

# Bounded Rationality and Satisficing in Young People's Web-Based Decision Making

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**This study investigated Simon's behavioral decision-making theories of bounded rationality and satisficing in relation to young people's decision making in the World Wide Web, and considered the role of personal preferences in Web-based decisions. It employed a qualitative research methodology involving group interviews with 22 adolescent females. Data analysis took the form of iterative pattern coding using QSR NUD\*IST Vivo qualitative data analysis software. Data analysis revealed that the study participants did operate within the limits of bounded rationality. These limits took the form of time constraints, information overload, and physical constraints. Data analysis also uncovered two major satisficing behaviors—reduction and termination. Personal preference was found to play a major role in Web site evaluation in the areas of graphic/multimedia and subject content preferences. This study has related implications for Web site designers and for adult intermediaries who work with young people and the Web.**

## Introduction

In the simplest terms, decision making involves “selecting among possible actions” (Gilhooly, 1988, p. 132). With his theories of bounded rationality and satisficing, Simon (1955, 1956) suggested that decision makers operate within time and cognitive limitations that prevent them from evaluating all possible decision outcomes. These theories are largely accepted in relation to adult decision making in traditional information environments (Tyszka, 1989). However, these theories have not been rigorously tested in relation to young people's decision making or in relation to decision making in the World Wide Web environment.

The vast majority of user studies employ adults as subjects, and computer designers and electronic resource evaluators rarely study or consult young people before designing or selecting electronic resources for youth (Druin, 1999;

Laurel, 1990). This study turned to young people as sources of knowledge about their own Web-based decision making to investigate the theories of bounded rationality and satisficing.

In addition to examining Simon's theories in relation to selection decisions among multiple Web sites, this study also explored the concept of personal preferences in evaluation decisions within individual Web sites. It was proposed that the evaluation of certain aspects of Web site content and design is a part of what Kuhlthau (1991) called the affective side of information seeking, and that personal preference is tied to affective decision making.

It follows that three main research questions framed this study:

- (1) How, if at all, does Simon's theory of bounded rationality relate to young people's Web-based decision making?
- (2) How, if at all, does Simon's theory of satisficing relate to young people's Web-based decision making?
- (3) What is the role of personal preference in young people's Web-based decision making?

## Theoretical Background

Throughout the early history of decision making research, researchers devised mathematical algorithms to predict purely rational, or optimal, decision making (Tyszka, 1989). Simon (1955, 1956) rejected the idea of optimal choice, proposing the theory of “bounded rationality.” He argued that due to time constraints and cognitive limitations, it is not possible for humans to consider all existing decision outcomes and then make fully reasoned, purely rational, choices. He suggested that humans operate rationally within practical boundaries, or within the limits of bounded rationality.

For example, classic rational choice models would indicate that a man who wanted to sell his house would perform a series of mathematical manipulations for each offer he would receive. These mathematical operations would iden-

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tify the probable range of likely offers, the probability of receiving a better offer within an acceptable time period, the relative diminished value of a higher offer at some future time, etc.

Such calculations are beyond the computational capacity of most decision makers and are prohibitively labor intensive for nearly all decision makers. Instead, Simon (1955) predicted that the man in this example would simplify the decision making process by

Assum[ing] a price at which he can certainly sell and will be willing to sell in the  $n$ th time period. Second, he will set his initial acceptance price quite high, watch the distribution of offers he receives, and gradually and approximately adjust his acceptance price downward or upward until he receives an offer he accepts—without ever making probability calculations. (Simon, 1955, pp. 117–118)

The idea of simplification methods underlies all of Simon's work in human cognition. The most important simplification mechanism is "satisficing," or choosing decision outcomes that are good enough to suit decision makers' purposes, but that are not necessarily optimal outcomes. Satisficing involves "setting an acceptable level or aspiration level as a final criterion and simply taking the first acceptable [option]" (Newell & Simon, 1972, p. 681). Gigerenzer and Goldstein (1996) explained the origin of this term: "*Satisficing*, a blend of *sufficing* and *satisfying*, is a word of Scottish origin, which Simon uses to characterize algorithms that successfully deal with conditions of limited time, knowledge, or computational capacities" (p. 651).

Satisficing acts as a "stop rule" (Simon, 1979, p. 4)—once an acceptable alternative is found, the decision maker concludes the decision process. Nonetheless, satisficing does not limit the decision maker to one deciding factor:

When the criterion of problem solution or action has more than one dimension, there is the matter of calculating the relative merits of several alternatives, one of which may be preferred along one dimension, another along another . . . The satisficing rule . . . stipulates that search stops when a solution has been found that is good enough along *all* dimensions. (Simon, 1979, p. 3)

Nor does satisficing lock the decision maker into searching for an unrealistically superior option or a needlessly inferior option. Decision makers adjust "aspirations upward or downward in the face of benign or harsh circumstances, respectively" (Simon, 1979, p. 3) as they work through the decision-making process.

Simon contended that satisficing generally leads to choices roughly equal in quality to the choices predicted by optimizing algorithms. Gigerenzer and Goldstein (1996) showed that a simple "Take the Best" option algorithm (the electronic equivalent of human satisficing) matched or outperformed an optimizing algorithm on accuracy and speed. Because decisions based on satisficing behaviors are much easier to make than decisions based on optimizing algo-

rithms, requiring less time and less cognitive exertion, satisficing is a highly rational, efficient decision-making behavior.

