Everything All of the Time:
A Study of Hyperlinks and Information Overload

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Declaration

I declare that the work described in this research paper is, except where otherwise stated, entirely my own work and has not been submitted as an exercise for a degree at this or any other university.

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Abstract

The term ‘information overload’ is often used to describe the feeling of being completely overwhelmed with information, and is often attributed to the tendency for certain forms of media to overstimulate the user. In light of recent discussions surrounding the cognitive effects of Internet use, this study will attempt its own investigation into the potential connection between ‘information overload’ and hyperlinks, the mechanisms that allow for the Internet’s non-linear structure.

It will do this by first getting up to speed with past and present arguments, and will then use these arguments to inform an empirical analysis of its own. This analysis will involve three parts: a reading task, a questionnaire and an examination of articles from newspapers, magazines and blogs that give a more personal flavour to the topic of hypertext-induced ‘information overload’. This three-phased approach ties together data gathered from the distinct experimental methods, attempting to show that the difference in cognitive load levels between the control and test groups in the reading task is linked to the subjective descriptions of ‘information overload’ provided by participants and by anecdotal literature.

The study concludes that while the presence of hyperlinks increases cognitive load, its connection with ‘information overload’ is still tenuous, and that because ‘information overload’ is qualitative in nature, the degree to which it affects online media consumers has a potential for variation that this research cannot fully account for. However, it does show that a majority of participants confirmed having experiences of ‘information overload’, and this combined with the results from the reading task, as well as the analysis of the anecdotal literature, provides at least some evidence that the current organisation of information on the Web is not suited to our cognitive faculties.

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1. Introduction

"And moving thro' a mirror clear

That hangs before her all the year,

Shadows of the world appear."

The Lady of Shalott, Alfred, Lord Tennyson

Coined by Alvin Toffler in his novel *Future Shock* (1970), 'information overload' describes the feeling of being overwhelmed with information to the point of becoming disorientated, a kind of crisis brought about by too many mentally-diverting stimuli. The phrase, like many others, has continued to occupy a part of the collective conscience long after it was originally introduced, it being particularly effective at relating a kind of experience felt by many, yet that is difficult to describe more evocatively. It is a term that often appears in discussions of popular media, as it represents a subjective experience while also sounding somewhat authoritative. Indeed, while literary in origin, 'information overload' does have scientific echoes – in 1956, psychologist George Miller published a paper on working memory entitled "The magical number seven, plus or minus two: some limits on our capacity for processing information". The paper explained how our working memory, referred to by Miller as "immediate memory" (p. 91) can only take in so many discrete pieces of information before becoming overburdened. Miller's conclusion, as the title suggests, was that our working memories "impose severe limitations on the amount of information that we are able to receive, process, and remember" (p. 95). Flooding the working memory would therefore be impractical, our cognitive abilities having evolved to allow for only so much information to be processed before the surplus is lost or forgotten.

This study's aim is to establish whether or not there is a causal connection between hyperlinks and 'information overload', the former being suspected of increasing what is known in psychological and cognitive science terms as 'cognitive load'. While hypertext, the primary enabling mechanism of Web

interaction, is not the first medium to be suspected of overstimulating its users, it is the medium around which an increasing amount of discussion is taking place due to its non-linear structure and the ease with which it allows for retrieval of information. Still a medium very much in development, new and novel means of creating and distributing content via the Internet are continually being introduced, the online world being subject to a kind of ongoing experimentation in order to discover the most quick and effective ways of delivering information to the maximum number of people. Hyperlinks, a feature of most, if not all web pages, are the crux of this drive to expedite the flow of information to the user.

Therefore, it is in this study's interest to highlight these particular mechanisms in order to examine whether or not our current use of hypermedia is leading to an increase in what is colloquially described as 'information overload'. While there is already a significant body of literature surrounding hypertext and relating to 'information overload', it is, due to the mutable nature of the Web and its content, in danger of becoming transient. That is certainly not to say that the hypertext literature produced so far is entirely outdated; some of the earlier literature that attempted to dissect the structure and the mechanics of hypertext, examples of which will be discussed anon, managed to intuit its enthusiastic adoption and celebration as a boundless informational medium by those whose livelihoods and lifestyles it appeared to positively alter. Despite the restlessness of the Internet, hypertext as a medium has not, it could be argued, undergone many major shifts since its adoption, the only significant change being the extent to which it is used. The essence of hypertext is still in its non-linearity, and its promise of comparatively quick or, increasingly, instantaneous information retrieval. However, in discussing such an unstable, continually-evolving medium, it is vital to the strength of the discourse surrounding 'information overload' that research, or indeed any related literature, keep in step with the ways in which online environments are being structured and restructured over time. While most of the older studies of hypertext are well-informed and in some cases eerily prescient, the rapid evolution of hypermedia demands a likewise response from research that claims to analyse it.

Also worth mentioning is the extent to which Web-induced 'information overload' continues to receive attention in media, both online and offline, some examples of which will also be evaluated later. The phenomenon's substantial media presence confirms that it is a concern among those who use the Internet, a group whose numbers seem to expand exponentially, but that may have reservations about how their approach to online media consumption is having an effect on their ability to maintain healthy concentration and attention levels. As the Internet continues to permeate daily routine, and as different forms of information continue to be outsourced to the Web, it is important to similarly expand the discussion of 'information overload', extending the dialogue to those who have experienced similar feelings

of being overwhelmed by information but who perhaps ignore one of the potential causes, either out of habit or necessity. Research into 'information overload' can provide a solution to this need to expand the dialogue, its results potentially further legitimising the conjectural accounts of journalists, writers and bloggers who regularly feel swamped with enormous amounts of online content. Only by doing this can we ensure that measures will eventually be taken to minimise the likelihood of Internet users suffering from 'information overload', either by changing how online content is displayed or by creating opportunities to assess the behavioural side of our hypermedia consumption.

This study speculates upon the potential connection between hyperlinks and 'information overload', hoping also to establish the strength of the connection, should it be shown to exist. Bearing in mind the limited capacity of our brains for processing information (Miller, 1956), it is expected that an information-saturated medium like the Internet has some sort of cognitive effect relative to other, more traditional media. Chapter 2 will provide an assessment of some of the more notable examples of the literature dealing with hypertext, focusing primarily on academic research and the kind of ‘popular science’ writing that makes use of empirical findings, but is more literary in style. In becoming more familiar with the extant literature, it is hoped that this study can contribute to this dialogue by not only reviewing some of the key texts relating to ‘information overload’ but also by engaging in an empirical analysis of its own; Chapter 3 will be dedicated to underlining the methodological framework for this empirical aspect of the research, and will discuss the project at both its design and implementation stages. This experimental exercise will take cues from previous studies in hypertext and hypermedia before setting out to gather data with which to test the hypothesis – that there is a connection between hyperlinks and 'information overload'.

The means of data collection having thus been outlined, Chapter 4 will then explore the data, evaluating the results with reference to literature discussed in Chapter 2 and examining the effectiveness of the methodology that was employed. Having found that the presence of hyperlinks in text increases cognitive load, questionnaire responses will be analysed in order to assess, among other aspects of online media consumption, the degree to which 'information overload' is a common phenomenon. Other, more informal examples of literature relating to 'information overload' will also be discussed, so as to identify common threads of thought regarding potential causes of, and solutions to, cognitive disorientation as effected by the Internet. The final section, Chapter 5, will then conclude the study, stating whether the results of the experiment either confirm or deny the hypothesis, before outlining opportunities for further research in the area. Ultimately, the research sees itself as being part of a larger dialogue surrounding a much-documented but perhaps still vaguely-understood phenomenon and its roots in non-linear online

media. While not wanting to make any disproportionate claims, this study is a continuation of what is arguably an increasingly relevant area of discussion whose success may determine the maintaining or diminishing of important cognitive faculties, such as those involved in deep reading, maintaining focus and awareness, and being able to easily recall information.

2. State-of-the-art

Overview

The aim of this chapter is to examine some of the previous literature discussing hypertext, particularly that which deals with or relates to information overload or reader disorientation. By becoming familiarised with studies undertaken in the area to date, a more relevant and informed approach to empirical research can be taken. This chapter will review empirical studies concerning hyperlinks, hypertext and their effect on human cognition. Also being examined will be some of the more popular scientifically-minded literature that discusses the ramifications of excessive hypertext or digital media consumption; while not empirical in itself, this body of work frequently makes reference to experimental research and uses it as a jumping-off point for stimulating further discussion. By building on top of the work of existing hypertext literature, this study will provide a comprehensive, up-to-date assessment of the topic while also granting the opportunity to make up for any oversights or inconsistencies among the previous research.

Although discussions surrounding the potential for electronic media to inundate the user with information have recently taken up more space in the collective conscience, these arguments were being made relatively early after the popularisation of hypertext and hyperlinks. “Hypertext”, write DeStefano and LeFevre, “can be defined broadly as a collection of documents containing links that allow readers to move from one chunk of text to another” (2007, p. 1616 – 1617). The linked structure described here is what gives the Internet its non-linear nature, something which the literature discussing the cognitive implications of hypertext usage sets out as distinguishing it from more linear forms of media, such as written word, radio, film and television. Regardless of whether that literature chooses to laud or lament the embracing of hypertext as a way of delivering information, there is a fairly common consensus that hypertext and other forms of media shape and are shaped by the human mind, that intellectual technologies contain within them “an intellectual ethic, a set of assumptions about how the human mind works of should work” (Carr, 2010, p. 45). Given the extent to which hypertext has infiltrated daily life in the last number of years, the question remains as to whether early discussions of hypertext were accurate in their predictions, and whether they make sense within the context of more contemporary writings on the issue.

