is unfamiliar. Headings which are considered easier to identify in text provide some advantage when searching and building an understanding of the structure of the text. Ease of identification may not be the most important factor in creating headings that best assist search of text as these heading styles provided more advantages for some readers than others.

Headings which are more easily identifiable in a passage of text assist readers with searching for information. The presentation of headings is more important in unfamiliar text, and for slower readers. The style of heading has an influence not only on search speed, but also on the chances of a participant persevering to find the answer they are searching for. When elaboration is used though, creating strong visual weight for indicating a heading in text, rather than just single change to create emphasis, we create text which is more easily searched, with a greater chance of search success.

Participants with a faster reading speed were less affected by heading style, but the presence of headings still improved their search time. For readers with a slower reading speed headings were more important, especially when searching an unfamiliar text. Bold-Sans Serif headings gave the fastest mean search time for slower readers, with Bold-Size headings being of less assistance than Bold headings with this group. However, once the article was familiar, Bold-Sans Serif or Bold-Size headings were of equal assistance for search. The greatest advantage of Bold-Sans Serif over Bold-Size for headings was in a familiar text with the number of questions skipped. Text with Bold-Sans Serif headings had one third fewer questions skipped in a familiar text.

9.2 Contributions

This section provides a summary of the contributions that this thesis makes to the use of headings and how they assist readers.

9.2.1 Understanding of Current Practice

The six most commonly used typographic methods for emphasising headings were Bold, increasing the typeface size, capitalisation, increased spacing between the heading and body copy following it, italics, and a sans serif typeface in comparison to a serif body copy typeface. The horizontal alignment of headings was also varied to differentiate headings, but this layout feature was not explored further as a variable in the remainder of the research. These six typographic emphasis methods were used alone or in combination with each other to create a wide variety of heading styles. It was also found that these heading styles were not always applied consistently across an article or publication and their consistency in appearance or treatment was not always maintained between print and screen versions of the same article. This lack of consistency may have an adverse effect on readers.

9.2.2 Ease of Identification

As was discussed in Chapter 2, established typographic practice generally recommends variations of Bold, Size and Capitalisation to emphasise headings in documents depending on the situation and printing restrictions. Prior to this research there was little empirical evidence to support this common practice in typesetting. The survey of current practice (Chapter 4) found that these three methods of emphasising headings were those most commonly used by publishers. The results of Study 1a and 1b provide empirical evidence through a paired comparison study that headings which are Bold or an increase in size are perceived by readers to be easiest to identify in a passage of text. The results of Study 2 extend this understanding by providing evidence that readers perceive the combining of two methods of typographic emphasis to be easier to identify than a single variation in appearance. By combining the typographic emphasis methods of Bold and an increase in Size together into a single heading, the ease of identification is further increased.

9.2.3 Visual Hierarchy of Headings

The paired comparisons method used for conducting Study 1a and 1b and Study 2 enabled a ranking of the compared heading styles to be generated. This ranking of the heading styles in each study ordered them from the heading style that was easiest to identify through to the heading style that was the least easily identified. These orders of emphasis help us to understand which heading styles may be considered more important in a visual hierarchy and which may be perceived as less important. The rank orders generated in Study 1a and 1b and Study 2 can be directly compared as Bold was used as a heading style in both studies, being the most easily identified heading style in Study 1a and 1b and the

least easily identified in Study 2. From this it can be concluded that combining two methods of typographic emphasis to a heading creates greater ease of identification than a heading emphasised using a single typographic emphasis method.

9.2.4 The Perception of the Use of Space

Study 1 was run once with a general population (Study 1a) and a second time with a group of participants who had education or experience in graphic design (Study 1b) and therefore had greater knowledge of typographic control. The only difference in the results from this group of participants to those of the general population was their perception of Spacing for emphasising headings. In the general population, Spacing was ranked fifth, providing little assistance with ease of identification of headings compared to when no emphasis was used. In contrast, Spacing was the heading style ranked second amongst the graphic design participants. This finding indicates that knowledge of the control and use of typography influences ease of identification of different heading styles.

When comparing the results of Study 1a and 1b and Study 2 it was also found that Spacing can alter the perception of other emphasis methods. Previous studies that have found that by altering one typographic feature it has an impact on other typographic features. These studies have been addressing the adjustment of typography for readability or legibility. The finding that the adjustment of typographic features can also not be done in isolation without affecting perception as well as readability or legibility is a further development in typographic research.

As with Study 1a and 1b, two groups of participants undertook Study 3. In comparing the results of Study 1a and Study 1b it was found that graphic designers perceive the importance of different typographic emphasis methods of headings differently to the general population. In Study 3, when the results of graphic designers were compared to the general population, there was no significant difference between the two groups. This shows that while the designers perceive headings differently, finding different heading styles easier to identify than the general population, when using headings to conduct a search task, this difference does not translate to assisting with building an understanding of the structure of the text.

9.2.5 Heading Style for Assisting Search

Previous studies that have considered headings have mainly focussed on the content and placement of headings rather than the visual appearance and have predominantly investigated their impact on comprehension and recall. This research focussed on the

visual appearance of headings and how they impact search for information. It was found that the heading styles that have the greatest ease of identification also best assist readers with their search for information.

Headings which were emphasised using Bold-Sans Serif and Bold-Size styles provide the greatest assistance for readers to build an understanding of the structure of the text and support their search tasks. Bold-Sans Serif headings provide further advantage for readers as they provide the broadest benefits to readers across the widest range of reading speeds and result in greater a likelihood of search success. For fast and medium speed readers headings that are most easily identified are of greatest benefit; however, for slower readers, it is an advantage for them when searching an unfamiliar text to have headings presented with Bold-Sans Serif as the method of emphasis. Bold-Sans Serif headings also provides greater benefit to readers over Bold-Size headings when measuring search success. In articles with Bold-Sans Serif headings that were familiar, readers were least likely to skip a question.

9.3 Future Work

Each of the three research questions were answered in this thesis, but in conducting these studies other questions were raised as a consequence of the findings. In this section, those questions are discussed as well as consideration given to how this research can be extended.

9.3.1 Visual Continuity Between Reading Environments

From the initial survey of current practice in journals, future research needs to consider how publishers can create an effective hierarchy of information in a text with headings and visual cues that will be effective in multiple document presentation formats. This information can then also be used to investigate how document search is affected by different methods of typographic emphasis of headings in both print and digital reading environments.

In Study 3, the style of headings shown in the unfamiliar version of the article were consistent with the headings style shown in the same article when it was familiar. It was found that there was significant improvement in the search speed for the task between the unfamiliar and the familiar tasks. The improvement in search time between the unfamiliar and familiar task was even significant when there were no headings in the article, the Control. In the preliminary survey of heading styles used in articles (Chapter 4) it was found that often the print and electronic versions of the same article have differing heading

styles and text presentations. It is not known what impact this may have on familiarity with an article and the impact this may have on search of the text. Does the familiarity with an article remain, or is there a loss in connection with the understanding of the structure that the reader has developed? Further research could be conducted building on the research reported here to determine whether the understanding of the structure of the text is connected to the visual presentation of the headings. This further study could explore whether the presentation of the headings in the text influences the ability for readers to maintain their familiarity with the content.

9.3.2 Expanding Understanding of Headings for Search

Many factors needed to be controlled in the design of Study 3, as well as the preceding studies which informed it. The heading frequency used for Study 3 was determined based on the page size and text size so that the heading frequency meant there were 1-2 headings per page, which was approximately every 250 words, based on the findings of Bartell et al. (2006). This decision was made as there is little research regarding the optimal frequency of headings other than in medical leaflets and medical information (Bartell et al., 2006; Schultz & Spyridakis, 2004). It would therefore be useful to pursue a series of studies to understand optimal heading frequency for assisting readers with searching for information.

Study 3 only considered four heading styles in comparison to a Control with no headings. The results from Study 3 warrant further investigation to understand whether there are other heading styles which better assist with search, or whether all headings that are adequately emphasised are equally useful to all readers to assist them with building an understanding of the structure of the text. There is considerable scope to pursue research into whether there any heading styles, which provide the same or better search speed advantage and skipping less questions over Bold-Sans Serif and Bold-Size.

The heading in this study that used Size as a method of emphasis had an increase in size of 20%. The decision to use an increase of this size was based on research by Williams and Spyridakis (1992) who found that headings with a 20% increase in size were more easily distinguished, though 20% was the largest difference in size that they studied. It was also recommended by Williamson (1983) that increasing a heading by 2 point sizes creates sufficient contrast. Is this optimal at all body copy sizes? In contrast, Bosler (2012) recommends making a heading twice the size of the body copy. Future research could consider, what the optimal increase in size for a heading to create adequate contrast to easily distinguish the heading, but without over emphasising it to distract the flow of

reading. Consideration specifically needs to be given to whether the difference in size between a heading and the body copy should be greater at smaller sizes and smaller at larger sizes.