### *Bounded Rationality and Satisficing in LIS Research*

Bounded rationality and satisficing have received limited attention in library and information science research. It does seem likely that users of libraries and other large information sources must satisfice. Certainly a library user could not enter a library and carefully evaluate every book, periodical, and multimedia resource before selecting an item. As Marchionini (1995) explained,

This principle is clearly demonstrated in libraries, whose users show high levels of satisfaction because they are able to find at least some relevant items with minimal investments of time and effort. This result is even more common in electronic environments because time and effort can be minimal and the scope of the sources can be broader. Satisficing is essential to most information seeking because all pertinent information for open-ended problems can seldom be assembled and assimilated optimally. (pp. 63–64)

A few library and information science studies have considered the theories of bounded rationality and/or satisficing. Schwartz (1989) suggested that collection developers act within the limits of bounded rationality when selecting library materials. He proposed a descriptive model of collection development that combined bounded rationality, tacit knowledge, and symbolic content. In a related application of bounded rationality to library practice, Chu (1994) suggested that reference librarians' and academic library patrons' time and cognitive limitations often result in ambiguous reference questions and answers.

Higgins (1999) examined the effect of source credibility on decision making and the effect of time constraints on reliance on source credibility. She found that time limits influenced study participants' decision making, causing them to rely less heavily on source credibility when operating with limited time than when operating with unlimited time.

Not all library and information science research has supported the theories of bounded rationality and satisficing. The model of a Generalized Information System (GIS) (Kleyle & Korvin, 1989; Yovits & Foulk, 1985) assumes that decision makers calculate the probability that each outcome within a set of possible decision outcomes will provide them with the best possible solution. According to the GIS, the decision maker considers each available outcome sequentially, returning to the outcome with the highest probability of matching the decision maker's idea of expected utility. This model is inconsistent with bounded rationality, because situational limitations are not considered, and it is inconsistent with satisficing, because the decision maker considers additional outcomes beyond the appearance of an acceptable choice.

Examples given to support the GIS model use a restricted number of possible decision outcomes, such as three possible outcomes (Kleyle & Korvin, 1989, 1990) or 100 possible outcomes (Yovits & Foulk, 1985). Brewington and Cybenko (2000) estimated that as of the year 2000, there were 800 million publicly accessible Web pages. The GIS model does not seem applicable to real-world decision making in the Web environment, with literally millions of possible decision outcomes.

Moreover, participants in Yovits and Foulk's (1985) study were instructed to "determine which C.O.A. [course of action] would in the long run yield the greatest return based on an unknown probability matrix which you will learn as you experiment" (p. 68). To assist in decision making, a computer would "calculate and display an outcome value using the probabilities which the computer knows" (p. 68). Rarely in real-world decision making do decision makers use a computerized probability calculator providing them with probability figures. Decision makers typically rely on their own minds to make everyday decisions, such as selecting a Web site for a homework assignment. Thus, this model is not applicable to the type of decision making central to this study: naturally occurring, everyday human decision making.

#### *Young People, Bounded Rationality, and Satisficing*

Little research has specifically considered young people, bounded rationality, and satisficing. Nonetheless, some studies of youth and their information seeking behaviors have indicated that young people use satisficing behaviors, even though the study authors did not specifically apply these theories.

Bilal (1998) explored seventh grade students' use of Yahoo!igans!, a Web search engine designed specifically for youth. The young Web users tended to examine briefly the first few hits on the initial results pages before performing new searches, rather than examining every hit in detail. This is a satisficing behavior that enables users to deal with prohibitively large amounts of information.

Hirsh (1999) found that elementary school children tended to skim resources when making relevance decisions, another satisficing behavior that reduces the amount of information necessary for making site selections.

Other studies examining youth information seeking in the Web have indicated that young people experience related cognitive constraints. To study how elementary school children learn using the Internet, Kafai and Bates (1997) asked children to create a directory of recommended Web sites. The authors found that many sites were written at levels beyond the comprehension of the study participants, who consequently placed heavy importance on the evaluation of visual content.

Schacter, Chung, and Dorr (1998) found fifth- and sixth-grade students to have difficulty finding desired information on the Web. They also found the participants to exhibit a

strong preference for browsing over "analytical" (planned or premeditatively structured) search techniques.

Fidel et al. (1999) studied high school students' Web-searching patterns using observation and think-aloud protocol analysis. The participants were quick to abandon seemingly unsuccessful searches, returning to known landmarks to begin new searches.

Bilal (2000) investigated 14 seventh-graders' cognitive, affective, and physical behaviors as they used Yahoo!igans! She found that the study participants preferred keyword searching to browsing, another attempt to reduce the pool of sites from which they must make selection decisions.

#### *Personal Preference in Web-Based Decision Making*

Another concept that underlies this study is the idea of personal preferences. Because the Web is a visual and aural environment, it was proposed that young people would exhibit strong personal preferences toward different sites based on their personal color, design, sound, etc., likes and dislikes. These personal preferences cannot be explained by demographic characteristics, such as age or gender, or by external conditions, such as time limits or system constraints.

Papert (1993) suggested that computers offer a framework for supporting different learning styles, a concept related to personal preferences. He proposed that "computers would not simply improve school learning but support different ways of thinking and learning" (p. 178). As he explained in his classic book *Mindstorms* (1980), the educational potential of the computer "is its universality, its power to simulate. Because it can take on a thousand forms and can serve a thousand functions, it can appeal to a thousand tastes" (p. viii). The multisensory (visual and aural) aspect of Web use makes the Web an ideal environment for studying personal preferences in young people's decision-making processes.