Popular Scientific Literature

Even in hypertext's infancy, some of the more effusive claims about its benefits for conveying information were being treated cautiously by those who, like McLuhan decades earlier, had recognised the potency that certain forms of media carry and the potential for them to shape and control "the scale and form of human association and action" (1964, p. 9). Prior to the development of hypertext as a medium in its own right, the written word had weathered the introduction of radio, film and television, and was still the dominant text-based means of transmitting information to be read or learned. Despite the fact that some works of literature that were considered to be non-linear already existed, hypertext was touted as a fully non-linear medium, leading to suggestions that it would liberate readers from physical text by presenting them with choices about how to advance a narrative or a flow of information. The reader of hypertext is able to "build his or her own paths, to select and organize the information relevant to his or her needs or objectives" (Rouet & Levonen, 1996, p. 9). Even as the potential of hypertext's non-linearity first began to be truly appreciated, it had been realised by some that processing information that had been gleamed from hypertext would require the reader to make use of additional mental faculties than would be necessary for the reading of linear text. Rouet and Levonen made the case that printed text allowed for the reader to be lead along the structure or the narrative imposed by the author, whereas reading hypertext would demand "active decision making on the part of the reader" (p. 12). This predicted trade-off could be somewhat negated, they proposed, firstly by "providing structural cues that make hypertext look like the traditional text structures readers usually rely on, and second, by improving the readers' hypertext literacy, that is by helping readers become…experts in the use of non-linear text" (p. 20).

There are a number of problems with this solution, particularly with the benefit of hindsight. The authors, while rightfully wary of the more emphatic claims for hypertext unshackling readers, still acknowledge that the medium poses to be extremely useful for the purposes of relaying information. However, by forcing hypertext to emulate the more linear literary structures that the reader would be familiar with, the inherent power of hypertext as a robust, user-guided medium would be somewhat nullified. The article also shows age when taking into account the sheer proliferation of hypertext since it was written; it could be argued that a very large portion of the computer-literature population now have significant levels of expertise in navigating hypertext and non-linear text due to its ubiquity. If, for example, we consider the idea of "flow" (Csikszentmihalyi, 1998) in relation to hypertext reading, and if in doing so we imagine a reader whose expertise in hypertext far exceeds the complexity of the non-linear document being read, their reaction to the text could be one of apathy, potentially making the text less remarkable and therefore more forgettable.

Some authors were notably less sparing in their criticism of some of the unsubstantiated claims surrounding the supposed emancipatory qualities of hypertext reading. One trend that Andrew Dillon foresaw as being particularly harmful is the willingness of cognitive scientists to apply technological or hypertext terminology to aspects of human cognition. “Many cognitive scientists”, he relates, “accept the computer metaphor of the mind so uncritically that it is inconceivable for them that mental life does not flow through the buffers and circuits in an algorithmic embrace of biological hardware” (1996, p. 25). This attitude, we understand, feeds into the overall structuring and design of hypertext, furthering the misconception that our brains are in some way analogous to electronic devices. In exposing this notion, the author also reveals the conflating of information *exploration* with information *integration* by hypertext enthusiasts.

Recent Writings

Despite the fact that these worries about the amount of information conveyed in hypertext were made known relatively early in its lifespan, more recent discussions contain a similarly sceptical rhetoric. This may be due in part to the fact that many of the concerns articulated by Rouet, Levonen, Dillon and others have not been fully addressed, and perhaps in some cases even ignored. Addressing the impending and widespread deficit in attention as a result of digital and online media, Maggie Jackson's *Distracted: the Erosion of Attention and the Coming Dark Age*, provides a troubling assessment of how the Internet is causing our attention to become dispersed, and how this in turn is leading to a major social upheaval that she somewhat alarmingly refers to as a new “dark age” (p. 26). By pursuing the kind of non-linear thinking that hypertext encourages, one that involves constant decision making on the part of the reader, we are, the author explains, “slipping toward a time of ignorance that is paradoxically born amid an abundance of information and connectivity” (2008, p. 16). The references to a coming “dark age” strike as being a bit hyperbolic, although it would perhaps be unfair to dismiss the author as scaremongering when considering the entirely sensible underlying premise of the book, theatrics aside. As was the case for Dillon, Jackson avoids pining after a time without the double-edged conveniences of the Internet and of technology, instead drawing our attention to the need to reassess the present, and to examine the “fine line…between rich relations and meaningless hyper-connectedness, between abundance and chaos”. The author never over-idealises the past, the primary concern for her being how we can prevent ourselves from “getting lost in these mercurial and diffuse realms, where time for reflection and focus is increasingly lost as a valued part of life” (p. 37).

While much of the popular science writing about information overload leaves the reader with a creeping sense of unease, not all of the conclusions that it draws are as bleak as that in Jackson's book. In the almost Keatsian-titled *The Overflowing Brain: Information Overload and the Limits of Working Memory*, Torkel Klingberg outlines how the technology that enables us to use hypertext has accelerated to such an extent that "[b]oundaries are defined no longer by technology, but by our own biology" (2009, p. 3). The author consistently refers to studies of working memory, which he helpfully defines as "our ability to remember information for a limited period of time, usually a matter of seconds" (p. 33). Relating how parts of the reader's frontal and parietal lobes force "a limit on how much information you can assimilate", Klingberg explains that performing an online task involving complicated text and peripheral advertisements foists upon the reader "a distraction task that places a heavy load on your working memory" (p. 163). The extra cognitive stimulation we receive when trying to balance focused reading with the high amount of visual stimulation that characterises hypertext couldn't *not* have an effect on our reading of that text.

An even more thorough assessment of the effects of large amounts of information on human cognition is provided by Nicholas Carr. While again not dismissive of the mediums strengths, Carr takes up a similar position to that of Jackson. Drawing on the idea of "positive reinforcements", he reminds us of how the Internet provides immediate or near-immediate intellectual and sensory feedback, turning us into "lab rats constantly pressing levers to get tiny pellets of social or intellectual nourishment" (2010, p. 117). The potential for media to condition the user into a kind of reward seeking behaviour is certainly not a novel one, although what Carr argues is that this tendency is accentuated when the rate of user feedback in a medium is increased. He writes: "The need to evaluate links and make related navigational choices, while also processing a multiplicity of fleeting sensory stimuli, requires constant mental coordination and decision making, distracting the brain from the work of interpreting text and other information" (p. 122). The concept of cognitive load, or "the information flowing into our working memory at any given moment" (p. 125), is central to Carr's thesis. Having referenced much of the academic hypertext literature, which on the whole showed increases in cognitive demands as a result of exposure to hypertext, the author concludes that processing these non-linear streams of information "increasers readers' cognitive load and hence weakens their ability to comprehend and retain what they're reading" (2010, p. 126).

Reading with Hypertext

Much of the empirical evidence regarding cognition and hypertext speaks directly to Carr's more accessible literary account. In a study of reading behaviour in the digital environment, participants were given questionnaires with which to provide an idea for how their reading behaviour had changed in the previous decade. While the participants reported that they spent more time reading than they had before, which the author put down to both the availability of digital text and the decided increase in information, the study found that reading in the digital environment was "characterised by more time on browsing and scanning", and that there was much less "in-depth reading and concentrated reading" (Liu, 2005, p. 705). In another series of studies into the reading of literature in hypertext form, it was found that "hypertext, as a vehicle for literary reading, seems to distance the text from the reader" (Miall & Dobson, 2001). The first study required one group of participants to read Elizabeth Bowen's short story "The Demon Lover" (1999) in linear form, while the other group read the same story but with embedded hyperlinks included in the text. A second test was also conducted, this time using as its text Sean O'Faolain's "The Trout" (1980), again being presented in linear and hypertext forms (it should be noted that in both of the studies, both texts were read on a computer, although there were no hyperlinks embedded in the linear versions of the texts). One of the participants who had read a hyperlinked text later reported that the story seemed to be "out of order". In fact, the story was presented in the same order as if it did not have hyperlinks embedded in the text, the links merely taking the reader to the next page while giving them the impression that they were determining the flow of the narrative. However, the nature of the text should also be taken into account, and it the study were to have examined a less inherently linear source text (such as an encyclopaedia entry) the reading experience may have been altogether different. In other words, the readers' prior expectations of the nature of the text that they are reading may have a lot to do with how texts are perceived in digital environments. Another participant commented about having felt more control over the narrative. This is somewhat ironic, especially when considering Miall and Dobson's earlier suggestion that hypertext is not quite as liberating as we are inclined to believe it is – that "the author's associations are not those of the reader" (2001).

Learning from Hypertext

One approach taken to the studying of hypertext looked at the role of the design and implementation of hypertext in how well information can be learned; research by Erping Zhu investigated specifically the effects of the number of hyperlinks and nodes in hypertext documents on reader cognition. The author asked students to perform reading and information-searching tasks in environments that

differed for individual participants in the number of hyperlinks and the size of the nodes that were present. The results suggested that "more links seem to hinder users from building a clear picture of a hypermedia system and establishing relationships between information in the link and that in the main node" (1999, p. 338). Confirming the suspicions about the higher mental demand that hypertext places on the readers, Zhu concludes that "the significant effect of the number of links on learning not only suggested a strong relationship between the number of links and students' learning performance, but also a relationship between the number of links and disorientation or cognitive overload" (p. 339).