9.3.3 Headings for Scrolling Text

Only one reading environment was considered in Study 3, paging text on screen as this was seen as a compromise between the different environments available for reading. Readers use the physical form of the page to remember the location of information in a text (Rothkopf, 1971). As discovered in this research headings also provide visual reference points in a text to assist readers with the location of information and headings which are more easily identified assist this process better. It is likely that scrolling on screen text would require even more distinct visual heading markers for readers to be able to build an understanding of the structure of the text. This is because there are not the same physical cues that readers used in paged text, such as remembering something was in the top-right of the page. It is suggested that future work build on the current findings and investigate which methods of typographic emphasis best assist readers with the search for information in scrolling text where the needs of readers are different and may rely more strongly on typographic access structures.

9.3.4 Creating Heading Hierarchy

Study 1a and 1b and Study 2 generated ranked orders of emphasis so that we now know which methods of typographic emphasis for heading styles are more easily identified than others. A visual hierarchy of headings implies that those headings which are most easily identified within a text are more important than those that are less easily identified. When conducting the paired comparison studies, participants frequently commented that they thought one was only just more preferred that the other, or that one was definitely preferred over the other. Additionally, when the results of Study 1a and 1b and Study 2 were compared it was found that there were differences in the participant's response to ease of identification when Spacing was introduced between Bold headings and headings with an increase in Size. Further investigation into the effect of spacing and how the spacing used could influence perception of heading hierarchy is needed. Conducting a study where the degree of preference is recorded may be able to provide further insight into levels of hierarchy in heading preference and which headings people feel are more important than others. Further investigation can now be undertaken to build on the findings of this thesis, and that of Williams and Spyridakis (1992) with their card sorting study, to better understand how a hierarchy of headings should be presented visually. This

will provide empirical evidence to support the established typographic knowledge that is currently applied in designing these typographic access structures.

Black (1990) recommends that to generate a typographic hierarchy for headings a single change in the body copy should be the first consideration. Successive changes in the emphasis used for the headings can then be made as the level of the heading in the hierarchy increases. The rank orders generated through Study 1a and 1b and Study 2 can be used to assist those making typesetting decisions regarding how they develop a heading hierarchy where the headings are progressively easier to identify as they get higher in importance. Having a clear hierarchy of headings that are easily identified and clearly distinguished from each other should assist readers with developing a strong understanding of the text structure.

9.4 Conclusion

The heading styles that this thesis found to provide this assistance combined Bold and an increase in Size or a change to a Sans Serif typeface. Bold-Sans Serif and Bold-Size headings are of greater assistance when the text is familiar to a reader, as they are likely to have helped the readers to build a stronger understanding of the structure of the text. Slower readers get greater benefit than fast or medium readers, from headings that are easily identified, especially when the text is familiar to them. As well as providing benefits when searching, Bold-Sans Serif and Bold-Size headings also resulted in greater search success, with readers less likely to skip a question.

The methods of typographic emphasis for headings that best assist with search in unfamiliar and familiar texts are those with enough visual weight to create easily identifiable headings.

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White, A. (1999). *Type in use: effective typography for electronic publishing*. New York: W.W. Norton.

White, A. W. (2002). *The Elements of Graphic Design*. New York, NY: Allworth Press.

Williams, T. R., & Spyridakis, J. H. (1992). Visual discriminability of headings in text. *Professional Communication, IEEE Transactions On*, *35*(2), 64–70.

Williamson, H. A. F. (1983). *Methods of Book Design: The Practice of an Industrial Craft*. Yale University Press.

Winn, W. (1993). Perception principles. *Instructional Message Design: Principles from the Behavioral and Cognitive Sciences*, 55–126.

Yelland, J. (2003). *Type Survival Kit*. Australia: Press for Success.

Appendix A: Journals Sampled in Survey of Current Practice (Chapter 4)

This appendix contains material related to the survey of current practice reported in Chapter 4.

- List of Journals sampled

Table A.1: List of Journals sampled in Survey of Current Practice (Chapter 4)

	PDF	HTML versions	Repositories	Call Number
Acta crystallographica. Crystal structure communications.	1	1	Wiley	QD901.A1883
British scholar.	1		Edinburgh University Press	DA20.B895
American journal of health behavior.	1	2		RA421.A512
American philosophical quarterly.	1			B1.A512
Communication quarterly	1	1	Taylor and Francis	PN4071.C734
Communication research trends.	1	2	ProQuest and Academic Onefile	P91.3.C625
Electrochemical and solid-state letters.	1	1		TP250.E37
Electrochemical Society interface.	1			TP250.E38
Forest Science	1	1	ProQuest	SD1.F716
GEO:connexion.	1			G70.2.G341
Geo-marine letters.	1	1	Springer	QE39.G345
Immigrants & minorities.	1	1		JV6002.I33
International journal of employment studies.	1	2	Academic Onefile and General Onefile	HD4811.I58
International journal of political economy.	1			HB1.I63
Journal of Asia-Pacific business.	1	1	Taylor and Francis	HF3751.J86
International review of hydrobiology.	1		Wiley-Blackwel	QH90.A1I61
Journal of clinical psychology.	1	1	Wiley-Blackwel	BF1.J621
Review of Metaphysics	1	2	ProQuest and Academic Onefile	BD11.R454
Journal of experimental psychology. Learning, memory, and cognition.	1	1	Ebsco Host	BF180.J8651
Journal of psychopathology and behavioral assessment.	1	1	SpringerIlnk	BF698.4.J65
Mediaeval Studies	1			D111.M49
Oral History Association of Australia journal.	1			D16.14.064
Environmental Values	1			H79.E5E52
Journal of economic issues.	1	2	Metapress and ProQuest	HB1.J78
Journal of ecotourism.	1	1	Taylor and Francis	G156.5.E26J86
Journal of financial and quantitative analysis.	1			HG1.J86
Population.	1	1	ProQuest	HB881.P672
Southern economic journal.	1	3	Ebsco Host,ProQuest and Academic Online	HC107.A13S727
Sociological review.	1	1	Wiley-Blackwell	NA9000.A5121
Linguistics.	1			P1.A1L755
Quality progress.	1	1	ProQuest	TS156.A1Q16
Journal of health psychology: an interdisciplinary, international journal.	1			R726.7.J68
Journal of popular film and television: JPF&T.	1	2	Academic OneFile and Taylor & Francis	PN1993.J862
Modern language review.	1			PB1.M693
New Zealand journal of crop and horticultural science.	1	1	Taylor & Francis	S17.N5691
Studies in Australasian cinema.	1			PN1993.5.A8S929
Review of religious research.	1	1	SpringerLink	BL1.R454
Journal of sustainable tourism.	1	1	Taylor & Francis	G155.A1J86
Machine learning.	1			Q335.M149

Second language research.	1			P53.S445
Bulletin of Spanish studies.	1	1	Taylor & Francis	PC4008.B8
International legal materials.	1			KZ64.I61
Journal of geophysical research. Planets: JGR.	1	1	ProQuest	QC801.J89E
New York University law review.	1			K14.N567
New York University journal of international law & politics.	1			KZ6.5.9567
Stanford law review.	1	2	ProQuest and Cengage	K23.S785
Radical philosophy.				B1.R129
Australasian science incorporating Search.	1	1	ProQuest	Q1.A9391
Journal of water resources planning and management.	1			TC401.J86
SIAM journal on optimization: a publication of the Society for Industrial and Applied Mathematics.	2	1	ProQuest	QA402.3.S564

Appendix B: Material for Paired Comparison Studies

This appendix contains material related to the paired comparison studies reported in Chapters 5, 6 and 7.

- Letter acknowledging ethical approval for Study 1a and Study 2 in print
- Letter acknowledging ethical approval for Study 1a and Study 2 on screen
- Letter acknowledging ethical approval to conduct Study 1b with graphic designers
- Copy of Participant Information Sheet for Study 1a and Study 2 in print
- Copy of Participant Information in Amazon Mechanical Turk for Study 1a and Study 2 on screen
- Copy of Participant Information Sheets for Study 1b with graphic designers
- Study recording sheet for Study 1a and 1b in print
- Example of Mechanical Turk interface for recording on screen responses for Study 1a and Study 2
- Study recording sheet for Study 2 in print

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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

20 March 2013

Claire Timpany
C/- Department of Computer Science
THE UNIVERSITY OF WAIKATO

Dear Claire

Request for approval to conduct a research study involving human participants

I have considered your request to carry out an initial study for your PhD research, *How the typographic relationships between access structure features (headings) improve within-document search and retrieval tasks in non-fiction texts.*

The primary purpose of the research is to establish which variables in typographic appearances are believed by readers to be the most influential in assisting to identify a heading within body text in both printed and screen-based environments.