Although she did not discuss personal preferences in the evaluation of information, Kuhlthau's (1991, 1993b) work is tied to this idea. Kuhlthau developed an integrated cognitive/affective/behavioral model of the information seeking process (ISP). Her model divided the ISP into six stages: initiation, selection, exploration, formulation, collection, and presentation.

Kuhlthau's work showed that there is an affective side to the research process and to young people's interaction with information. Personal preferences are an aspect of the affective side of information seeking, as these preferences are based on personal feelings (such as personal dislikes for particular colors), rather than on cognitive or behavioral information seeking.

Based on additional past research, it is clear that adult experts exhibit personal preferences for particular information source design features. According to Wang and Soergel (1998), "It is important to point out that individual user's cognitive structures determine their ability to use the type of information elements necessary for decision making; and

they also have personal preference as to how certain elements should be arranged and sequenced" (p. 129). Unfortunately, the authors did not elaborate on this connection between personal preference and information resource design.

## Methodology

This study employed a qualitative research methodology comprised of Web-surfing sessions and group interviews. Participants were assigned very general tasks, making the study largely unstructured and inductive. This methodology was selected to minimize demand characteristics that might have stemmed from a more prescribed design.

### Participants

Twenty-two ninth- and tenth-grade females participated in this study. These young women were participants in the Rutgers University Douglass Project for Rutgers Women in Math, Science, and Engineering Leadership Institutes. The Institutes aim to encourage young women to enter science and technology fields. Each Institute lasts for six hours on a Saturday during the school year, and is comprised of four science-related workshop sessions, such as hands-on chemistry lab demonstrations. The Institutes are held in classrooms and laboratories at Douglass College in New Brunswick, NJ. They are open to New Jersey high school women across New Jersey on a first-come, first-serve basis for any female ninth- and tenth- graders recommended to the program by their guidance counselors.

Students participating in the Institutes range in academic achievement, but all exhibit interest in science and technology. The current study took place immediately following one such Institute during the fall of 1999. Forty-eight students took part in the Institute. All 48 students were invited to participate in the current study on a volunteer basis. Twenty-two did join the study, for a participation rate of 45.8%. The research sessions took place in the Douglass Project computer lab on the Rutgers Douglass College campus.

The participants first completed short questionnaires about their age and the frequency and location of their Web use (see Appendix A). Five participants were 14 years old, 16 were 15 years old, and one was 16 years old. All of the participants had previously used the Web, with the frequency of their use ranging from every day to less than once a month. Nineteen used the Web at least once a week. Most of the participants typically accessed the Web from home and/or school.

### Web-Surfing Sessions

After completing the questionnaires, the participants took part in 50-minute long Web-surfing sessions in the Douglass Project computer lab. The project investigator instructed the participants to visit three preselected Web

sites for as long as they wished and to spend the remainder of the time freely surfing the Web. On average, the participants spent about 25 to 30 minutes visiting the three test sites, leaving about 20 to 25 minutes for the free surfing portion of the sessions. The three sites were: The Women of NASA (<http://quest.arc.nasa.gov/women/intro.html>), Hurricane Hunters.com ([www.hurricanehunters.com](http://www.hurricanehunters.com)), and The Boston Museum of Science site (<http://www.mos.org/home.html>). These sites were selected from a pool of science-related sites recommended as a part of the Leading Young Women to the Sciences and Technology project. They were chosen because they varied widely in graphic and multimedia design and because they presented their science-related content in informal, entertaining manners.

The participants were instructed to consider three questions as they visited each site: "What do you like about the site?" "What don't you like?" "What would you change if you could?" Participants were not instructed to consider more specific aspects of the sites, such as design, accuracy, or currency, because this study sought to be user-directed as much as possible. Instructing the participants how to evaluate the sites would have biased their evaluations. If the researcher had instructed them to evaluate the sites according to currency, for example, they would have done so whether or not they normally evaluated sites according to currency when using the Web on their own. This study sought to examine the participants' already formed site decision-making processes, not to prescribe new processes for their decision making.

Paper and pens were placed beside each computer, and the participants were encouraged to write comments and opinions as they worked. For the free surfing period of the sessions, the participants were told simply to use the Web in whatever manner they wished, again in an attempt to reduce demand characteristics.

### Group Interviews

Following the Web surfing sessions, the participants were divided into two interview groups of 11 interviewees each. The group interview methodology was selected for this study because group interviews allow a researcher to capture data about inherently unobservable processes, such as decision making (Morgan, 1997). The group discussion setting of a group interview can make invisible, habitual processes recordable, and qualitative interviews are effective in revealing processes of human behaviors in general (Weiss, 1994). As a group discusses a topic, the participants become more aware of their related cognitive processes, making the articulation of those processes possible.

Group interviews differ from focus group interviews in that a major goal of focus group interviews is to achieve group consensus, whereas this is not a goal of group interview research (Frey, 1991). Because personal preference is a theoretical underpinning of this study, group consensus, which in effect thwarts differences of opinion, was undesirable. It was hoped that the group interview methodology



would bring to light differences of opinion based on personal preferences in Web-based decision making.

Each interview lasted 50 minutes, and was tape recorded.<sup>1</sup> Each participant first introduced herself to the group and made a brief opening statement about her opinions of the three test sites she had visited during the Web-surfing sessions. This opening procedure acted as protection against “groupthink” (Janis, 1982). The fact that the interviewees had written down their reactions to the test sites on their Web surfing sheets before the interviews began also served as defense against groupthink. “There is something about the process of writing things down that reinforces a person’s commitment to contributing these thoughts to the group, even in the face of apparent disapproval” (Morgan, 1997, p. 50).