Shapiro and Niederhauser, who also critiqued hypertext as an educational device, explain that hypertext learning places upon the reader a "greater degree of *learner control*" (2004, p. 605 – italics are not mine). The researchers make it clear that control is only greater relative to linear text, as Zhu seemed to imply, and that while "the sequence of accessing information in a hypertext is not imposed", the reader takes what is "a linear path through the text by following the tasks the author has established" (p. 607). This leads us to believe that the promise of freedom in hypertext, a running theme in much of the literature espousing the medium's benefits, is not as fully realised as we think it is, and that it is in fact imperative for the readers to make choices – restricted choices, no less – that still are much more taxing on cognitive load than reading a more traditional, linearly-structured text. The authors also make known the importance of the effect of prior knowledge on hypertext reading, suggesting that readers' knowledge of the topic they are coming into contact with could be another significant factor in determining the effectiveness of hypertexts as learning tools. This is certainly a reasonable conclusion to make, although it does call into question McLuhan's thoughts on the relative innocence of a medium's content when compared with the medium itself (1964). In any case, Shapiro and Niederhauser's conclusion is consistent with the empirically-based literature mentioned up to this point, although they do offer that hypertext can provide "greater opportunities for students to engage in the type of cognitive activities recognized by theorists as encouraging learning" (p. 618).

Multitasking and Hypertext

Another study into the effect of the number of links on cognition examined participants' ability to read hypertext while responding to an intermittent beeping noise by pressing a key on their keyboards (Ignacio Madrid et al., 2009). This experimental paradigm is often found in studies in the psychological and cognitive science disciplines relating to attention, the participants being asked to respond to secondary stimuli while engaging in a primary task such as reading. The research in question posited that a hypertext document containing three hyperlinks would pose less of a demand on readers' cognitive loads than a

document with eight links when either were being read, while the readers registered a series of beeps at random intervals. The results, contrary to the initial hypothesis, demonstrated that a greater number of links did not increase cognitive load, and that the cognitive faculties of the participants were only put under increased strain if they happened to choose a less coherent reading order than others. The finding that reading order has an effect on cognitive load is not unexpected. However the number of hyperlinks in the text not having an effect on cognitive load does initially seem surprising, especially when taking into consideration the results of the studies previously discussed. If we examine the methodology more closely, however, we may find issues with the decision about the number of hyperlinks to include in the different versions of the text. One could argue that the difference between three and eight hyperlinks does not constitute a significant enough variation for there to be an observed increase in cognitive load. The researchers, their initial hypothesis having been challenged, do go some way towards acknowledging this, stating that future tests could prove interesting by having a greater variation in the number of hyperlinks present across different versions of the same text (p. 73). This could determine whether or not the amount of hyperlinks in a text matters, or whether their mere presence causes disorientation in the reader, regardless of their frequency.

Materiality and Immersion as Factors in Cognitive Load

There too exist other interesting perspectives on the cognitive load debate. Focussing on fiction reading in hypertext form, Anne Mangen identifies both the immersive quality of a text and its materiality as potential variables in cognitive load. Mangen distinguishes between two kinds of immersion, that which draws the reader into the fictional world by means of "technological features and material devices" (which she terms "technological immersion") and the kind of immersion in which "the technical features of the material support…are ideally transparent" – what Mangen calls "phenomenological immersion" (2008, p. 406). The phenomenological nature of what is being read, she argues, has "consequences for our reading of different texts" (p. 408), the intangibility of text in a digital environment demanding a different treatment from the reader.

If, to return to the aforementioned study by Ignacio Madrid et al., we make sense of the results this time on the basis that the intangibility of the text increased cognitive load across the board, this introduces new difficulties to the debate. Such a conclusion would seem to disagree with some of the other literature on the topic, although the level of materiality that the text possesses shouldn't be ruled out as a factor in increasing cognitive strain. Mangen does clarify her position somewhat by referring to an online hypertext called *Lasting Image* (Guyer & Joyce, 2000), in which the story is presented from two points of view, one

using a chaotic embedded-link structure (in which some of the links are hidden) and the other merely providing the user with arrows in the corner of the screen that advance the narrative. She writes: "The mere possibility of the click bringing about some degree and kind of visual change impacts our phenomenological immersion in a narrative fiction in a way that is simply not possible when reading print narratives" (2008, p. 412). If the linked structure of a hypertext document even so much as suggests the possibility of removing the reader from the text being read, then there is a possibility that what hypertext ultimately does is effectively disengages the reader so that they must use extra cognitive faculties in refocusing their attention on the task at hand. However, it would be difficult to ignore the possibility that the very lack of materiality of hypertext increases cognitive load, and that the introduction of hyperlinks – which are a medium in their own right, if we are to follow McLuhan's reasoning that "the 'content' of any medium is always another medium" (1964, p. 8) – only further increases cognitive load relative to printed, linear text.

Conclusions

From what can be gathered from the hypertext literature to date, there is, at the very least, something of a loose consensus that hypertext and hyperlinks strain cognition relative to printed text. Although much of the popular science literature emphasises the personal experiences of the author, it usually refers to empirical studies in order to back up its anecdotal evidence. This makes it a crucial aspect of forming a wider discussion around hypertext, as it has the benefit of being able to cite experimentally-based research while at the same time addressing the reader in a more immediately accessible, and more personal, literary style. Another interesting point that both the popular science literature and the empirical studies examine is the allegedly democratic nature of the hypertext environment. While in some senses more freeing than its printed, linear counterpart, readers are ultimately walled in by design, the author of the web page having guided the user down one or several paths, all of which were put in place with a specific flow of information in mind but may lead to the original train of thought becoming frustratingly diverted.

A counterpoint to this criticism is that the far more flexible and, it could be argued, more democratic environs of websites like *Wikipedia* (www.wikipedia.org) or *TV Tropes* (www.tvtropes.org) do free the user, in as much of a way as they can be freed. These websites could both be considered extreme examples of the application of hypertext, in that text that is not purely grammatical often contains links to other pages, wherein the user is met with more links to choose from. Whether the number of hyperlinks in a page has any effect on cognition has already been addressed to some extent in the literature, although it

may have been the case that the design of the experiment may not have effectively echoed websites which users commonly interact with. More research into disorientating effects relative to the number of links on a page is therefore warranted.

Furthermore, the literature has brought to our attention the possibility that several other factors could provoke information overload in readers of hypertext. Prior knowledge could play a considerable role in the extent to which Internet users become overloaded with information. This, along with the immersive quality of the hypertext that was also discussed in the literature, is something which future studies in the area could experiment with, particularly when participants are to be met with text whose ability to maintain interest is entirely subjective. In terms of research examining printed versus digital text, materiality may be a factor. This is perhaps easier to measure effectively than immersiveness, in that text is generally either one of two states – physical or virtual – whereas measuring immersion suggests tackling the less categorical issue of how thought-provoking or engaging a piece of literature is. Varying the *kind* of text that is to be read is something which future research should also focus on, comparing, if possible, text with an obvious narrative and text with less inherent structure. Finally, in discussing the pitfalls of hypertext when it comes to presenting relevant information, the popular science literature could seek to address whether or not hypertext is itself redefining what is and isn't relevant. Practically speaking, hypertext offers a seemingly unending chain of information, and cognitive load and 'information overload' considered, it might also be worthwhile pondering how non-linear digital text is shaping how we make associations between once-discrete pieces of information.

3. Methodology & Implementation

Introduction

This study's primary concern is the potential for hyperlinks to exacerbate information overload. Many of the studies of hypertext that were previously mentioned supported the idea that hypertext does have a detrimental effect on cognition, whether, in the context of those studies, hypertext referred explicitly to hyperlinks or to any text presented in a digital environment. Therefore, the trouble with the literature dealing with the effects of hypertext exposure arises from there not having been much discussion about what the word 'hypertext' delimits as the very intangible nature of hypertext, as well as the speed with which it has become an everyday phenomenon, makes it increasingly hard to pin down. However, for the purposes of this study, 'hypertext' will be taken to refer to "a collection of documents containing links that allow readers to move from one chunk of text to another" (DeStefano & LeFevre, 2007, p. 1616 – 1617). By using this particular definition of hypertext, a distinction is made between digital text that contains embedded hyperlinks and that which does not, whether it is manifested in digital or print form. While the precise definition of 'hypertext' may be up for discussion, digital text in linear form has arguably more in common with physical, printed text than with hypertext in terms of the order in which the information that is contained within is relayed and processed. In choosing to examine the effect of both kinds of text presented in digital environments, this study does not attempt to deny or ignore the possibility that linear digital text has an effect on cognition relative to printed text. In doing so, it is merely a recognition that a significant amount of reading is now carried out online, if not by necessity then by choice, and that the ever-increasing pervasiveness of the Internet in everyday life implies a depth to the topic of digital media that demands the research in the area attempt a more specific, and therefore more realistic, appraisal.

With this in mind, the current research examines primarily the effect of reading hypertext versus reading linear digital text, and whether one kind of reading causes 'information overload' or disorientation relative to the other. Due to the increasing amount of attention that the effects of hypertext reading and exposure have been receiving in online and print media (Burkeman, 2012; Carr, 2008; Chabris, 2008; Iyer, 2012; Mullally, 2012), it is in the interest of this study, and other studies like it, that some kind of qualitative assessment be made in order to bolster the more clinical type of data that is gathered. In some senses, cultural or even anecdotal recognition of an issue like Internet-induced 'information overload' is as

effective a gauge of its veracity as hard data, and although somewhat more difficult to quantify, it remains an important part of the hypertext discourse and perhaps makes its findings more personally applicable. The object of this study is not to advocate avoiding Internet usage entirely (and in any case, this wouldn't be at all practical); it shares the conviction with most if not all of the hypertext literature that the Internet is a profoundly useful tool, and that hypertext facilitates the easy access of useful, relevant information and knowledge. What is of interest to the study is how information in hypertext is deemed to be useful or relevant in the first place, and whether or not hypertext in its current state is at all conducive to providing information that is only relevant and not needlessly fragmented. In order to best gather data that is quantitative in nature but that will lend itself to a more qualitative style of analysis, this research will attempt to recreate a fairly typical online reading environment, with the emphasis primarily on hyperlinks.