The procedure described in your request is acceptable.

I note that publications and reports will not identify participants however basic demographic information may be published as well as photographs, but with facial or distinguishing features obscured. Any items of clothing or aspects of the background of the image that may lead to the identification of the participants will also be obscured.

The research participants' information sheets, consent forms and recording sheets meet the requirements of the University's human research ethics policies and procedures.

I therefore approve your application to perform the evaluation.

Yours sincerely,

Mike Mayo
Human Research Ethics Committee
School of Computing and Mathematical Sciences

Figure B.1: Letter acknowledging ethical approval for Study 1a and Study 2 in print

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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

15 July 2014

Claire Timpany
C/- Department of Computer Science
THE UNIVERSITY OF WAIKATO

Dear Claire

Request for approval to conduct a research study involving human participants

I have considered your request to carry out a study for your PhD research with the working title *Which methods of typographic emphasis for headings best assist with search in familiar and unfamiliar texts?*

The study will take place using Mechanical Turk online.

The primary purpose of the research is to establish an understanding of which variables are most effective for heading identification

I note that publications and reports will not identify participants however basic demographic information may be published.

The research participants' information/instruction sheet and questionnaire form meet the requirements of the University's human research ethics policies and procedures.

I therefore approve your application to perform the evaluation.

Yours sincerely,

Mike Mayo
Human Research Ethics Committee
School of Computing and Mathematical Sciences

Figure B.2: Letter acknowledging ethical approval for Study 1a and Study 2 on screen

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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

22 July 2014

Claire Timpany
C/- Department of Computer Science
THE UNIVERSITY OF WAIKATO

Dear Claire

Request for approval to conduct a research study involving human participants

I have considered your request to carry out an evaluation for your PhD research, *The effect of typographic variables on heading identification with graphic designers.*

The primary purpose of the research is to attempt to establish which variables in typographic appearances are believed by graphic designers to be the most influential in assisting them to identify a heading in a body of text.

The procedures described in your request are acceptable.

I note that publications and reports will not contain participants names.

The research participants' information sheets, consent forms and recording sheets meet the requirements of the University's human research ethics policies and procedures.

I therefore approve your application to perform the evaluation.

Yours sincerely,

Mike Mayo
Human Research Ethics Committee
School of Computing and Mathematical Sciences

Figure B.3: Letter acknowledging ethical approval to conduct Study 1b with graphic designers

Participant Information Sheet

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Ethics Committee, School of Computing and Mathematical Sciences

Project Title
The Effect of Typographic Variables on Heading Identification

Purpose
This research is part of a series of studies towards PhD research looking at which typographic variables of headings best assist with the search and retrieval of information in text.

What is this research project about?
The purpose of the study is to attempt to establish which variables in typographic appearance are believed by graphic designers to be the most influential in assisting them to identify a heading in a body of text.

What will you have to do and how long will it take?
This study will take place as a paired stimulus activity where participants will be shown each page of text paired with each other page and asked to indicate in which of the pages they find the headings easiest to identify, or whether they perceive no difference in the ability to identify the headings. Participants will also be asked for some basic demographic information. There is no limit to the time participants can take to perform this study, but it is estimated that it will take up to 5 minutes.

What will happen to the information collected?
This research will be published as part of my PhD thesis and presented as part of these findings in verbal presentations. The research may also be published in working papers, academic conferences and journals. The results will be presented at talks at these conferences or during visits to other universities. Only the researchers will be privy to the notes and documents of this research. Afterwards, notes and raw research documents will be destroyed. No participants will be named in the publications. Data collected from participants through the investigation will be available to be viewed only by the researchers. For the duration of the study physical documents will be kept in the locked office of the researcher. When the research is completed data will be stored in the FCMS Data Archive for 5 years before being destroyed.

Declaration to participants
If you take part in the study, they have the right to:

- Refuse to answer any particular question, and to withdraw from the study before analysis has commenced on the data.
- Ask any further questions about the study during your participation.
- Be given access to a summary of findings from the study when it is concluded.

Who's responsible?
If you have any questions or concerns about the project, either now or in the future, please feel free to contact either:

Researcher:
Claire Timpany
Email: ctimpany@waikato.ac.nz
Phone: 838 4309

Supervisors:
Sally Jo Cunningham
Phone: 838 4402
Email: ***sallyjo@waikato.ac.nz***

Lyn Hunt
Phone: 838 4466 ext 8338
Email: ***lah@waikato.ac.nz***

Figure B.4: Copy of Participant Information Sheets for Study 1a and Study 2 in print

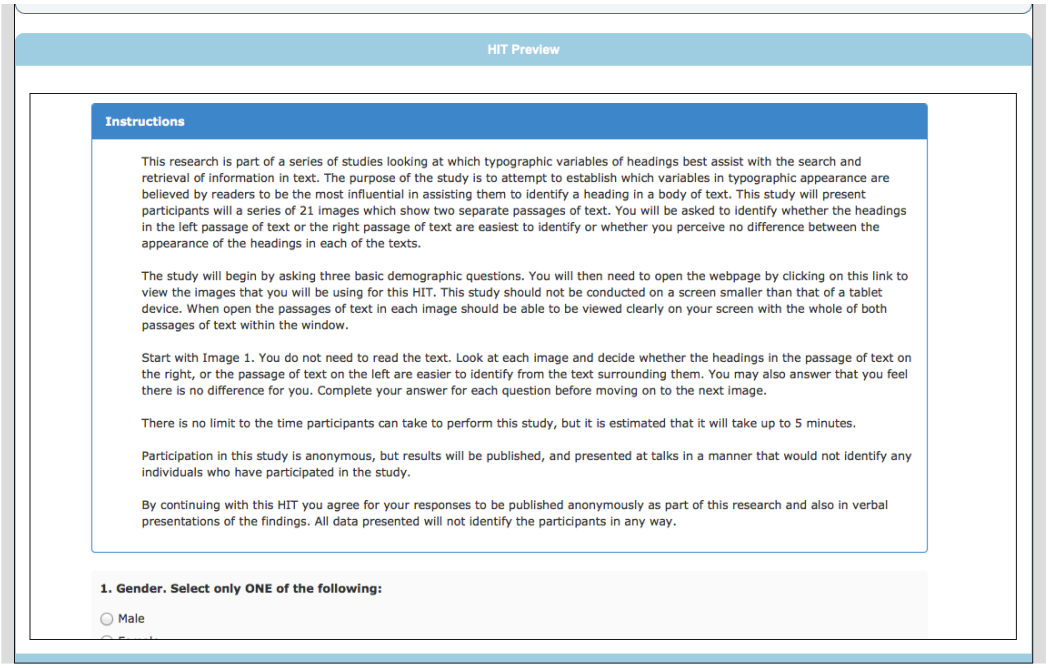

Figure B.5: Copy of participant information in Amazon Mechanical Turk for Study 1a and Study 2 on screen

Participant Information Sheet

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Ethics Committee, School of Computing and Mathematical Sciences

Project Title
The Effect of Typographic Variables on Heading Identification with graphic designers

Purpose
This research is part of a series of studies towards PhD research looking at which typographic variables of headings best assist with the search and retrieval of information in text.

What is this research project about?
The purpose of the study is to attempt to establish which variables in typographic appearance are believed by graphic designers to be the most influential in assisting them to identify a heading in a body of text.

What will you have to do and how long will it take?
This study will take place as a paired stimulus activity where participants will be shown each page of text paired with each other page and asked to indicate in which of the pages they find the headings easiest to identify, or whether they perceive no difference in the ability to identify the headings. Participants will also be asked for some basic demographic information. There is no limit to the time participants can take to perform this study, but it is estimated that it will take up to 5 minutes.

What will happen to the information collected?
This research will be published as part of my PhD thesis and presented as part of these findings in verbal presentations. The research may also be published in working papers, academic conferences and journals. The results will be presented at talks at these conferences or during visits to other universities. Only the researchers will be privy to the notes and documents of this research. Afterwards, notes and raw research documents will be destroyed. No participants will be named in the publications. Data collected from participants through the investigation will be available to be viewed only by the researchers. For the duration of the study physical documents will be kept in the locked office of the researcher. When the research is completed data will be stored in the FCMS Data Archive for 5 years before being destroyed.