After the participants made their opening remarks, the interviewer asked them to give their opinions about the Web in general, not limited to their experiences during the Web surfing sessions. Many of the ensuing discussions focused on homework projects for which the participants had previously consulted the Web; other discussions focused on past leisure use for purposes such as game playing or shopping. During these conversations the participants tended to refer back to the test sites as bases of comparison and shared reference.

The qualitative research philosophy posits that study participants have rich and varied life experiences that they bring to bear on any research situation, and qualitative researchers maintain that participants’ past experiences cannot be completely suppressed during data collection (short of hypnosis, drug administration, etc.). Because all of the participants had previously used the Web for various tasks, their past Web experiences were likely to be fertile sources of data related to the research questions. Investigating past Web use in addition to use during the study surfing sessions was, therefore, likely to increase the depth and range of the resulting data.

This largely unstructured interview methodology was intended to make the interviews highly user-centered, with the participants discussing topics they felt to be important, rather than discussing topics introduced by the interviewer. For the majority of the interview periods, the participants spoke without interruption from the project investigator, but the interviewer did ask occasional probe questions to clarify vague responses.

## Data Analysis

The project investigator fully transcribed each group interview tape into electronic (word processor) form. Iterative readings of the transcripts, involving searching for recognizable data patterns and attempting to tie pieces of

data to deeper theoretical considerations, resulted in the creation of a coding scheme for data analysis.

More specifically, analysis of the group interview transcripts took the form of an analysis method called alternatively: iterative pattern coding (Miles & Huberman, 1994), the cut-and-paste technique (Stewart & Shamdasani, 1990, pp. 104–105), “making thematic connections” (Seidman, 1991), and simply “the analysis of qualitative interviews” (Wester, 1996). This method of analysis involves first reading the raw data in detail, identifying any sections relevant to the research questions. Next, the identified sections are coded according to topics related to the research questions by aggregating data into recurrent themes. Initial codes are called “pattern codes” (Miles & Huberman, 1994), or “open codes” (Wester, 1996).

Coding may take several passes as categories evolve and as the analyst forms a deeper understanding of the data and their relationships to the research questions. The initial codes are then transformed into more or fewer categories, fluidly changing as analysis progresses from iteration to iteration. After the coding is complete, the coded sections are cut out and pasted into groups by thematic topics (either manually or electronically). Newly organized according to coded categories, the data then become the basis for writing the research report.

The researcher used NVivo (QSR NUD\*IST Vivo) software (Qualitative Solutions & Research, 1999) to conduct the coding. NVivo is a qualitative data analysis software program. It is the most recent version of NUD\*IST (Non Numerical Unstructured Data Indexing Searching and Theorizing), one of the most popularly used computerized qualitative data analysis tools on the market.

Rouse and Dick (1994) explained that computerized software tools such as NUD\*IST are especially useful in the “decontextualizing and recontextualizing of data” (p. 56). In the iterative data coding process, decontextualizing involves data reduction from its original format into smaller individual units of meaning. For this study, the data were decontextualized from continuous interviews into separate units by conversation turns. Recontextualizing involves the reorganization of the decontextualized data into themes. This process involved the iterative reading of the data and the subsequent creation of category codes relating to the research questions.

Of course, a program such as NVivo does not recontextualize data on its own. The researcher must create his/her own category codes, called “nodes” in NVivo. The strength of a digital tool for qualitative data analysis is that it facilitates the researcher’s ability to manipulate large quantities of nonnumerical data from node to node once the nodes have been established. In this way, the researcher can more easily determine the quality of the fit between the data and the nodes.

The two main advantages of using programs such as NVivo are the ability to complete the iterative pattern coding process much more quickly than with hand coding and

<sup>1</sup> While each group participated in the interviews, the other group returned to the computer lab to evaluate a set of CD-ROMs for a related study.

the ability to test alternate coding patterns more easily. As Rouse and Dick (1994) explained, "With NUDIST, the initial coding is still time-consuming, but once it has been done, the retrieval and combining of information is far easier than manual methods and far more flexible" (p. 59). NVivo also allows the researcher to create meaningful links between derived category codes, such as linking all data units from a particular interview.

## Limitations

The most significant limitation of this study is that the participant groups were comprised exclusively of females. It is likely that most of the results are transferable to adolescent male Web users as well, but the next step in the research process should be replication with male participants.

Similarly, the participant age range (14 to 16 years) was relatively limited. Again, it is likely that many of the results can be extended to additional populations, but this is an area that requires further examination.

Of course, generalizability is not commonly sought in qualitative research (Lincoln & Guba, 1985). Instead the issue of "transferability" (p. 297) comes into play. Transferability indicates that the results of a qualitative study can be applied to other similar contexts. Transferable results go a long way to explaining a similar situation, but it is recognized that there are always differences between any two situations. Considering the gender and age limitations of this study, the results are largely transferable to the population of U.S. ninth- and tenth-grade females with an interest in science and technology issues.

An additional limitation involves the test websites. All three test sites were science related. It is possible that this somewhat monolithic site pool suppressed other decision-making patterns that the participants might have otherwise used. However, because the interviews focused on the participants' past use of the Web, as well as on their evaluations of the test sites, it seems doubtful that this limitation seriously affected the results.

