EXAMINING VISUAL COGNITIVE COMPLEXITY
IN THE CONTEXT OF ONLINE WOMEN’S MAGAZINE HOME PAGES

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by
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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

EXAMINING VISUAL COGNITIVE COMPLEXITY IN THE CONTEXT OF ONLINE WOMEN’S MAGAZINE HOME PAGES

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a candidate for the degree of master of arts,

and hereby certify that, in their opinion, it is worthy of acceptance.

________________________________________
Professor Paul Bolls

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Professor John Fennell

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Professor Steve Hackley

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Professor Kevin Wise
To my mom and dad,
Whose constant love, support, and encouragement have helped me through grad school and in life. Their love for each other, my sisters, and me is inspiring. My parents let me grow into the person I wanted to be, and for that I will always be thankful.

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EXAMINING VISUAL COGNITIVE COMPLEXITY IN THE CONTEXT OF ONLINE WOMEN’S MAGAZINE HOME PAGES

Kirby Moore

Dr. Paul Bolls, Thesis Committee Chair

ABSTRACT

An experiment (N=48) on 18 to 30 year-old women was run to see how the visual cognitive complexity of digital women’s magazines’ home pages affects the cognitive processing of individuals and their evaluations of the sites. A content analysis of 13 online magazines was conducted and six magazine sites were chosen for the experiment and put in the complexity levels of low, medium, and high. There were two sites per level. Visual cognitive complexity did not affect the time it took participants to select a story or recognition. Additionally, perceived complexity did not match up to the levels operationally defined in the content analysis. The original measures were based off of Lang’s concept of information introduced ($I^2$). Although the hypotheses were not significant, a lot of insight can be gained about how to operationally define visual cognitive complexity. Although, the measure presented here did not yield significant results, there are ideas presented on how to build off this measure and create new measures for the future. This research is a starting point on studying visual complexity from a cognitive standpoint.
CHAPTER I: INTRODUCTION

How does the visual cognitive complexity of digital women’s magazines’ home pages affect the cognitive processing of individuals and their evaluations of the sites? To begin researching this question, it is critical to conceptually define visual cognitive complexity and to distinguish this concept from the related concept of visual complexity. Visual cognitive complexity expands on the basic definition of visual complexity by more directly taking into consideration demands on individuals’ cognitive resources due to the presentation and content of mediated visual information. In a conference paper, E. Michailidou described how she defined visual complexity in her master’s thesis (Michailidou, Harper, and Bechhofer, 2008). At the basic level, she conceptually defined it in a manner that only really considers the amount of “stuff” that appears on a page, how the visual components are presented, and how different the elements are (Michailidou, Harper, and Bechhofer, 2008). Most research on visual complexity studies the concept by using this basic definition and approaches the research from a practical design or visual aesthetics standpoint. This study will expand on this basic definition of visual complexity by looking at the term from a theoretical approach that is systematically grounded in how humans cognitively process information. In turn, visual cognitive complexity will be defined as: the potential demand on an individual’s cognitive resources due to the number of visual elements, their semantic differences, and their presentation on a page. Although this is an explanation of a new concept, the idea is grounded in research done by A. Lang and colleagues (2006) surrounding a concept they have labeled information introduced (I²), which represents a systematic attempt to index cognitive complexity of audio and
video media content. In their study, $I^2$ was the amount of new information a person needed to process after a camera cut. The researchers took a cognitive approach, and in their secondary analysis the researchers found: “With increasing levels of $I^2$, resources required increases faster than resources allocated resulting in fewer available resources and slower STRTs” (Lang, Bradley, Park, Shin, and Chung, 2006, p. 391). STRT stands for secondary task reaction time and is used to measure available resources (Lang, Bradley, Park, Shin, And Chung, 2006). The primary objective of this study is to attempt to extend the notion of $I^2$ to visual information presented on websites while studying the impact of visual cognitive complexity of women’s online magazines’ home pages.

Studying visual cognitive complexity of digital women’s magazines is important because of the practical implications it can have on how designers create home pages. There are many factors that support the practical importance of this study and its cognitive approach. The first is that people and magazines are overwhelmingly turning to the Web. Magazine publishing is being redefined in this age of new technologies where people have an appetite for digital media. Many magazines now have websites or are launching sites and are looking for ways to attract users. In research done by Magazines Publishers of America [MPA] (2008/09), it was found that 207 “magazine digital initiatives” were reported by magazine agencies in 2007 (p. 6). This is a 34% increase from 2006 with 155 initiatives (MPA, 2008/09, p. 6). Also, according to a Pew Internet & American Life Project (2008) December survey, 87 % of adults between the ages of 18 and 29 use the Internet.

The second factor is that studying women’s magazines’ home pages is useful because of the role women play as consumers and the role of home pages in engaging
users. According to the same Pew Internet & American Life Project (2008) December survey, 75% of adult women use the Internet. Also, T. R. Troland (2005) expressed that women are a large group of magazine consumers and part of magazines’ struggles have been that women have changed how they shop and consume media. Home pages will be the focus because they are similar to magazine covers in the sense that both function as a gateway to the information contained within. Also, home pages need to inform and persuade readers to stay on a site (Singh & Dalal, 1999). This is much like covers needing to be persuasive enough for a person to want to buy a magazine on the newsstands.

Studying visual cognitive complexity has theoretical applications, as well. There are not many studies of visual complexity on the Web that include any cognitive aspects. For example, an early study of Web page complexity that systematically broke down the elements of home pages studied how much designers were exploiting the design possibilities of the Web and how complexity affected site traffic (Bucy, Lang, Potter, and Grabe, 1999). This study did not look at how those broken down elements affected an individual’s cognitive processing. Understanding how visual cognitive complexity affects how users process a site will add to the research on cognitive processing and visual complexity. It will also inspire researchers to combine the two concepts into one study rather than looking at them as separate entities. The study could lead to different thinking and new bodies of research.

To begin researching the visual cognitive complexity of online women’s magazines’ home pages, the researcher performed a content analysis of 13 digital magazines’ home pages. This was done in order to begin to develop an operational
definition of visual cognitive complexity of women’s magazines’ home pages by systematically describing how visual information is presented in this context. Different aspects of each site were studied and counted, including the number of links, the number of semantically different links, how information was packaged, the types of buttons, and the types of multimedia. Visual cognitive complexity scores were calculated for each site, and they took into account both the raw number of links on a page as well as the degree to which information presented on the page was semantically different. This represented an exploratory attempt to apply the notion of I² to Web pages by attempting to estimate the potential cognitive demand involved in processing visual information on these sites. More details on the content analysis and visual cognitive complexity scores are presented in the methods chapter of this thesis. Visual cognitive complexity scores calculated from the content analysis were used to identify magazines’ home pages that can be used to manipulate visual cognitive complexity in the proposed experiment. The home pages chosen were from: Fitness, InStyle, Glamour, Real Simple, Self, and Vogue.

In the experiment, participants were asked to interact with the six home pages of varying complexity, and the mental effort they invest in choosing a story link was studied. Mental effort was looked at because it should theoretically be directly impacted by visual cognitive complexity of the website. Mental effort was studied through the time it takes participants to make a story selection and recognition of Web page content. Users’ evaluations of the site were studied through self-report questions. Overall, each person interacted with the six sites in random order, was timed on how long it took them to select a story, and was asked self-report questions about that particular site. They repeated this procedure for each site. The self-report evaluations measured perceived
complexity, attractiveness, and usability of the home page. This information was useful to compare to how people actually processed media rather than how they perceived the media. Once they viewed all the sites and answered the self-report questions, users responded to the recognition questions for all the sites at once.

Overall, the hope is that the data collected from this experiment will lead to insight on how users’ processes visual messages by using research grounded in a theoretical approach based on individual’s cognitive processing of messages. Also, the self-report evaluations will help researchers to understand how people themselves view the media and how that compares to their processing of the media message. This data will help designers and journalists design more effective messages and will open up a new body of research in understanding how visual cognitive complexity affects mental effort and individual’s processing of visual elements on the Web. Additionally, this research will add to the overall understanding of cognitive processing. Visual complexity as a whole is understudied, especially from a cognitive processing approach. This study will provide insight and expand on the concept to provide valuable research that will help pave the way for effective magazine home pages on the Web.
CHAPTER II: LITERATURE REVIEW

Visual Complexity

There have been some studies done to attempt to describe what visual complexity on the Web is, what it is made up of, and how it works. Although there have been a few studies, they have not been theoretical and have not researched visual complexity from a cognitive processing standpoint. Most of the studies look at visual complexity from a practical or applied point of view. Before understanding visual cognitive complexity – the terminology used in this study – it is vital to understand visual complexity at its basic applied level.

