ABSTRACT

Title of Dissertation: THE EFFECTS OF SPATIAL INFORMATION PRESENTATION ON HUMAN DECISION-MAKING

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Empirical studies of cognitive representations have shown that judgment and reasoning can be affected by the spatial properties of information. Empirical studies of human-computer interface design have shown that spatial presentations of information can aid users' navigation through data and enhance user performance. This study investigates how one spatial property, the location of information, can influence human decision-making and recognition when using a hypertext database. The location of information was manipulated on individual screen displays as well as being placed at different levels in the database hierarchy. The experimental reasoning task used here, to decide a legal case, involved judgments of information relevance and inductive reasoning. Subjects tended to decide in favor of the party whose precedents were more directly linked to the evidence. Hence, the manipulation of the links caused a bias in subjects' reasoning. Subjects based their decisions the information that was most available to their mental models when they thought about the evidence and issues in the case. The availability of information was controlled by its presentation and subjects' prior belief biases, suggesting a new principle: representation availability. There were no effects found for spatial processing on recognition. Results from this study have implications for the design of data linkages in systems constructed to assist human reasoning and suggest guidelines for the development of such systems.

THE EFFECTS OF

SPATIAL INFORMATION PRESENTATION

ON HUMAN DECISION-MAKING

by

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CHAPTER I INTRODUCTION

Purpose

This study was undertaken to investigate the effects of spatially presented data on subjects' judgment and reasoning. Spatial data presentations were controlled through the design of the user-interface of hypertext program. User-interface design manipulations were hypothesized to affect the formation of subjects' mental models and the judgments based on these mental models. Subjects' judgments about the data are at issue here because they could influence subjects' selection of rules of inference and hence their final decisions. Subjects' task was to examine legal precedents and decide a legal case based on those precedents.

Statement of the General Problem

Humans often exhibit unreliable judgment when asked to weigh data for and against arguments. One reason for this may be that the manner in which data is presented affects the reasoner's judgment by causing biases in the reasoner's formation of mental representations. A person's mental representation of a reasoning problem, know as the *problem space* (Newell & Simon, 1972) or *mental model* (Johnson-Laird, 1983), has strong effects on human judgment. Determining how factors of computerized presentations (particular to mental representations) influence judgment may help us improve decision-making. Although this research focuses on one particular domain of decision-making, it is expected that the principles of judgment and reasoning generalize well to many professional situations (Dowie & Elstein, 1988).

Significance of the Problem

People are faced with decision tasks that involve argument and debate in many arenas of life, such as product design, public policy, and jurisprudence. These reasoning tasks, as with most inductive reasoning problems, have the characteristics of providing the reasoner with too much data (some of it irrelevant to the decision), or not enough relevant data, and no clear-cut answers. Induction is difficult because it is hard to determine whether you have considered enough relevant information and whether you have reached an optimal solution. Humans exhibit various biases when faced with such reasoning tasks.

The use of computers to facilitate reasoning in these domains has been under investigation for sometime (Conklin & Begeman, 1989; Hair, 1991; Lowe, 1985; & Marshall, 1987, 1989). Computers play an important role in research on human reasoning for two reasons. Computers can be programmed to present information in a variety of ways; therefore, they provide a practical format for testing theories about the effects of information acquisition and evaluation on human judgment. In addition, computerized databases are rapidly becoming the most commonly used means of information storage and presentation. As computers become more essential to the work of decision-makers, the design of computer systems will become increasingly significant not only to those who use the systems, but also to those *affected* by decisions based on those systems.

Issues of Human-Computer Interface Design

One issue of human-computer interface design is where to place information in a database. Information can be displayed in different areas on a screen and at different levels in a database. Developments in computing technology provide interface designers with numerous alternatives for information presentation. One set of alternatives is provided by *windows* which are sections of screen (sometimes defined by a boarder) dedicated to displaying one kind of information. Windows can be either fixed in their location or user-controlled, and either overlapping or not. Interface design must determine if it is best for the user to control the placement of these windows or if the interface should remain fixed in its placement of windows. Another set of alternatives is provided by dynamic data links, methods for accessing one type of data directly from another. Possible alternatives for linking data grow exponentially with the amount of data involved.

Determining where to place information can be complicated because the placement of information may influence a decision makers' use of the information. Interface designers must look to cognitive psychology to guide decisions about the placement of specific information. This study was an attempt to show that theories of cognition can guide the selection of interface design alternatives.

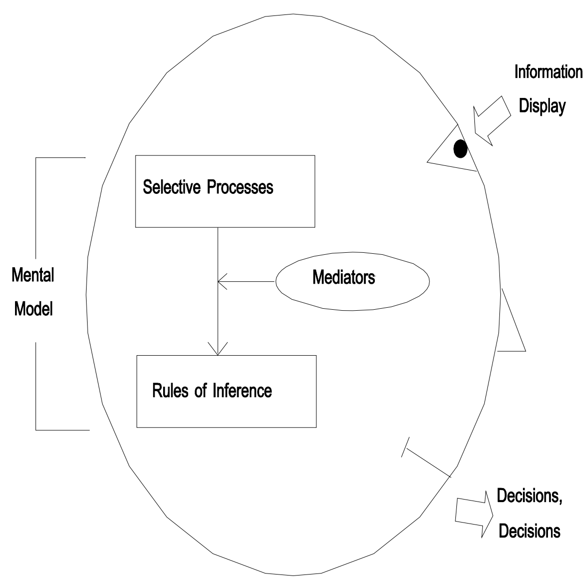
CHAPTER II HUMAN REASONING

Cognitive Processes in Human Reasoning

There are two general types of reasoning recognized in the literature on cognition, deduction and induction. It has been suggested that both deduction (Evans, 1982) and induction (Holyoak & Nisbett, 1988) should be treated as types of problem solving. Newell and Simon's (1972) approach in this area is applicable to research on reasoning. They contend that problem solving (including reasoning problems) requires the use of *heuristics* to evaluate the various knowledge states the problem solver has represented in his mind. Heuristics are rules of thumb that often, thought not always, lead to satisfactory conclusions.

Sternberg (1986) expands on the Newell and Simon approach by outlining the selective processes characteristic of human reasoning, the constraints on human reasoning that mediate the processes, and the inferential rules to which the processes are applied.   The following sections are a description of Sternberg's conception of selective processes, mediators, and rules of inference used in the reasoning process. Figure 1 illustrates Sternberg's approach to reasoning.

Figure 1. Relationships between selective processes, mediators, and inferential rules.



Selective Processes in Cognition

Selective Encoding

In the first process, selective encoding, relevant data presented in the reasoning problem is distinguished from irrelevant data and then represented in the reasoner's working memory (abbreviated WM and also known as short term memory). The mental representation of data extracted from a problem is called a mental model. Reasoning is not directly based upon the actual problems humans are faced with; it is based on mental models humans have represented in their working memories.

If you cannot select the appropriate information on which to make a judgment, you of course, cannot make a good judgment. There are innumerable ways to present data with computers. The computer should present data in ways that encourage the selection and use of appropriate information.

Selective Comparison

The second process, selective comparison, involves the comparison of the recently encoded data (the mental model in WM) to the reasoner's knowledge currently stored in his long term memory (abbreviated LTM). Relevant information is then selected from the reasoner's LTM and added to the reasoner's mental model in working memory (WM).

Previously acquired knowledge is critical to solving most problems and this information is stored in LTM until needed. The amount and quality of existing knowledge available to any reasoner depend on previous learning and experience. Locating and evaluating potentially relevant knowledge, which is located in the vast reserves of LTM, require the use of specific heuristics known as search strategies.

Selective Combination

Selective combination is the final process; it involves the combination of information encoded about the specific problem and relevant knowledge retrieved from LTM to arrive at a conclusion concerning appropriate action for this problem. This process occurs in the working memory. Heuristics (i.e., search strategies) are also employed here to select the correct combination of knowledge states specifying an optimal or at least satisfactory solution to a problem.

Rules of Inference

Selective processes are used to select inferential rules. Inferential rules describe how to formulate possible conclusions from different kinds of data and what conclusions are allowable. Rules of inference can be retrieved from knowledge in long term memory and/or presented in a reasoning problem.

Inferential rules can involve heuristics (i.e., rules of thumb or strategies for reasoning). Inferential rules can also involve specifically stated rules. Examples of explicitly stated inference rules abound in the law. An example of such a rule is: an owner of property has only the duty to refrain from inflicting willful or wanton injury on a trespasser. From this sort of rule one might infer that a trespasser who injures himself (due to his own carelessness) cannot hold the property owner responsible.

Cognitive Mediators

The effectiveness of human decision-making is mediated by factors that influence human judgment and reasoning. There are certain constraints on decision-making (due to the nature of human cognition) that are largely influenced by the data and structure contained in a problem. Sternberg describes mediators as, "any intervening variable that increases or decreases the availability or accessibility of the inferential rules used to solve a problem" (Sternberg, 1986, p.290).

Cognitive mediators affect information processed in working memory while solving a problem, as well as information that is learned (stored in long term memory) and available for problem solving at a later time. Mediators that affect human cognition include: the capacity of human memory systems (working memory or long term memory), the type of information processing (controlled or automatic, parallel or serial), the format of cognitive memory codes (spatial or verbal), and attention. These mediators will be discussed in reference to spatial information presentation in the following chapter.

Practical Reasoning

The type of decision-making under investigation in the present study has been termed several things, such as informal logic, plausible reasoning, rhetoric, argument, and practical reasoning (Smith, Benson, & Curley, 1991). These terms are intended to distinguish practical reasoning (induction) from formal logic (deduction). Practical reasoning "encompasses the varied inferential patterns by which humans reach **conclusions in daily thought**," (Smith, et al., 1991, p. 300).

The difference between deduction (e.g., formal logic) and induction (e.g., practical reasoning) is fairly simple. In deductive problems (for example syllogisms), the question is whether the data given in the premises necessarily implies a certain conclusion, and it is decided using the rules of formal logic. Deduction is the evaluation or formulation of conclusions based solely on the information as given. Deductive validity is an all-or-nothing matter; it is not a matter of degrees of truth or likelihood.

Practical reasoning requires a bit more than deduction; it also involves inductive reasoning. Induction is *not* an all-or-nothing matter; it is more complicated than deduction. There is always a degree of uncertainty in practical reasoning because all the data given is NOT clearly relevant or irrelevant, and some useful data may even be missing. Induction requires the sorting of irrelevant information from relevant information, i.e., judgments of the relevancy of information (Sternberg, 1986). Induction is the formulation of conclusions that are based on *evidence* that is insufficient to rule out all alternative conclusions. Selective encoding and selective comparison are inductive processes. These processes require the selection of relevant data from the problem and then selection of relevant prior knowledge.

Legal Reasoning

Roles of Judicial Decision-Makers

Legal work demands a great deal of reasoning skill, both deductive and inductive. Legislators and judges, use deductive reasoning to define new laws logically consistent with past laws and current mores (Hofer, 1987). This reasoning is much like that of a philosopher working on problems of logic. The overall question legislators are faced with is: *Should* the law be made to apply to this case? Judges ask the question: *Does* the law apply to this case?

Lawyers who serve as advisors and advocates employ inductive reasoning to determine how a particular case will be judged in the light of current law (Hofer, 1987). This inductive reasoning is analogous to that used by scientists who depend on the observation of facts (evidence) to make predictions. This reasoning is probabilistic. Advisors ask the question: *Will* the law apply to this case? Advocates have to consider how likely it is that a jury will find certain evidence convincing, and whether the jury can properly evaluate evidence involving likelihoods. The question advocates are faced with is: *How* can I *cause* a rule to be applied (or not) to this case?

Uncertainty in Legal Reasoning

One very important purpose of a trial is to select the most valid interpretations of the evidence under conditions of uncertainty (Saks & Kidd, 1986). This uncertainty is due to the very nature of the questions and information used by judicial decision-makers. The uncertainty of the reasoning required by lawyers is evident from the notes and commentaries to the Federal Rules of Evidence:

> In serving a client as adviser, a lawyer in appropriate circumstances should give his professional opinion as to what the ultimate decisions of the courts would *likely* be as to the applicable law.

Saks and Kidd (1986) list several excellent examples of the uncertainty characteristic of legal problems:

> to assess the likelihood that a witness's report is congruent with the actual event; the probability, given certain evidence, that a defendant committed the alleged offense; the risk of harm that reasonably should have been foreseen as associated with certain design features of

> a product; the probability that a pollutant caused certain damage; or the likelihood that a person in jeopardy of civil commitment is dangerous to self or others. (p. 216)

This uncertainty explains why judges never ask juries to be certain of their conclusions. Juries are instructed to decide *beyond a reasonable doubt*.