## Results

### *Coding Scheme*

The unit of analysis was a conversation turn. Data analysis of the interview transcripts resulted in the coding scheme represented in Appendix B. This coding scheme strongly supports the application of bounded rationality, satisficing, and personal preference to young people's Web-based decision making. Results for the three research questions are presented below. In reporting these results, the project investigator has relied heavily on direct quotes,

employing a "discursive strategy" of qualitative research (Lindloff, 1995, p. 234).<sup>2</sup>

### *Research Question #1: Bounded Rationality*

Research Question #1: "How, if at all, does Simon's theory of bounded rationality relate to young people's Web-based decision making?"

To reiterate, Simon discussed two types of constraints on decision makers: time and cognitive. Data analysis indicated that the participants operated under both of these types of limits of **bounded rationality**<sup>3</sup> when decision making in the Web. An additional constraint also arose: physical constraint.

### *Time Constraints*

The participants found **time constraints** to be a constant problem when using the Web. They considered time limitations particularly restrictive in Web use for homework purposes, causing them to examine only a few possible websites before selecting one. As one participant explained, "We don't have that much time when we're doing a report or something to look through everything." They agreed that improved search functions would help to reduce wasted search time by allowing them to zero in on the particular pieces of information in which they were interested.

The participants considered extraneous information, or information that simply did not interest them, to be a waste of precious time. They agreed that they simply wanted to "click onto [the desired information] real fast so that you can get out of there fast."

Despite this wish, the participants had rarely found searching to be a quick or an efficient process in their previous experiences with the Web. One participant described her frustration at using the Web for a science project she had recently completed:

I was looking for solar panels, how they work. And I put in specifically, "How do solar panels work?" And they gave me how they're made, how for electricity, and how for this and that. I just wanted to know specifically how does it work. How does it transform into energy. And it took me at least 20 minutes for that one simple thing. It was ridiculous.

The other members of her group responded by saying that 20 minutes was actually a short search compared to the average time needed to answer even seemingly simply queries. Indeed, another participant described a similarly frustrating research experience, concluding with the complaint, "I spent *two hours* to find three sites."

<sup>2</sup> Transcript quotes are verbatim, although occurrences of phrases such as "you know" and "like" have been removed for greater readability.

<sup>3</sup> Boldface is used to indicate the coding categories in the coding scheme (Appendix B).

Data analysis showed that there were two major categories of time constraints within which the participants operated: **imposed** and **self-generated**. These are the same two divisions that Gross (1999) discussed in relation to task generation. Self-generated tasks are “internally motivated by personal context” (p. 501), or those that are created by the user. Imposed tasks are “set in motion by someone else” (p. 501), or created by another person.

When using the Web for homework purposes, the participants operated within imposed time constraints set by their teachers in the form of assignment due dates. Some of the participants also created stricter self-generated time constraints. They felt they did their best work under increased time pressures, so they would intentionally begin their homework projects as close to the due dates as possible. Decision-making time constraints are not only externally imposed, but also internally generated.

### *Cognitive Constraints*

Strong evidence also supported Simon’s idea of cognitive limitations as applicable to young people’s Web-based decision making. Simon discussed cognitive constraint as computational capacity limitations. Cognitive limitations in the participants’ Web-based decision making took the form of **information overload**, both within individual sites and within the Web as a whole.

Within individual sites, the participants found resources with large percentages of textual content, as opposed to graphic or multimedia content, to be tedious and mentally taxing. As one participant stated: “I just wish they’d make things shorter and less to read.” Similarly, in Kafai and Bates’ (1997) study, “text-only sites were often left unexplored” (p. 109). Based on **textual overload**, both groups preferred the graphic-intensive *Hurricanehunters.com* and Boston Museum of Science sites over the primarily text-based *Women of NASA* site.

The participants expressed even more frequent objections to the vast number of Web sites available within the entire Web, identifying the enormous size of the Web as a whole as bewildering. In decision making terms, the roughly 800 million possible decision outcomes cause **outcome overload**. One young woman described the free surfing part of the Web surfing session as enjoyable but overwhelming: “I didn’t find anything that I didn’t like except that there was so much to choose from.”

The low quality of a large proportion of Web sites intensified outcome overload. As one frustrated participant said,

If you just put a general word in, they have a whole list of things. And if you click on every single one, probably out of every 15, two of them will be informative. So many of them are just junk.

The participants explained that they devoted much of their Web use time to culling out low-quality sites from the pool of sites under consideration.

### *Physical Constraints*

Data from both interviews indicated that young people face an additional type of constraint in the Web environment, **physical constraints**. The study participants had learned from past experiences that sore bones, headaches, wrist pain, and eye strain resulted from excessive computer use. The desire to avoid the recurrence of these types of physical **discomfort** prevented them from using the Web as much as they would like to otherwise:

Participant #1: And then your bones get tired and you wind up with arthritis and a hump.

Participant #2: And you sleep in the computer position.

Participant #3: You get tired and you get a really bad headache like I had.

Participant #1: And when your eyes hurt—the burning in the back of your eyes, oh my God!

Participant #2: From staring at the computer.

Participant #4: It hurts.

Participant #5: And sometimes you don’t even find anything good during that time.

Young Web users must make bounded decisions, or they will experience serious physical discomfort. This unexpected study result indicates that Simon’s original theory must be expanded to include physical constraints as well as time and cognitive constraints in decision making.

The concept of physical limitations as a part bounded rationality also arose independently from the physical discomfort of excessive computer use. The participants explained that they valued the Web as a method for reducing the physical **exertion** otherwise required for information gathering. For example, one participant praised a medical information site she had visited for its ability to reduce the physical effort needed for accessing medical information, as well as to reduce the amount of time needed for information gathering:

No one wants to go all the way to the hospital and spend two hours with the doctors talking about [their symptoms]. They could just go to the website and [the necessary information] is just right there.