Design

In choosing a cohort of participants, it was decided that the class group of the MSc in Interactive Digital Media to which the current researcher belongs would be asked to take part in the study. This presented several advantages, one of which was the fact that students' places on the course necessitated a significant degree of familiarity with computers and with the Internet. In choosing a group of participants who had developed or were developing a high level of technological expertise, the research sought to minimise any variations in the results that could correspond with digital media proficiency. That being said, it was decided that the fairly wide age-range among the students would be taken into account in the event that the results from the experiment could be better analysed when situated within a larger demographic context. The relatively even female-to-male ratio was also taken into consideration, it providing another metric with which to contextualise quantitative data where it proved relevant. Furthermore, recruiting participants from the Interactive Digital Media class meant that they could be contacted via the class email mailing list, allowing for all communication to take place in one manageable virtual space.

Another, somewhat more contentious reason for the choosing of this particular cohort was that it ensured a relatively high response rate to the experimental part of the research. The mailing list mentioned above was used for all necessary communication from the University and to and from lecturers, and therefore needed to be regularly checked. However, while certainly a boon to carrying out the research, one could take issue with the fact that classmates may, in some sense, have felt *obliged* to help with the research, and therefore the need for participation to be voluntary could have been compromised; although proving a more convenient, less hands-on approach to selecting participants, one could argue for the research not being entirely representative of the wider Web-using community. Nevertheless, in the interest

of time and efficiency, as well as taking into account the notably broad demographic make-up of the class, the Interactive Digital Media students were deemed to be the most suitable participants.

In designing the first task, it was decided that the participants would be split into control and test groups. The test group would receive a piece of text containing hyperlinks, and would be timed to determine how long it took them to read the provided material. The control group received the same text, but without the embedded hyperlinks, the expectation being that the greater cognitive demands that hypertext places on readers relative to linear text would mean that the test group would take longer on average to complete the task than the control group. Several other measurement options were also considered, including the use of eye-tracking equipment, and testing participants on their ability to remember parts of a provided text. Timing the participants was ultimately chosen, as it was deemed to be both non-invasive and complimentary of survey questions regarding reading experience, concentration and feelings of 'information overload'. However, it is important to stress the fact that any variation in timing between the two groups could not by itself confirm or deny the hypothesis; if a participant experienced an increase in cognitive load, that would not necessarily imply that they were suffering from 'information overload', itself a qualitative phenomenon. To make up for this, it was concluded that the first task would be complimented with another method of gathering data, one that could potentially bridge the empirical gap between cognitive load and 'information overload'.

Selecting the text which the participants would be asked to read proved a somewhat subjective process. Ultimately, it was decided that a reformatted version of the Wikipedia entry for the 'Carnation Revolution' that took place in Portugal in the 1970s would be used, as this was deemed to be stimulating enough to engage readers, yet obscure enough so that the effects of prior knowledge could be minimised (as discussed in the previous chapter).

The embedded hyperlinks in the text that the test group received would, when clicked, bring the participant to a variety of different web pages that corresponded to the highlighted word or words. Again, the relevance of the pages that were linked to was a matter of personal judgement. However, bearing in mind Markham's description of the Internet as "a multiplicity of cultural phenomena not limited to either a monolithic entity or a universal set of experiences" (2012, p. 379), an attempt was made to incorporate the various forms of media – text, image, video – that make up a large part of peoples' online experiences. Taking into account the amount of hyperlinks incorporated in the text and the varied nature of the media they provided access to, it was decided not to measure the number of links that participants clicked on, or

which ones were clicked on. While potentially making for an interesting and relevant exercise, the current study made a point of studying hyperlinks at an abstract, mechanical level, as a more minute analysis would demand a greater amount of time than was available to perform the research. For the sake of authenticity, participants were not discouraged from visiting other websites in other tabs or browser windows, as this wouldn't be entirely faithful to the multi-tasking dynamic of modern Internet usage.

An important aspect of the reading experiment was that, in order to best emulate a set of everyday online interactions, the participants were not to be told beforehand that they were to be timed. Should they have been made aware of the covert side of the experiment, the participants might have been led to believe that completing the reading task in the shortest possible time was the main objective. Therefore, to preserve the nature of the task, it was decided that the participants would be told of their having been timed *after* they completed the reading, then being offered a chance to opt out of having their data submitted if they objected to the covert nature of the experiment. Shaughnessy, Zechmeister and Zechmeister provide a guideline for deceiving participants for the purposes of generating data when they discuss the “moral principle of ‘beneficience’”, referring to “the idea that research activities should be beneficient...for individuals and society”. “If deception is shown to harm individuals or society”, they surmise, “then the beneficience of the research can be questioned” (2009, p. 419). With this is mind, the covert aspect of the task was included in the design, it having been deemed inoffensive enough not to pose any major issues. In any case, an intermediate page offering participants an option to opt out was displayed before they were directed to the questionnaire (see Appendix A).

For the second task, the participants took part in a questionnaire asking them about their personal experiences with hyperlinks, information overload and online media. This was thought to be another effective way of gathering data, the nature of which would be quantitative but that would allow for a more qualitative assessment of information overload, something which was reflective of the research as a whole. The decision to add another quantitative dimension to the research as opposed to a qualitative one was influenced by the level of practicality that it would pose for data analysis; the questionnaire, while quantitative in nature, provided answers that were qualitative *enough* to compensate for the drawbacks of the reading task. Participants were to be offered a series of questions, the answers to which would be presented in 'Likert scale' form, a paradigm borrowed from other psychological and cognitive research that uses self-report methods of gathering data. This allows participants to respond to questions with one of a series of answers, ranging from “Strongly Agree”, to “Neither Agree nor Disagree”, to “Strongly Disagree”, or from “Almost Always” to “Almost Never”, or similar. Despite its seeming flexibility, this method of gathering data is not without its flaws, as people responding to the questionnaire “may have to choose a

less-than-preferred response because no presented alternative really captures their view" (Shaughnessy, Zechmeister, & Zechmeister, 2009, p. 167). All things considered, while still locking participants into giving one of a predefined series of answers for fairly non-negotiable questions, this method does provide a spectrum upon which a more extensive series of answers than other quantitative methods afford can be situated.

In terms of individual questions, great care was taken so as not to lead the participant towards a certain conclusion. When a situation arose in which asking a leading question couldn't be easily avoided, it was made sure that the questionnaire provided other questions that, in some sense, balanced out any shifting to one side. Some questions were worded positively, while others were more negative (Sproull, 1995, p. 201), and the questionnaire posed more general questions to participants before becoming increasingly specific (Groves et al., 2004, p. 232). Attention was also paid to "context effects", which are described as "influences on question answers that occur because of information passed on to the respondent *from the survey environment* in which the question is answered" (Smyth, Dillman, & Christian, 2007, p. 430 – italics are not mine). According to Smyth, Dillman and Christian, "presenting all of the questions on one screen allows respondents to easily scroll back and forth throughout the survey...to re-examine relationships between questions, but in doing so may increase the likelihood of context effects" (p. 435). Although the questions being situated on a single webpage allowed for a more accessible questionnaire, it is worth acknowledging that this design may have allowed participants' earlier answers to inform their later ones.

Two additional questions, pertaining to age and gender, were also included in the questionnaire, in order to provide some context in which to situate the responses where it was warranted. It was also made clear to the participants that each question in the questionnaire was optional, and that they would be free to skip questions that they did not wish to answer.

In order to compliment the quantitative data generated from the first two methods of research, the third portion of the study examined personal, anecdotal accounts of information overload (regardless of whether this terminology was used) from magazine and newspaper articles. While in some sense providing a less time-consuming alternative to direct interviews, these articles also reflected a thoroughly-considered, literary body of work from which to draw out evidence about the potential links between hyperlinks and 'information overload'. The criteria for selecting these articles were fairly relaxed, although those that were selected had appeared in fairly reputable or well-known media sources.

As previously mentioned, first-hand discussions about phenomena like information overload are in many ways very valuable, and while much more conjectural, they are also more immediately accessible than boiled-down data, and therefore may be more likely to spark off a wider debate.

Due to the fact that the research involved human participants, it was necessary to gain ethical approval from the University before beginning the study. An application outlining the experiment was sent to the Ethics Committee, explaining in detail how the data was to be gathered and pre-empting some of the more noteworthy ethical issues. The Committee approved the experiment, deeming it to be in compliance with the ethics regulations of Trinity College Dublin.

Implementation

Participants were divided into two groups, the control group and the test group, using systematic sampling, a method involving the choosing of participants from a list at a preselected random interval; once half of the participants on the list were selected they were put into the control group, the remaining participants making up the test group. Due to the cohort not being large enough to warrant a more heterogeneous selection method, this was deemed to be the best approach, despite the potential significance of the relative diversity in age and gender among the class. Each group was then sent an email (see Appendix B) informing them of the study and providing them with a link to the experiment. Due to the fact that there were two versions of the reading task, two different links were used, and the subsequent pages from the respective versions of the text were also kept separate in order to keep the data organised. Before being taken to the first task, participants were asked to read the Information Sheet (see Appendix C), from where they would be directed to the Consent Form (see Appendix D). It was understood that participation in the study could be ended at any time by closing the active tab or the browser window. By clicking on the link at the bottom of the Consent Form, they agreed to take part in the experiment.

After the reading task, the participants were taken to an intermediate page in which they were alerted to the fact that they had been timed, and were offered the option not to have their data analysed (see Appendix E). Once they had indicated their preference, they were directed to another page which, had they agreed to have their data analysed, would record the time in seconds that they spent on the reading task to a text file on the University's web server. This data was only accessible by the current researcher.