Legal Analysis

Every lawsuit has to answer three basic questions (Kelso, 1984). Questions of fact (e.g., who, when, where) determine exactly what evidence can be brought to bear on the case. Questions of law ask what were the rules of law (commonly accepted legal principles) at a particular time and place. Questions of law and fact ask how should the facts be characterized in terms of relevant law. Questions of law and fact are answered by appealing to previously decided cases involving similar facts to determine how particular facts were used in the past to select appropriate legal rules.

Judicial reasoners develop their skills by acquiring a sensitivity to the interaction of facts and legal rules, a knowledge of legal rules (based on precedents and statues), and an ability to manipulate the rules in light of current facts (Kelso, 1984). These reasoning skills require the use of all three selective cognitive processes. Determining which facts are relevant to a case involves selective encoding (questions of fact). Selective comparison is required to determine which legal principles, precedents, or statutes are relevant (questions of law). The final decision of culpability is based on the selective combination of the evidence and the relevant legal rules (questions of law and fact).

In this research, questions of fact require subjects to determine what evidence is relevant. Questions of law were answered by the presentation of past cases demonstrating which laws are potentially applicable. Questions of law and fact are the ones of particular interest here; subjects were required to evaluate the rules of inference (i.e., laws applied in the precedents) and use them to reach a appropriate decision based on the facts in this case.

Parts of A Legal Argument

Legal arguments revolve around a claim presented by a plaintiff. This claim is an expression that the plaintiff seeks relief from the courts (i.e., compensation or restitution) to be paid by a defendant who has allegedly caused the plaintiff damages of some kind. To prove the claim (beyond any reasonable doubt) the plaintiff must provide evidence and show why that evidence leads to the claim.

Rules of law are used to draw conclusions from the evidence presented in a case. Rules of law serve as inference rules in legal reasoning. Two sources are used to derive rules of law, legislative enactments (i.e., statues) and precedents. A precedent is "a previously decided case which is recognized as authority for the disposition of future cases" (Gifis, 1984, p. 356).

Under what is known as the common law system (e.g., the American legal system) precedents are regarded as the major source of the law. In common law, courts are bound to decide cases in accordance with the most analogous precedents. This is known as the doctrine of *stare decisis*--like cases must be decided alike. Although statutes are important, precedents are required to determine which statutes to apply. Legal reasoning is *reasoning by analogy,* i.e., remaining consistent with examples already established.

The usefulness of precedents for supporting claims depends on how closely the precedents resemble the current claim. The closer the similarity between the precedent and the current case with regard to the plaintiff's position on the claim, the more *on point* the precedent and hence, the stronger the argument for applying the rule of law.

An attorney's job is show that precedents cited by the opposing attorney are not representative of the current case, and therefore cannot be used to support the rule of law used to justify the claim. Attorneys form rebuttals by citing similar cases that reached contradictory decisions or by *distinguishing* the opposition's precedents, i.e., demonstrating how they are different from the current case. (For introductions to legal analysis and attempts to model it with computers, see Ashley, 1991 or Gardner, 1987.)

Computerized Tools for Legal Research

Lawyers can turn to several computerized databases to assist them in researching statues and precedents (Staudt & Farber, 1987). In 1973, Mead Data Central, Inc. launched one of the first legal database search systems, LEXIS. LEXIS is a full-text database containing statues, cases, law reviews, and many other related materials. The main competitor to LEXIS is WESTLAW, produced by West Publishing Company. These two services contain similar data. One other commonly used service is VERALEX, a joint undertaking of Mead Data Central and the Lawyer's Co-operative Publishing Company. VERALEX provides lawyers the ability to view and print the text from past cases. Justus, a legal system developed in England, is a hypertext database (Wilson, 1990). For more information on computerized research in law see Harrington (1985), Sprowl (1981), or Staudt and Farber (1987).

CHAPTER III HYPERTEXT AND SPATIAL INFORMATION PRESENTATION

This chapter starts with an introduction to hypertext and continues with a discussion of how spatial presentation features of hypertext can influence human cognition. The relationship between spatial mental representations and judgment is then discussed, followed by the hypotheses under investigation in the present study. A discussion of the implications of this research for designers of human-computer interfaces concludes this chapter.

Hypertext

Introduction and Terms

Hypertext software involves nodes (units) of information connected via programmed links into a non-linear network of information (For excellent reviews of hypertext see Conklin, 1987 and Nielsen, 1990). It is non-linear in that the user of a hypertext system can decide what information to read when, unlike information in a book that is read in the order it was written. This non-linear structuring of information allows the developer of hypertext documents to suppress detailed information until the user decides to see it. Users access information usually by clicking on an active area of the screen with a mouse. These active areas, are often termed *icons* or *screen buttons*. *Hypermedia* is a term used to describe this kind of software when it consists of media such as still images, motion video, or sound, in addition to text and simple graphics. In this study, it will be referred to as hypertext because the information presented was textual.

History of Hypertext

The beginnings of hypertext came as early as 1945, when President Roosevelt's Science Advisor, Vannevar Bush (1945) published his influential article, *As We May Think*. Bush advocated the design of a system that would allow easy access to scientific literature. His proposed system, Memex, would be useful to those searching scientific knowledge because it would employ the same structure found in the human mind to store and access knowledge, i.e., networks of associations.

Influenced by Bush's ideas, Douglas Engelbart (1963) wrote, "A Conceptual Framework for the Augmentation of Man's Intellect." The ideas in this paper led to the first actual system to exhibit hypertext capabilities, Engelbart's NLS (ONLINE System) developed by the Stanford University's Augmented Human Intellect Research Center. The goal of this system was to augment or extend the human intellect in an effort to aid *knowledge workers.* NLS (now marketed by McDonnell-Douglas as Augment) has evolved into a commercial network system for exchanging ideas and collaborative work among software engineers.

The actual term *hypertext* was coined by Ted Nelson of Brown University. Nelson's hypertext system, started in 1970, was named Xanadu, after the "magical place of literary memory" in Coleridge's poem, Kubla Khan. Nelson (1980) hopes that Xanadu will become a system for storing the entire world's literary corpus on line. He has long been a proponent of the benefits of hypertext over traditional computer-assisted instruction for stimulating and teaching students.

Hypertext was for many years a research tool used primarily in universities, but today it is rapidly spreading commercial technology. Hypertext has proven useful for the development of online manuals, help systems, training systems, sales support system, catalogs, and encyclopedias. Hypertext systems for representing argument and debate have been under investigation for several years (see for example, Conklin & Begeman, 1989; Lowe, 1985; & Smolensky, Bell, Fox, King, & Lewis, 1987). A popular paradigm for representing arguments, the Toulmin jurisprudence model (Toulmin, 1958), has been employed in the development of hypertext systems for legal reasoning (Hair, 1991; Marshall, 1987, 1989; & Newman & Marshall, 1991). Hypertext is already in use in legal databases (Johnson, 1989; Wilson, 1990; Wilson, 1991).

Currently there are at least twelve MS-DOS hypertext development packages and at least four packages for the Macintosh. The research firm of Venture Economics, Inc. estimates that the market for hypertext software will be $80 million in 1991 and $168 million in 1992 (Soat, 1990). Market Intelligence Research Corp. predicts that sales in hypertext authoring products will reach 1.8 million packages yielding revenues of $458 million by 1993 (Fresko-Weiss, 1991). This is an important technology to explore because trends indicate there will be numerous hypertext systems developed in years to come.

Advantages and Disadvantages of Hypertext

One advantage of even the simplest hypermedia programs is the facility for providing alternate formats for data presentation and access, i.e., verbal *and* graphical formats. Graphical presentations of data assist users by providing such things as flow charts to show relationships, idea maps to show the hierarchy of concepts, and highlighting or graphics to show emphasis. The graphical attributes of presentations, such as those listed above, assist users in forming richer, more elaborate mental models of the information. Elaborations on mental models provide addition avenues of association that serve as cues for retrieval of mental models from memory. The more elaborations encoded with a mental model, the easier to it is to retrieve from memory and to understand in relation to other information (Anderson, 1985).

Most hypertext programs employ active (sometimes referred to as *dynamic*) areas on the screen to display icons, buttons, or *hotwords*. These areas on the screen are active in that they provide direct access to other information. Clicking with a mouse on these active areas is called *direct manipulation* because the information is manipulated (in this case navigated through) by the user's action on its representation. (For excellent reviews of direct manipulation see Hutchins, Hollan, & Norman, 1986 and Shneiderman, 1983.) An other capability often found in direct manipulation interfaces is the ability to select and drag icons to different places on the screen to perform functions like copying or deleting data. Direct manipulation interfaces generally have the following characteristics, "visibility of objects and actions of interest, rapid reversible incremental actions, and replacement of the complex command language syntax by direct manipulation of the object of interest" (Shneiderman, 1987, p.180). By employing direct manipulation, users receive spatial feedback from their proprioceptive receptors (which sense the position and motion of limbs) in addition to any visual feedback the computer presents.

Another advantage of hypertext is the facility for providing alternate orderings of data presentation, (e.g., overviews followed by detailed information or user selected orderings of presentation). This can be a disadvantage when it leads to users feeling lost (discussed under "Hypertext Navigation" below) or affects users' reasoning about information through ordering effects (discussed under "Processing of Spatial Representations" below). Alternate orderings of data presentation allow programmers to suppress more detailed information until needed and allow users repeated access to information exactly when needed. The ability to access information when needed dramatically reduces the load on working memory and allows the user to make decisions based all the information worth considering.

Navigation through hypertext databases can be problematic and frustrating to its users. Hypertext is extremely flexible because individual units of information (nodes) can be accessed from any number of other nodes. This means that many different paths (links) can lead to the same information. This factor can cause users to feel disoriented, and unable to find the information they wish to find or have previously found (Conklin, 1987; Edwards & Hardman, 1988; Elm & Woods, 1985; Nielsen, 1990). There are ways to aid users in finding their way through the data. Two of these, browsers and menu maps, have been investigated (see for example, Edwards & Hardman, 1988; Schwartz, Norman, & Shneiderman, 1985; Vicente &

Williges, 1988). Evidence that these spatially presented aids are helpful supports the notion that spatial representations (in the users' mental models of the data) play an important role in users' success with hypertext. For this reason, research should investigate how factors of spatial presentation affect users' mental models and how those models affect users' judgment.

Spatial Representation and Cognitive Mediators

The user-interface of hypertext programs provides two important capabilities, graphical presentations and direct manipulation. These capabilities allow us to take advantage of the influence of spatial representation on human reasoning. Spatial interface design is important to research on reasoning because there is evidence that spatial representations: (a) aid in the recall of information, (b) are automatically encoded and stored in long term memory, and (c) influence decision-making. A clear understanding of the influence of spatial cognitive processing can aid in the effort to improve judgment, reasoning, and learning through the use of computers and hypertext.

Presentation format can influence the content, encoding, and processing of users' mental models of information. Cognitive mediators influenced by presentation include the format of memory codes, attention, depth of processing, controlled versus automatic processing, and parallel versus serial processing. The effects of cognitive mediators and how they are influenced by spatial representations is discussed below.

Content of Memory Codes

According to Paivio's (1986) dual-coding theory, decision performance is mediated by the joint activity of spatial and linguistic (verbal) representations, also know as memory codes. Spatial presentations are characterized by concepts such as proximity, ordering, distance, and direction. Linguistic presentations are characterized by concepts such as logical, functional, and semantic relationships. Graphic presentations evoke spatial mental representations and textual presentations evoke linguistic mental representations. This dual-code theory of memory organization would imply that textual information presented in a spatial format would have two representations in memory, a spatial one and a linguistic one.

Although some researchers dispute the dual-code theory (e.g., Anderson & Bower, 1973; Kosslyn, 1981), there is evidence that information presented in multiple modes can lead to improved decision-making performance over information presented in just one mode. Use of spatial, as well as linguistic, presentations was shown to be helpful to decision-makers in several studies (De Soete, 1986; Nibbelin, 1988; & Powers, Conda, Sanchez, 1984; & Shneiderman, 1984). The capabilities found in hypertext may encourage the use of spatial representations and enhance decision-making.

Encoding of Memory Codes

The first step in decision making is encoding the information into memory. This can be influenced by users' attention to and use of the different elements comprising an interface.

Attention and display attributes. Attention is a mediator of cognition affecting what information and how much of it is encoded into memory. The encoding of graphic displays is enhanced by the fact that the users' attention can be drawn by various display attributes (e.g., highlighting, color, boxes and lines) to important information. Attention may not be required for the encoding of these display attributes, but the verbal content of information must be attended to in order to be remembered. Attention plays an important role during the encoding process because the more attention is maintained on a source of perceptual inputs, the more likely a representation will be stored in memory (Glass & Holyoak, 1986).