Largely as a result of this reduced physical effort, the participants favored Web-based research over more traditional information gathering methods, such as using their school libraries. Even one participant who claimed to dislike the Web still used it an average of once a week for homework assignments. The high school students in Fidel et al.’s (1999) study also felt that the main research advantage of the Web over a traditional library was the ease in accessing information. Similarly, the children in Large and Beheshti (2000) favored the Web but they found it more difficult to use than print sources.

### *Research Question #2: Satisficing*

Research Question #2: “How, if at all, does Simon’s theory of satisficing relate to young people’s Web-based decision making?”



Participants in both group interviews indicated that they used various behaviors to combat information overload, each of which contradicts an optimizing model. These **satisficing** behaviors fall into two major categories: reduction and termination.

### *Reduction*

**Reduction** methods serve to decrease the enormous number of sites on the Web to a small subset of sites for consideration. The decision maker then evaluates the sites within that subset until she finds a satisficing outcome. Reduction methods included: returning to known sites, relying on site synopses, and using indexing categories to dismiss sites from deeper consideration.

The most common reduction method involved returning to **known sites**. The participants agreed that they generally relied upon a small subset of familiar sites to serve both their homework and leisure purposes. Because they worked constantly under time pressures, it was more efficient to rely on familiar information sources than to take the time to evaluate new sources. As one participant explained: "Usually I do [return to familiar sites] because I don't have the time to go skim websites to see if they're good or not. I just want to get it done. So I just go to the same websites."

In addition to reducing the pool of sites for evaluation, this routine use of known sites played a less obvious function. Returning to familiar sites was also a method of avoiding undesirable sites: "I don't really like going to new websites because some of them are cool, but some of them, you walk onto things. You think it's gonna be a science paper, and it's a Klan site or something." Other participants mentioned their reliance on familiar sites as protection against accidentally wandering onto sites with pornographic content.

Reliance on known sites was not always successful. If the subset of known sites would not contain a satisficing outcome for the query at hand, then the participants would widen their searches: "I go to the same [sites], but the only time I really look for something new is if I really need more information." Even in these cases, the participants would begin their widened searches at familiar points, consistently returning to one favorite search engine. Many of the high school students in Fidel et al.'s (1999) study also had a favorite starting point, such as a commercial search engine front page or the school library's home page. Each time they began a new search, these students returned to their home bases.

The participants' behaviors with search engine hit lists continued to adhere to the concept of satisficing. After exhausting the pool of known sites, they would turn next to site **synopses** of various types. Whenever possible, they would avoid entering an unfamiliar site to determine if it would suit their needs, turning first to **search engine descriptions** to narrow the field of possible sites. They would then enter and examine only those sites with appealing summaries. One participant's explanation of her search engine results page use typified this behavior:

Usually, if I'm using a search engine, I'll read the little description before I'll click on it. I just wouldn't go down the list trying to find something because some of the sites are just like a little paragraph that people stuck up.

Again, the idea of the often low quality of Web sites arose.

However, the participants criticized search engine site summaries as often vague and unhelpful. In cases of poor quality site summaries, they would turn next to **introductory summaries** within the sites themselves when available. Participants in both interviews wished that more sites provided concise summaries on their initial pages. As one participant explained: "They need a quick intro so you know, 'Oh. Do I want to be here or not?'"

Similarly, the participants in one interview group called for textual summaries of video content. In their past Web use, they had found the process of downloading video clips to be time consuming. After viewing the downloaded clips, they had often concluded that the videos did not cover content of interest and, therefore, had not merited the time invested. As a result, the participants had grown hesitant to invest time in the downloading process. They felt that summaries of video content would help them to decide in advance whether or not video clips would likely merit downloading time.

In the absence of acceptable search engine descriptions and introductory summaries, the participants explained that they would enter a site and use **skimming** to form an evaluation, a practice consistent with Hirsh's (1999) findings. Skimming was reserved as the last of the three synopsis options because it would take the most time.

The final reduction method was **categorization**. Two participants suggested that function-based site categories would help to reduce outcome overload. They wanted to see sites categorized as "personal websites, scientific websites, and other websites" or as sites "that are best for science, for math, for fun" and so on. The other members of their interview group enthusiastically received this suggestion, expressing similar frustration in locating appropriate sites for particular purposes.

### *Termination*

Simon suggested that satisficing acts as a "stop rule" (1979, p. 4); decision makers take the first acceptable option that arises, or the first option that meets their aspiration levels, and then conclude the decision making process. In contradiction to this idea, data analysis showed that finding a satisficing outcome was not the only stop rule on which the participants relied. Instead, the participants used multiple **termination** signals as stop rules.

When searching the Web, the participants sometimes used the finding of a satisficing outcome as a stop rule, evaluating sites sequentially and stopping after they found an acceptable choice. As one participant explained this **acceptance** process: "You just say, 'OK. Let's try this.'



And if it doesn't work, you try another one until you find a good one. It's basically trial and error."

In many cases, other stop rules would come into play before the finding of a satisficing outcome. In these cases, the search was terminated before acceptance could occur. The onset of physical **discomfort** associated with excessive computer use also served as one such stop rule, as did **boredom onset**, setting specific **time limits**, and the appearance of repetition, or information **snowballing**. A transcript excerpt supports most of these additional stop rules:

Interviewer: So, you said one problem that you have is that there's just too much stuff out there. How do you decide when to stop?

Participant #1: When you get bored.