From there, the participants were taken to the questionnaire portion of the study, which was made using the *Survey Monkey* website (www.surveymonkey.com), an online questionnaire tool designed to make creating and deploying questionnaires straight-forward. Two identical versions of the questionnaire were used for each group, so that if necessary, the results from the reading task could be brought to bear on the questionnaire responses. They were presented with a set of twelve questions, ten relating to hyperlinks, information overload, reading and online media, and two relating to the age and gender of the participants. Upon completing the questionnaire, the participants were thanked for taking part.

4. Results & Evaluation

Reading Task Results

Average Time Spent Reading Text

Control Group: 3 mins 37 secs

Test Group: 5 mins 32 secs

Questionnaire Results

Q.1 For approximately how long do you use the Internet on a daily basis?

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
0 – 1 hours	0%	0	0%	0
1 – 2 hours	0%	0	0%	0
2 – 4 hours	28.57%	2	28.57%	2
4 – 6 hours	28.57%	2	28.57%	2
6+ hours	42.86%	3	42.86%	3

Q.2 For approximately how long do you spend reading every day, online or otherwise?

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
0 – 1 hours	0%	0	0%	0
1 – 2 hours	42.86%	3	28.57%	2
2 – 4 hours	28.57%	2	28.57%	2
4 – 6 hours	28.57%	2	28.57%	2
6+ hours	0%	0	14.29%	1

Q.3 About how much of your reading is done online/using an Internet-capable device?

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
None	0%	0	0%	0
Some	0%	0	0%	0
Roughly half	14.29%	1	42.86%	3
Most	85.71%	6	57.14%	4
All	0%	0	0%	0

Q.4 Do you find it easier to read text online (on a website, in an online article, etc.) or physical text (a novel, a magazine, a newspaper, etc.)?

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
Much easier to read text online	0%	0	0%	0
Somewhat easier to read text online	14.29%	1	0%	0
Both are equally easy/difficult to read	28.57%	2	14.29%	1
Somewhat easier to read physical text	42.86%	3	28.57%	2
Much easier to read physical text	14.29%	1	57.14%	4

Q.5 Indicate whether you agree or disagree with the following statement: "Reading online allows me to remember more of what I have read than reading printed text"

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
Strongly agree	0%	0	0%	0
Somewhat agree	0%	0	0%	0
Neither agree nor disagree	28.57%	2	14.29%	1
Somewhat disagree	71.43%	5	28.57%	2
Strongly disagree	0%	0	57.14%	4

Q.6 Indicate whether you agree or disagree with the following statement: “Reading online negatively affects my ability to concentrate on what I'm reading”

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
Strongly agree	0%	0	14.29%	1
Somewhat agree	42.86%	3	57.14%	4
Neither agree nor disagree	28.57%	2	28.57%	2
Somewhat disagree	28.57%	2	0%	0
Strongly disagree	0%	0	0%	0

Q.7 Is finding information online easier or more difficult than finding information from printed text?

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
Much easier	71.43%	5	42.86%	3
Somewhat easier	28.57%	2	28.57%	2
Neither easier nor more difficult	0%	0	28.57%	2
Somewhat more difficult	0%	0	0%	0
Much more difficult	0%	0	0%	0

Q.8 How helpful are Hyperlinks in allowing you to concentrate on what you are reading?

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
Very helpful	14.29%	1	0%	0
Somewhat helpful	28.57%	2	42.86%	3
Neither helpful nor unhelpful	42.86%	3	14.29%	1
Somewhat unhelpful	0%	0	42.86%	3
Very unhelpful	14.29%	1	0%	0

Q.9 Do you find that text with hyperlinks provides for a better or worse reading experience than reading text without hyperlinks (this may be either printed text or digital text without hyperlinks)?

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
Much better	28.57%	2	0%	0
Somewhat better	14.29%	1	42.86%	3
Neither better nor worse	28.57%	2	14.29%	1
Somewhat worse	28.57%	2	42.86%	3
Much worse	0%	0	0%	0

Q.10 Indicate whether you agree or disagree with the following statement: "I sometimes feel that I suffer from 'Information Overload' "

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
Strongly agree	14.29%	1	14.29%	1
Somewhat agree	57.14%	4	57.14%	4
Neither agree nor disagree	14.29%	1	0%	0
Somewhat disagree	0%	0	28.57%	2
Strongly disagree	14.29%	1	0%	0

Q.11 What is your age?

Control Group	Test Group
Age	Age
40	28
25	23
24	25
37	25
24	24
27	24
22	31

Q.12 What is your gender?

Answer Options	Control Group		Test Group	
	% Response	Response Count	% Response	Response Count
Female	14.29%	1	57.14%	4
Male	85.71%	6	42.86%	3

Analysis

Out of all of the people that had been contacted about the research, fourteen took part in the experiment. The final number of participants was divided evenly between the control and test groups, each having contained seven participants, which made comparing both groups' questionnaire responses easier. Although one participant in the control group opted out of having their data for the reading task analysed, all of the participants in the cohort responded to the questionnaire, with no question being left out in either group. All respondents were between age twenty-three and forty; the average age of the respondents in the control group was twenty-eight, and for the test group, twenty-six.

As previously stated, the advantages of asking the students of the Interactive Digital Media class to take part in the experiment were several; as well as posing the possibility of a higher-than-normal participation level, a certain level of technological expertise and familiarity with hypertext could be assumed. Furthermore, the demographic make-up of the class was such that it contained students of varying ages, and of both genders. However, there are some drawbacks to selecting this class as a cohort that deserve to be mentioned, drawbacks that, it could be argued, threaten to distort slightly the results; due to the fact that the current researcher is also a member of the Interactive Digital Media class, students may have felt obliged to participate in the research, which could somewhat negate the voluntary aspect of deciding whether or not to participate in the experiment. Additionally, despite the considerable diversity in age and gender of the students in the class, one could still take issue with the study's ability to generalise

the results, the group perhaps not being representative of a larger Web-using community in certain respects. With this is mind, a more ideal selection method would recognise a greater number of demographic factors, but taking into consideration the limited time frame in which the current research was conducted, it was felt that the chosen group was adequate, and that the results could, at the very least, be extended out to certain, more specific subgroups of society.

Overall, the results of the reading task were conclusive; on average, the test group took almost two minutes longer to read the provided text than the control group. Although individual reading times occasionally differed, the difference in the average reading time between the two groups ultimately proved quite significant, in that it added more weight to the idea that hypertext consumption increases the demands placed on cognition (Liu, 2005; Miall & Dobson, 2001; Shapiro & Niederhauser, 2004). However, one shortcoming of using timing as the primary measurement for the reading task was that it only provided evidence for increased cognitive load from hypertext reading, 'information overload' evidently not being an inevitability of meeting greater cognitive demands in some cases. Therefore, the only confirmation that the reading task provided was that the participants in the test group experienced an increase in cognitive load relative to the control group, leaving the task of validating the hypothesis – that there is a connection between hyperlinks and 'information overload' – to the latter parts of the research.

Initially, the answers given for the questionnaire were for the most part consistent across both groups. The responses from **Question 1**, which asked participants about their daily Internet usage, showed that a majority of the participants spent more than 6 hours on the Internet per day. This was not entirely surprising given the nature of the course being undertaken by the students. One potential oversight was that the question didn't distinguish between passively having a browser window open in the background and actively 'using' the Internet, the criteria for actual Internet use having become somewhat hard to pin down with the increasing ubiquity of always-on broadband and mobile Internet access.

Responses for **Question 2**, which asked about daily reading times, were similar to the previous question, although more respondents in the control group read for one-to-two hours than did respondents in the test group, with one respondent in the latter reading for more than six hours a day. For **Question 3**, participants in both groups answered either "Roughly Half" or "Most" to the question "About how much of your reading is done online/using an Internet-capable device?", hinting at the extent to which digital devices have permeated daily life. Again, this is not particularly revealing, but nonetheless provides an interesting look at how 'reading' as we know it has come to be predominantly carried out through a non-

linear and, some might argue, non-literary medium, hence the question's inclusion in the final version of the questionnaire.

The results that were generated from **Question 4** were more eclectic. In response to participants being asked whether they found it easier to read physical or online text, a significant majority of the test group at said that they found it "[m]uch easier to read physical text", whereas those in the control group favoured slightly more neutral responses overall. Part of this may be to do with the phenomenological nature of the medium in question; when reading a physical text such as a book, "the technological artefact...partly withdraws, so that our intentionality is primarily directed towards the narrative fiction itself, and not to the technological object" (Mangen, 2008, p. 415). On the whole, however, the broader trend suggested that participants found it easier to read physical text. The results from the reading task add another dimension to this response, indicating that the very idea of reading online text may by default conjure up images of documents saturated with hyperlinks and other diverting features of hypermedia.

The responses to **Question 5** indicated that a majority of the participants didn't agree with the statement "Reading online allows me to remember more of what I have read than reading printed text". This is consistent with Liu's finding that "screen-based reading behaviour is characterised by more time on browsing and scanning, keyword spotting, one-time reading, non-linear reading, and more reading selectively" (2005, p. 705). Being somewhat mixed, the results for **Question 6** were a bit more difficult to account for, especially when taking into consideration responses to previous questions. The question asked the participants to indicate whether they agreed or disagreed with the statement "Reading online negatively affects my ability to concentrate on what I'm reading". The word "concentrate" is nuanced enough that in some respects it could be thought to be independent of readers' preferences for whether the material they read is in digital or print form. Readers' abilities to concentrate on online text might be considerably high when considered in isolation, and therefore the question may have yielded more consistent results if the participants were asked to compare concentration levels between online and printed text.