As mentioned earlier, memory system storage capacity is a cognitive mediator. Long term memory (LTM) is perhaps limitless, but just because information has been stored there does not mean we can find it in all the other information there. Retrieval of any information from LTM is facilitated by the number of separate attributes encoded while attending to the information. Attributes stored in memories become cues for the retrieval of those memories. The more attributes stored with a particular memory, the more discriminable the memory will be from other memories (Craik & Lockhart, 1972). Discrimination of memories is critical to the selective comparison stage of reasoning.

Most hypertext systems allow the use of graphic display attributes such as highlighting, color, icons, boxes, and lines. These display attributes draw the users' attention and provide cues concerning the types of information to be found on different parts of a screen and in different parts of the hypertext database. Retrieval of information is enhanced by the storage of graphic attributes with the information because these cues help the user develop richer mental models that include spatial qualities of the information in addition to verbal representations.

Enhancement of encoding through direct manipulation. Direct manipulation may encourage the use of the spatial representations by reinforcing any visual spatial processing. This is understandable since there is evidence that hand (proprioception) and eye (vision) share the same spatial representations. In fact, spatial representations are referred to as *spatial* instead of visual because there is evidence that blind subjects employ spatial imagery as do sighted subjects (Marmor & Zaback, 1976). One study of saccadic eye movements and hand pointing (Nemire & Bridgeman, 1987) suggests very strongly that people employ the same spatial representation when using their visual or motor systems. Balakrishnan, Klatzky, Loomis, & Lederman, (1989) studied the errors people make in judgments of distance and found similar distortions of distance estimates in experiments on visual and motor exploration. In addition, there is evidence from Hintzman, O'Dell, & Arndt (1981) that visual contact and action in space can enhance spatial processing. Te'eni (1990) found that feedback from a direct manipulation interface can enhance users' judgment in complex task more than interfaces without direct manipulation capability.

It is possible that direct manipulation enhances spatial representations by increasing the depth of processing during the encoding of the information. The nature of the mental operations performed on information at the time the information is perceived determines the ease with which that information can be retrieved. In fact, it is not the intent to learn (Mandler, 1967) or the time spent on studying (Craik & Tulving, 1975) that affects the amount of learning, it is what is done with the information--how completely it is mentally processed--that determines amount of learning. Mental rehearsal, e.g., saying a phone number over to yourself, is shallow processing; identifying the interrelationships between concepts is deeper processing. The amount and quality of knowledge available for selective comparison (step 2 in human reasoning) depend on the degree of prior learning. Therefore, all reasoning ability is affected by how deeply a reasoner has processed what he has learned.

Direct manipulation of screen buttons to access different pieces of information may increase depth of processing, if those buttons correspond to relationships found in the data. Selecting and activating buttons requires users to think about what buttons lead to what information forcing users to process additional data about the relative locations and meanings of screen buttons.

Processing of Spatial Representations

Several factors mediate the processing of mental representations including human memory capacity and to what extent the processing is automatic and parallel in nature.

Human memory capacity. One mediator of cognition is the storage capacity of human memory systems. Long term memory is perhaps unlimited in its storage capacity, but working memory (WM) is not. The capacity of WM is critical because selective combination (the last step in human reasoning) is performed in working memory. Encoding and comparison (steps 1 and 2 in human reasoning) must be very selective because WM can hold only a few items of information at a time. People can only hold (i.e., attend to) five to nine chunks of information in their working memories, depending on the processing the information requires (Miller, 1956). Therefore the processing demands of information are critical to the quality of decisions made from that information.

Automatic versus controlled processing. Another mediator of human cognition is the type of information processing required to reach a decision. A major constraint on one's ability to reason effectively is the extent to which the mental processes must be controlled instead of being automatic. Controlled processes require attention and WM capacity. Processes that are automatic do not require any WM resources, leaving room for the operation of other processes.

Based on an extensive review of the research literature, Hasher & Zacks (1979) concluded certain automatic processes are ones for which humans are genetically prepared. Among these processes, they include the processing of spatial information. Spatial cognitive processing results in three perceptual codes-- shape, brightness/color, and location (Treisman & Gelade, 1980)--without taking up working memory resources needed for other information processing. Remembering spatial attributes is effortless; they require no mental resources to process.

One useful characteristic of spatial presentations is that the process of remembering (encoding) them often occurs incidentally (i.e., without the intention to remember them) (Mandler, Seegmiller, & Day, 1977). Recent evidence for this is found in the work of Ellis (1990) and Ellis & Rickard (1989) who found that subjects' memories of the locations of objects were not affected by intention, instruction, concurrent processing demands, practice, intelligence level, or age. Perhaps data presentations that include spatial attributes can enhance reasoning ability by providing more associative cues for accurate memory retrieval WITHOUT demanding additional mental resources.

Parallel versus serial processing. Linguistic processing, like most controlled processes, is generally serial in nature. Spatial processing, like most automatic processes, often occurs in parallel (Hoard, 1983; Treisman & Gelade, 1980). A spatial presentation can be examined and processed all at once in a holistic manner instead of piece by piece in a serial or linear manner. For some kinds of tasks, parallel processing is much easier to employ than a serial processing. For example, it is often easier to recognize a person from a picture or find your way with a map than to read and process a verbal description of these things.

The parallel processing of spatial presentations may help eliminate judgment biases resulting from the serial presentation order of information. One very common judgment bias, anchoring and adjustment (Tversky & Kahneman, 1974), leads one to stick to the first information learned on a topic and judge the following information based on what is already assumed to be true. This anchoring (to initially learned information) and insufficient adjustment (based on new information) is controlled by the ordering of information. Hypertext links can be created to yield any number of serial orderings of the same information. If information can be retrieved in a parallel fashion, the serial ordering of its initial presentation will have less of an effect on the user of that information, than would be the case if the information was retrieved in a serial order. In fact, evidence for the elimination of ordering effects in recall can be found in Wall, Karl, & Smigiel (1986).

Spatial Representations and Judgment

The influence of encoding one particular spatial attribute, location, on human judgment was of interest in this study. The location of information has been shown to affect reasoning by providing recall cues, organization in mental models, and heuristics for decision making.

Memory for Locations of Information

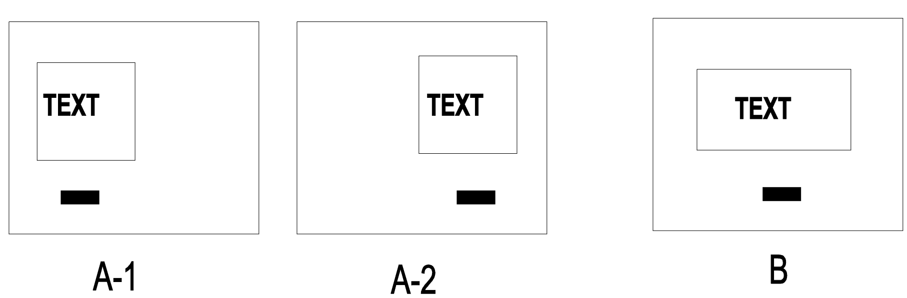
Location can serve as an associate cue for memory retrieval as demonstrated in several studies. Von Wright, Gebhard, and Karttunen (1975) found that subjects' memories of objects presented on a visual array were correlated with their memories for object location. Pezdek, Roman, & Sobolik (1986) found that spatial representations are more likely to be encoded with objects than words, but location is encoded for words and does aid recall. Subject who study a spatial map of a hierarchy recall more words than subjects who study unstructured lists (Bower, Clark, Lesgold, and Winenz, 1969; Broadbent, Cooper, and Broadbent, 1978).

Spatial properties of information may assist subjects' understanding as well. Several researchers have found that recall of spatial location of text in passages was above chance and was correlated with recall of content (Christie & Just, 1976; Rothkopf, 1971; Zechmeister & McKillip, 1972; Zechmeister, McKillip, Pasko, & Bespalec, 1975). Recent research has indicated that spatial presentations enhance students' understanding and recall expository text (Guri-Rosenblit, 1989; & Ruddell & Boyle, 1989).

The use of spatial location on screen displays has been investigated by Aspillaga (1991). She found that consistent location of related information versus random location facilitated students' recall of information. Generally, screen designers would probably be expected to place information consistently, but a recent development in personal computing allows users to change information locations--windowing. Windowing ability is often provided in hypertext programs. One of the design decisions shaping the way a windowing system works is whether the window locations are user or system controlled (Bury, Davies, & Darnell, 1985). If learning while browsing a hypertext system is important to users and if the system presents information in windows, perhaps it would be better for users if they did not have control of window placement. In the present study, subjects did not have control of information placement. It is hypothesized that the consistent placement of information would aid in the recognition of a certain property of that information because the information's location would help users categorize the information.

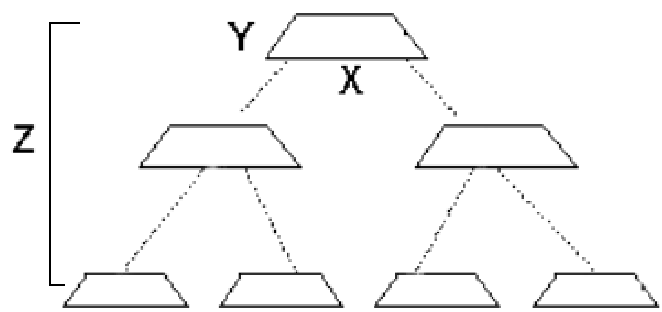
Figure 2 illustrates how information (text) and buttons to access related information (the little striped rectangles) could be displayed in different programs. Screens A-1 and A-2 shows information located on opposite sides of the screen, and screen B shows information located only in the middle of the screen.

Figure 2. Two methods for locating information on screens.



Users' mental model of information location includes its placement lengthwise and width-wise on a screen, as well as the screen's placement in the hierarchy of the program (e.g., depth or the number of screens between a target screen and the first screen). An illustration is provided in Figure 3, a diagram of the links between seven screen displays where the x-coordinate and y-coordinates represent the location of information across a screen, and the z-coordinate represents the location of information in the hierarchy of screens. Currently, the display and manipulation of three-dimensional representation are under investigation using such cues as real-time animation (Robertson, Mackinlay, & Card, 1991).

Figure 3. Three dimensions of information location on computer screens.



There is strong evidence for that three-dimensional relationships are encoded in human memory. Shepard and Metzler (1971) found that subjects could rotate line drawings of three-dimensional objects in depth as well as in the picture plane. Garling, Book, Lindberg, & Arc (1990) had subjects travel to various locations and then estimate the elevation of the locations. Results indicated that subjects recalled differences in elevations fairly accurately. Pinker (1980) had subjects memorize the locations of objects suspended in space. Reaction time required to verify relative positions of objects increased linearly with the three-dimensional distance between the objects. In fact, adding depth increases cognitive capacity for the representation of spatial location in imagery (Kerr, 1987). Clearly, the relative placement of information in all three dimensions should be carefully considered when designing computer interfaces.

Organization of Spatial Mental Models

There is a great deal of evidence that people structure their spatial representations in a hierarchical manner (McNamara, 1986). Superordinate categories systematically distort how subordinate elements in spatial relations are stored in memory. Certain elements of data in a spatial representation are clustered or categorized together because they share certain properties. A classic experiment demonstrating this was conducted by Stevens & Coupe (1978). They asked subjects to specify the direction between geographical locations--directions that were not what you'd expect from their superordinate geographic boundaries.

Stevens and Coupe found that subjects consistently think San Diego, California is west of Reno, Nevada. Subjects' mental models took the form of a hierarchical representation where states serve as superordinate categories and cities are subordinate elements that fit under their respective states. Subjects were very confident of their judgments, even when wrong.

Stevens and Coupe believe subjects' systematic errors in judgments of location reflect a cognitive storage-computation trade-off. Categorizing the similar objects (e.g., cities) under a superordinate label (e.g., California) serves two purposes: it conserves space in memory compared with saving the individual characteristics for each object (e.g., San Diego, Los

Angeles, etc.) and allows people to make judgments quicker by drawing inferences about individual objects based on their superordinate categories.

Another type of evidence supports the idea that spatial representations are hierarchically organized. Reaction times to verify directional judgments (e.g., east, west, in this country or that country) reveal that subjects have clustered spatial data based on a hierarchical organization. Wilton (1979) found that reaction times for verification of relative locations were shorter when towns were in different states than when they were in the same state.