Visual complexity is referred to by different names, including structural complexity, Web page complexity, home page complexity, and visual clutter (Lang, Park, Sanders-Jackson, Wilson, and Wang, 2007; Bucy, Lang, Potter, and Grabe, 1999; Geissler, Zinkham, Watson, 2006; Rosenholtz, Li, and Nakano, 2007). As mentioned earlier, visual complexity is not only the amount of “stuff,” but also the way the elements are packaged (Michailidou, Harper, and Bechhofer, 2008). An example of packaging would be the arrangement of a headline, photo, and description all describing the same story. Packaging is how the content ties together. Packaging is important and will play a role in perceived complexity, but for the purpose of looking at visual complexity from a cognitive perspective, the amount of elements on the page and their diversity will play the most crucial role. The number of links and their semantic difference are more important than packaging because people are not always aware of the cognitive processes going on when they process media. They might notice how things are packaged, but they
are not going to look at a website and count the number of links they are exposed to and study how many of the links lead to different places. Although users will not consciously do this, subconsciously their brain is taking in the information for them and working to cognitively process the information. Although understanding user feedback of what they consciously notice is important, this experiment aims to understand the processes going on that the user themselves might not be able to describe. This idea has been researched in multiple studies on the processing of television messages (Lang, Bradley, Park, Shin, and Chung, 2006; Lang, Potter, & Bolls, 1999; Fox et al., 2004; Wise, Lee, Lang, Fox, and Grabe, 2008). Not many studies have been undertaken on processing the Web.

E. Michailidou (2006) however, did point out how visual complexity can be conceptualized for the Web: “Within the literature, visual complexity of an HTML document is described through Web site accessibility and usability research” (p. 25). What she means is that visual complexity is often studied by looking at how the site is designed and what elements it is made up of. In this discussion of one of her studies, the researchers describe how the aim of the study is to develop measures and rankings for visual complexity and “relate user’s implicit understanding of visual complexity with its layout” (Michailidou, 2006, p. 25). There is a further hope in the study to help visually impaired users maneuver the Web (Michailidou, 2006). In this study, accessibility is understanding how easily people can access or get to information (Michailidou, 2006). As mentioned, to fully understand visual complexity, it is vital to know what contributes to its makeup.

In a study on Web page complexity, researchers described that complexity is made up by the format structure of the Web, including packaging (Bucy, Lang, Potter,
and Grabe, 1999). They distinguished this from content, which includes the story itself (Bucy, Lang, Potter, and Grabe, 1999). In a project description, E. Michailidou (2006) described other elements that make up complexity and how complexity is described:

During this study we concluded that the main factors that affect the visual complexity of a Web page are the diversity (how many different elements are used), density (how many of each element are used) and position of the page elements (e.g. links, words, images) (p. 26).

Overall, visual complexity is made up of different formatting features including packaging. It is not just the number of elements and links present, though this is significant and helps explain visual cognitive complexity. Although this is the basic idea of visual complexity, as explained earlier, this study will define the concept as visual cognitive complexity because cognitive processing plays the most important role in understanding how people process the home pages.

*Visual cognitive complexity.* Visual cognitive complexity includes all that is mentioned on visual complexity but adds the extra layer of theoretically considering the potential cognitive demand associated with processing visual information. It is important to carefully consider the nature of visual cognitive complexity because people are not always aware of the precise nature of mental processes involved in cognitive processing. Cognitive processing of information presented on a website is a more complex and dynamic process than individuals might be aware of. Usability tests in which people self-report their perceived complexity of the website oversimplify this process. They measure a perceptual response rather than more precisely how easy or difficult it potentially is to thoroughly process information. Visual cognitive complexity is grounded in looking at
concrete features of the Web and specific processes involved in cognitively processing information. Usability testing only looks at what people think and how easily they appear to navigate a Web page. Standard usability tests miss the cognitive processing occurring while someone is interacting with a site. The test is usually used to see if a person is interacting with a site the way designers intended. By looking at visual cognitive complexity and understanding cognitive processing, researchers can gain theoretical insight into cognitive processing of information on a Web page that goes beyond the more simple and applied studies of visual complexity.

As mentioned in the introduction, visual cognitive complexity is based upon the $I^2$ concept. $I^2$ was originally used to look at camera cuts in television production (Lang, Bradley, Park, Shin, and Chung, 2006). $I^2$ was developed to measure resources required by measuring the amount of new information introduced by each camera cut in a television production (Lang, Bradley, Park, Shin, and Chung, 2006). $I^2$ uses a seven-point scale to determine the amount of new information introduced (Lang, Bradley, Park, Shin, and Chung, 2006). Seven different dimensions of visual media were chosen to code for the new measure (Lang, Bradley, Park, Shin, and Chung, 2006). They were: object change, novelty, relatedness, distance, perspective, form change, and emotion (Lang, Bradley, Park, Shin, and Chung, 2006). Although this Lang study was original done to understand how people process television messages, these dimensions can cross over to the Web. For this study on visual cognitive complexity, the magazine home pages were not coded on all these dimensions specifically, but rather for some that are analogous to the dimensions considered by Lang and colleagues.
The new term visual cognitive complexity is used because it combines the idea of $I^2$, which in previous research was applied to audio and video, with visual complexity of Web pages to look at all the visual elements a person is exposed to on the home page in relation to how many are semantically different or related. Considering the work by Lang and colleagues it appears there are two significant superordinate dimensions of $I^2$, diversity of information presented in the media content being processed and the emotional intensity of the content. As an exploratory study on cognitive processing of magazines’ home pages a decision was made to focus on the most explicitly “cognitive” dimension, diversity of information to be processed. A clear way of establishing the diversity of information to be processed on a home page is by the degree to which links on the webpage lead to semantically different content. This is analogous to Lang and colleagues dimension of relatedness (the degree of similarity between sequential scenes in a video message) in their explication of video $I^2$. Lang and colleagues found that video messages that scored low on the dimension of relatedness (meaning the message contained more visually diverse content) require more cognitive resources to be thoroughly processed in a way that leads to good memory for the message (Lang, Bradley, Park, Shin, And Chung, 2006). A similar relationship could exist for online women’s magazines’ home pages in that pages with more semantically different links potentially present a higher demand for cognitive resources. Also, user control adds another layer to understanding visual cognitive complexity because users’ actions can lead them to expose themselves to new information. Additionally, it was found that when people had control to change the channel when watching television, resources were not automatically allocated to process the new information, and there was an increase in
sympathetic activation (Wise, Lee, Lang, Fox, and Grabe, 2008). In one of the experiments researchers performed in this study, recognition was better after a cut rather than a channel change (Wise, Lee, Lang, Fox, and Grabe, 2008). A cut was when there was a production change versus a viewer changing the channel (Wise, Lee, Lang, Fox, and Grabe, 2008). This shows that when viewers had control, there was the possibility that their recognition of the television messages could suffer.

In this study on visual cognitive complexity, there was user control but also experimental control. Participants were able to interact with the sites, and they were timed to see how long it took them to make a story selection. Although the home pages were being studied, they were introduced to other pages in the site, depending on what they clicked on. This added a new challenge to the recognition test because participants introduced themselves to new information, but the test was on the home pages. In the end, how long it takes them to make a story selection and how complex the home page is could both affect recognition.

Overall, visual cognitive complexity looks at the mental effort it takes a person to process visual information in a message, in this case a digital magazine home page. To better understand how mental effort will be affected, it is important to understand the levels of complexity.

Levels of complexity. To understand visual cognitive complexity and how it affects user mental effort, it is important to understand the varying levels of complexity used on the Web. There are three basic levels: low, medium, and high (Martin, Sherrard, and Wentzel, 2005). Martin and colleagues (2005) said there are two different elements to
look at that make up how visually complex a site is: visual elements and verbal elements. They used Resource-Matching Theory to describe that a site that is high in visual and verbal elements is a high complex site, and a site that has low visual and verbal elements is a low complex site (Martin, Sherrard, and Wentzel, 2005). They also described how there are two medium levels: one that has high visual and low verbal elements, and one that has low visual elements and high verbal (Martin, Sherrard, and Wentzel, 2005). In their experiment, they manipulated visual complexity by having animation and static images versus verbal complexity by the amount of text on the page (Martin, Sherrard, and Wentzel, 2005). They discovered that sites in the medium complexity range were evaluated more positively than the others. Sensation seeking played a role in their study, and this concept can affect how people process a media message.