Declaration to participants
If you take part in the study, they have the right to:

- Refuse to answer any particular question, and to withdraw from the study before analysis has commenced on the data.
- Ask any further questions about the study during your participation.
- Be given access to a summary of findings from the study when it is concluded.

Who's responsible?
If you have any questions or concerns about the project, either now or in the future, please feel free to contact either:

Researcher:
Claire Timpany
Email: ctimpany@waikato.ac.nz
Phone: 838 4309

Supervisors:
Sally Jo Cunningham
Phone: 838 4402
Email: ***sallyjo@waikato.ac.nz***

Lyn Hunt
Phone: 838 4466 ext 8338
Email: ***lah@waikato.ac.nz***

Figure B.6: Copy of Participant Information Sheets for Study 1b with graphic designers

Recording Sheet

(To be filled in by researcher)

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Participant ID#: _____

Age: 17-25 26-35 36-45 46-55 56-65 Over 65

Gender: Male / Female

Highest Completed Qualification: _____

Set 1

	L	R
20		
1		
19		
8		
4		
17		
13		
21		
15		
18		
10		
12		
14		
11		
7		
16		
5		
3		
9		
6		
2		

Set 2

	L	R
5		
18		
16		
8		
19		
10		
17		
15		
11		
9		
14		
20		
2		
7		
21		
1		
6		
4		
12		
13		
3		

Set 3

	L	R
2		
11		
8		
1		
7		
9		
15		
13		
16		
19		
17		
20		
18		
14		
21		
10		
6		
3		
4		
5		
12		

Set 4

	L	R
5		
19		
17		
15		
2		
14		
6		
7		
12		
11		
20		
4		
3		
21		
8		
10		
9		
16		
13		
1		
18		

Are you willing to be contacted to participate in future related studies? Yes / No

Figure B.7: Study recording sheet for Study 1a and 1b in print

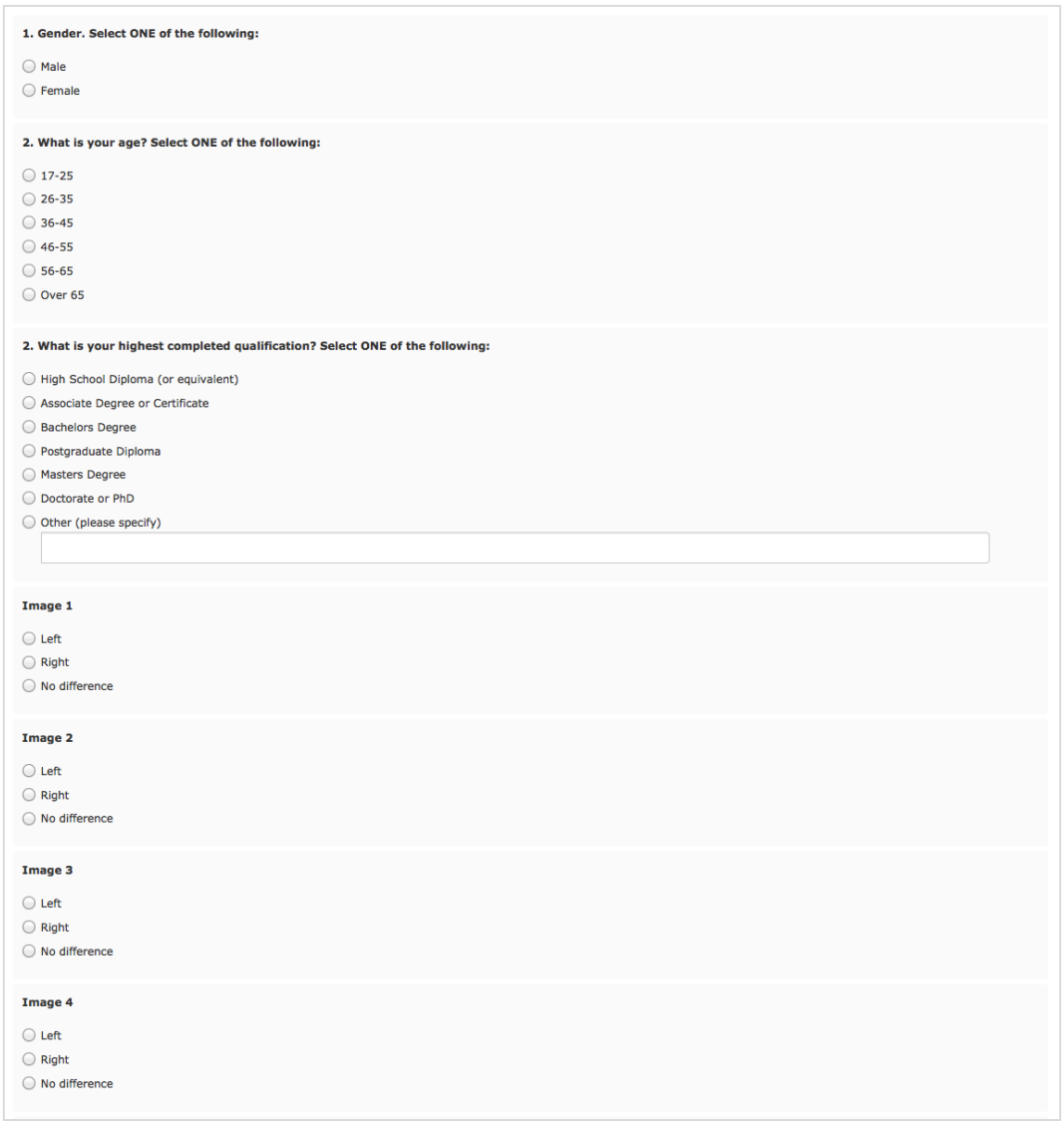

Figure B.8: Example of Mechanical Turk interface for recording on screen responses for Study 1a and Study 2

Recording Sheet

(To be filled in by researcher)

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Participant ID#: _____

Age: 17-25 26-35 36-45 46-55 56-65 Over 65

Gender: Male / Female

Highest Completed Qualification: _____

Set 1

	L	R
10		
2		
9		
3		
5		
1		
7		
4		
6		
8		

Set 2

	L	R
9		
1		
8		
2		
5		
10		
3		
6		
7		
4		

Set 3

	L	R
5		
6		
10		
7		
4		
8		
3		
2		
1		
9		

Set 4

	L	R
9		
4		
2		
8		
10		
3		
6		
5		
1		
7		

Are you willing to be contacted to participate in future related studies? Yes / No

If yes, email: _____

Figure B.9: Study recording sheet for Study 2 in print

Appendix C:
Calculation of Coefficient of Consistence
and Coefficient of Agreement

This appendix contains descriptions for the calculation of the Coefficient of Consistence and Coefficient of Agreement used in the analysis of results for Study 1a and 1b and Study 2.

- Coefficient of Consistence
- Coefficient of Agreement

Calculation of Coefficient of Consistence

The coefficient of consistence (Kendall, 1970), is calculated using a series of equations to understand the degree of consistency a participant has had when making choices in a paired comparison study. These equations take into consideration the number of circular triads within the responses of an individual.

Before calculating the coefficient of consistence, the number of circular triads within an individual's responses (d) should be calculated.

When n (the number of items being compared) is odd the equation used for calculating the coefficient of consistence is:

$$\zeta = 1 - \frac{24d}{n^3 - n}\ , n\ odd$$

In the formula used to calculate the coefficient of consistence, d is equal to the number of circular triads within the responses of a given judge and is determined by the formula:

$$d = \left(\frac{1}{12}\right)(n)(n-1)(2n-1) - \frac{1}{2}\sum a^2$$

In the formula for d, to calculate a^2, a is given by summing the number of times each item was chosen by a participant across all pairs. For example, if Bold was chosen by a participant in 5 out of 6 comparisons, a would be equal to 5 and a^2 would be 25. For the above formula, we take the sum of a^2 for all items being compared.