Even when spatial boundaries are not clearly indicated, subjects store spatial elements in a hierarchical representation. Allen (1981) found evidence for hierarchical organization where clusters were defined by changes in landscapes rather than boundaries. Hirtle and Jonides (1985) found strong evidence for the clustering of spatial representation using response time measures. Instead of clear boundaries as organizing structures, they used an algorithm that generated hierarchies of landmarks from recall protocols. They found that equal distances within clusters are judged shorter than those across clusters. McNamara, Hardy, & Hirtle (1989) using measures of item recognition, free and cued recall, and distance estimation found evidence for the encoding of hierarchical spatial clustering *even in the absence* of perceptual, physical and semantic boundaries.

Distance Judgments as a Heuristic for Reasoning

Canter, Rivers, & Storrs (1985) felt that "It is fruitful to recognize the direct parallels between navigating concrete environments, such as cities or buildings and navigating data." Two factors have been shown to affect people's judgments of distance when navigating their environment--time required for navigation and the form of path navigated. Judgments of distances can be related to evaluations of similarity between target items.

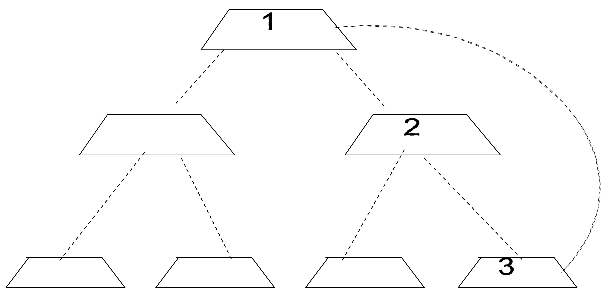
The amount of time required to travel a route has been shown to affect people's estimates of distance. MacEachren (1980) found that travel time was a better predictor of subjective distances than actual distances. Herman & Klein (1985) found that subjects used the duration of a walk required to reach a location (without considering the various conditions such as going up hill) as an estimator for distances.

The form of a path may also affect judgments of distance. Allen & Kirasic (1985) found that how subjects divide a route into segments affects their judgments of distances along those routes. Kahl, Herman, & Klein (1984) found that distances along paths with few segments were generally underestimated, and distances along paths with many segments are overestimated. As paths become more circuitous, distance estimates inflate to a similar extent whether the paths are presented visually or through haptic exploration (Balakrishnan, Klatzky, Loomis, & Lederman, 1989).

One very interesting result comes from the study of Hirtle and Kallman (1988). Subjects estimated the distances between pictures, and judged more similar pictures as being closer together than equidistant dissimilar pictures. Pictured items were clustered together in subjects' minds based on pictorial similarity, and this led to biases in distance judgments.

The design of data links controls the form of the path between data and the time required to traverse the paths between data. These paths could affect users' judgments about the distances between data. In turn, these judgments about distances between data could affect users' evaluation of the data. Figure 4 illustrates two kinds of paths between data--a direct path linking screens 1 and 3, and an indirect path with another segment, i.e., from screen 1 (through screen 2) to screen 3.

Figure 4. Direct and indirect links (paths) between screens.



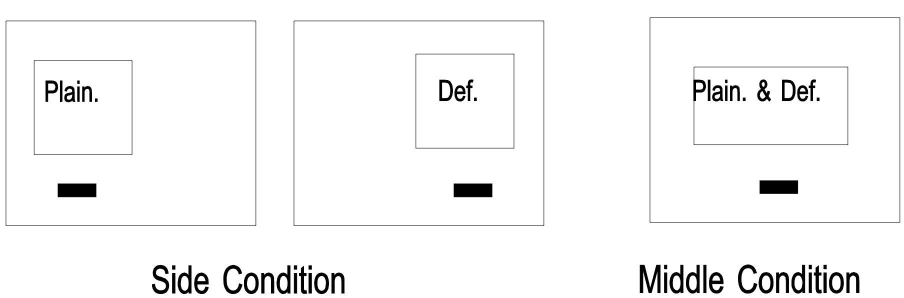
Based on previous research indicating that spatial organization (both visual and motor) can affect judgment, the present study investigated how navigating through data can affect judgments of that data. One of the hypothesis in the present research, is whether the effect that similarity judgments have on distance judgments works in reverse, that is, can distance judgments have an effect on similarity judgments.

Hypotheses

The questions of interest in this study are (a) does the placement of information, on screens affect subjects' mental models of the information and thereby affect their recognition of the category to which the information belongs, and (b) does the placement of information in the database hierarchy affect subjects' judgments of the information.

In this experiment, it was hypothesized that the placement of categories of information, either on opposite sides of the screens versus in the middle, would effect subjects' recognition of whether a precedent was cited by the plaintiff or the defendant. The location on the screen could perhaps serve as a spatial organizing factor. In one condition, a category of information and its buttons were displayed on one side of the screen, while the other category and buttons were displayed on the other side. In the other condition, all information was placed in the middle of the screen. See Figure 5 for an illustration of the these two conditions.

Figure 5. "Side" and "Middle" experimental conditions.



It was also hypothesized that the type of links provided between screens (direct or indirect) can affect subjects' evaluations of the information on the screens. See Figure 4 for an illustration of types of links. Subjects in this study were asked to compare the similarity of target information to data that are close to the target information and data that are further down a database hierarchy. Finding the more distant data required more time and the navigation of a path with more segments (intervening screens). When the paths are shorter between screens of information (because the links are direct), subjects may evaluate the information contained on the screens as more relevant than information separated by longer paths with indirect links.

Implications for Design of Human-Computer Interfaces

Hypertext is rapidly growing in popularity and may soon become a large part of many people's computing experience. Designers must make many decisions concerning how to present information with this technology. They must consider the placement of information in light of human cognitive tendencies to ensure that people make the best use of this technology.

One of the decisions designers must make is whether to allow users to control the placement of windows on screens. If placement serves as an effective associative memory cue, then designers must determine if memory recall is important to a system's proper use. For example, users may need to recall information categories, because confusing those categories could lead to inappropriate conclusions.

In a legal dispute, (such as that employed in this experiment), remembering which party has cited a precedent is critical to drawing the conclusions intended by citing that precedent. Designers of legal databases could allow users to place windows of information where preferred by the user, but user-controlled placement could interfere with associative memory cues provided by a fixed placement. Decision making of the user may be more reliable if window placement is fixed.

Another decision designers are faced with is how to link together the information in a database. Link design would be a critical issue, if the distances traversed by those links affect users' evaluations of the linked data. Designers would have to consider what data was to be compared and provide direct links between those data.

CHAPTER IV METHODOLOGY

Experimental Design

Independent Variables

The experiment conducted was a 2 x 2 between-subjects factorial design. Two factors related to the spatial design of the human-computer interface were examined: (a) the linkage of data (b) the layout of the screens. The four conditions were:

Plaintiff-Middle	Defendant-Middle
Plaintiff-Side	Defendant-Side

Linkage. Linkage between screens of data (i.e., access to one screen from another) was achieved by clicking a screen button with a mouse. In the Plaintiff condition there was direct linkage between the plaintiff's precedents and the evidence, with indirect linkage (a number of intervening screens) between the defendant's precedents and the evidence. In the Defendant condition there was direct linkage between the defendant's precedents and the evidence with indirect linkage between the plaintiff's precedents and the evidence.

Layout. Layout of the screens was manipulated by placing all the information pertaining to a party (the plaintiff or defendant) either in the middle of each screen display, or placing the plaintiff's data consistently on the left of the screen and the defendant's data consistently on the right of the screen. Another condition for the layout factor was considered, having the precedents placed inconsistently on different sides of the screens (e.g., two precedents on the left, one on the right for each party). This condition was not used however as explained in the results.

Cognitive abilities. Subjects inferential reasoning and spatial visualization abilities were measured for use as covariates (explained further under "Materials").

Dependent Variables

The dependent measures of interest can be broken down as follows:
(a)Subjects' evaluations of the legal data presented via a hypertext program
1. Subjects' ratings of the parties' precedents
2. Subjects' final decision in the case
3. The relationship between subjects' ratings and decisions
(b)Subjects' recognition memory for the party who cited each precedent
(c)Subjects' confidence that they made the correct decision

Subjects

Subjects were drawn from Psychology 100, the introductory psychology course at the University of Maryland, a large mid-Atlantic state university. They were given class credit for their participation. Students in Psychology 100 are usually in their first and second years of undergraduate study. Only subjects speaking English as a native language participated because the experiment involved reading about legal case that might be too confusing for those who are not native English speakers. To reduce variance in the subject population, data were discarded from two subjects whose spatial reasoning scores fell below two standard deviations based on the norming data in the Kit of Factor-Referenced Cognitive Tests (Ekstrom, French, & Harman, 1987). A total of 64 subjects were used, 16 subjects in each condition.

Materials

Cognitive Measures

Cognitive abilities have been found to mediate users' performance with computer systems (see for example, Butler, 1990; Campagnoni & Ehrlich, 1989; Egan & Gomez, 1985; Norman & Butler, 1989; and Vicente, Hays, & Williges, 1987). For this study two cognitive tests were selected from the Educational Testing Service's Kit of Factor-Referenced Cognitive Tests (Ekstrom, French, & Harman, 1987). These tests were employed because they measure abilities that may serve as mediators in a task exercising spatial and inferential reasoning. The effects of cognitive abilities can be factored out using an analysis of covariance, yielding a clearer picture of experimental manipulation effects.

Inferential reasoning. The first test administered, the RL-3 Inference Test, was employed to measure logical reasoning ability, described as the "ability to reason from premise to conclusion, or to evaluate the correctness of a conclusion," (Ekstrom, French, & Harman, 1987, p.141). This test was selected because rating precedents requires subjects to reason from each precedent to the current case and to evaluate the appropriateness of applying the decisions found in the precedent to the current case. The Inference Test requires subjects to read a statement and select one of four valid conclusions based solely on that statement. The test allows subjects twelve minutes to complete twenty such statements. See Appendix A for the instructions for this test and a sample item.

Inferential reasoning has also been called "logical evaluation" by Guilford (1972) and Cattell (1953). Carroll (1974) felt that this was a complicated factor involving both the retrieval of meanings and algorithms from long term memory and the performance of serial operations on these recalled items. Carroll also felt that performance requiring this cognitive ability depended to a degree on the attention subjects gave their stimulus materials.

Spatial visualization. The VZ-2 (otherwise known as the Paper-Folding Test) was employed to measure "the ability to manipulate or transform the image of spatial patterns into other arrangements." (Ekstrom, French, & Harman, 1976, p. 173). The VZ-2 requires subjects to match a 2-D representations of a folded piece of paper with a hole in it with one of five alternatives showing the location of the hole when the paper is unfolded. The test allows subjects six minutes to match twenty such 2-D representations. See Appendix B for the instructions and a sample item.

The VZ-2 was selected because it has been found to correlate with subjects' ability to search computer systems. Vicente, Hays, & Williges (1987) found that subjects with low visualization required more time to locate targets in a hierarchical file system and more often appeared to be lost. Subjects with low visualization ability are less efficient in searching for information in a hierarchical menu system (Butler, 1990; Norman & Butler, 1989). Campagnoni & Ehrlich (1989) found that subjects with low visualization ability were less efficient in searching a hypertext system; they had to access more screens to locate specific information.

The Training Program

To familiarize subjects with the operation of the database, a training program was developed using HyperPAD 2.2 (Brightbill-Roberts & Co., Ltd., 1991), a hypertext application generator for MS-DOS based computers. This training program included six screens that were very similar to the legal database in design, color, button placement, and screen access. For practice in making relevance ratings, this program required subjects to rate the relevance of two factors, carpet color and rental cost, to the selection of an apartment. The program instructed them to use a scale of 1 to 9 with 1 indicating very little relevance and 9 indicating high relevance. On the screen following the ratings, the ratings of the two factors were switched so that they did not match the earlier screen. To gain practice in changing ratings, subjects were required to correct the ratings on this screen.

Task Instructions

All subjects were given a one page, written explanation of legal reasoning and what their task was in this study. These instructions explained what "precedents" were and why judges use them to decide cases. Subjects were told that judges decide cases based solely on precedents (never on personal preferences), and that judges are required to reach the same conclusions as those reached in previously decided cases that are similar to a case in question. In addition, the instructions explained that the judges' task is to decide which previously decided case is most similar to the current case and to decide accordingly. The subjects' task was to take the role of a judge and decide a case. A copy of the instructions can be found in Appendix G.

The Hypertext Database

A hypertext program developed in HyperPAD was used on IBM PS/2 computers to display the legal database. These computers provided almost instantaneous access to screens and displayed the screens in color. Navigation through the screens was achieved by clicking on screen buttons with a mouse. Subjects were allowed to go back and forth to re-read screens as much as they liked. The only typing subjects were required to perform was to enter a single digit to indicate their rating for each of the six precedents (as explained below).