Although the effect was small, in the 2005 study on sensation seeking and Web complexity, it was found that people rated medium complexity websites better than low or high complexity sites on attitude scales (Martin, Sherrard, and Wentzel, 2005). Sensation seeking will not be studied in this research on visual cognitive complexity but has been studied in past research on visual complexity. Sensation seeking is the idea that people seek out information to increase their “sensory arousal” (Martin, Sherrard, and Wentzel, 2005, p. 110). In their study, these researchers found that high sensation seekers favored high complex visual designs while low sensation seekers favored low complex visual designs but high verbal complex designs (Martin, Sherrard, and Wentzel, 2005). This means that, the low sensation seekers favored more text than visuals. Their results were only significant when the site was designed with medium complexity (Martin, Sherrard, and Wentzel, 2005). Another study on advertising and home pages came by
similar results finding that participants favored moderate complexity over other complexity levels (Geissler, Zinkham, and Watson, 2006). The researchers pointed out some key factors for effective moderately complex designs and said that often times the elements used to create this level of complexity depend on the company type and their competitors (Geissler, Zinkham, and Watson, 2006). They said that people like having a lot of working links that help them navigate a website but added that the more links there are on a site the more complex it gets (Geissler, Zinkham, and Watson, 2006). In their study, 13 links were used on moderate complexity home pages, but these home pages were promotions used by advertisers (Geissler, Zinkham, and Watson, 2006).

In this study on visual cognitive complexity, there are a lot more links on each home page. The mean number for medium complexity is about 177. This is because magazine home pages are used as sources of information and the goal is to provide as much information as possible for the reader. Overall, the researchers pointed out that the home page elements that make up visual complexity are “the number of graphics, the number of links, and home page length” (Geissler, Zinkham, and Watson, 2006, p. 75).

Another study suggests that the ways to create low and medium sites are to only provide two types of links for entering a site: text only and rich graphics (Nadkarni & Gupta, 2007). The researchers also suggested a registration or log in section so users who want more information can have access to more visually complex areas of the site (Nadkarni & Gupta, 2007). The researchers say this could be good because, like sensation seeking, a person’s goals on a site can influence how complex they find a site to be (Nadkarni & Gupta, 2007). The more goal-oriented a person is, the simpler they
want the site to be so they might not register (Nadkarni & Gupta, 2007). Experiential users might want more complexity and will register (Nadkarni & Gupta, 2007).

For the purposes of this study, the levels of complexity will be low, medium, and high. The complexity of each site will be based on visual cognitive complexity scores based on both the raw number of links on a page and the proportion of those links that represent semantically different pieces of information. This is also in line with an I² study where low, medium, and high were used to describe camera cuts with a low, medium, or high number of edits or cuts (Lang, Bradley, Park, Shin, and Chung, 2006). Because the researchers counted edits and cuts, their levels also depended on structural features (Lang, Bradley, Park, Shin, and Chung, 2006). The scores will be explained in depth in the methods section.

Understanding how the levels of complexity affect people is vital to understanding this research, but it is also important to understand perceived complexity.

*Perceived complexity*. Perceived complexity is how complex a person perceives a message to be. In the case of this study, it is how complex people think a digital magazine home page is. In a study on perceived website complexity (PWC), it was proposed that PWC affects a users’ satisfaction with a site (Nadkarni & Gupta, 2007). Although this study on visual cognitive complexity focuses on cognitive processing, perceived complexity is still important. From a practical standpoint, it is important to look at because magazine professionals care about the attitudes and perceptions of their readers. From a theoretical standpoint, studying perceived complexity can be useful to compare to the actual cognitive processing going on. It can lead to a better understanding
of how closely tied cognitive and psychological processes are to each other. Users’ attitudinal evaluations of the site, including perceived complexity, will be compared to recognition questions testing their cognitive processing. This will show if there is a difference in how a site affects their processing based on its complexity and how complex they think it is. This is where the idea that users’ are not always aware of what they are processing is important. Making the comparison can help designers understand the difference between what users think they can process and what they really can. D. J. O’Keefe (2003) distinguished describing effective persuasive messages through variable definitions, such as psychological states of arousal or fear from definitions of intrinsic features of the message, such as the design. Overall he said:

One way of putting this larger argument is this: Progress in understanding persuasive message effects requires an understanding of persuasive message properties (p. 269).

He argues that the intrinsic features are more important to look at because psychological states cannot provide real help or information on how to design effective messages because there is no information about how the features of the message itself are affecting persuasion (O’Keefe, 2003). So, though perceived complexity will be measured and can help designers in the industry understand how people perceive the design and complexity of a home page, understanding how people cognitively process a home page will help designers create more effective messages. To understand exactly how people cognitively process the home pages, a theory grounded in cognitive processing is being used.

Limited Capacity Model of Motivated Mediated Message Processing

The LC4MP is a theory that has been extensively used to study how “individuals
process mediated messages” (Lang, 2000; Lang, 2006, p. S58; Fox et al., 2004; Grabe, Zhou, Lang and Bolls, 2000; Lang, Park, Sanders-Jackson, Wilson, and Wang, 2007).

Using this theory and its theoretical concepts, this thesis examines how individuals cognitively process the visual cognitive complexity of online women’s magazines’ home pages that vary in visual cognitive complexity. Digital magazines’ home pages are mediated messages, so this theory works to describe them. Also, this theory is grounded in cognitive processing and, as mentioned above, multiple studies have been done using this theory to understand cognitive processing of media messages. The theory gets to the heart of this study by applying measures that can help explain the processing going on when users interact with an online magazine home page. Additionally, visual cognitive complexity looks at the mental effort used to process visual messages. The LC4MP helps break down processing into subprocesses, which, when studied, can help show how processing is strengthened or weakened by a message (Lang, 2006). In other words, it can look at the mental effort it takes to process a message. A critical concept to the LC4MP is that messages are designed differently depending if a person is seeking out the information or just exposed to it (Lang, 2006). This idea is important to note because, for the purposes of this study, it will be assumed that readers are seeking out the magazines’ home pages or information on them. Knowing readers are seeking the information helps understand users’ motivation better and how they are allocating resources to process the information (Lang, 2006). A person’s motivation for going to a site could affect how visually complex they perceive it to be. Another important aspect of this theory is that it can help ensure that journalists’ messages are getting encoded by viewers (Lang, 2006). Encoding is a subprocess of this theory and will be explained in more depth later. At a
basic level, it is the stage where people decide which information they will examine further (Lang, 2006). In the case of visual cognitive complexity research, it will help to make sure that the complexity is enhancing the stories online and that the design is easing mental effort rather than inhibiting processing of the Web page. If encoding suffers, it will show that more mental effort had to be involved to process that home page.

One of the most important aspects of the LC4MP is the assumption that people only have so much capacity to handle information (Lang, 2006). This means that when people are presented with too much information, their processing could suffer and they could become overloaded (Lang, 2006). An example of this appeared in a study concerning graphics in television news. The researchers found that people went through cognitive overload while dealing with more difficult stories with no graphics and ended up recalling less (Fox et al., 2004). Age also played a role in the study because the graphics actually strengthened encoding for younger people but not for older people (Fox et al., 2004). Encoding will be explained in depth later.

This assumption is something to keep in mind while doing research using this model: people can only handle so much information. In a study done by S. S. Iyengar and M. R. Lepper (2000), it was found that more choices might seem good at first, but they can later cause issues with a person’s motivation. Also, subjects could become dissatisfied with their choice when there were many options (Iyengar & Lepper, 2000). When reading a digital magazine, the choice readers are making is what to click on and read or interact with. This will be called story selection. The way information is packaged adds a new complexity level to story selection. In a study done by D. E. Berlyne (1966) on different stimuli, it was found that participants spent more time
looking at “more complex” stimuli than “less complex” (p. 28). Another study by B. J. Morrison and M. J. Dainoff (1972) found that people looked at magazine ads that were more visually complex than others for a longer time. One issue that arises is that on high visual cognitive complex sites, it is hard to distinguish if the site is past the cognitive threshold for overload. In an I² study researchers found that secondary task reaction times (STRTs) were faster on high complexity television productions because people were overloaded (Lang, Bradley, Park, Shin, and Chung, 2006). This relates to the first assumption that people can only process so much information. If there is overload, people might just click the first story they see to get themselves off the too complex of a site. Lang and colleagues (2006) have established a pattern of results for indicating when individuals’ cognitive capacity is overloaded by a mediated message. Theoretically, it appears that when overloaded, individuals disengage from the mediated content (Lang, Bradley, Park, Shin, and Chung, 2006). In this study, that would be indicated by individuals taking significantly less time to choose stories when viewing websites that are high in visual cognitive complexity. There is no way of knowing beforehand if the high complexity websites used in this experiment reached the level of visual cognitive complexity at which cognitive overload occurs. Thus, hypotheses will be framed for both situations in which cognitive overload might or might not occur. Because people take more time to look at complex stimuli, there should be a simple positive linear relationship between visual cognitive complexity of a website and the amount of time it takes to make a story selection, as long as cognitive capacity is not overloaded. Thus,

**H1a:** There will be a significant main effect of visual cognitive complexity on time spent to make a story selection, such that as the visual cognitive complexity of the website increases, individuals will take longer to make a
story selection.