To understand the significance of the results for the coefficient of consistence, and therefore how likely a participants' choices are random, the formula for χ^2 given by Kendall (1970) is used:

$$\chi^2 = \left(\frac{8}{n-4}\right)\left(\frac{1}{4}{}_n \quad C_3 - d + \frac{1}{2}\right) + df$$

To calculate the number of degrees of freedom, required for the calculation of χ^2 to following formula is used:

$$df = \frac{n(n-1)(n-2)}{(n-4)^2}$$

Calculation of Coefficient of Agreement

The coefficient of agreement, defined by Kendall (1970), is used to help understand the degree of agreement between participants' in a paired comparison, as even if several participants have a coefficient of consistence of 1, they may still not agree on the order of their choices. The coefficient of agreement is calculated using only the entries below the diagonal in the preference tables (Study 1; Table 2 and

Table 3, for Study 2; Table 11 and Table 10, and for Study 3; Table 18 and Table 19). Therefore, in the calculation of the coefficient of agreement we need to acknowledge the treatment of ties in this context. Where a pair of stimuli were considered by a judge to be of equal preference, each of the stimuli in the pair were assigned 0.5 each, splitting the '1' assigned to a preferred stimuli in a pair where a judge had indicated a preference, this approach is discussed by Chamber (1940). The columns below the diagonal are totalled to give f_{ij} *and then squared to get* f_{ij}^2. Using f_{ij}^2 first, T must be found using the following formula (where m is the number of judges and n is the number of stimuli):

$$T = \left(\sum f_{ij^2} - m \sum f_{ij} \right) + \left({}_mC_2 \right) \left({}_nC_2 \right)$$

T can then be used to calculate Kendal's coefficient of agreement, which is defined as:

$$u = \frac{2T}{\left({}_mC_2 \right) \left({}_nC_2 \right)} - 1$$

The result for u can then be tested for significance using Kendall's test of significance, using the χ^2 distribution. The χ^2 (chi-squared) test measures the observed count and the expected count.

$$\chi^2 = \left[\frac{4}{m-2} \right] \left[T - \frac{1}{2} \left({}_nC_2 \right) \left({}_mC_2 \right) \left(\frac{m-3}{m-2} \right) \right]$$

The degrees of freedom for the χ^2 value is then able to be determined.

$$df = \left({}_nC_2 \right) \frac{m\left(m-1\right)}{\left(m-2\right)^2}$$

Appendix D:
Study 2 On Screen Plot of Ranking by Age

This appendix contains the full version of the plot for the comparison of on screen results compared by age bracket shown in Figure 53 in Section 7.3.3.6.

This plot gives the full output of the relative ranking of the five heading emphasis methods on screen when compared according to the age of participants. The plots shown in Figure 53 had two different scales to more clearly show the rankings because of the small number of participants aged 56+ years (n=3).

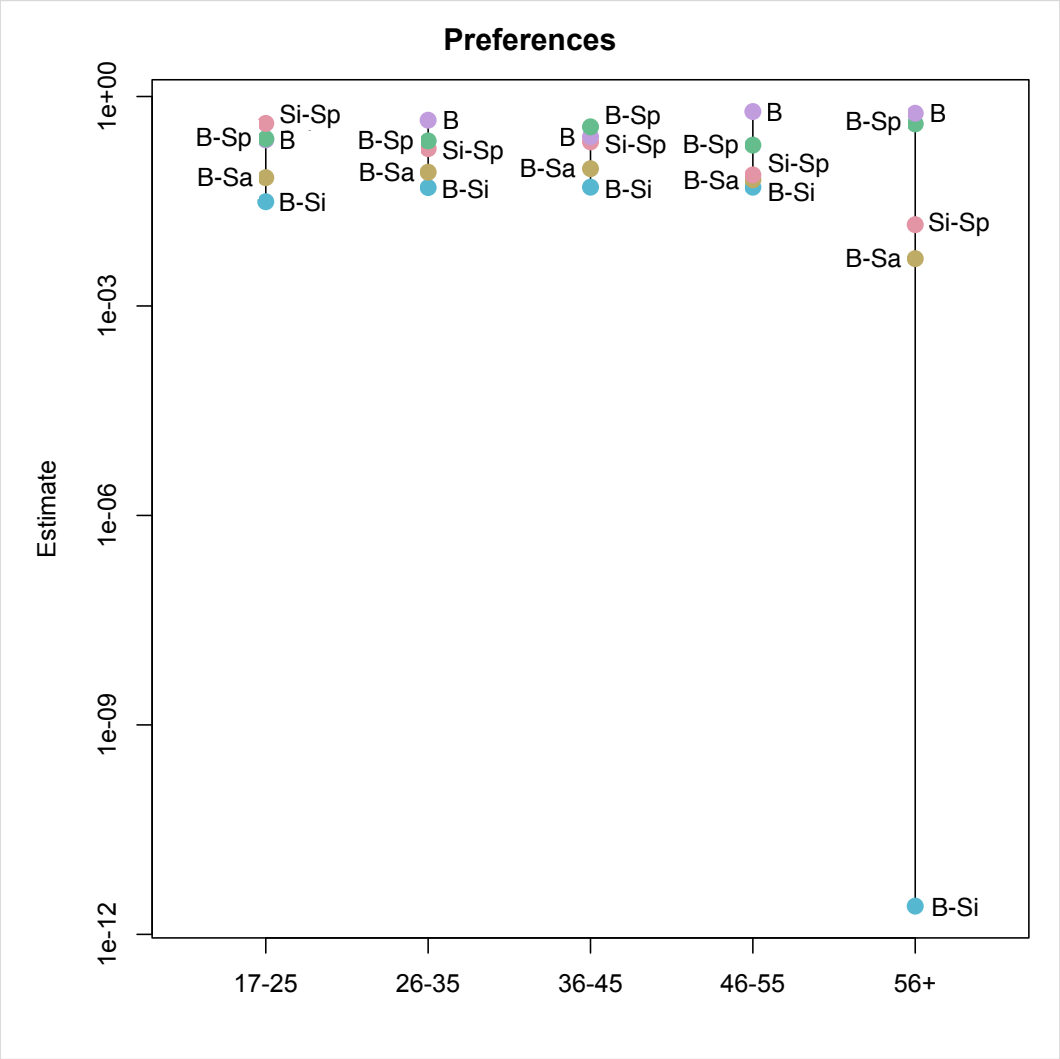

Figure D.1: Study 2 screen results by age (full plot)

Appendix E:
Material for Article Search Tasks (Study 3)

This appendix contains material related to the article search task (Study 3) reported in Chapter 8.

- Letter acknowledging ethical approval for Study 3
- Copy of Participant Information Sheet for Study 3
- Examples of interfaces from programme used for conducting Study 3
- Study 3 questions and headings

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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

13 December 2016

Claire Timpany
C/- Department of Computer Science
THE UNIVERSITY OF WAIKATO

Dear Claire

Application for approval under the Ethical Conduct in Human Research and Related Activities Regulations

I have considered your application for a research project involving human participants entitled "Typographic Heading Emphasis methods for searching familiar and unfamiliar texts".

The procedure described in your request is acceptable. I note that participants involved in the study will not be identified in publications and/or reports, and that video stills will visually conceal the identity of participants as well as obscuring any items of clothing that may lead to the their identification.

When research is completed data will be stored in the FCMS Data Archive for 5 years.

The procedures provided in your request are acceptable. The Participant Information Sheet and Research Consent Form comply with the requirements of the University's Human Research Ethics policies and procedures.

We wish you well with your research.

Mark Apperley
Human Research Ethics Committee
Faculty of Computing and Mathematical Sciences

Figure E.1: Letter acknowledging ethical approval for Study 3

Participant Information Sheet

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Ethics Committee, Faculty of Computing and Mathematical Sciences

Project Title
Typographic Heading Emphasis methods for searching familiar and unfamiliar texts.

Purpose
This research is part of a series of studies towards PhD research looking at which typographic variables of headings best assist with the search and retrieval of information in text.

What is this research project about?
The purpose of the study is to attempt to establish which variables in typographic appearance of headings are best for assisting with searching familiar and unfamiliar text to locate specific information.

What will you have to do and how long will it take?
This study will take place over four sessions. The study will comprise of four sessions where you will be asked to perform a series of search and reading tasks on screen with four different passages of text with different typographic methods for emphasizing the headings within each of the passages. For each of the passages of text you will be asked to locate answers to questions when the text is unfamiliar to you. You will be given a period of time to familiarize yourself with the text, and 2 days later you will be asked to locate different answers in the same text now that you are familiar with it. You will see two passages of text with different headings in each of the sessions. Sessions 1 and 3 are likely to take approximately 45 minutes. Sessions 2 and 4 are likely to take approximately 20 minutes each. Sessions 1 & 2, and 3 & 4 will occur 2 days apart. You will also be asked to complete a short reading speed test in the first session.
The search and familiarization reading sessions will be video recorded.
Participants who complete all four sessions of the study will be offered a $30 voucher, (unfortunately this voucher cannot to offered to University of Waikato staff).