The database consisted of thirteen different screens. Six of the screens displayed general information about the case, such as, the facts and evidence presented, the legal issues, the parties involved, and their legal claims. Six screens explained the legal precedents cited by the parties. There were four versions of the program, one for each experimental condition. All versions contained the exact same text, but differed in design (see the "Design manipulations" below). The program was equipped to record a history of each subject's interaction including the how long subjects displayed each screen.

Ratings screen. One screen was used by subjects to enter and record their ratings on the relevance of each precedent. They did this by rating the similarity of each precedent to the current case with the same scale that was used in the training program (i.e., 1 to 9). Subjects entered ratings by typing a number in a field corresponding to the name of each precedent on the "Ratings" screen. If subjects changed their minds on any rating, they were allowed to alter their ratings until they were satisfied that they were done. The program saved the subjects' final ratings in a file along with their screen histories.

The Ratings screen was accessed by clicking a button labeled "Ratings" located on the screen describing the evidence in the current case, the "Facts." To enter or change a rating, subjects had to first get to the Facts screen. Subjects were all required to return to the Facts screen before performing ratings because pilot studies indicated that some subjects would go back to the Facts for comparison, whereas some would not. This reluctance in some subjects to navigate through the program to make comparisons created a great deal of variability in the subjects' exposure to the program's data and design. In addition, the effects of verbal memory for what was displayed on screens would have been a confounding factor if all subjects did not return to the information needed for the comparisons.

Design manipulations. In the two Linkage conditions, one party's precedent screens were linked directly to the Facts screen by a button labeled "The Facts," and the other party's precedent screens had buttons that led subjects back through four intervening screens before reaching the Facts. The precedents for the party with the direct linkage could be returned to directly from the Ratings screen; the precedents for the party with indirect linkage could only be reached by traveling back through the same four intervening screens. For the Plaintiff conditions, screens describing precedents cited by the plaintiff were linked directly to the screen describing the evidence for the case (the Facts screen), and screens describing the defendant's precedents were linked indirectly to the Facts. For the Defendant conditions, screens describing precedents cited by the defendant were linked directly to the Facts screen, and screens describing the plaintiff's precedents were linked indirectly to the Facts. The party that was directly linked is referred to here as the party *favored* in the linkage condition.

In the two Layout conditions, screen elements relevant to either party (i.e., titles and descriptions of precedents, and buttons) were placed differently depending on whether it was the Middle or the Side condition. For the Side conditions, all screen elements concerning the plaintiff were placed on the left of the screen, and all elements concerning the defendant were placed on the right side of the screen. Because people read from left to right, the plaintiff's elements were presented on the left of the screen, so they would most likely be seen first. In a court of law, the plaintiff presents his case first. For the Middle layout conditions, all screen elements concerning both parties were centered on the screen.

Appendix D contains screen printouts from the Plaintiff-Side version of the program, Appendix E contains an example of a Plaintiff-Middle precedent screen, and Appendix F contains a map of the screens.

The Legal Case

The case selected for this study is an adaptation of Hynes v. New York Central Railroad Co., a case involving Tort law (i.e., non-contractual obligations to avoid harming others). The case was taken from Kelso's (1984) textbook, Studying Law: An Introduction. There are some interesting issues of selecting appropriate legal categories in this case, so it is a useful one for training lawyers.

This particular case was first decided for the plaintiff (Hynes) by a jury, then overturned by the judge in favor of the defendant (NY Railroad); that decision was upheld by the appellate court, then finally decided by the state supreme court for the plaintiff. The decision in this case went back and forth because it is difficult to decide what information is really relevant to the case. Because of the difficult issues involved in this case, it has been cited numerous times by the courts in attempts to clarify how legal principles should be used.

The facts in the case were altered in several ways. In the original case, a young boy was killed; in the experimental case, he only broke a leg. This change was intended to reduce the emotional content of the case. The precedents cited in the program for this experiment are not those used in the actual case. Based on subjects' responses to why they decided as the did in the pilot testing, the precedents were altered to make them as equally persuasive as possible. An attempt was also made to provide simpler precedents than those cited in the actual case. In addition, the names of precedents have been changed to reduce the chances that some would be more memorable than others. Names selected to identify precedents were chosen from the 22 most common surnames in the United States (Smith, 1969) and names that sounded like other selected names were avoided to reduce the chances that subjects would confuse the names.

Procedure

The experiment was conducted in a computer lab with eight computers and several tables. Six subjects participated in the study at a time. Initially subjects were seated at the tables away from the computers and administered the inference and spatial visualization tests. Then the subjects were seated at the computer desks and instructed in how to start the training program. All six subjects ran the training programs on their individual computers at once. This took less than ten minutes for each subject to complete. Subjects were then given the instruction sheet on how judges make decisions and how to perform their task. When they were finished reading the instructions, they were instructed as a group how to start their databases.

They started the database and ran through the program to read about the case and make their ratings. Subjects were not permitted to talk to each other, but they were allowed to ask questions of the experimenter concerning their task. The experimenter however, would not discuss the actual case, telling the subjects that the ratings and the final decisions were up to them. A typical question subjects asked was, "Should I rate a precedent higher if it supports the side I'm in favor of?" To which the experimenter would respond, "Rate each precedent based on how much it has in common with this case before you decide for either side."

After each subject rated the precedents and felt ready to reach a decision, s/he was allowed to sit down at a table on the other side of the room from the computers and quietly read. When all subjects were seated at the tables, they were asked to record their decisions and rate their confidence (that they had decided the case correctly) on a sheet of paper. The same scale used for other ratings in this study (i.e., 1-9) was used for the confidence ratings. The last thing subjects were required to do was to mark on the sheet of paper whether each of the six precedents was cited by the plaintiff or the defendant. The subjects marked a letter (indicating the party) next to a number corresponding to the order in which the precedents were read. The order that the precedents were read was randomized for each experimental session. At the end of the session, subjects were debriefed by the experimenter about the outcome of the actual case and the purpose of the experiment.

CHAPTER V RESULTS

Several issues of user performance were examined in this study employing a hypertext description of a legal case. Three general hypotheses were investigated: (a) does the linkage of data affect users' evaluations of the data, (b) does the layout of data on individual screens affect users' recognition memory, and (c) do users' cognitive abilities (i.e., spatial visualization or inferential reasoning) affect their confidence or performance with a hypertext database. The two factors in this study, data linkage and screen layout, were crossed to yield four conditions. Also under consideration was whether these factors might affect how subjects used the database--as measured by the number of screens accessed and time spent displaying the screens.

Database Usage

How subjects used this database is important because it affects how much exposure they have to different aspects of the database. Data were collected on the time subjects spent on each screen and number of times subjects accessed each screen. (See Appendix C for some sample screen traversal histories.) Differences in the length of exposure to the screen displays could prove influential in how subjects evaluated what they saw. Unfortunately, there is no way to determine if the time spent on a screen is actually time spent reading it. Even if subjects were carefully observed to see if they were reading while screens were displayed, subjects could have been thinking about something else while staring at their monitors. The number of screens accessed was included as another measure of subjects' exposure to the database. To determine if the experimental factors had an effect subjects' access to the precedent screens, data were also collected on the time subjects spent examining the precedents as well as the number of screen traversals to the precedents. One other aspect of usage is the order in which subjects accessed the parties' precedents. This may be of interest because the ordering of information presentation can bias subjects.

Total Time for Task

There was no time limit imposed on subjects' use of the database. Subjects used the database for periods lasting from 464 to 1743 seconds (7.73 to 29.05 minutes). The mean for all subjects was 991.55 seconds (16.56 minutes) (SD=306.66 seconds). Conditions labeled Plaintiff are those for which the linkage favors (is direct) for the plaintiff and indirect for the defendant; conditions labeled Defendant are those for which the linkage favors (is direct) for the defendant and indirect for the plaintiff. The means by condition are found in Table 1.

Table 1
Mean Time for Task (in Seconds)

Condition	M	SD
Plaintiff-Middle	973.62	376.34
Plaintiff-Side	941.62	222.57
Defendant-Middle	1026.12	304.10
Defendant-Side	1024.81	325.39

There were no significant differences on time for task between the experimental conditions. Time for task had no effect on the dependent measures in this study (i.e., precedent ratings, final decisions, recognition, or confidence). Total time for task was not related to any variables measured in this study except for the first party examined (discussed below).

Total Number of Screen Traversals

The database contained fifteen different screens. Subjects were allowed to go back and forth to re-read screens as much as they liked. Subjects accessed screens between 36 and 169 times. The mean for all subjects was 97.88 (SD=27.26). The means by condition are found in Table 2.

Table 2
Means for the Total Number of Screen Traversals

Condition	M	SD
Plaintiff-Middle	95.69	27.24
Plaintiff-Side	89.94	26.94
Defendant-Middle	109.56	25.48
Defendant-Side	96.31	28.00

There were no significant differences in the number of screen traversals between the experimental conditions. Number of screen traversals had no effect on the dependent measures in this study (i.e., precedent ratings, final decisions, recognition, or confidence). Total number of screen traversals was not related to any variables measured in this study.

Time On Precedents

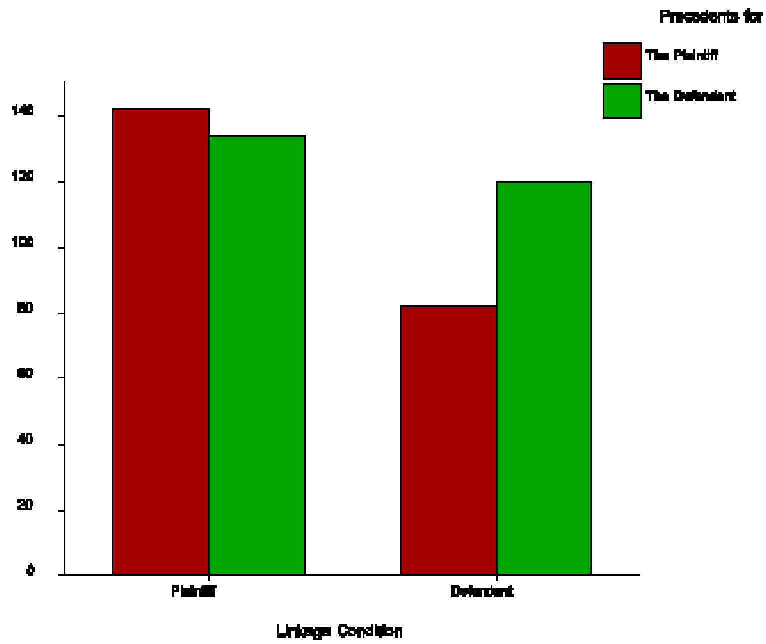
Subjects spent on between 10 and 294 seconds (M=138, SD=61) examining the plaintiff's precedents and 10 to 366 seconds (M=101, SD=60) examining the defendant's precedents. The means are found in Table 3.

Table 3
Mean Time Spent Examining Precedents (Seconds)

	Plaintiff's Precedents		Defendant's Precedents	
Condition	M	SD	M	SD
Plaintiff-Middle	150.25	80.49	92.50	39.44
Plaintiff-Side	133.19	50.27	72.44	33.88
Defendant-Middle	129.75	49.27	118.31	70.36
Defendant-Side	139.19	60.77	120.75	75.05

There were no significant differences between experimental conditions in the time spent on plaintiff's precedents. However, for the time spent on defendant's precedents, subjects differed by linkage ($F(1,60)=6.62$, $p<.01$), though not by layout ($F(1,60)=.54$, $p>.05$) or the interaction of these factors ($F(1,60)=.44$, $p>.05$). Figure 6 shows the mean time on precedents by linkage.

Figure 6. Mean time on precedents by linkage.



Subjects who were grouped by their final decisions (i.e., subjects who decided in favor of the plaintiff versus those who decided in favor of the defendant) differed in the time spent on the defendant's precedents ($F(1,62)=3.88$, $p<.05$). (They did not differ significantly in the time they spent on the plaintiff's precedents.) The time spent on the defendant's precedents was significantly greater for subjects who decided in favor of the defendant ($M=115.84$, $SD=74.99$) than subjects who decided in favor of the plaintiff ($M=87.06$, $SD=36.48$). Time spent on the precedents had no effect on other dependent measures in this study (i.e., precedent ratings, recognition, or confidence). In sum, linkage may have affected subjects' final decisions by affecting the time subjects spent on the defendant's precedents.