Alternatively, if, as according to Lang and colleagues, individuals disengage from processing mediated information when cognitive capacity is overloaded and the high complexity websites used in this experiment overload cognitive capacity, time spent making a story selection will increase from low to medium complexity and then significantly decrease from medium to high complexity websites. Thus,

**H1b:** There will be a significant main effect of visual cognitive complexity on time spent to make a story selection, such that individuals will take significantly longer time to select stories from medium complexity websites compared to low complexity websites and significantly less time to select stories from high complexity websites compared to medium complexity websites.

Figure 1 graphically displays the predicted alternative patterns in H1.

![Figure 1](image)

*Figure 1: A representation of predicted patterns for H1a and H1b*

There are four other assumptions in the LC4MP in addition to the assumption that people only have so much capacity to handle information. The second is that people have an appetitive and aversive system, which are motivational systems (Lang, 2006). Next, media is displayed through different mediums and formats in repetitive streams of
information (Lang, 2006). The fourth is that human behavior is continuously changing over time (Lang, 2006). “Fifth, communication is the overtime interaction between the human motivated information processing system and the communication message” (Lang, 2006, p. S59, Lang, 2000). Although the appetitive and aversive systems are important in studying humans’ responses to media, they will not be discussed for the purposes of this visual cognitive complexity research. Rather, the subprocesses of this theory will be explored.

The LCM4P includes three subprocesses of processing media: encoding, storage and retrieval (Lang, 2006). Encoding is the stage where a person chooses information that they will process further (Lang, 2006). Storage is where an individual connects new information with information already stored (Lang, 2006). Retrieval is the subprocess where people retrieve already stored information (Lang, 2006). The subprocesses are continuous and occur at the same time (Lang, 2006). Encoding is the focus of this study.

In studying how design affects a user’s cognitive processing, it is important to look at encoding because this is the stage at which people choose the content that they will examine further (Lang, 2006). One way to measure encoding is to do audio and video recognition (Lang, 2006). In the research being conducted on online magazines, audio is not being considered part of the design. Also, videos might be on the page, but only their visual presence and not their content, will play a role in the research. A study was conducted to see if visual encoding was an automatic process and if verbal encoding was a controlled process. The part of the outcome that is significant to research on visual communication is the finding that visual encoding of television messages seems to be automatic (Lang, Potter, & Bolls, 1999). This means that if a researcher manipulates
visual elements, there should not be a change in visual encoding (Lang, Potter, & Bolls, 1999). Although this study did utilize both audio and video. The research on visual cognitive complexity only utilized visual encoding. The Lang study found that there should not be a change in visual encoding, but the other study by researchers mentioned earlier showed that graphics that complemented television news stories enhanced encoding of the information for young viewers (Lang, Potter, & Bolls, 1999; Fox et al., 2004). In another study titled “The Capacity of Visual Short-Term Memory Is Set Both by Visual Information Load and by Number of Objects,” (2004) the researchers said:

> We feel that the encoding and comparison times for the display items are therefore a reasonable measure of the complexity of the stored representation to which they are compared (Alvarez, & Cavanagh, p. 110).

They used encoding to understand memory while viewing complex stimulus, but, as shown, it can also be used to gauge mental effort. In the $I^2$ studies it was found that:

> Recognition increases significantly from low to medium levels of $I^2/\text{sec}$. At high levels of $I^2/\text{sec}$, mean recognition is between the low and medium levels. It is significantly lower than the high level but does not differ significantly from the low level. This indicates that cognitive overload may have begun at the high level of $I^2/\text{sec}$ (Lang, Bradley, Park, Shin, and Chung, 2006, p. 338).

As mentioned for H1a and H1b, there is no way of knowing beforehand if the high complexity websites used in this experiment reached the level of visual cognitive complexity at which cognitive overload occurs. Thus, hypotheses will be framed for situations in which cognitive overload might or might not occur. If this is the case that recognition was better from the low to medium, it should also be better from medium to high:
**H2a:** There will be a significant main effect of visual cognitive complexity on home page recognition, such that recognition will be significantly better for home pages on each higher level of complexity.

If, as mentioned in H1b, cognitive overload happens and users disengage, then it can be expected that recognition would be better from low to medium but worse from medium to high:

**H2b:** There will be a significant main effect of visual cognitive complexity on home page recognition, such that recognition will be significantly better for home pages of medium complexity than for low and high complexity.

Figure 2 graphically displays the predicted alternative patterns in H2.

![Figure 2: A representation of predicted patterns for H2a and H2b](image)

It is important to note that while visual cognitive complexity scores were calculated for the sites, there is no exact line between the levels. This means that there is no proof set in stone to show exactly where one level starts and the other ends. This hypothesis will thus, be based on the sites deemed in the medium complexity level from the content analysis done here.

An important aspect of the LC4MP that plays a role in searching for information on
highly visual magazine sites is motivation. When evaluating effective cancer communication messages, A. Lang (2006) posed the question: “What is the motivational and personal relevance of the main information in the message for the majority of people in the target audience” (p. S64)? In the case of digital magazines and this study, what is the relevance of the design to the user? In a Wise and colleague’s (2008) study on viewers’ controlled changes on TV versus programmed changes, it was found that:

Overall the results of these studies further highlight that the context in which media is used and the viewer’s goals and intentions play an important role in the three-way interaction among media message, media user, and the environment that makes up message processing (p. 197).

Why people are going to a site plays a role in how they process content. In two different studies it was also found that the ability to control the message seems to change how viewers process the media message (Wise & Byron, 2007; Wise, Lee, Lang, Fox, and Grabe, 2008). On digital magazines, viewers can control what they click on, so motivation plays a part in their online experience. Also, as these studies have pointed out, when a person can control their content, processing might change based on what they are seeking or motivated to do.

Overall, the LC4MP theory, recognition testing, and self-report data can help to explain how visual cognitive complexity affects a user’s encoding of the information and ultimately what levels of visual cognitive complexity involve the most mental effort. The assumption that people can only process so much information at once and that motivation can play a role in how people process media are taken under consideration in this study.

As previously mentioned, it is also beneficial to consider individual’s perceptual and attitudinal responses to mediated messages. In a study on the effects of graphics on
processing television news, researchers asked participants self-report questions to access their opinions and perceptions of the news stories (Fox et al., 2004). Often self-report is used along with other measures, such as recognition. In a study on the packaging of TV news and arousal, self-report and psychological measures were used (Grabe, Zhou, Lang, and Bolls, 2000). In this study, self-report will be used to understand users’ attitudes toward the home pages. As mentioned in the section on perceived complexity, it is interesting to know how people perceive the home pages, but what really help people design effective messages are the actual features of the home page. The attitudinal responses will be used to see if there is a disconnect between how people perceive the home page as compared to its visual cognitive complexity score. This will be helpful because depending on the goal of the designers, such as attitude influencing or memory improving, one of the measures might be more important to them. Even if designers care more about influencing attitude and how people feel about a site, knowing about the cognitive processes going on that people are not aware of will still be beneficial in designing a fundamentally effective message. In this study, self-report questions will be used to determine answers to this question:

**R1:** How does visual cognitive complexity affect users’ attitudinal responses to the site?
CHAPTER III: METHODOLOGY

Experimental Design

This experiment used a 3 (levels of complexity) x 2 (website home pages) repeated measures, within subjects design. Participants interacted with two women’s digital magazines’ home pages in each level of complexity: low, medium, and high. Overall, each participant was exposed to six sites. Presentation order of the individual websites was randomized for each participant.