Question 7 was a more straight-forward affair, a majority of participants indicating that they found it easier to retrieve information online than from printed text. The true power of the Internet as a technological tool, this seems to suggest, lies not in allowing its users to switch between linear and non-linear manifestations of the medium without any cognitive overhead required, something which previous research has come to refute (Miall & Dobson, 2001; Shapiro & Niederhauser, 2004), but in its capacity to

index information and allow for its instantaneous or near-instantaneous retrieval. Despite its detrimental effects on the user's cognition, the Internet is still an immensely beneficial technology, the question remaining how to maximise its potential without inadvertently compromising important mental faculties.

Perhaps the most varied set of results was that for **Question 8**, which asked participants to rate how helpful hyperlinks were in allowing them to concentrate on what they were reading. The results revealed the lack of common consensus on whether or not hyperlinks aided concentration when reading, a discrepancy which might be accounted for in the fact that one's concentration level is relative to the kind of task being undertaken and the medium in question. **Question 9**, which asked about the effect of hyperlinks on the participants' reading experiences, also provided a scattered set of responses. Personal preference is likely the most crucial influence on one's reading experience; whether the reader's experience is quantifiably 'good' or 'bad' could be based off of a number of factors, such as how interesting a text is, how long it is and the difficulty of the language used within. In their comparison of experiences of linear and non-linear fictional text, Miall and Dobson note that a participant who was asked to read a hyperlinked version Sean O'Faolain's "The Trout" (1980) enjoyed the short story "not because she found it interesting or emotionally engaging, but simply because she was able to piece together the plot" (2001). When a reader is involved in this kind of piecing together a non-linear version of a text, they may become "part of the meaning construction as they 'write' an individualized text that may differ from what the author intended" (Shapiro & Niederhauser, 2004, p. 607). Miall and Dobson found that for the readers of the non-linear configuration of the story, "attention was directed towards the machinery of the hypertext and its functions rather than to the experience offered by the story". Again, this could potentially be put down to Mangen's idea of "phenomenological immersion" (2008, p. 406), the fixed nature of a physical text's presentation proving less jarring on the senses than its hypertext equivalent. With this in mind, perhaps the mixed response to this question indicates that 'reading experience' is linked to the immersive quality of a text, some readers preferring to be drawn seamlessly into a narrative while others relish the more mechanical aspects of the literature.

Question 10, the last 'closed' question, asked respondents to indicate their level of agreement or disagreement with the statement "I sometimes feel that I suffer from 'Information Overload'". While a majority in both groups agreed with this statement, the verdict wasn't quite unanimous. This may simply be due to some participants having internalised more effective strategies at dealing with large swathes of information, or may even be due to how much of certain *kinds* of hypermedia they consume. Alternatively, increased cognitive load may not pose as much of a problem for some participants as it does for others, those in the minority perhaps not being as prone to 'information overload'. What this question was

ultimately interested in gauging, though, was how common an experience 'information overload' was, and whether its prevalence would correspond to both the amount of attention the phenomenon receives in various media outlets, and to the difference in the groups' reading times for the first task.

Evaluation of Literary Material

In order to balance out the purely quantitative end of the research that was undertaken, several articles from newspapers, magazines and technology websites were examined so that an idea could be gotten of the amount of attention given to 'information overload' in the public discourse. These articles, having been gathered from a variety of publicly available media outlets, provide an alternative, anecdotal examination of the effects of Internet usage, and of hypertext and hyperlinks, than do those from academic backgrounds. While research studies are sometimes provided as evidence for the negative effects of the Internet on cognition, the articles being examined mostly rely on personal experiences and observations of the authors in question. These accounts don't necessarily hold any empirical sway in the traditional sense – however, what this part of the research is concerned with is whether or not there is a kind of conjectural consensus established from the writers' shared experiences. In the cases where these articles put forward ideas about how to counter the effects of 'information overload', these will be evaluated in light of the advice the scientific literature that has been previously discussed has provided.

Something that receives a significant amount of attention in the 'information overload' literature is the idea that online environments are so inherently distracting because of the level of novelty that they continually promise. Christopher Chabris, in an article for *The Wall Street Journal*, writes the following: "We are easily distracted…because we vastly overvalue what happens to us *right now* compared with what comes in the future and because novelty is intrinsically rewarding" (2008 – italics are not mine). Our ability to be distracted is made worse by the fact that, on some level, we seek out novel informational content. The reason that the Internet is a prime culprit here is that it makes accessing that content almost instantaneous, the worrying implication being that "positive reinforcements" (Carr, 2010, p. 117) are behind decreasing attention spans in people who regularly use the Internet. In neurochemical terms, "[f]or each bit of new information we find our brain releases a dose of dopamine, a pleasure-inducing chemical which has been linked to addictive behaviour" (Collins, 2010). While receiving new information isn't the only event that triggers a release of dopamine in our brains, the effortlessness with which the Internet allows for accessing information makes it a wholly compelling and addictive medium.

Although less overtly concerned with hypertext's contribution to 'information overload', Paul Miller amusingly describes an Internet-enabled society in his article "Offline: What is the internet?" (2012). Writing for technology website *The Verge*, Miller lays plain his frustration with not being able to "ask a question without getting an answer that was checked or double-checked on the internet". The picture of a connected society that he paints is a droll one, but it is not without its more sobering side, the writer lamenting of how "[e]very conversation feels informed by the internet in some way, or like it will end up on the internet some way". There is no information that, we are told, is not now in some way mediated by the online world; while this claim may be exaggerated – it applies, first and foremost, to the author's social circle – it gets the point across that the Internet has taken up a kind of central-node position in the forming of culture. In the mind of the author, this has become something of a dilemma, and he dwells on this by expressing his wish for "a metric that could measure the amount of the internet that exists only to serve and perpetuate the internet – the 'meaningless' part".

Others have pondered various self-help style solutions to eliminate cognitive stress. Oliver Burkeman proposes some fairly straight-forward, practically-minded ideas, one of which is using online tools such as Google's "Inbox Pause" (Baydin, 2012), an add-on for their online mail service, Gmail (mail.google.com), or the "Boomerang" app (Baydin, 2012) that allows you to "fling emails away, then have them redelivered later" (Burkeman, 2012). Burkeman underlines how 'information overload' is actually brought on by not feeling in control of the information that is being directed at us, implying that the problem lies not in the limits of our cognition, but in how we allow large amounts of information to overwhelm us. This ignores much of what the empirical literature surrounding 'information overload' has already told us, and is, for that reason, less convincing. If the solution lay in productivity tools and other apps designed to temporarily stem the flow of information, 'information overload' would likely not be receiving as much attention as it currently is. Furthermore, the apps and add-ons espoused by the author merely delay the information flood, and do nothing to lighten the load when it does finally reach our inboxes. But the author does make a very valid point in showing how fruitless it can be to attempt to separate out vital information from extraneous chaff: "There are millions of information sources we could, in theory, keep up with, but only a few that we tell ourselves we must – and the distinction's pretty arbitrary". The problem, it would seem, lies in our very definition of useful information, which itself is shaped by the chaotic nature of the Internet. Hyperlinks allow for near-instantaneous retrieval of information, and as the questionnaire portion of the current research has demonstrated, they make tracking down information notably less difficult than with other media. Whether that information is entirely necessary or whether it is merely included for its own sake is where we may find one of the root causes of Internet-induced 'information overload'.

Paul Laudicina takes a different approach to trying to solve 'information overload', suggesting that it arises out of "travelling the same mental routes every day and becoming a "silo" expert when we need more generalists" (2012). The author's suggestions, however, are not entirely imaginative or innovative; while perfectly valid, Laudicina merely offers the well-worn wisdom that "[f]inding time to pause, think, reflect, recharge, and be creative is absolutely essential to success in any field". Another solution comes in the form of the sensible, yet somewhat trite suggestion that "[w]e need to take stock of things overlooked in the hubbub of daily life". One glaring issue with both Burkeman's and Laudicina's solutions is that they assume that, once we can momentarily relieve ourselves of checking our email or browsing the Web, the information will not be as overwhelming when we return to it. This ignores the very nature of the Internet and the way in which it delivers information. Without wanting to tear too many notions of agency away from the user, the Internet, and by extension hypertext, may covertly pummel its readers into submission by narrowing, or removing entirely, the risk-reward aspect of information retrieval, making finding out what we need to know all reward and no risk, no potentially expended effort.

The internet has become something of a linchpin for any major task or occupation that deals with creating, processing or delivering information. Perhaps, then, the most troubling facet of its development and adoption is that, depending on how we come to interact with the technology, we are often not given the luxury of, or at least that we are obstructed from tearing ourselves away from our online lives if we feel particularly burdened with information. Una Mullally writes of how, as a journalist, "ideas [being] your currency, you must consume a monumental amount of information every week" (2012). To be fair, Mullally's job in particular is one that relies heavily on retaining trivia, although one could argue that the Internet in its current state – "a shape-shifting, user-generated open community" (Mullally, 2012) – tacitly goads information-consumers into feeling that they must also become information-producers.
Mullally, like Chabris, notes that "a fear of missing out seems to tinge everything", and, to return to an earlier point, dissects the irresistible pull that makes people feel that they must constantly interact with devices that strain cognition, whether they are an integral part of working life of a key feature in conversation and social interaction:

> As children, we were told not to sit in front of the TV all day, to put the Nintendo down, and go outside and get some fresh air. Yet as adults, we are amplifying these bad habits, staring at screens in work, staring at phones on the bus, staring at iPads at home. (Mullally, 2012)

For the author, there has taken place a kind of hypocritical shift in attitudes: once electronic devices give the impression that they increase productivity and efficiency and are no longer mere entertainment devices, they become fetishised and made to seem as if interacting with them is a crucial part of daily life. But to return some sense of agency to the users, can it be said that there is any merit in arguing for a judicious use of hypermedia being the solution, as others have (Burkeman, 2012; Laudicina, 2012)?