Number of Traversals to Precedents

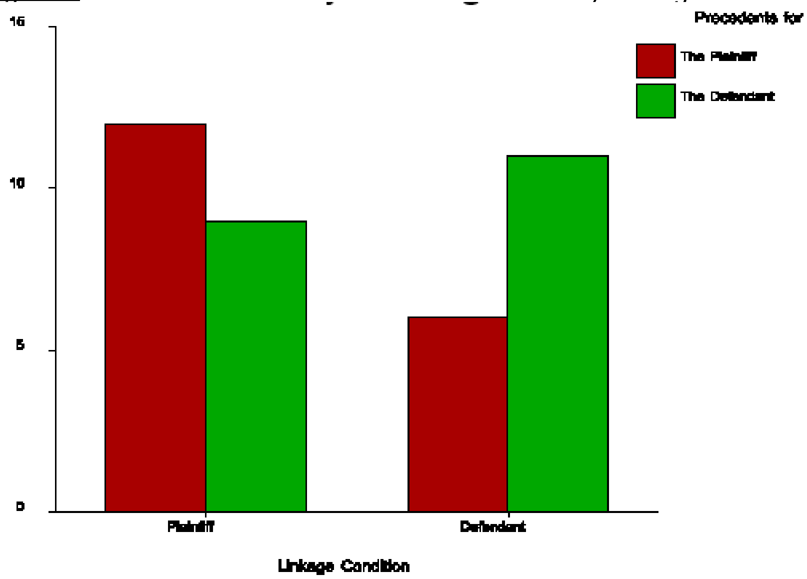
Subjects traversed to the plaintiff's precedents between 3 and 29 times ($M=10.27$, $SD=5.24$) and to the defendant's precedents between 3 and 24 times ($M=8.5$, $SD=4.76$). The means by condition are found in Table 4.

Table 4
Number of Traversals to Precedents

	Plaintiff's Precedents		Defendant's Precedents	
Condition	M	SD	M	SD
Plaintiff-Middle	12.44	5.88	6.62	3.14
Plaintiff-Side	10.69	4.85	5.62	1.71
Defendant-Middle	8.62	3.70	10.94	5.16
Defendant-Side	9.31	5.88	10.81	5.58

For number of traversals to plaintiff's precedents, subjects differed by linkage ($F(1,60)=4.05$, $p<.05$), but not by layout ($F(1,60)=.68$, $p>.05$) or the interaction ($F(1,60)=.35$, $p>.05$). For the number of traversals to the defendant's precedents, subjects also differed by linkage ($F(1,60)=20.49$, $p<.0001$), though not by layout ($F(1,60)=.29$, $p>.05$) or the interaction of these factors ($F(1,60)=.68$, $p>.05$). Figure 7 graphs the mean number of precedents accessed by linkage.

Figure 7. Mean Number of Precedents Accessed by Linkage.



Subjects who were grouped by their final decisions (i.e., subjects who decided in favor of the plaintiff versus those who decided in favor of the defendant), differed in the number of traversals to the defendant's precedents ($F(1,62)=5.07$, $p<.05$). (They did not differ significantly in the number of traversals to the plaintiff's precedents.) The number of traversals to the defendant's precedents were significantly greater for subjects who decided in favor of the defendant ($M=9.84$, $SD=5.77$) than for subjects who decided for the plaintiff ($M=7.42$, $SD=3.16$). Number of traversals to the precedents had no effect on other dependent measures in this study (i.e., precedent ratings, recognition, or confidence). In sum, linkage may have affected subjects' final decisions by affecting the number of traversals to the defendant's precedents.

Party Examined First

The party whose precedents were examined first was probably determined by the placement of the plaintiff's data on the left of the screen introducing the parties to the litigation. Another possible explanation could be that subjects knew that the plaintiff's side is always presented to the judge first. Almost all of the subjects (88%) displayed the plaintiff's precedents first. Table 5 shows frequencies for the party whose precedents were examined first by the subjects.

Table 5
Frequencies for the Party Examined First

	Precedents Examined First	
Condition	Plaintiff's	Defendant's
Plaintiff-Middle	13 (81.25%)	3 (18.75%)
Plaintiff-Side	14 (87.50%)	2 (12.50%)
Defendant-Middle	16 (100.00%)	0 (00.00%)
Defendant-Side	13 (81.25%)	3 (18.75%)

There were no significant differences between experimental groups on this variable. The party whose precedents were examined first did have an effect on subjects' exposure to the database; it affected total time for task ($F(1,62)=7.82$, $p<.01$) and time that the Facts screen was displayed by subjects ($F(1,62)=17.63$, $p<.0001$). It also affected the number of traversals to the plaintiff's precedents ($F(1,60)=6.48$, $p<.01$), and time spent on the plaintiff's precedents ($F(1,60)=6.02$, $p<.05$).

First party examined had no effect on the dependent measures in this study (i.e., precedent ratings, final decisions, recognition, or confidence). In sum, first party examined affected several measures of database usage, in particular subjects' exposure to the plaintiff's precedents, but none of these measures of usage significantly affected any of the dependent measures in the this study.

Data Linkage Factor

Relevance Ratings of the Precedents

The first hypothesis under investigation was whether data linkage could affect subjects' evaluations of information. Subjects were asked to compare several precedents to the evidence from a current case, and rate the relevance of the precedents to this case. Three precedents were cited by each party (i.e., the plaintiff and the defendant).

The two conditions in the linkage factor determined whether the plaintiff or the defendant's precedent screens were directly linked to the screen explaining the evidence in the case. The party that was directly linked is referred to here as the party "favored" in the linkage condition. The party that was indirectly linked required subjects to traverse several intervening screens to compare the precedents and the evidence. Many of the subjects noticed that there was a difference in the paths linking the two parties to the evidence screen.

Subjects used the full range of possible ratings (i.e., 1-9) when rating each of the precedents. To yield one aggregate rating for each party (referred to here as either the plaintiff rating, the defendant rating, or in general, the party rating), the three precedents cited by each side were summed.

To determine if the mere textual contents of the precedents could bias subjects in favor of either party, t-tests were performed comparing each precedent's mean rating to the overall mean rating for all six of the precedents. Two of the plaintiff's ratings were significantly above and one was significantly below the overall rating. One of the defendant's ratings was significantly above and one was significantly below the overall rating. In the table below, "P" refers to a precedent cited by the plaintiff, Hynes, and "D" refers to a precedent cited by the defendant, the Rail Road. The mean ratings are found in Table 6.

Table 6
Mean Ratings for Individual Precedents

Precedent	M	SD	t	p
Overall	5.15	2.61		
P1	5.86	2.62	2.16	.03*
P2	4.27	2.31	-3.06	.003**
P3	6.2	2.41	3.49	.001**
D1	6.52	2.48	4.40	.0001**
D2	4.50	2.48	-2.10	.04*
D3	5.52	2.62	1.11	.27

* $p<.05$ ** $p<.01$

There was no significant difference between the mean ratings based on the party that cited them ($t=-.12$, $p>.05$); therefore there was no overall bias to rate one party higher than the other. The mean party ratings across all subjects are found in Table 7.

Table 7
Mean Party Ratings for All Subjects

Party	M	SD	t	p
Plaintiff	16.27	4.36	-.12	.90
Defendant	16.38	5.30		

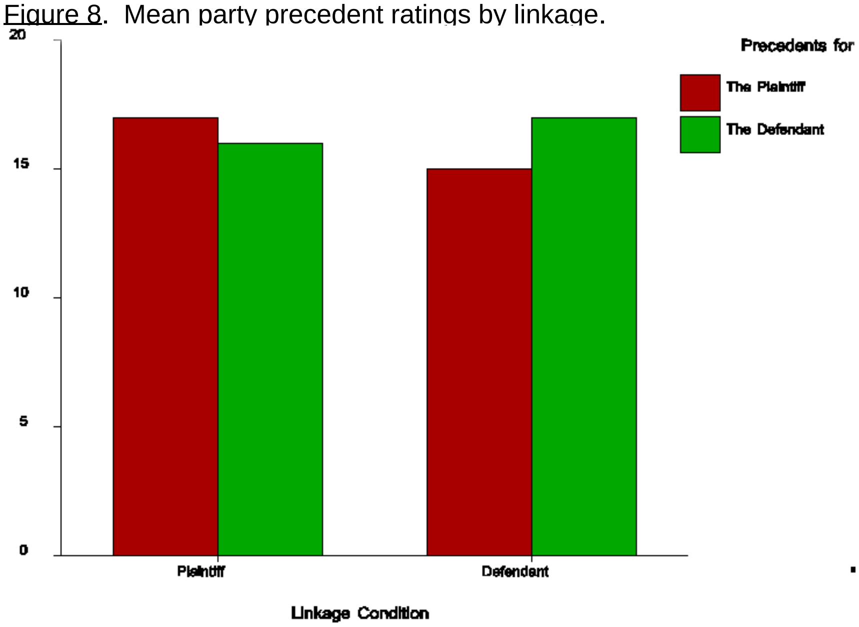
For the condition with linkage direct the plaintiff (indirect to defendant), the mean rating for the plaintiff's precedents was 16.59 (SD=4.23), and for the defendant's precedents the mean was 15.47 (SD=6.10). For the condition with linkage direct to the defendant (indirect to the plaintiff), the mean rating for the plaintiff's precedents was 15.94 (SD=4.53), and for the defendant's precedents the mean was 17.28 (SD=4.26). This trend was as predicted, that is, the ratings would be higher for the party that was favored by the linkage condition. Mean party ratings and party rating differences are found in Table 8.

Table 8
Mean Precedent Ratings by Condition

	Plaintiff's Precedents		Defendant's Precedents	
Condition	M	SD	M	SD
Plaintiff-Middle	16.44	4.37	16.69	5.06
Plaintiff-Side	16.75	4.22	14.25	6.94
Defendant-Middle	15.00	5.01	17.31	4.53
Defendant-Side	16.68	3.93	17.25	4.12

A two-factor ANOVA of the plaintiff's precedent ratings was not significant based on linkage ($F(1,60)=.36$, $p>.05$), screen layout ($F(1,60)=.99$, $p>.05$), or the interaction of these two factors ($F(1,60)=.50$, $p>.05$). A two-factor ANOVA of the defendant's precedent ratings was not significant for either linkage ($F(1,60)=1.89$, $p>.05$), screen layout ($F(1,60)=.90$, $p>.05$), or the interaction of these two factors ($F(1,60)=.81$, $p>.05$). The mean average ratings by linkage are graphed in Figure 8.

Figure 8. Mean party precedent ratings by linkage.



Due to effects from the first party (the party whose precedents subjects were exposed to first, discussed earlier), on the total exposure subjects had to the precedents, some p[illegible]c analysis were suggested. Two-factor ANOVAs of the effects of linkage and first party on precedent ratings were conducted. For the defendant's ratings, the ANOVA yielded significance for linkage ($F(1,60)=4.45$, $p<.05$) but not for the first party ($F(1,60)=.88$, $p>.05$), or the interaction ($F(1,60)=.11$, $p>.05$). There were no effects on the plaintiff's precedent ratings. In sum, the linkage manipulation alone had no significant effects on either the defendant's or the plaintiff's precedent ratings, but when combined in an analysis considering what party subjects examined first, linkage did affect subjects' ratings of the defendant's precedents.

Final Decision

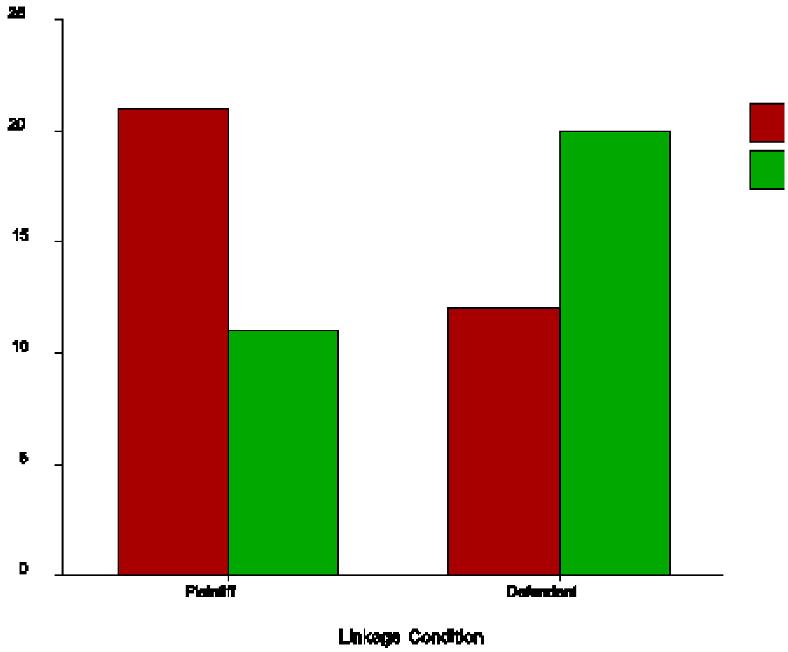
Subjects were also asked to reach a final decision in their case, either for the plaintiff or the defendant. The Linkage condition did have a significant effect on subjects' final decision in the case ($x^2(1)=5.07$, $p<.05$). The Layout factor did not have any effect on final decisions ($x^2(1)=1.56$, $p>.05$). Table 9 shows the frequencies for the final decisions based on the linkage factor. Figure 9 shows the frequencies of final decisions by the linkage.