Independent Variable

Visual cognitive complexity. As mentioned in the literature review, visual cognitive complexity is not only understanding how much information is visually available and how it is presented, but also keeping in mind the cognitive aspects of visual overload. For this experiment, visual cognitive complexity is conceptualized as: the potential demand on an individual’s cognitive resources due to the number of visual elements, their semantic differences, and their presentation on a page. Visual cognitive complexity was manipulated by exposing subjects to low, medium, and high complexity home pages. Visual cognitive complexity scores were given to each site based on the results of a content analysis and drawing on work done by A. Lang and colleagues (2006) on information complexity in video.

The content analysis was done on 13 women’s digital magazines’ home pages. The original 13 sites were chosen based on their similar content, their focus on women, circulation numbers from the Audit Bureau of Circulation’s website, and the median age
in the magazines’ media kits. The content analysis involved counting the total number of clickable links, counting the number of semantically different links, and counting and analyzing the different packaging styles on the home pages. The setup of the analysis was similar to a study about the structure of Web home pages (Bucy, Lang, Potter, and Grabe, 1999). In order to obtain a visual cognitive complexity score for each website, the total number of links on each home page was divided by 265, which was the highest number of links found on any of the analyzed home pages (Vanityfair.com). This step made the visual cognitively complexity score relative to a number that likely represents an extremely high number of links on a women’s magazine home page. Thus, the first part of the visual cognitive complexity score consisted of a percentage that represented how complex each home page was due to the raw number of links. Then the percentage of semantically different links relative to the raw number of links for each home page was calculated. Once this was done, the two percentages were added. Based on this visual cognitive complexity score, six sites, two from each level of complexity, were chosen for the experiment. They included: Fitness, InStyle, Glamour, Real Simple, Self, and Vogue. Fitness and InStyle were the low complexity sites, and Self and Vogue were the high complexity sites. These were placed in these categories based on their cognitive complexity score. The two sites in medium complexity were Glamour and Real Simple. To ensure that that these were a good sample, the individual scores in each level were added and averaged to make sure there was enough variation across the complexity levels. Although Vanity Fair had the highest link count, it was not used because the researcher decided that the content was not similar enough to the other magazines. The numbers to the calculations for all the sites can be found in table 1.
Dependent Variables

*Mental effort.* Mental effort invested in making a story choice was measured as the amount of time it took participants to select a story from among the links on the Web pages. For this study, story selection is when a person clicks on the story link that they would like to read first. Story selection was timed, in seconds, to see how long it took participants to make a choice. This was used as an index of mental effort that enabled an examination of the impact of visual cognitive complexity of women’s magazine home pages on cognitive processing of information. By looking at women’s interest publications that deal with beauty, fashion, health, fitness, and women’s lifestyles, this study tried to control for the possible confounding effect of story topic by narrowing story topic to these general subject areas.

*Recognition.* Recognition was used to test how well story information from the home page was encoded. As mentioned in the literature review, recognition is one way to test the effects of visual cognitive complexity on encoding. Multiple studies have used recognition testing to understand media’s effects on encoding in different situations (Lang, Schwartz, Chung, and Lee, 2004; Lang, Chung, Lee, Schwartz, and Shin, 2005; Wise, Lee, Lang, Fox, and Grabe, 2008). As mentioned above, each participant viewed six sites. To test their recognition, three screen captures of different areas of each site were taken. Overall, there were 18 screen shots or targets. Mixed in were 18 foils, which were screen shots from six of the other sites in the content analysis not used in the experiment. The targets and foils were each flashed for only 600 milliseconds, and participants were asked if they saw the visual image on the sites while participating in the
experiment. This helped determine how visual cognitive complexity affects how people encode the varying sites. Overall, recognition data helped further explore the impact of visual cognitive complexity on cognitive processing of Web pages.

*Attitudinal Evaluations.* Users’ attitudinal evaluations of the home pages were measured through self-report scales. This is an area where the visual elements and their packaging play an important role. In addition to studying cognitive processing of information contained on a Web page, it is interesting and important to assess the impact of visual elements and design on individuals’ attitudinal evaluations of a website. Participants were asked to answer questions about their opinions of the site based on what they saw. As mentioned in the discussion on the LC4MP, self-report is often used to understand a person’s perceptions of a message. The self-report questions helped shed light on how complex people perceived a home page to be, and how usable and attractive they thought the home page was. The scale used in this study was adjusted from Cacioppo and colleagues’ “Bivariate Evaluations and Ambivalence Measures” (BEAMs) (Cacioppo, Gardner, and Berntson, 1997, p. 16). This scale gives words that can be used in questions to test attitude. For this study, the words that were used were: favorable, undesirable, appealing, attractive, unpleasant, and unsatisfying (Cacioppo, Gardner, and Berntson, 1997, p. 16). The researchers also used a scale of 1 (not at all) to 5 (extremely) to determine people’s reactions towards certain attitude stimuli (Cacioppo, Gardner, and Berntson, 1997). So, for example, a question could be: on a scale of 1 (not at all) to 5 (extremely) how attractive do you find this home page to be? Perceived complexity was measured by adapting a scale used in a study by Nadkarni and Gupta (2007) on perceived
website complexity. They compiled ideas from many different studies to get the measures. Each section of their measure uses seven-point scales in seven different dimensions to measure users’ perceived complexity (Nadkarni & Gupta, 2007). Refer to Appendix 2 to see the measures and sections used.

Stimulus

As mentioned in the independent variable section, six online women’s magazine home pages were used as stimuli in the experiment. A content analysis was done on 13 sites, and Fitness, InStyle, Glamour, Real Simple, Self, and Vogue were chosen because of their visual cognitive complexity scores. There are two sites for each level of complexity: low, medium, and high. Below is a table, which shows the visual cognitive complexity scores of each site and the means for each complexity level. The means were calculated by adding the cognitive complexity scores of the two home pages in each level and dividing by two. The information for these sites can be seen in the following table:

<table>
<thead>
<tr>
<th>Magazine home page</th>
<th>Fitness</th>
<th>InStyle</th>
<th>Glamour</th>
<th>Real Simple</th>
<th>Self</th>
<th>Vogue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual cognitive complexity score</td>
<td>1.237</td>
<td>1.304</td>
<td>1.428</td>
<td>1.414</td>
<td>1.557</td>
<td>1.465</td>
</tr>
<tr>
<td>Mean</td>
<td>1.2705</td>
<td></td>
<td>1.421</td>
<td></td>
<td>1.511</td>
<td></td>
</tr>
</tbody>
</table>

Participants

Participants were college women between the ages of 18 and 30 recruited from a large Midwestern university. This age group was chosen because they are close to the
readership of the websites. There were 48 participants, and they were recruited from undergraduate courses and the community.

**Procedure**

Participants were greeted by the researcher and read the consent form. They saw a welcome menu and were told to follow the instructions. Then they were asked to interact with the six digital magazine home pages. The software MediaLab was used to collect the data and randomized the order in which subjects were exposed to the sites. Subjects received instructions to interact with the digital sites as they would at home but had a total of five minutes on each site. Also, they were asked to make a selection by clicking on the story they would like to read first. The participants were timed to see how long it took them to make a selection on the home pages. MediaLab logged their interactions with the sites. After subjects made a selection, they were asked self-report questions about the home page. This procedure was repeated for each site. At the end, participants watched a short three-minute video clip to clear their short-term memory and then were asked the recognition questions about the home pages. At the very end, the participants answered some questions about how familiar they were with the sites and magazines presented in the experiment. When participants finished they were thanked and briefed by the researcher.
CHAPTER IV: RESULTS

Hypothesis 1

Hypothesis one stated that there would be a significant main effect of visual cognitive complexity on time spent to make a story selection such that as the visual cognitive complexity of the website increases, individuals will take longer to make a story selection. Part b of the hypothesis dealt with overload and stated that there will be a significant main effect of visual cognitive complexity on time spent to make a story selection such that individuals will take significantly longer time to select stories from medium complexity websites compared to low complexity websites in significantly less time to select stories from high complexity websites compared to medium complexity websites. The hypothesis was not supported.