What will happen to the information collected?
This research will be published as part of my PhD thesis and presented as part of these findings in verbal presentations. The research may also be published in working papers, academic conferences and journals. The results will be presented at talks at these conferences or during visits to other universities. Only the researchers will be privy to the notes and documents of this research. Afterwards, notes and raw research documents will be destroyed. No participants will be named in the publications. Data collected from participants through the investigation will be available to be viewed only by the researchers. For the duration of the study physical documents will be kept in the locked office of the researcher. When the research is completed data will be stored in the FCMS Data Archive for 5 years before being destroyed.

Declaration to participants
If you take part in the study, you have the right to:

- Refuse to answer any particular question, withdraw information pertaining to specific interactions observed or to withdraw from the study before analysis has commenced on the data.
- Ask any further questions about the study that occurs to you during your participation.
- Be given access to a summary of findings from the study when it is concluded.

Who's responsible?
If you have any questions or concerns about the project, either now or in the future, please feel free to contact either:

Researcher:
Claire Timpany
Email: ctimpany@waikato.ac.nz
Phone: 838 4309

Supervisors:
Sally Jo Cunningham
Phone: 838 4402
Email: ***sallyjo@waikato.ac.nz***

Lyn Hunt
Phone: 838 4466 ext 8338
Email: ***lah@waikato.ac.nz***

Figure E.2: Copy of Participant Information Sheet for Study 3

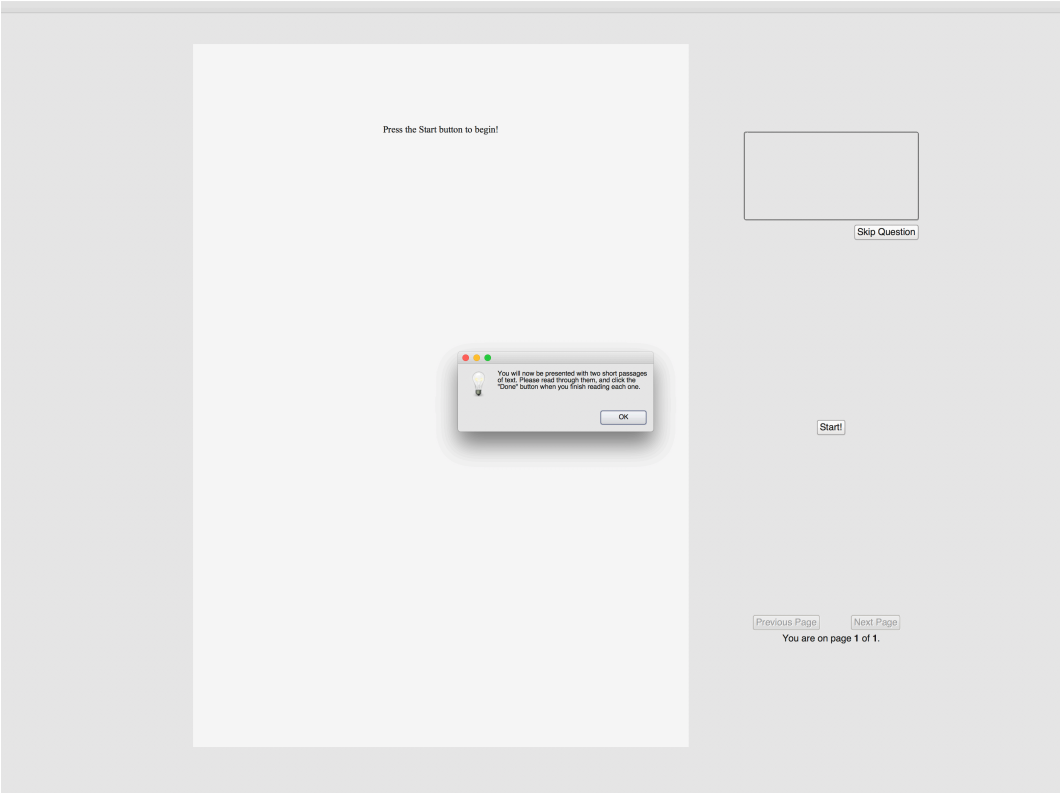

Figure E.3: Study 3 programme interface – Begin session

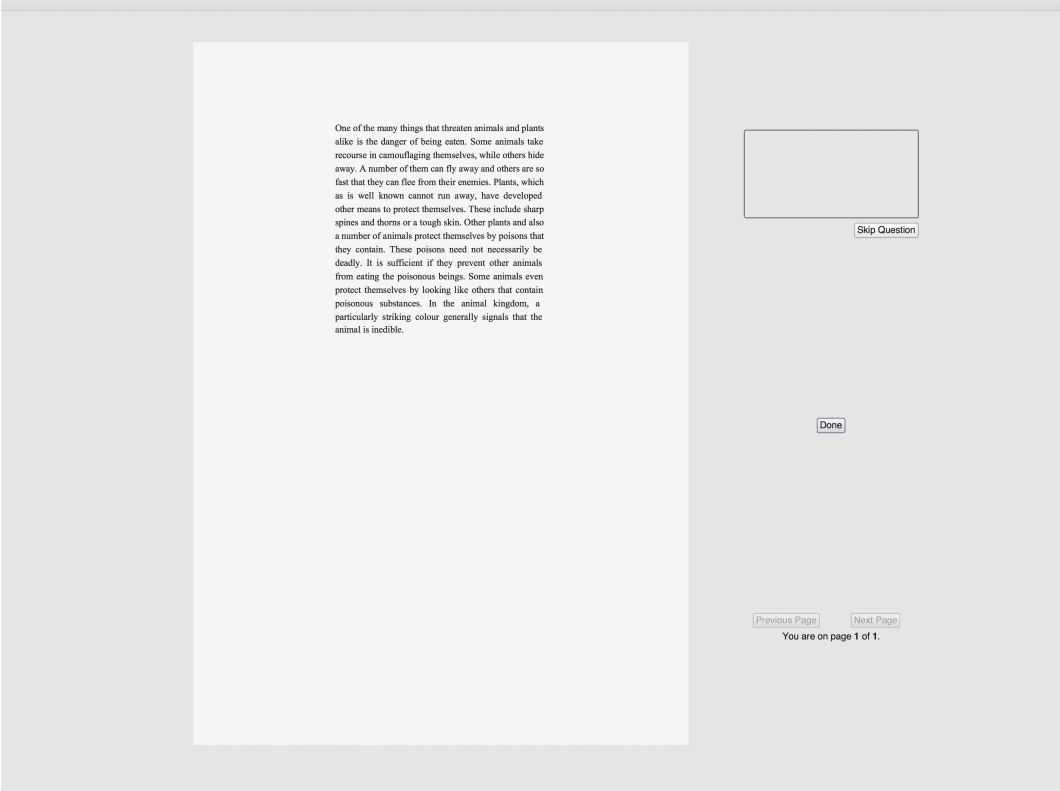

Figure E.4: Study 3 programme interface – Reading Speed Test Example

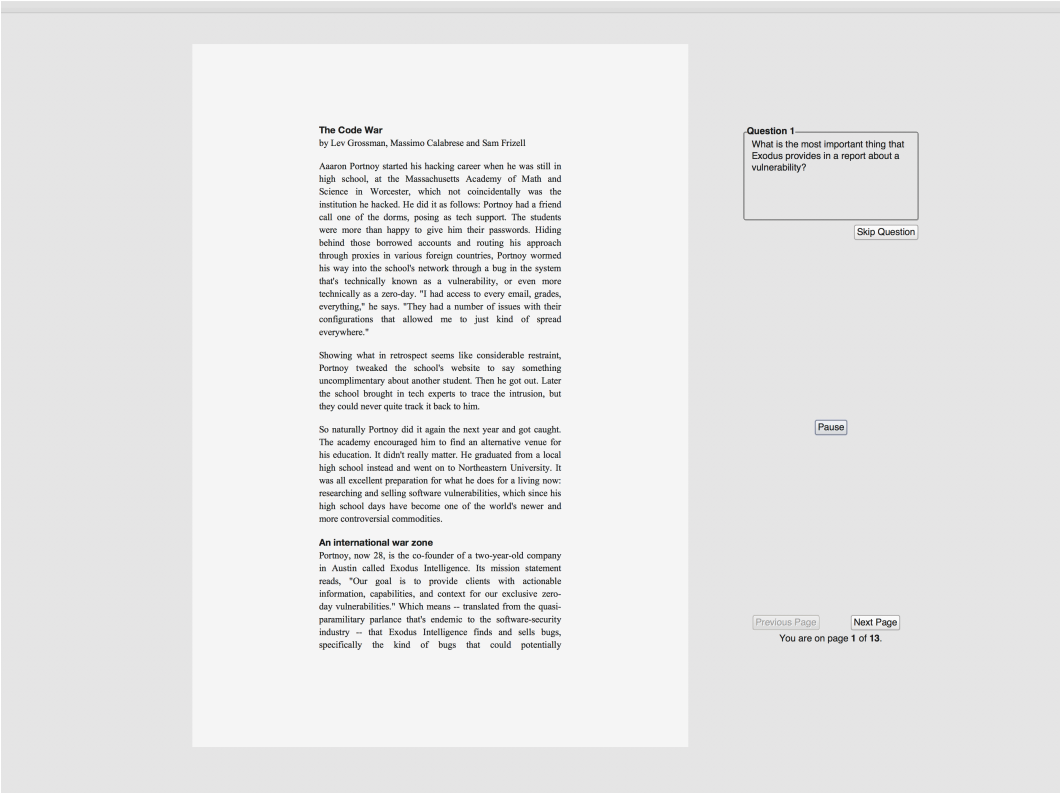

Figure E.5: Study 3 programme interface – Article search interface example

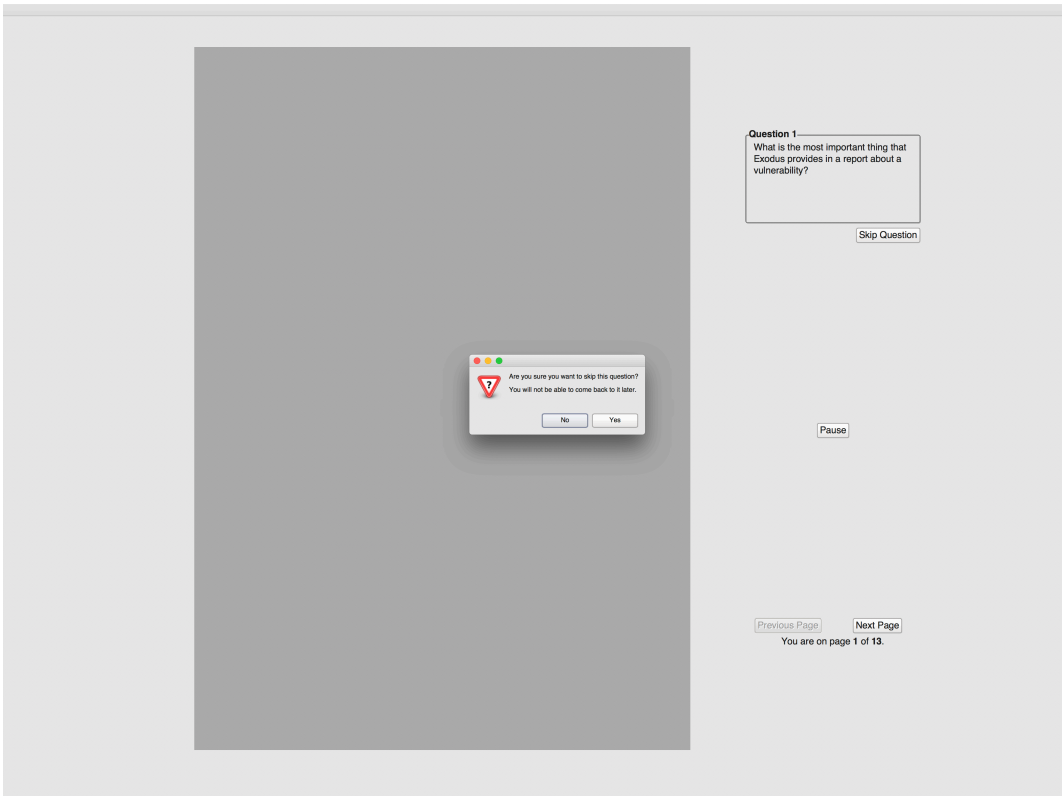

Figure E.6: Study 3 programme interface – 'Skip question' dialogue alert

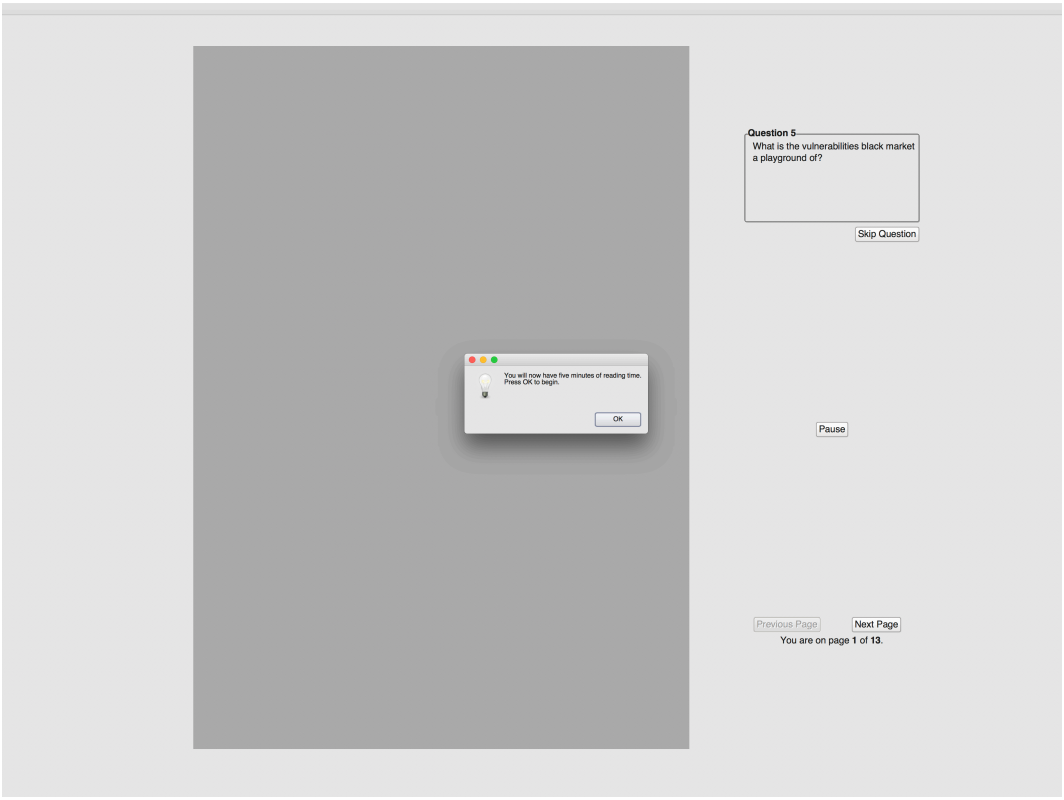

Figure E.7: Study 3 programme interface – Article search completion dialogue

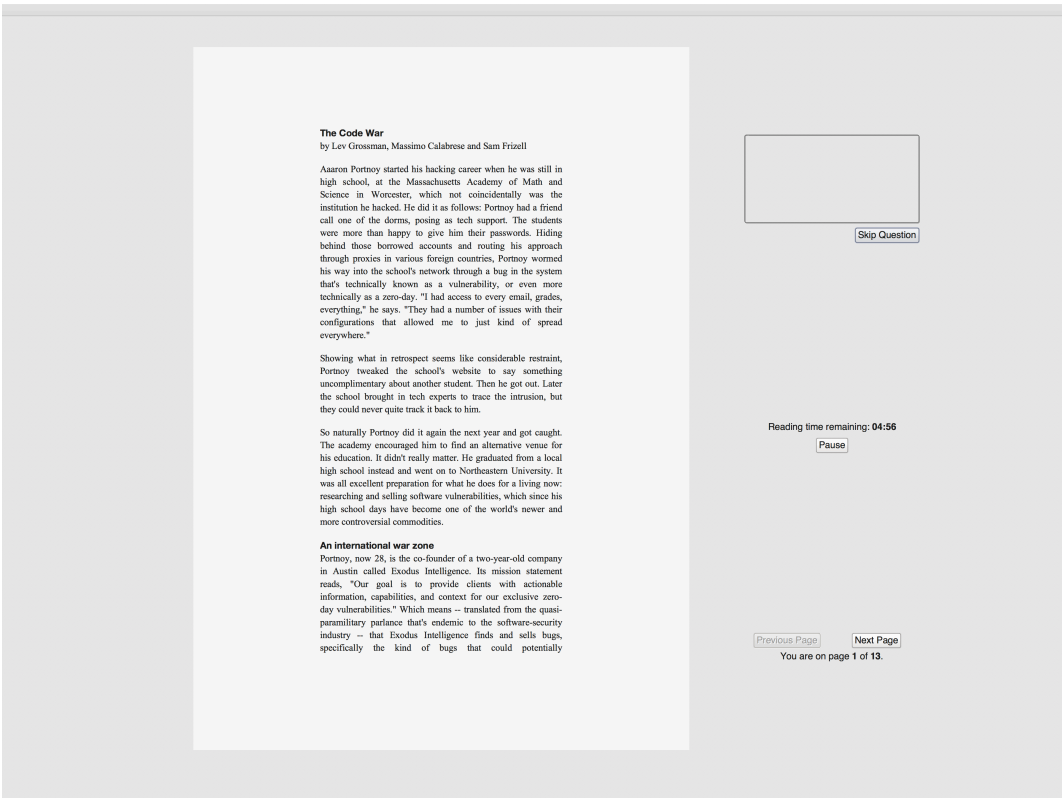

Figure E.8: Study 3 programme interface – Reading time interface example

Study 3 Questions and Headings

Headings in each article are given in bold-sans serif, with the answers that were under them listed below each.