Table 9
Frequencies of Final Decisions

Condition	For the Plaintiff	For the Defendant
Plaintiff-Middle	9 (56.25%)	7 (43.75%)
Plaintiff-Side	12 (75.0%)	4 (25.0%)
Defendant-Middle	5 (31.25%)	11 (68.75%)
Defendant-Side	7 (47.75%)	9 (56.25%)

Frequencies

Figure 9. Frequencies of final decisions by the linkage.



Subjects' ratings of the precedents appear closely related to their final judgments, as they were hypothesized to be. Subjects' decisions were significantly correlated with the difference between their party ratings (mean difference between each subject's ratings for plaintiff and defendant) (r=.74, p<.001).

Subjects grouped by their final decisions (i.e., subjects who decided in favor of the plaintiff versus those who decided in favor of the defendant) differed significantly in their party ratings (F(1,62)=71.76, p<.0001) as well as their exposure to the defendant's precedents (described above). In sum, linkage affected subjects' final decisions and subjects' final decisions were related to subjects' precedent ratings. Mean precedent ratings by subjects' final decision are found in Table 10.

Table 10
Mean Precedent Ratings by Final Decision

	Plaintiff's Precedents		Defendant's Precedents	
Decision in Favor of	M	SD	M	SD
the Plaintiff	17.67	3.89	12.79	4.02
the Defendant	14.77	4.39	20.19	3.53

Confidence

After subjects completed the task, they were asked how confident they were with their performance as a judge, that is, did they decide as a judge is required to--by following precedent. Confidence was measured on a scale of 1 to 9 (the same scale used for rating the precedents) with 1 indicating very little confidence and 9 indicating absolute confidence. Neither linkage ($F(1,60)=3.59$, $p>.05$), layout ($F(1,60)=.02$, $p>.05$), or the interaction ($F(1,60)=.02$, $p>.05$) had any effect on subjects' confidence. Mean subject confidence ratings by experimental condition are found in Table 11.

Table 11
Mean Confidence Ratings by Experimental Condition

Condition	M	SD
Plaintiff-Middle	7.31	.87
Plaintiff-Side	7.38	.62
Defendant-Middle	6.88	.96
Defendant-Side	6.88	1.36

Screen Layout

Recognition

The second hypothesis in this study was whether the layout of information on screens could affect subjects' recognition of the information. There were two conditions in the layout factor: precedents all displayed in the middle of the screen or precedents displayed on different sides of the screen based on the party citing them. Another condition was considered, having the precedents placed inconsistently on different sides of the screens (e.g., two precedents on the left, one on the right for each party). This condition was not employed as it became evident that layout was having no effect.

After deciding the case, subjects were read the names of the precedents (e.g., Taylor v. California Electric Co.) and were asked after hearing each one to indicate who cited it (i.e., the plaintiff or the defendant). The dependent measure was the number of correctly recognized precedents out of the six possible. The mean number correctly recognized for all subjects was 4.19 ($SD=1.39$). Table 11 shows the mean number of precedents recognized by condition.

Table 11
Mean Total of Precedents Recognized

Condition	M	SD
Plaintiff-Middle	4.00	1.21
Plaintiff-Side	4.12	1.36
Defendant-Middle	4.50	1.55
Defendant-Side	4.12	1.50

A two-factor ANOVA found no significant difference between the mean total items recognized based on layout ($F(1,60)=.13$, $p>.05$), linkage ($F(1,60)=.50$, $p>.05$), or the interaction of these factors ($F(.50)$, $p>.05$). When the precedents were broken down by the party that cited them, analyses on the number of recognized defendant's precedents as well as the number of recognized plaintiff's precedents recognized were also insignificant.

A post hoc ANOVA was performed to determine if subjects differed in their precedent recognition by the party they decided for. If subjects had better recognition of the precedents cited by the party they decided for (i.e., in favor of the plaintiff or the defendant) this may have indicated that recognition played in role in such judgments. However, based on their final decision (i.e., subjects who decided in favor of the plaintiff versus those who decided in favor of the defendant), subjects did not differ in their recognition of the plaintiff's precedents or the defendant's precedents.

Confidence

As noted above (under "Data Linkage Factor") confidence was not affected by layout.

Cognitive Abilities

The last hypothesis under investigation was whether subjects' cognitive abilities would have an effect while using a hypertext database. Subjects completed two cognitive ability tests produced by the Educational Testing Service, the RL-3 Inferential Reasoning Test and the VZ-2 Paper-Folding Test, a spatial visualization test. Both tests had a possible twenty correct answers. The mean for all subjects on the Inferential Reasoning test was 14.83 ($SD=2.74$) and the mean for all subjects on the spatial visualization test was 12.62 ($SD=3.39$). The two measures of cognitive functioning were not significantly correlated with each other. The means of the cognitive ability scores for the groups are listed below in Table 12. There were no significant differences between the experimental conditions on their inferential reasoning ($F(1,62)=.008$, $p>.05$) or spatial visualization scores ($F(1,62)=.005$, $p>.05$).

Table 12
Means for the Cognitive Measures for All Subjects

	Inferential Reasoning		Spatial Visualization	
Condition	M	SD	M	SD
Plaintiff-Middle	14.88	2.83	13.50	3.35
Plaintiff-Side	13.81	3.17	11.69	3.81
Defendant-Middle	14.83	2.58	11.81	3.29
Defendant-Side	13.50	2.92	13.50	2.92

Data Evaluation

A multiple regression of the cognitive measures on subjects' ratings of the plaintiff's precedents did not prove significant for inferential reasoning ($F(1,60)=2.27$, $p>.05$), spatial visualization ($F(1,60)=2.86$, $p>.05$), or the interaction ($F(1,60)=3.12$, $p>.05$). The same regression on subjects' ratings of the defendant's precedents was also non significant for inferential reasoning ($F(1,60)=1.35$, $p>.05$), spatial reasoning ($F(1,60)=1.43$, $p>.05$), and the interaction ($F(1,60)=.20$, $p>.05$). Subjects did not differ in their cognitive abilities based on the final decision they chose. In sum, cognitive abilities had no effect on how subjects evaluated the data presented to them.

Recognition

Subjects' cognitive ability scores were compared with their recognition scores. Regression of spatial visualization scores on the total number of precedents recognized was not significant ($F(1,62)=1.06$, $p>.05$). However, regression of inferential reasoning scores on recognition was significant ($F(1,62)=9.76$, $p<.01$).

Because of the correlation between inferential reasoning and recognition ($R=.37$, $p<.05$), a two-way analysis of covariance was performed using inferential reasoning as a covariate. However, neither the layout ($F(1,57)=2.14$, $p>.05$), linkage ($F(1,57)=.39$, $p>.05$), inferential reasoning ($F(1,57)=2.46$, $p>.05$), or interaction between the factors ($F(3,57)=1.26$, $p>.05$) was significant. Subjects were divided in half based on their inferential reasoning scores and again analyzed, but no significant recognition results were detected for either the high or low scorers. Table 13 contains correlations of recognition with cognitive measures, confidence, and usage.

Confidence

A multiple-regression of subjects' cognitive ability scores found no significant relationship between inferential reasoning ($F(1,60)=.08$, $p>.05$), spatial visualization ($F(1,60)=1.19$, $p>.05$), or the interaction ($F(1,60)= .59$, $p>.05$) on confidence. Therefore, these cognitive abilities had no effect on subjects' confidence. See Table 13 for correlations of confidence with cognitive measures, recognition, and database usage.

Table 13
Correlations of the Cognitive Measures with Recognition, Confidence, and Overall Usage

	Inference	Spatial Vis.	Recog-ition	Confid-ence	Time for Task	No. of Travers.
Inference	1.00					
Spatial Vis.	.18	1.00				
Recognition	.37**	.13	1.00			
Confidence	.17	.17	-.26	1.00		
Time for Task	.06	-.10	.10	-.19	1.00	
No. of Traversals	.02	.01	.14	-.17	.62**	1.00

** $p<.01$

CHAPTER VI DISCUSSION

When faced with decisions, people can be influenced or biased by a number of different factors, including their access to information on which to base their decisions. Since computers provide for economical data storage with fast retrieval mechanisms, many decision makers rely on computerized information. Decisions that impact large segments of society are often made with the help of computers. Computerized information is used to make critical decisions in many professions including medicine, engineering, government, and law. The design of computerized information systems is therefore a concern to many facets of society.

The legal profession regulates the functioning of society by determining what rules apply to the settlement of disputes. To select appropriate legal rules, lawyers must research statues (i.e., legislative enactments) and precedents (i.e., previously decided cases which serve as guides for the resolution of future cases). The effort and time required to research this information is tremendous; lawyers have increasingly turned to computers to expedite this process. The size alone of legal databases necessitates the use of automated search mechanisms. For example, "every year the commercial information retrieval system LEXIS is enlarged by the addition of 800-1200 cases from 42 different series of law reports (the reported cases) and 2500-3000 transcripts from court stenographers (the unreported cases)" (Wilson, 1990, p. 195).

The extent of computer usage in the legal profession has been examined by the IIT Chicago-Kent Center for Law and Computers in a survey of 500 of the largest American law firms (Staudt & Farber, 1987). In 1985, 70 percent of the firms had at least one lawyer using a computer; by 1986, this number increased to 83 percent. In addition, the vast majority of these firms (86 percent) were using the computerized databases WESTLAW and/or LEXIS in 1986. The legal profession's dependance on computers will continue to grow because with each passing year the legal database becomes increasing more difficult to search without a computer.

This experiment explored how the access to computerized information might affect decision making in the legal domain. Two variables related to the spatial properties of information presentation via hypertext were investigated. It was believed that these variables would affect how subjects evaluated information, how they used that information, and how well they remembered the information. In addition, the effects of subjects' cognitive abilities on their performance and confidence were also investigated.

Summary and Interpretation of Linkage Results

The most important finding of this study was that the data linkage (i.e., how data were accessed from screens containing other data) biased subjects' decision making. Subjects were given a hypertext database about a legal case. They were asked to examine the precedents and decide the case based on the precedents.

For the linkage manipulation, the screens describing the precedents for one party (either the plaintiff or the defendant) were directly linked to the screen describing the evidence, while the precedents for the other party were several screens away from the evidence. Screens that were directly linked required only one step (the click of a button) to be accessed. Indirectly linked screens required subjects to traverse several intervening screens to move between the evidence and the precedents. Subjects tended to decide in favor of the party whose precedents were directly linked to the evidence. Hence, the manipulation of the links caused a bias in subjects' reasoning.

Display Proximity

Seidler, Wickens, and Davis (1991) propose that distances between screens of information can be characterized in at least two ways. *Navigational distance* is a measure how many steps (e.g., button clicks) are required to traverse between screens. Seidler, et al. also recognize *cognitive distances*, "Information screens that are viewed by the user as more related can be said to be separated by a shorter cognitive distance. This relatedness may be defined by frequency of sequential use or alternatively, by shared semantic features" (p. 2). They suggest that bringing screens closer navigationally can help create a spatial metaphor for the database and imply to the user that the screens are more related.

According to the proximity compatibility principal (PCP) (Andre & Wickens, 1989; & Wickens & Andre, 1990) there is an interaction between the type of task and display proximity of data involved. When a task requires focused attention on one target datum, performance is improved with less display proximity to other data. Less cluttered screens are important for tasks requiring focused attention because less clutter helps to psychologically isolate the target data from other data.

Other tasks require users to integrate two or more data items. Comparing the precedents used in this experiment to the evidence was an information integration task. When the task requires information integration, performance is improved when the target data is located closely together, i.e., there is less navigational distance. Integration of information may be more difficult with longer navigational paths between target data items. In this experiment, traversing irrelevant screens between targets provided subjects with more time for memory decay and irrelevant information to displace the memories of the target information. This would be consistent with Seidler's, et al. (1991) findings that greater navigational distances resulted decreased memory accuracy. Memory decay and displacement of target information during encoding weakens the association between the navigationally distant information. The form of users' mental model of the database is probably a result of the memory associations between the navigationally close or distant information.

This theorizing on spatial proximity is consistent with the work on the design of hierarchical menu systems. One issue for the design of menu systems is whether to increase the breadth of depth of a menu structure to accommodate all possible selections. Breadth is the number of menu items displayed on each screen (or the average number) and depth is the number of screens in the menu structure. The more menu items per screen, the longer it takes for users to read and select their choice. The more depth per menu structure the more likely users are to get lost or not understand where their target selection is located (Norman, 1991).