A 3x2 repeated-measures ANOVA was calculated comparing the time it took for participants to make a story selection in three levels of visual cognitive complexity: low, medium and high. There were two sites in each level. No significant effect was found (F(2,96) = .317, p > .05). The site and level interaction was also not significant. The following table shows the mean times it took users to make a story selection for the individual sites and the levels.
Table 3
Mean time it took users to make a story selection in each level of complexity

<table>
<thead>
<tr>
<th>Complexity level</th>
<th>Site</th>
<th>Mean</th>
<th>Std. error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Fitness</td>
<td>24.061</td>
<td>2.839</td>
</tr>
<tr>
<td></td>
<td>InStyle</td>
<td>33.755</td>
<td>5.681</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>29.582</td>
<td>3.136</td>
</tr>
<tr>
<td></td>
<td>Glamour</td>
<td>35.673</td>
<td>5.347</td>
</tr>
<tr>
<td></td>
<td>Real Simple</td>
<td>23.490</td>
<td>2.839</td>
</tr>
<tr>
<td>High</td>
<td>Self</td>
<td>31.622</td>
<td>2.960</td>
</tr>
<tr>
<td></td>
<td>Vogue</td>
<td>32.265</td>
<td>3.508</td>
</tr>
</tbody>
</table>

Note: N = 49

Hypothesis 2

Hypothesis two stated that there would be a significant main affect of visual cognitive complexity on home page recognition such that recognition will be significantly better for home pages on each higher level of complexity. As before, the second part of this hypothesis took into account overload by stating that there would be a significant main affect of visual cognitive complexity on home page recognition such that recognition will be significantly better for home pages of medium complexity than for low and high complexity. Hypothesis two was not supported.

A 3x2 repeated-measures ANOVA was calculated comparing the recognition accuracy in three levels of visual cognitive complexity: low, medium and high. There were two sites in each level. No significant effect was found (F(2,94) = .190, p > .05). No significant difference exists among low, medium, or high on the recognition test. While level was not significant, the level and site
interaction was \( F(2,94) = 6.776, p < .05 \). This means that the level of visual
cognitive complexity did not affect recognition but something about the sites
themselves did. This table shows the means for the recognition test:

Table 4

<table>
<thead>
<tr>
<th>Complexity level</th>
<th>Site</th>
<th>Mean</th>
<th>Std. error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Fitness</td>
<td>0.729</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>InStyle</td>
<td>0.569</td>
<td>0.043</td>
</tr>
<tr>
<td>Medium</td>
<td>Glamour</td>
<td>0.778</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>Real Simple</td>
<td>0.722</td>
<td>0.040</td>
</tr>
<tr>
<td>High</td>
<td>Self</td>
<td>0.785</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>Vogue</td>
<td>0.688</td>
<td>0.043</td>
</tr>
</tbody>
</table>

Note: \( N = 48 \)

Research Question 1

The research question asked: How does visual cognitive complexity affect
user attitudinal responses to the site? Since levels was never found to be
significant based on the operational definition presented here, the levels and
visual cognitive complexity did not affect attitudinal evaluations. Cronbach’s
Alpha was calculated for the evaluation questions of each magazine.

Table 5

<table>
<thead>
<tr>
<th>Home page</th>
<th>Positive words</th>
<th>Negative words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitness</td>
<td>.974</td>
<td>.935</td>
</tr>
<tr>
<td>Glamour</td>
<td>.961</td>
<td>.865</td>
</tr>
<tr>
<td>InStyle</td>
<td>.936</td>
<td>.904</td>
</tr>
<tr>
<td>Real Simple</td>
<td>.910</td>
<td>.843</td>
</tr>
<tr>
<td>Self</td>
<td>.908</td>
<td>.891</td>
</tr>
<tr>
<td>Vogue</td>
<td>.928</td>
<td>.909</td>
</tr>
</tbody>
</table>
A 3x2 repeated-measures ANOVA was run, which calculated the evaluations of the two sites in the three levels of visual cognitive complexity: low, medium and high. No significant effect was found for the positive evaluations (F(2,94) = .062, p > .05). No significant difference exists. Table 6 represents the means for the positively worded questions.

Table 6

<table>
<thead>
<tr>
<th>Complexity level</th>
<th>Site</th>
<th>Mean</th>
<th>Std. error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Fitness</td>
<td>3.618</td>
<td>0.144</td>
</tr>
<tr>
<td></td>
<td>InStyle</td>
<td>3.354</td>
<td>0.155</td>
</tr>
<tr>
<td>Medium</td>
<td>Glamour</td>
<td>3.340</td>
<td>0.152</td>
</tr>
<tr>
<td></td>
<td>Real Simple</td>
<td>3.597</td>
<td>0.145</td>
</tr>
<tr>
<td>High</td>
<td>Self</td>
<td>3.493</td>
<td>0.132</td>
</tr>
<tr>
<td></td>
<td>Vogue</td>
<td>3.382</td>
<td>0.127</td>
</tr>
</tbody>
</table>

*Note: N = 48*

No significant effect of level was found for the negative evaluations either, (F(2,94) = .091, p > .05). Although, the level and site interaction was found to be significant (F(2,94) = 4.037, p < .05). Table 7 shows the means for the negatively worded questions.
Table 7

<table>
<thead>
<tr>
<th>Complexity level</th>
<th>Site</th>
<th>Mean</th>
<th>Std. error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Fitness</td>
<td>1.972</td>
<td>0.134</td>
</tr>
<tr>
<td></td>
<td>InStyle</td>
<td>2.306</td>
<td>0.160</td>
</tr>
<tr>
<td>Medium</td>
<td>Fitness</td>
<td>2.135</td>
<td>0.109</td>
</tr>
<tr>
<td></td>
<td>Glamour</td>
<td>2.326</td>
<td>0.148</td>
</tr>
<tr>
<td></td>
<td>Real Simple</td>
<td>1.944</td>
<td>0.145</td>
</tr>
<tr>
<td>High</td>
<td>Self</td>
<td>2.094</td>
<td>0.109</td>
</tr>
<tr>
<td></td>
<td>Vogue</td>
<td>2.125</td>
<td>0.139</td>
</tr>
</tbody>
</table>

Note: N = 48

Although the research question asked about attitudinal evaluations, the researcher also tested how visual cognitive complexity related to users’ perceived complexity. The eight questions asked from the Nadkarni and Gupta (2007) measurement scales for perceived complexity each measures a different element of Web page design that could impact complexity. Therefore, each item was analyzed separately. For five of the eight items there was a significant main effect of visual cognitive complexity. This means that the levels defined by the content analysis did affect perceived complexity for these questions. The three questions that were not significant were: “the range of the alternative links to find information was Broad (1) – Narrow (7), the variety of information clusters (groups of related information) was Low (1) – High (7), the information clusters (groups of related information) were Interrelated (1) – Not at all interrelated (7)” (Nadkarni and Gupta, 2007, p. 509). All these questions were from the Coordinative Complexity section. Results of the F tests and means for the five significant main effects are in the following table:
Table 8

*Five perceived complexity questions where level was significant*

<table>
<thead>
<tr>
<th>Item</th>
<th>F, df</th>
<th>p</th>
<th>Mean,</th>
</tr>
</thead>
<tbody>
<tr>
<td>The images (or graphics) on the webpages were: Similar (1) – Dissimilar (7)</td>
<td>3.645, (2,94)</td>
<td>0.030*</td>
<td>Low: 2.542</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium: 3.052</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High: 2.771</td>
</tr>
<tr>
<td>The information items on the webpages were Similar (1) – Dissimilar (7)</td>
<td>5.481, (2,94)</td>
<td>0.006*</td>
<td>Low: 2.750</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium: 3.271</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High: 2.792</td>
</tr>
<tr>
<td>The webpage backgrounds were Not visually dense at all (1) – Visually Dense (7)</td>
<td>3.682, (2,94)</td>
<td>0.029*</td>
<td>Low: 3.854</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium: 3.271</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High: 3.521</td>
</tr>
<tr>
<td>The graphics on the webpages were Not visually dense at all (1) – Visually dense (7)</td>
<td>4.142, (2,94)</td>
<td>0.019*</td>
<td>Low: 4.167</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium: 3.667</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High: 3.688</td>
</tr>
<tr>
<td>The text on the webpages was Short (1) – Long (7)</td>
<td>7.671, (2,94)</td>
<td>0.001*</td>
<td>Low: 2.740</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium: 2.708</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High: 3.375</td>
</tr>
</tbody>
</table>

*Note: N = 48
*p < .05*

While the results for these questions were found significant, the levels people perceived the sites to be in did not match the levels the sites were put in by the content analysis.
CHAPTER V: DISCUSSION

Overview

The goal of this study was to understand how the visual cognitive complexity of digital women’s magazines’ home pages affects the cognitive processing of individuals and their evaluations of the sites. While none of the hypotheses were supported there are still many insights to take away from the study.