Pico Iyer discusses an experiment carried out by Intel (Zeldes, 2008), in which, for four hours every Tuesday, three-hundred workers "were not allowed to use the phone or send e-mail, but simply had the chance to clear their heads and to hear themselves think." (Iyer, 2012) "A majority of Intel's trial group", we are told, "recommended that the policy be extended to others" (Iyer, 2012). Whether time spent away from electronic distraction helps to gradually restore our ability to steadily process information is up for debate, but it is certainly clear that occasional hypermedia-free periods are beneficial in some personal way. Iyer dwells on the irony of electronic devices creating a series of new problems after having supposedly solved old ones, relating how "[t]he central paradox of the machines that have made our lives so much brighter, quicker, longer and healthier is that they cannot teach us how to make best use of them". The utility of computers and of the Internet in finding information is abundantly clear – when given this information, however, we are prone to becoming listless and are much less likely to take it in.

Overall, the articles examined in this chapter offer varying degrees of insight into 'information overload'. Some of authors that were discussed attempt to provide solutions, and these too are not always consistent with empirical research and are somewhat limited in their assessment of the problem. Despite all this, the fact that 'information overload' is discussed to such an extent is promising in that it provides a bridge between academic research and general public interest. If the topic increases its presence in newspapers, blogs, magazines and other online and print media, it is more likely that those who produce and distribute hypermedia will take the lessons of both academic and literary texts on board, potentially making for a more useful, less overwhelming online environment. Currently though, the Internet seems to be as much a cause of chronic distraction as a means of retrieving information, and hypertext – to remain with DeStefano and LeFevre's definition as "a collection of documents containing links that allow readers to move from one chunk of text to another" (2007, p. 1616 – 1617) – is the enabling mechanism of this chronic distraction.

5. Conclusion & Future Work

Writing in an article for *The American Scholar*, Sven Birkerts offers the following wisdom:

> Information comes to seem like an environment. If anything "important" happens anywhere, we will be informed. The effect of this is to pull the word in close. Nothing penetrates, or punctures. The real, which used to be defined by sensory immediacy, is redefined. (2010)

The availability of instant information may mean that we have come to redefine what "real" is, resulting in a flattening of our conception of what it is to experience something. The "real" that Birkerts refers to does not necessarily translate into an idea of tangibility, but one that what is being experienced has an immediate effect on the senses. 'Experience', therefore, is no longer only about events that have a sensory impact, but also about those that trigger other kinds of responses – one kind, perhaps, being cognitive. By "[p]ulling the world in close", the kind of immediacy we are subject to may be of a different nature entirely. What this does to our senses and our individual notions of the actual quality of experiences is up for debate.

This research has managed to demonstrate to a reasonable degree that there is a link between hyperlinks (and hypertext as a whole) and increased cognitive load. By attempting to capture individual opinions surrounding 'information overload', the study made an effort to bridge the empirical gap between increased cognitive load as demonstrated in the reading task, and 'information overload', hoping to determine whether or not non-linear media has a negative effect on the ability of its consumers to maintain concentration. As, to make something of a sweeping statement, we are now all consumers of non-linear media either actively or passively, the importance of examining this kind of consumption, what enables it and whether or not it proves detrimental to our cognition cannot be understated. Despite its ubiquity, online hypermedia is still at a stage in which it is undergoing constant change and is subject to experimentation, and it would be altogether foolish to ignore what its users increasingly refer to as 'information overload', regardless of that phenomenon's highly subjective component.

For the fact of the matter is, 'information overload' *can* be said to exist, and if it is having an effect on a significant portion of the population as a result of hypermedia exposure, this would provide reason enough to re-asses the manner in which we currently deploy hypermedia. A more ideal scenario would perhaps be one in which we can still avail of the many useful aspects of the Internet and yet not feel like we are being overburdened with information or having our important cognitive faculties eroded, something of a running theme in much of the literature already examined. Nicholas Carr writes:

> It would be rash to jump to the conclusion that the Internet is undermining our moral sense.
> It would not be rash to suggest that as the Net reroutes our vital paths and diminishes our capacity for contemplation, it is altering the depth of our emotions as well as our thoughts. (2010, p. 221)

The Internet is an astonishingly powerful tool, one that can store and retrieve information with unprecedented ease so that it can be accessed the world over. In theory, it offers us a profound opportunity to expand our collective wisdom, in that it enables us to share information so that it can be accessed by the maximum number of people and at almost any time, near-instantaneously. Its enormous implications – social, political, personal – are still being revealed, and it is regularly touted as a truly democratic, user-defined medium. While this may be true to a certain extent, the emancipatory quality of the Internet has been taken to such an extreme by its more fervent proponents that the technology's adoption has outpaced concerted efforts to question whether in its current form it is providing the most human-centred experience while still retaining its efficiency. This makes the literature that *has* been produced that relates to Internet-induced 'information overload', whether it is literary or academic, all the more valuable, as it provides an insight into a phenomenon that is very real and yet is somewhat overshadowed by the sheer amount of hype and novelty surrounding and emanating from online environments.

This very novelty is the primary agent in the ongoing reshaping of our media consumption habits, and is arguably now the major agitating factor in how culture is produced and disseminated. Precisely what enables this novelty is the underlying mechanism that allows for the non-linear information progressions and narratives of the Internet, that of hypertext. Hypertext is a seemingly infinitely flexible medium, and its promise of immediate rewards in exchange for minimal effort is endlessly enticing. Even when taking into consideration the fact that hypertext fiction, the focus of some of the hypermedia studies to date (Mangen, 2008; Miall and Dobson, 2001), remains a somewhat niche market in literature, its very existence asks us to redefine what we immediately think of when we refer to concepts like 'reading'. Can the act of reading still

be said to be linear by default? Non-linear narratives came into existence long before the Internet, although the act of reading non-linear text, literary or otherwise, has only become an everyday activity for many people since use of the Internet has become widespread. Also, can linear text still be considered completely linear if conveyed through a non-linear medium, such as hypertext?

In addition to redefining 'reading', hypertext may also be challenging our ideas of relevance. This is evident in the amusing Wikipedia-based game known as *5 Clicks To Jesus* (www.thewikigame.com/5-clicks-to-jesus), in which the player is given a random Wikipedia article and must navigate to the entry for Jesus by following a trail of embedded hyperlinks. The intertwining webs of online content that hyperlinks provide mean that there is now a much wider range of information that could be considered relevant to anyone who uses the Internet. Whereas a printed book or encyclopaedia leaves it up to the reader to decide what is relevant to their reading of the text, web authors and online content creators are largely responsible for determining precisely what information is relevant, potentially allowing for needless amounts of information to reach the user. While this is only a reality in some extreme cases, it should serve as caution for those who do not exercise a degree of restraint when creating hypertext-based content.

This redefinition of well-worn concepts is something that needs to be taken into account when conducting further research in the topic of 'information overload'. In constructing the reading task for the current research, the text that included hyperlinks was made to be strongly reminiscent of a typical piece of online text that might be encountered by Internet users. However, future research could perhaps employ a similar method but provide more versions of the text, each whose link structures reflect varying degrees of relevance to the topic at hand. Relevance itself may be difficult to quantify, although one version of a text might contain links that are deemed to be only absolutely necessary to understanding the primary text, while another could make use of links to other pages of more questionable relevance. This would also involve a larger sample group, hence the reason for the current study only using two versions of the text, one with embedded hyperlinks and one without.

Another possibility would be to replace the reading task entirely with something that could measure more directly whether what people are experiencing is 'information overload' (insofar as it can be delineated) when they are responding to a stimulus. While timing participants proved effective at discovering the slowing effect that hyperlinks have on reading and at demonstrating an increase in cognitive load as a result of hyperlink exposure, the connection between increased cognitive load and 'information overload' remains unclear, the former not necessarily implying the experiencing of the latter.

Such an endeavour might necessitate the use of specialist equipment that, for reasons relating to time, money and expertise, did not feature in the current research. However, should these not feature as major factors in future research, this could be a more effective way of solidifying 'information overload' as an empirically-sound phenomenon, and might result in its possible causes and effects being taken into greater consideration when designing or compiling online content.

All in all, this study proved mostly conclusive in that it confirmed the role of hyperlinks in increasing cognitive load, and from there examined questionnaire responses and publicly available literature in order to make less ambiguous the phenomenon known as 'information overload' as it relates to online media usage. While having been limited in some respects as a result of the factors already discussed, the study was perhaps not as comprehensive as it initially set out to be. Nevertheless, the results that were generated provided further insight into the effect of hypermedia on cognition, and it stands to reason that the current use of hypertext is having a negative impact on our ability to read and recall information that we gleam from the Web. The Internet is a very welcome feature of daily life, although it is important to remind ourselves of McLuhan's warning that “[t]he effects of technology do not occur at the level of opinions or concepts, but alter sense ratios or patterns of perception steadily and without resistance” (1964, p. 18). We must stay attuned to potential side-effects in our fervour to whole-heartedly embrace seemingly liberating technologies.

Appendix A – Questionnaire

Q1. For approximately how long do you use the Internet on a daily basis?

- 0 – 1 hours
- 1 – 2 hours
- 2 – 4 hours
- 4 – 6 hours
- 6+ hours

Q2. For approximately how long do you spend reading every day, online or otherwise?