10.1.1 Article 1 – Don't Blame Fat

Question Set a)

1. According to historian Roger Horowitz how much meat did the average 19th century American eat compared to now? (or change to 'per year'?)

2. New research suggests that overconsumption of carbohydrates, sugar and sweeteners is chiefly responsible for what?

3. Studies by Westman found that replacing carbohydrates with fat could help manage or reverse what?

4. Key's research was flawed because he left what out of his data?

5. A problem with diet research is that researchers must study nutrients in relation to what?

Question Set b)

1. According to Dr Eckel, what is said to happen when you replace saturated fats with polyunsaturated and monounsaturated fats?

2. What are simple refined cards like bread and corn converted to when digested?

3. Which of the two types of fat is cardioprotective?

4. What crop was planted to produce the sweeteners to replace fat?

5. Small LDL cholesterol particles seem to be increased by our intake of what?

The Effects of Replacing Fat

Q b) 4. Answer: subsidized corn

The New Research

Q a) 2. Answer: the epidemics of obesity and Type 2 diabetes.

The 'Two Types of Fat' Hypothesis

Q b) 3. Answer: HDL cholesterol

The Key Flawed Research

Q a) 4. Answer: countries like France and West Germany that had high-fat diets but low rates of heart disease.

A History of Meat Eating

Q a) 1. Answer: in line with what we eat now.

Unsaturated and Saturated Fats

Q b) 1. Answer: you lower LDL cholesterol

The Truth about Fat

Large and Small LDL Cholesterol

Q b) 5. Answer: Carb intake,

The Problem with Diet Research

Q a) 5. Answer: one another.

The Unintended Diet

Refined Carbs in Our Bodies

Q b) 2. Answer: sugar

Replacing Carbs with Fat

Q a) 3. Answer: diabetes.

Changing Our Eating Habits

10.1.2 Article 2 – A Star is Born

Questions Set a)

1. What is a tokamak?

2. What is the name of the phenomenon where plasma generates its own magnetic field that confines it?

3. What is the difference between nuclear fusion and nuclear fission?

4. You can make better-behaved plasma by bringing what into the realm of physics?

5. Helion Energy is competing by trying to develop what as fast as possible?

Questions Set b)

1. Has anyone achieved the "break-even point" for a reactor?

2. What is generally considered the tougher piece in the fusion two-piece puzzle?

3. What makes fusion hard?

4. According to Ronald Davidson, in a Department of Energy laboratory, how is fusion different than it is in industry?

5. What is the problem with plasma when you torture it with temperature and pressure?

The Scope of the Fusion Field

The Aim of Fusion Energy Generation

Nuclear Fusion Versus Nuclear Fission

Q a) 3. Answer: is the reverse of nuclear fission: instead of splitting atoms, you're squashing small ones together to form bigger ones.

Nuclear Fusion is Hard

Q b) 3. Answer: that atomic nuclei don't particularly want to fuse.

The Plasma Problem

Q b) 5. Answer: it becomes wildly unstable and writhes like a cat in a sack.

The Development of Tokamaks

Q a) 1. Answer: a big hollow metal doughnut wrapped in massively powerful electromagnetic coils.

The Break-Even Point

Q b) 1. Answer: nobody has quite done it yet,

The Behaviour of Plasma Particles

Q a) 4. Answer: accelerator physics into the realm of fusion,

A Departure from Theory

Energy Research in Industry and Academia

Q b) 4. Answer: the level of regulations and restrictions you have on how you do things is somewhat different

The Magnetic Fields Within Reactors

Q a) 2. Answer: phenomenon called a field-reversed configuration, or FRC

It's a Two-Piece Puzzle

Q b) 2. Answer: stabilizing the plasma

Competition from General Fusion and Helion Energy

Q a) 5. Answer: developing a smaller-scale, truck-size reactor

Startups and Research Both in The Race

How Long Until We Get It?

10.1.3 Article 3 – One and Done

Questions Set a)

1. Who creates the expectation of only children to perform at a peer level with their parents?

2. The 'second demographic transition' refers to the fertility shift that occurred when?

3. What do first borns, and those with only one sibling have an advantage in?

4. In areas of China where the one-child policy is relaxed, how many children to families usually have?

5. During a recession in the economy what quickly becomes one of the few growth industries?

Questions Set b)

1. What did a demography professor find was the reason parents often say is their reason for having a second child?

2. In the US, what is predicted to grow alongside the growing number of only-child families?

3. The undiluted resources and more attention leads to higher self-esteem and what else?

4. What is one of the most consistent self-perceived challenges for only children?

5. The early Stereotype of the lonely only child came from the work of which man?

Economics and Perceptions

a) 5. During a recession in the economy what quickly becomes one of the few growth industries?

Birth control

A Stereotype is Born

Q b) 5. Answer: Granville Stanley Hall.

The Advantages of Onelies

Q a) 3. Answer: measures of intelligence and achievement.

Undiluted Resources

Q b) 3. Answer: SAT scores

Overindulged Versus Highly Indulged

Expectations on Onelies

Q a) 1. Answer: Much of it is self-imposed

The Reason We Have More Than One

Q b) 4. Answer: parents felt so madly in love with their first child

A Parents Perspective

The Traditional Family

Family Sizes in America and China

Q a) 4. Answer: still choose to have only one

Challenges for Only Children

Q b) 1. Answer: being the sole caretaker for aging parents

Shrinking and Growing Families

Q b) 2. Answer: the number of larger families

Changing Demographics

Q a) 2. Answer: the industrial world moved from high birth and death rates to low ones.

Creating Balance

10.1.4 Article 4 – The Code War

Question Set a)

1. What is the most important thing that Exodus provides in a report about a vulnerability?

2. Ethically, who does Portnoy say they will not work with?

3. At Exodus Intelligence headquarters what is the one piece of interior decoration?

4. Who is sitting on a private arsenal of software vulnerabilities rather than reporting them and getting them fixed?

5. What is the vulnerabilities black market a playground of?

Question Set b)

1. Who do Exodus describe as their defensive clients?

2. Which company started the trend of buying their own bugs by offering rewards for finding bugs in their own software?

3. Which government was found to be using zero-days to their advantage in survailing it's dissidents?

4. The market for bugs is a consequence of what?

5. Why is it difficult to distinguish cyberespionage from the industrial cybercrime?

An International War Zone

The Market for Bugs

Q b) 4. Answer: of the larger oddness of our present technological era

The History Bugs

The Start for Exodus Intelligence

Q a) 3. Answer: a pirate flag tacked up on a wall.

The Reporting and Selling of Vulnerabilities

Q a) 1. Answer: provides you with an exploit,

Offensive and Defensive Clients

Q b) 1. Answer: security firms and antivirus vendors

Bugs for Government Agencies

Regulating Against Cyberespionage

Q b) 5. Answer: because it's so hard to pinpoint the source and intent of an attack.

The Ethics of Cyber Security

Q a) 2. Answer: embargoed countries: North Korea, Sudan, Iran, Cuba

Using Zero Days to Your Advantage

Q b) 3. Answer: Syrian government

The Black Market

Q a) 5. Answer: financially driven, highly organized and sophisticated groups."

Buying Your Own Bugs

Q b) 2. Answer: Google

Stockpiling Software Vulnerabilities

Q a) 4. Answer: U.S. intelligence agencies

An Infinite Number of Bugs

A Continually Evolving Battlefield