This experiment showed that visual cognitive complexity, as operationally defined in this study, had no significant affect on recognition, time spent to make a story selection, and attitudinal evaluations. The levels: low, medium, and high, were never found to be significant but something about the sites themselves did affect recognition. Even though levels were not significant there are some explanations on different aspects of the sites and experiment that could have affected the outcome. Since nothing was significant it is important to look at the possibility of Type II error and the three categories within it. Type II error is where the researcher says the results are not significant but they are.

The first explanation and area of Type II error to look at is weak manipulation. In this study, the way visual cognitive complexity was operationally defined does not affect other measures of cognitive processing. It might not have captured true cognitive demand. While the content analysis was thorough and took into account the total number of links and semantic differences it is not a measure that predicts other variables. Two of its major issues might be
that the measure created here did not fully get at the elements that truly affect the
cognitive resources required, and the measure did not include a way to measure
the emotionality of content.

In the past, Lang’s $I^2$ has been used for analyzing television messages.
Through cuts and edits Lang and her colleagues used $I^2$ to understand and
measure the cognitive resources required to process audio and video (Lang,
Bradley, Park, Shin, and Chung, 2006). There is more user control on the Web
than in other forms of Media. Due to user control and the fact that information on
the Web is vast and created for all audiences, the measure created by adapting $I^2$
might not have captured elements that have a strong affect on visual cognitive
complexity and cognitive resources required. Users’ have a wide array of content
to choose from along with multimedia pieces. This study did not look into video,
multimedia, or the emotionality of content, along with user control. Users’ on the
Web are introducing new information to themselves with every click and the
content analysis measures did not take this into account. It is hard to measure user
actions before they happen, though, adding a component that takes into account
content and how people are emotionally tied to it is something that needs to be
done. So while $I^2$ is a strong concept that in the future might be able to be applied
to the Web, researchers have to find ways to adapt it so that it takes into account
elements that have a strong affect on cognitive resources required. In this study,
the number of links and their semantic differences or relatedness were not strong
enough elements to have an affect on the resources required. There is not a post
hoc test that can be run to see if this idea is actually a cause for the experiment to
have no significance. Yet, it is important to note that weak manipulation could have led to the results found.

To help subside the affects of weak manipulation a way to create a measure that takes into account both the visual cognitive complexity scores from the content analysis and the perceived complexity answers needs to be created. In this experiment the perceived complexity questions were a validity check on the content analysis and the two did not match up. The question becomes why? Some of the reasons for this could be that researchers cannot truly divide the sites into the three levels. When analysis was run on the perceived complexity questions it seemed two levels natural occurred instead of three. Maybe combining the levels would help create a stronger manipulation. So, instead of having low, medium, and high, there could just be low, and high. Also, as will be discussed further down, the perceived complexity questions were not worded in everyday language so this might have affected how people interpreted them. Finally, the sites might not have had enough variance in the design so people were rating them in a similar fashion. They might not have been able to noticeably see a difference between the complexities of the sites.

The best way to combat all the issues above is to either, as mentioned, have fewer levels or create sites specifically for the experiment. It seems weak manipulation could have been one of the major issues and if sites were created this would allow for a greater more noticeable difference. Also, combining the levels might have helped since in testing perceived complexity only two levels appeared.
Another idea would be to ask people outright how complex they think each site is, along with the perceived complexity questions in a pretest. So before the actual experiment find a scale that could be used in perceived complexity questions but could also be used in a content analysis. Have people answer the perceived complexity questions in a pretest and add that to the numbers calculated on the content analysis. The problem with the measures in this study is that since the perceived complexity answers were on a seven-point scale and then the content analysis was calculated totally differently there is not a way to combine them. The best way to combine those types of measures is to have them be on similar scales. Researchers will have the challenge of finding a way to make the scales similar so they can add the score they find by looking at the structural features with the perceived complexity answers. This study originally only really took into account the structural features.

Many of the studies referred to in the literature review also only looked at the structural features of the Web. This study tried to systematically break down the fundamental design features of a home page without including the emotionality of content. While the semantic differences were included in the original content analysis, this does not include content enough. It really only looked at the relatedness of the links. After performing the experiment, it seems that content and design are so intertwined on the Web that both must be included in studies of visual cognitive complexity. It seems that users were not affected by the complexity because they were driven to seek content that interested them and this overruled any cognitive affects complexity may have had.
The phrase content is king might be true for the Web. Although the experimenter tried to control for content by choosing magazines that covered similar topics, there were still various topics and information on each site users could click on. Had the measure taken into account the emotions associated with reading and choosing content along with the structural features then maybe the levels would have been significant. For future research, a researcher will have the challenge of finding a measure that includes content since it seems to play a bigger role than the straight design features of the Web. Content not being included in the measure is also a form of weak manipulation.

The final component that could have added to the weak manipulation is that there may not be enough variance in the complexity of online magazine home pages. In this study, real sites were used for the experiment to get results that applied to real-world situations. In the industry, many of the sites look similar. While the content analysis showed differences in the scores between sites, the difference may not be noticeable to users. This could be one of the reasons why the perceived complexity answers were inconsistent and did not match up with the results of the content analysis. While creating sites specifically for the experiment could have allowed for more manipulation, it would not have been as practical in nature. When one site finds a design that works, other sites follow and create a similar look. So while people tested average on the recognition test, there was so significant difference between the sites. Additionally, as mentioned in the literature review one study found that in television messages visual encoding is automatic (Lang, Potter, & Bolls, 1999). This might also be true for the Web and
should be pursued further. Again, this seems like a very practical solution to why there were not significant results but based on the data collected there is not a way to test it.

The second area of Type II error that could have affected the results is insensitive measures. In this study, the perceived complexity questions may not have asked the right questions and may have confused participants. The questions were not worded in everyday language. This might add to why the perceived complexity answers did not match up to the content analysis.

The final area of Type II that might have had an affect was low statistical power. In this study there were only 48 participants. Having more participants might have affected the results and provided more statistical power.

Additionally, outside of Type II error, the researcher thought maybe perceptual factors trumped visual cognitive complexity. These factors include: familiarity, interest, and selective attention. To check familiarity simple linear regressions were run to see if familiarity to the sites predicted recognition or the time it took to make a story selection.

A simple linear regression was calculated predicting users’ recognition scores based on their familiarity of the sites. The regression equation was not significant for any six of the sites. This means that familiarity is not a significant predictor of recognition. Therefore, no matter how many times a person had been to a site previous to the study it did not affect how they performed on the recognition testing. This also means that familiarity is not the reason that the sites ended up have a significant affect on recognition. As
mentioned above, it may be that certain site features and the emotionality of content affected how people did on the recognition test.

Another simple linear regression was calculated predicting the time users took to make a story selection on the home page based on their familiarity of the site. The regression equation was not significant for any six of the sites. This means that familiarity is not a significant predictor of the time it takes to select a story or mental effort. Again, no matter how many times a person had been to a site previous to the study it did not affect how long it took them to choose a story to read.

Another possible solution to why the levels were not significant is interest. As mentioned above, finding a way to categorize the topics and emotionality of content on the Web pages might be important but more important is understanding people’s interest. Interest is a psychological state. People’s drive to read something interesting to them might have overruled any affects of the complexity levels on their recognition test and how long it took them to select a story. They might have been so focused on finding something interesting to read that they did not notice other aspects of the site. There were no questions in the experiment that asked people how interested they were in the content on a site. For the future, this could be interesting to ask and see if interest predicts recognition and time it takes to select a story. Due to the nature of the data from the experiment, the women might have chosen what interested them and this completely voided the measurement provided. This also goes along with selective attention.
Women might have been so focused on seeking certain information or finding something that interested them that they were engaging in selective attention. This means that they only paid attention to a select amount of information on the home pages. Participants were not asked any questions about what they remembered or liked about sites. Selective attention might have been one of the reasons that the levels were not significant and perceived complexity evaluations were different for each element of the site.

Practical Implications

The question now becomes what does this mean for designers? People should not jump to the conclusion that design does not matter on the Web but rather that the function of design does. As mentioned earlier, many of the sites have a similar look and feel. A standard is being created. This does not mean that designers should avoid trying to things, it means that they need to find ways to enhance the content through design. The design needs to be functional so users can easily access the information they are looking for. If visual encoding is automatic on the Web, then people are not noticing the design or changes in it as much as they might notice content changes. This can be good since online magazines are trying to get information out to large audiences. One way to vary up sites is to cycle the content and change the photos. This will be stimulating to users and add to the design.