Participant #2: After about 15 minutes. I actually give myself a time limit.

Participant #3: When you find what you need.

Participant #4: If you really need it for a report, I guess you just keep on looking. You'll sit there longer.

Participant #1: Oh definitely.

Participant #5: I stop when it starts repeating itself. When site after site has the same thing.

In this example, only participant #3 claimed to stop after finding a satisficing site. Due to the huge amount of information on the Web, the participants had often been forced to conclude their Web-based decision making *before* a satisficing option appeared, settling for an inferior option.

### Research Question #3: Personal Preference

Research Question #3: "What is the role of personal preference in young people's Web-based decision making?"

The group interview methodology proved to be successful in preserving interviewees' differences of opinions, enabling the researcher to examine the concept of **personal preferences**. In discussing the Women of NASA site background color, for example, one group returned to the subject of the background color four times, and the other three times. Participants maintained their individual opinions throughout each of these continuing discussions, rather than reaching consensus.

For the most part, the participants shared decision-making behaviors in the site selection process. All had employed strategies to reduce the number of sites necessary to evaluate for decision making, and all had used various methods for ending the site evaluation process before an optimal site had been located. Personal preference played a much stronger role in evaluation decisions within individual sites. Data analysis showed that personal preference affected the participants' site evaluation decisions in two main areas: the evaluation of graphic/multimedia content, and the evaluation of subject content.

### Graphic/Multimedia Content Preferences

The most frequently discussed area of **graphic/multimedia content** preferences was **color**. The participants en-

gaged in detailed discussions about the perceived attractiveness of site colors, such as the discussion surrounding the background color of the Women of NASA site. Nearly all of the participants agreed that the green wallpaper was essential in their forming an overall site evaluation, but they disagreed as to whether it was attractive or unattractive. Color was so important to them that one participant even attempted to change the shade of green by adjusting the monitor buttons on the computer she was using. Displeased with the results she concluded, "But it was still dull."

Although personal preferences clearly played a role in determining whether or not the participants liked the background color, with some participants liking the green and some disliking it, for the most part the participants agreed that bright shades were preferable to duller shades. The words "bright" and "bold" appeared repeatedly in the transcripts when the participants suggested changes they would like to see in the sites.

In addition to color preferences, the participants exhibited personal **design** preferences. Many comments about design preferences were general, such as "The format didn't appeal to me. It was too formal and ugly." One word that the participants commonly used to describe the design of the websites they examined was "boring." When asked for further clarification, both interview groups indicated that "boring" meant lacking animation; lacking large, bold type fonts; and lacking bright colors.

In the Boston Museum of Science site, for example, the introductory page to an exhibit about Leonard da Vinci depicts a drawing of the artist, surrounded by blocks of text describing the various sections of the exhibit. The artist's eyes change direction and follow the cursor as the user moves from text block to text block. The participants found this subtle use of animation to be highly desirable. The inclusion of this simple animation transformed an otherwise "boring" Web site into one that they were excited to enter and explore.

### Subject Content Preferences

Personal preferences also played a role in the evaluation of **subject content**. Many of the participants evaluated a site positively or negatively based on their **interest** in the subject matter. Participants uninterested in meteorology, for example, were much less likely to evaluate Hurricane Hunters.com positively than were those with an interest in weather.

The participants also tended to infer a general tone from each site, such as a patronizing, friendly, funny, or irreverent overall tone. **Interpretation** of tone varied from participant to participant, as can be seen in excerpts typifying dissenting opinions about the tone of the Women of NASA site: "It was self-promoting." "[I liked] the teen-friendly vocabulary . . . They had good language." and "The descriptions of the women's jobs made [the site] boring."

Finally, site evaluations varied according to personal **conviction**. For instance, disagreement arose regarding the

fact that the Women of NASA site dealt exclusively with female scientists. Some of the participants found the site inspirational; others thought its feminist aspect was artificial and affected. At one extreme, a participant said, "I like that it showed that women can get this high up [at NASA]. It sets a good example."

At the other extreme, a participant in one group decried not only the site's feminist leaning but also the entire feminist movement: "I'm not really into the whole women's rights, power, women thing. Let me burn my bra, you know, stuff like that. I'm not really into that." Her personal rejection of feminism led her to evaluate the entire site negatively.

## Discussion

### *Unexpected Results*

This study led to two major unexpected results. The expansion of bounded rationality to include physical constraints was the first unexpected finding. Ergonomic workstations might reduce some of the physical discomfort associated with excessive Web use, but discomfort would still result from extended use periods. The physical side of Web use is not fully negative, as it can significantly reduce the constraints of physical exertion.

It seems likely that this physical component of bounded rationality is not restricted to decision making in the Web, just as the time and cognitive restraints of bounded rationality apply to decision making in other contexts. To illustrate this point, there is Simon's (1955) example of the man who is trying to sell his house (see above discussion). The man might decide to display open house signs to attract buyers. He might limit his actions to posting signs around his own block, not because he does not have the time or the cognitive ability to walk to other neighborhoods, but because to do so would require additional physical effort, more effort than he feels posting the signs would merit.

Decision making has normally been couched in terms of cognitive activity, as has the 45-year discussion of bounded rationality. Bilal (2000) did examine children's physical actions when searching the Web, but she limited her examination to the actual physical movements the children made, rather than considering the physical constraints under which they operated. Human decision making, regardless of context, must occur within the constraints of the human body. Human beings are not merely cognitive beings functioning under time limitations, but also physical beings functioning under the limitations of their physicality. The cognitive-physical duality of the human condition is unbreakable.