- 0 – 1 hours
- 1 – 2 hours
- 2 – 4 hours
- 4 – 6 hours
- 6+ hours

Q3. About how much of your reading is done online/using an Internet capable device?

- None
- Some
- Roughly half
- Most
- All

Q4. Do you find it easier to read text online (on a website, in an online article, etc.) or physical text (a novel, a magazine, a newspaper, etc.)?

- Much easier to read text online
- Somewhat easier to read text online
- Both are equally easy/difficult to read
- Somewhat easier to read physical text
- Much easier to read physical text

Q5. Indicate whether you agree or disagree with the following statement: "Reading online allows me to remember more of what I have read than reading printed text"

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q6. Indicate whether you agree or disagree with the following statement: “Reading online negatively affects my ability to concentrate on what I'm reading”

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q7. Is finding information online easier or more difficult than finding information from printed text?

- Much easier
- Somewhat easier
- Neither easier nor more difficult
- Somewhat more difficult
- Much more difficult

Q8. How helpful are Hyperlinks in allowing you to concentrate on what you are reading?

- Very helpful
- Somewhat helpful
- Neither helpful nor unhelpful
- Somewhat unhelpful
- Very unhelpful

Q9. Do you find that text with hyperlinks provides for a better or worse reading experience than reading text without hyperlinks (this may be either printed text or digital text without hyperlinks)?

- Much better
- Somewhat better
- Neither better nor worse
- Somewhat worse
- Much worse

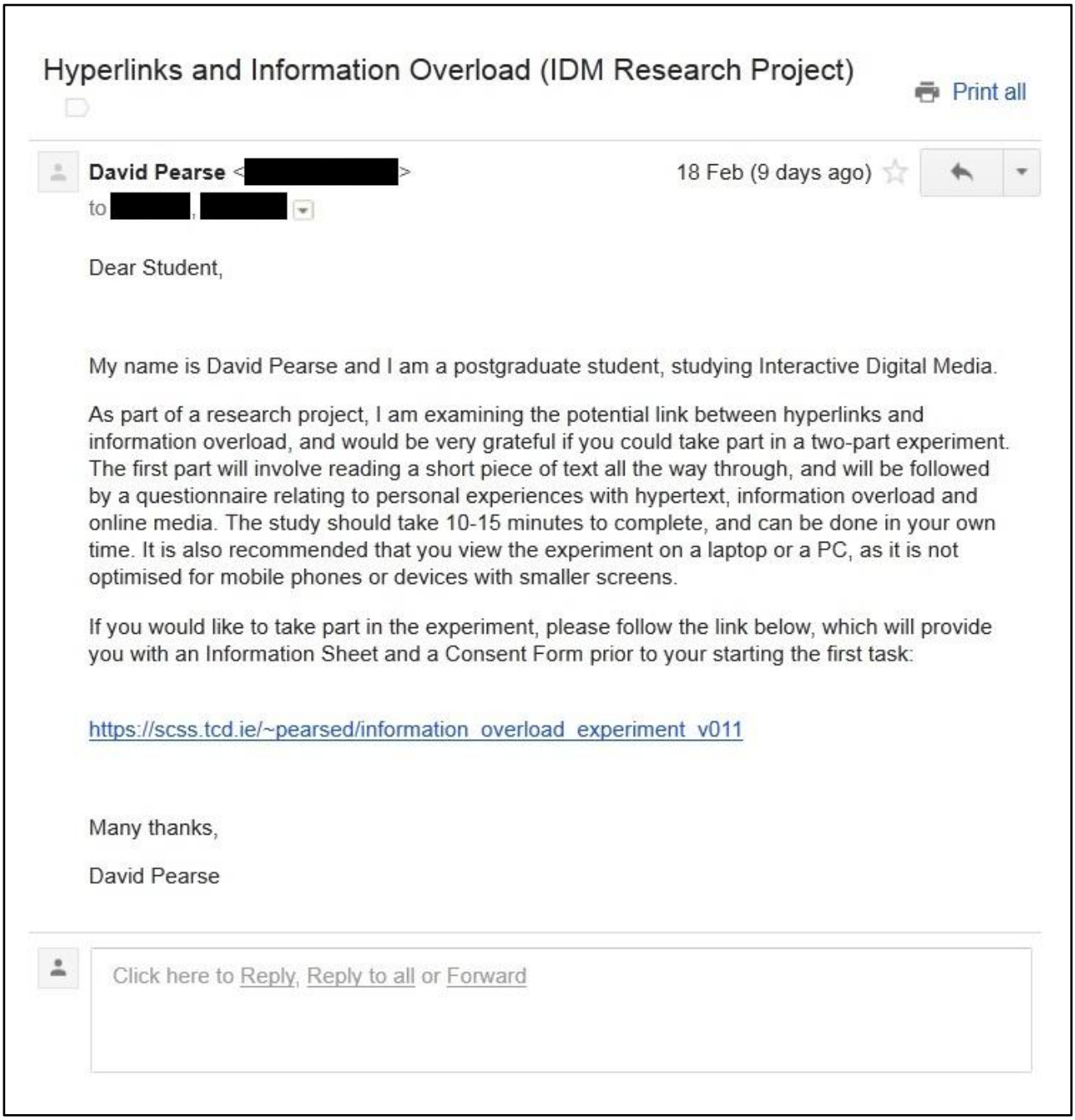
Q10. Indicate whether you agree or disagree with the following statement: "I sometimes feel that I suffer from 'Information Overload' "

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Q11. What is your age?

Q12. What is your gender?

Appendix B – Group Email



Hyperlinks and Information Overload (IDM Research Project)

Print all

David Pearse <[redacted]> 18 Feb (9 days ago)

to [redacted], [redacted]

Dear Student,

My name is David Pearse and I am a postgraduate student, studying Interactive Digital Media.

As part of a research project, I am examining the potential link between hyperlinks and information overload, and would be very grateful if you could take part in a two-part experiment. The first part will involve reading a short piece of text all the way through, and will be followed by a questionnaire relating to personal experiences with hypertext, information overload and online media. The study should take 10-15 minutes to complete, and can be done in your own time. It is also recommended that you view the experiment on a laptop or a PC, as it is not optimised for mobile phones or devices with smaller screens.

If you would like to take part in the experiment, please follow the link below, which will provide you with an Information Sheet and a Consent Form prior to your starting the first task:

https://scss.tcd.ie/~pearsed/information_overload_experiment_v011

Many thanks,

David Pearse

Click here to Reply, Reply to all or Forward

Appendix C – Information Sheet

This study is an examination of information overload and hyperlinks. Before taking part in the experiment, participants should read both this document and the consent form.

In the first part of the experiment, the participant will be directed to a webpage, where they will be presented with a piece of text to be read the whole way through. Once this has been completed, the participant will proceed to the next page via a link located below the text.

The participant will then be directed to a questionnaire, which will constitute the second part of the experiment. The questionnaire will contain questions relating to the participant's usage of the internet and to their own experiences with information overload. There will also be questions relating to age and gender; these questions are merely intended to provide additional data, and will be used to contextualise the first set of questions.

If a participant does not wish to answer one, or several, of the questions, they may leave the corresponding field(s) blank. Also, should the participant not wish to complete the experiment, they may opt out at any point by closing the browser window. After the questionnaire has been completed, the participant will be presented with an option not to have their data submitted for analysis, should they not wish for it to be used as part of the study.

The participant must complete the experiment in one sitting. However, there is no time limit, and it is important that the participant do so in their own time.

At no point in the experiment will the participant be asked for their name, and results published in the final research project will not identify any of the participants.

Participants may also request that their data be destroyed at any point after the experiment has been completed.

In the unlikely event that any illicit activities are reported, the appropriate authorities will be notified. Additionally, any references to any third parties will be anonymised.

Appendix D – Consent Form

Lead Researcher: David Pearse

Background of Research:
This study is an examination of hyperlinks and information overload, borrowing experimental methods from psychology and from the social sciences.

Procedures of this study:
The experimental part of the study will contain two parts. Participants will first be asked to read a piece of text in the form of a webpage. Once this is completed, they will be redirected to second part of the experiment, in which they will fill out an online questionnaire.

Publication:
Individual results will be collected and presented only for the purposes of this research. Identities of the participants will not be revealed.

Declaration:
By proceeding to the website linked below, I have read and acknowledged the following conditions:

- I am 18 years or older and am competent to provide consent. I have read a document providing adequate information about this consent form and about the study.
- I agree for my data to be used for scientific purposes and I have no objections to my data being published in scientific publications in a way that does not reveal my identity.
- I am aware that at no point in the study will I be asked for my name.
- I understand that my data will only be analysed by the current researcher, and will not be used for marketing purposes.
- I understand that if I make illicit activities known, these will be reported to the appropriate authorities.
- I understand that if I make any references to third parties, they will be anonymised.
- I understand that I may choose to withdraw from the study at any time should I wish to do so by closing the browser window or by otherwise indicating that I do not wish to continue.
- I understand that I may choose not to submit my data by indicating as much where appropriate, and that I may at any time, even subsequent to my participation, have my data destroyed (except in situations of making illicit activities known).
- I understand that if I or anyone in my family has a history of epilepsy then I am proceeding at my own risk.
- I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights.

Appendix E – 'Opt-out' Page

Important, Plese Read

For the purposes of this experiment, the amount of time you spent on the previous page was recorded. This aspect of the experiment is not revealed to participants beforehand, as doing so would change the nature of the reading task.
If, for any reason, you object to your time being analysed, please indicate below. Bare in mind that this data will *not* be used in any way that is not specified in the Consent Form.

☐ I **do not** want my data to be analysed.

When you are ready, please proceed to the next page.

Proceed to Next Page

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