Another important concept for designers to think about is that they might not feel a site is that complex but users might perceive it to be. The measure
presented here could not predict perceived complexity. It is important to have 
users evaluate sites every so often because how designers evaluate the site might 
be different. It is important for designers to think about how they evaluate the 
design and complexity of a site and periodically compare that to what users think. 
The study presented here shows that content mixed with the design is important to 
consider. It also shows the way a researcher operationally defines how something 
is complex might not match how complex users feel something is and the 
elements that make up the measure might not be good predictors.

This research also adds to studies on the Web and processing by providing 
results that show perceptual states might have a larger impact on Web behavior 
than originally thought. There are cognitive processes going on but, in the case of 
this study, it seems perceptual factors, such as interest, affected evaluations, 
perceived complexity, recognition, and time it took to select a story more than the 
concrete features of the site.

Limitations

This experiment and research has some limitations. One of the main limitations is 
that the sites were not created for this experiment. The sites used in the experiment are 
real magazine sites. Since these sites were not made for the experiment they could not be 
manipulated like sites made just for the experiment. Sites were not made because the 
researcher felt it was more important to use sites that actually existed and had presence 
on the Web because then this would produce more practical and useful results. Also, 
producing sites with as many options and links as the real magazine sites would have
been time consuming. To offset the fact that new sites were not created, two sites were used per level. Along those lines, it is hard to distinguish if there was enough difference between the levels. Although a content analysis was done and visual cognitive complexity scores were calculated, when using real sites researchers cannot make greater variations between low, medium and high. In addition to this, the experiment was done in a lab and not in the real world. Participants may not act as they would at home because they are not in their everyday surroundings and know they are being watched. This means the experiment loses some of its external validity.

Other limitations include that only 48 women were tested so the study only applies to women in the age group of 18-30. Also, there were certain computer issues that popped up every once in a while. Some participants would get a message asking them if they wanted to debug the computer when they were on a website. This was distracting and it would have been helpful if there were a way to block the messages. Two sites had to be switched in the experiment because the message came so frequently. Also, since the sites appeared in MediaLab there was no back button. This threw people off a little because people are used to hitting the back button to go back to the home page. Within MediaLab, WebTracker was used to track what people did on the site. This component of the software could not ignore ads so the researcher had to weed through the data and do many manual calculations. While the calculations were sound, this leaves too much room for error.

One comment that some participants made is that spending five minutes on a site seems like a long time. Many people go to a site and multitask while they are online. Since people were in a lab they were forced to pay attention to the site for that whole
time. This means that they might have performed better on the recognition test than they would have if they had full control of how long they are on the magazine sites. Finally, this research is limited because it only looked at online magazines and not all websites.

Future Research

This research on visual cognitive complexity opens the doors to further research that can be done. Further research should be done where content and design and their interaction are studied. While the research here controlled for content it did not fully take into account how it interacts with visual cognitive complexity and its affect on people. Also, perceived complexity should be taken into account when creating a measure and added to structural measures of the sites.

Other studies should have bigger sample sizes and also look at men. This would mean another type of magazine should be chosen. There are many online magazine categories, so researchers could look at sports or news magazines as well. Additionally, other types of sites could be looked at. Researchers could also make their own sites. While this would allow for more manipulation, it might cut down on some external validity.

Many studies mentioned in the literature review studied the affects of sensation seeking on visual complexity. This would be a good area to study in the future. While the research presented here looked at how people evaluated the sites it did not ask questions about their Web usage or what they like to see on sites. If sensation seeking is looked at then the age group of the participants needs to be expanded.
Also, studying how user control affects visual cognitive complexity would help further understand the concept. User control may have been one of the major reasons that the visual cognitive complexity scores did not fit perceived complexity evaluations. Also, since only the home pages were looked at but people could click off of them, there needs to be a better way of keeping track of where users go.

The last major area of study would be to look at how interest and emotion affect the processing of online magazines. This study shows that perceptual factors might have played a large role in how people processed and navigated the pages. It would be interesting to find a way to tie these concepts to design and to a visual cognitive complexity score.

This study paves the way for people to do more research on visual complexity from a cognitive approach. A better measure, which takes into account more aspects of content, the magazine industry standards, and other psychological processes, will need to be created to fully understand the affect of visual cognitive complexity on the cognitive processing of online magazine home pages.

Conclusion

This study presented the concept of visual cognitive complexity and found that the measurement as operationally defined in this study did not have a significant affect on recognition or the time it took to select a story. It has opened the doors for further research in visual cognitive complexity, although new measures will have to be created. The purpose of this research was to understand the affects of the visual cognitive complexity of digital women’s magazine home pages on the cognitive processing of
individuals and their evaluations of the sites. While no significant effects were found, insight has been provided on why that could be. Also, ideas for future research have been suggested. The Web is a vast medium that has yet to be explored. It is constantly shifting and changing, which adds to its elusive nature. The challenge will be finding an objective measure that can capture all the Web has to offer and how it affects users. Also, finding out what specific parts of sites themselves might affect recognition, perceived complexity, attitudinal evaluations, and mental effort could be vital to the future of online design.
### Table 1

**Visual Complexity Scores**

<table>
<thead>
<tr>
<th>Home page</th>
<th>Number of links</th>
<th>Number of different links</th>
<th>All links divided by 265</th>
<th>All links to different links</th>
<th>Visual complexity score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allure</td>
<td>133</td>
<td>108</td>
<td>0.501</td>
<td>0.812</td>
<td>1.313</td>
</tr>
<tr>
<td>Cosmopolitan</td>
<td>187</td>
<td>127</td>
<td>0.716</td>
<td>0.7</td>
<td>1.416</td>
</tr>
<tr>
<td>Elle</td>
<td>198</td>
<td>140</td>
<td>0.747</td>
<td>0.707</td>
<td>1.454</td>
</tr>
<tr>
<td>Fitness</td>
<td>130</td>
<td>97</td>
<td>0.491</td>
<td>0.746</td>
<td>1.237</td>
</tr>
<tr>
<td>Glamour</td>
<td>187</td>
<td>135</td>
<td>0.706</td>
<td>0.722</td>
<td>1.428</td>
</tr>
<tr>
<td>In Style</td>
<td>160</td>
<td>112</td>
<td>0.604</td>
<td>0.7</td>
<td>1.304</td>
</tr>
<tr>
<td>Lucky</td>
<td>127</td>
<td>98</td>
<td>0.48</td>
<td>0.772</td>
<td>1.252</td>
</tr>
<tr>
<td>Real Simple</td>
<td>167</td>
<td>131</td>
<td>0.65</td>
<td>0.784</td>
<td>1.414</td>
</tr>
<tr>
<td>Self</td>
<td>194</td>
<td>164</td>
<td>0.732</td>
<td>0.845</td>
<td>1.577</td>
</tr>
<tr>
<td>Seventeen</td>
<td>156</td>
<td>120</td>
<td>0.589</td>
<td>0.77</td>
<td>1.359</td>
</tr>
<tr>
<td>Shape</td>
<td>160</td>
<td>116</td>
<td>0.601</td>
<td>0.725</td>
<td>1.326</td>
</tr>
<tr>
<td>Vanity Fair</td>
<td>265</td>
<td>183</td>
<td>1</td>
<td>0.691</td>
<td>1.691</td>
</tr>
<tr>
<td>Vogue</td>
<td>176</td>
<td>141</td>
<td>0.664</td>
<td>0.801</td>
<td>1.465</td>
</tr>
</tbody>
</table>
APPENDIX 1

Site URLs and dates accessed for content analysis

APPENDIX 2

Nadkarni and Gupta (2007) measurement scales for perceived complexity (p. 509)

Component Complexity:
1. The images (or graphics) on the webpages were Similar (1) – Dissimilar (7)
2. The information items on the webpages were Similar (1) – Dissimilar (7)
3. The text on the webpages was Short (1) – Long (7)
4. The webpage backgrounds were Not visually dense at all (1) – Visually Dense (7)
5. The graphics on the webpages were Not visually dense at all (1) – Visually dense (7)

Coordinative Complexity:
6. The range of the alternative links to find information was Broad (1) – Narrow (7)
7. The variety of information clusters (groups of related information) was Low (1) – High (7)
8. The information clusters (groups of related information) were Interrelated (1) – Not at all interrelated (7)
REFERENCES

Allure. See Appendix 1


Cosmopolitan. See Appendix 1

Elle. See Appendix 1

Fitness. See Appendix 1


Glamour. See Appendix 1


InStyle. See Appendix 1


Lucky. See Appendix 1


Real Simple. See Appendix 1

Self. See Appendix 1

Seventeen. See Appendix 1

Shape. See Appendix 1


Vanity Fair. See Appendix 1

Vogue. See Appendix 1