The second unexpected finding involves Simon's concept of satisficing. Although this research supports the idea that young people satisfice when making Web-based decisions, the concept of termination varies from Simon's description of satisficing. Simon suggested that decision makers take the first satisficing option that they encounter, or the first option that meets their aspiration levels, and that the

finding of this first acceptable option is *the* major decision making stop rule. The study participants had used the finding of a satisficing option as a stop rule (called "acceptance" in the coding scheme), but they had used other occurrences as stop rules (physical discomfort onset, boredom onset, preset time limits, and snowballing) as well. These other stop rules require decision makers to stop evaluating decision outcomes *before* they locate a satisficing choice.

Simon indicated that satisficing results in relatively high-quality outcome selection. This does not always hold true for young people's decision making on the Web. The prevalence of low-quality and "boring" Web sites often forces young searchers to select disappointingly inferior outcomes. Decision making in the Web environment is, therefore, an often frustrating and unsatisfactory experience.

### *Implications of This Study*

The concepts of time, cognitive, and physical constraints in youth Web-based decision making have important implications for adult intermediaries who work with young people and information. Kuhlthau (1998) asserted that the most important role of intermediaries in the information age is to enable student inquiry learning. This research suggests that two important components of that role include working to ease the frustration that often results from outcome overload, and working to overcome the outcome dissatisfaction to which Web-based satisficing frequently leads.

These mitigation roles coincide with Kuhlthau's (1993a) discussion of the emotional uncertainty and anxiety commonly involved in the information search process. The role of intermediary as mitigator of uneasiness is not a new one. However, it seems to be even more significant in Web-based information seeking than in information seeking in traditional paper-based environments due to the massive number of available Web sites and to the low quality so many of those sites.

A related area of theoretical importance is the discovery of the satisficing patterns of reduction and termination. These patterns reflected the participants' attempts to cope with the cognitive, time, and physical constraints under which they had operated in the Web. Once familiar with these patterns, intermediaries can work to mold youths' natural Web use patterns into more efficient patterns. For example, this research indicates that young people tend to dismiss sites with large percentages of textual content. Intermediaries can teach young Web users to judge site content according to traditionally recommended criteria for judging print materials (i.e., currency, authority, accuracy, etc.), rather than basing judgements on visual appearance.

This examination of satisficing also has important implications for Web site designers. Designers should create sites that more easily support youth satisficing behaviors, such as including concise introductory site summaries to support reduction behaviors. Similarly, search engine designers can work to improve search engine categorization options, basing their categories on the divisions that youth use to clas-

sify their searches. The study participants categorized their searches, above all, for homework or for leisure purposes, but they also suggested more specific category labels such as research sites, reference source sites, game sites, commercial sites, etc. Further research is needed to understand better what types of categories would best assist youth in their reduction efforts.

The concept of personal preferences in young people's Web site selection and evaluation also has significant design implications. This concept indicates that designers should program choice into their products as much as possible to match varying user tastes and styles. By giving users the option of selecting site color schemes, for example, designers could create sites that are more likely to appeal to larger audiences. Many of the participants dismissed the Women of NASA site solely based on its background color. It is unfortunate that the educational potential of this resource is lost on a large number of possible users when such a simple modification could increase its appeal. Choices of this type also give the user feelings of empowerment and confidence, feelings that might partially counteract the disappointment and frustration so common in youth Web use.

A better understanding of young people's decision-making processes in the Web will help intermediaries to assist youth in their information-seeking efforts. It will also enable site designers to build sites with increased youth appeal, making youth Web use a more enjoyable pursuit and a more positive learning experience. Just as Oliver and Oliver (1997) found that increased engagement with a query topic leads to increased student learning, it is likely that young people would learn more from the Web if its component sites were more appealing to them. Above all, such an understanding will make it possible for the Web to reach its full potential as an information resource for the next generation.

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## Appendix A: Questionnaire Responses

1. How old are you?  
Responses:  
14 years old: 5  
15 years old: 16  
16 years old: 1
2. How often do you use the World Wide Web, if at all?  
Responses:  
Every day: 9  
Three to four times a week: 5  
Twice a week: 2  
Once a week: 3

Once a month: 2  
Less than once a month: 1

3. If you do use the Web, from where do you access it?

Responses:  
At home: 13  
At home and school: 5  
At the public library: 1  
At school: 1  
At home, school, and public library: 1  
At home and friends' houses: 1

## Appendix B: Coding Scheme

- (1) Bounded Rationality
  - (1.1) time constraints
    - (1.1.1) imposed
    - (1.1.2) self-generated
  - (1.2) information overload
    - (1.2.1) textual overload
    - (1.2.2) outcome overload
  - (1.3) physical constraints
    - (1.3.1) discomfort
    - (1.3.2) exertion
- (2) Satisficing
  - (2.1) reduction
    - (2.1.1) known sites
    - (2.1.2) synopses
      - (2.1.2.1) search engine descriptions
      - (2.1.2.2) introductory summaries
      - (2.1.2.3) skimming
    - (2.1.3) categorization
  - (2.2) termination
    - (2.2.1) acceptance
    - (2.2.2) discomfort
    - (2.2.3) boredom
    - (2.2.4) time limits
    - (2.2.5) snowballing
- (3) Personal Preference
  - (3.1) graphic/multimedia content
    - (3.1.1) color
    - (3.1.2) design
  - (3.2) subject content
    - (3.2.1) interest
    - (3.2.2) interpretation
    - (3.2.3) conviction