Research seems to indicate that it is better to increase the breadth rather than depth of a menu structure (Norman, 1991; Paap & Roske-Hofstrand, 1988). This recommendation could be further supported by the spatial properties of information outlined above. Selecting a menu item often requires users' to compare the available options first. Comparison is an information integration task and is easier when selections are close together (e.g., on one screen versus on different screens). In addition, users' feelings of being lost in a deeper menu structure may be due to weaker associations in users' mental models between selection items. Deep menu structures imply a spatial metaphor in which the menu items are not closely related because there is more navigational distance between them.

Availability

Judgments common to everyday, practical reasoning can be made using the availability heuristic (Tversky & Kahneman, 1974). People often employ the availability heuristic when making judgments of probability, frequency, or causality assessments. One important factor affecting availability likelihood is strength of association. Stronger associations are easier to recall.

Information contained in the precedents may have been more available for the party with the direct linkage (the party navigationally closer to the evidence). These precedents were probably more strongly associated with the evidence than the precedents for the opposing party.

The associations between the evidence and the navigationally closer party were not interfered with by intervening screens as were associations to the opposing party.

The linkage of the database also affected how much subjects were exposed to some of the precedent information, measured by both the number of screen traversals (to both parties' precedents) and time on precedents (for the defendant's precedents). Subjects were exposed more to the side with the direct linkage. This lends support to the influence of availability. Based on their final decision in the case, subjects differed significantly in how much they were exposed to the defendant's precedents (measured in time on screens and number of traversals to screens). Increased access to the defendant's precedents may have increased the availability of information on the defendant and thus led to a decision in favor of the defendant.

Another factor that may have influenced availability was the positioning of the parties' names and descriptions on the screen introducing the two parties to the subjects. This particular positioning (plaintiff on the right, defendant on the left) may have affected which precedents subjects read first. The precedents (plaintiff's or defendant's) that subjects were exposed to first affected how much exposure (time and traversals) subjects had to the plaintiff's precedents. Subjects who differed in their exposure to precedent information reached different decisions as noted above. This exposure could have also influenced to some degree the availability of information for subjects. (This topic is treated further under "Methodological Issues and Future Research.")

Motivational Hypothesis

A competing theory to explain the effect of linkage could be a motivational theory. Subjects may have been more motivated to explore the information related to the party that was directly linked versus the party that was indirectly linked. Increased motivation could be due to the fact that it was easier to explore the directly linked information (there were less intervening screens to traverse). If this were the case, subjects would have spent more time and made more traversals to the party they finally decided for.

Subjects whose programs had direct linkage to the defendant decided for the defendant more often than for the plaintiff, and saw more of the defendant's precedents than subjects who decided in favor of the plaintiff. Perhaps subjects were more sure of the information they had more exposure to, so they decided for the party they were more familiar with. The motivational hypothesis should hold for the other condition (linkage direct to the plaintiff) as well, but linkage had no effect on how much subjects were exposed to the plaintiff's precedents. Therefore, there is doubt that motivation played a role in the linkage manipulation.

Future studies of linkage should try to rule out this motivational hypothesis. One group of subjects could be offered an incentive to make sure that they invest sufficient effort to explore both plaintiff and defendant arguments thoroughly. A control group would be given no incentive. Alternatively, one group could be told they should try to make the best decision because they would be evaluated by a panel of experts. The purpose of providing an external motivation is to reduce the differential influence of motivation favoring one side due to ease of access.

Belief Bias

Subjects were instructed to decide the case based on the relevance of the precedents to the evidence. They may not have totally understood what was intended by the concept of "relevance" as described in the instructions. However, this does not appear likely because of the significant correlation between subjects' decisions (for the plaintiff or the defendant) and their precedent ratings. A relationship between the ratings and the linkages may not have appeared due to a lack of experimental power. The trends were as predicted, but the strength of the effect may not have been great enough to reach statistical significance.

Another factor explaining the lack of significance for the relevance ratings could be the effects of a belief bias. A belief bias occurs when the truth or desirability of a conclusion influences a person's judgment on the validity an argument. In this experiment, precedents that were relevant were the valid arguments. People are inclined to accept arguments they believe to be true disregarding the validity of arguments. Similarly, people neglect arguments they believe are false (Evans, Barston, & Pollard, 1983). Belief biases can result from a failure to discriminate between information given from information retrieved stored in long term memory. A belief bias leads a person to maintain a conclusion despite rational, valid arguments against it.

A belief bias may have mediated the encoding of information learned from the precedents. Sternberg describes mediators as, "any intervening variable that increases or decreases the availability or accessibility of the inferential rules used to solve a problem" (Sternberg, 1986, p.290). In this case the inferential rules were the decisions implied by the precedents. A belief bias may have lead subjects to a conclusion based on something other than the actual relevance of the precedents or influenced subjects' evaluations of the precedents. Perhaps some subjects had previous biases against young boys (like the plaintiff) or large companies (like the defendant) which interacted with what they learned in the experiment to produce their final decisions.

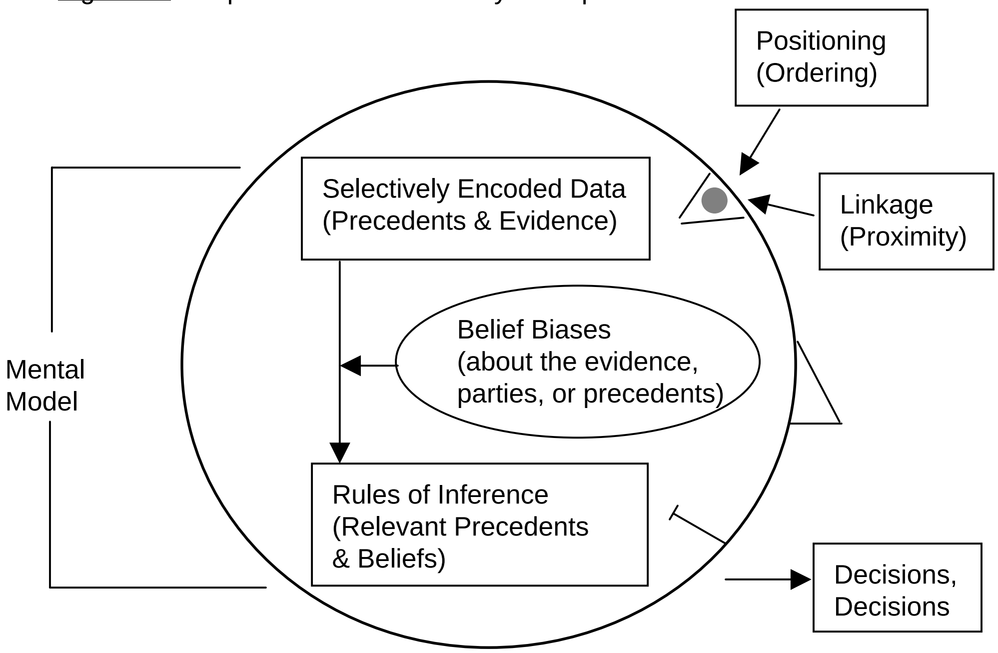
Representation Availability Principle

Subjects may have based their final judgments on the category of information (plaintiff or defendant) that was more available when they thought about the evidence in their case. The party that was directly linked to the evidence and the party that subjects were exposed to first contributed to the amount of exposure subjects had to the information. Increased exposure to sources of information increases availability by building stronger associations between those items of information during the encoding of subjects' mental representations. Subjects made their final decisions in the case based on the availability in their representations of particular classes of information, i.e., information pertaining to the plaintiff or pertaining to the defendant.

Subjects were told to base their decision on the precedents and evidence alone, but their ratings of the precedent relevance did not differ by linkage. Some factors beside the actual information contained in the program influenced subjects' decisions. People bring many beliefs, relevant or not, to any judgments they make. It is not easy to separate one's prior beliefs from what one has just learned about an issue. These beliefs mediate the encoding of information about an issue and affect the availability of aspects of that information. Subjects in this study based their decisions on what information was most available to them when they thought about the evidence and issues in the case.

Two factors of data presentation were found to affect subjects' usage of a database, the linkage and positioning of the data. The linkage affected the navigational distances between data items which affected the cognitive proximity and strength of association between the data items. The positioning of the data (i.e., plaintiff on the left, defendant on the right of the screen) affected the ordering of data presentation to the users (i.e., most subjects looked at the plaintiff's precedents first) and this affected to their exposures to some of the data. Subjects' selective encoding of data from the program was influenced by the characteristics of the data presentation itself. The representation of this data in subjects' mental models is mediated by subjects' prior belief biases. Subjects' final decisions were therefore, largely influenced by the characteristics of the data displays and subjects' belief biases. Figure 10 illustrates how these factors may lead to a decision based on the theory outlined above, the representation availability principle.

Figure 10. Representation Availability Principle



Summary and Interpretation of the Screen Layout Results

The screen layout experimental factor (i.e., where data was placed on screens) did not affect subjects' recognition or evaluation of the data. This is probably not because location is unimportant, but because other recognition cues were used and a lack of variability in recognition measurements. In one condition, the descriptions of the plaintiff's precedents and buttons for accessing the precedents were placed on the left side of the screen while the defendants' precedents and buttons were placed on the right side. In the other condition, the descriptions and buttons for both parties were placed in the middle of the screen. It was hypothesized that placing the data and buttons consistently on either side of the screen would help subjects recognize which party cited the precedents.

Recognition cues were provided by other mechanisms in addition to location. The names of the precedents and the party citing them were located closely together whether the precedents were located on the sides or in the middle. Because the citing party was so clearly evident in all conditions displaying the precedents, any recognition cues due to location were negligible above cues provided by names of the parties.

The measure of recognition used here had too little variability. The range of scores for each question (i.e., correct or incorrect), as well as, the number of questions (i.e., six) was too small. With just two possible responses for a recognition question, the chances of a correct answer is 50%. With such a high probability of a correct recognition by chance, results could contain a lot of error in measurement. The possible effects of spatial location on recognition should not be dismissed without improved research (see below).

Summary and Interpretation of the Cognitive Abilities Results

The only significant effect found based on the cognitive measures was the effect of inferential reasoning on recognition. Subjects with higher inferential reasoning scores had higher recognition scores. Cognitive abilities had no effect on how subjects used the database or their data evaluations. To determine if any effects would hold for the upper or lower halves of the cognitive score ranges, subjects were divided in half based on their scores. Both halves of both cognitive measures were examined to see if any effects could be detected, but none were.

Spatial visualization measures have been used successfully in studies with far more hierarchical menu structures. However, the structure of the system used in this study was quite simple and nothing like a true hierarchical menu system and the measures used in studies of hierarchial menu systems are not those employed in this study. Ones' ability to navigate a hierarchical menu system is really not relevant to this study of bias and reasoning based on presentation. The only choices to be made in navigation were move forward, move back, or on one screen only--move towards the plaintiff or move towards the defendant. Previous studies were interested in measures such as time for task or number of correct answers based on searching a database. Legal reasoning problems are subjective in nature; they have no absolutely correct answers. Legal reasoning requires contemplation and comparison; therefore, the time for task would be influenced by far more than one's ability to navigate the screens.

The inferential reasoning test was not selected for its relationship to recognition, but it did show such a relationship. This is not surprising as Carroll (1974) has pointed out that performance on this factor depends partially on retrieval from long term memory and attention paid to stimulus materials. If subjects' abilities to retrieve what they had read or if they paid little attention to it, they would have little chance of latter recognizing characteristics about what they read. The effect of this factor was not strong enough though, to serve as a useful covariate in analysis of screen location and recognition. A more effective measure of subjects' memory would be an appropriate covariate for studies of location and recognition.

Methodological Issues and Future Research

The legal domain presents several problems for the study of the spatial presentations of information. In legal arguments one party, the plaintiff, always goes first in presenting his or her arguments. Ordering of presentations has been shown to bias reasoning (Tversky & Kahneman, 1974). People may give too much weight to what they learn first, leading to a confirmation bias (looking for only for data that supports your original ideas), or may place too much weight on what they heard last causing a recency effect. The effects of ordering cannot be controlled in a legal reasoning domain and still produce an experiment that accurately simulates legal reasoning. Other judgment domains must be to used in order to control the ordering bias (through counterbalancing of left/right positioning) if studies are to be applicable to all reasoning domains.

Another difficulty with studying legal reasoning is that subjects all have prior beliefs about what or who is good or bad and they use these biases to help them make judgements. These biases may reduce or confound any effects due to the presentation of data (such as effects on the precedent relevance ratings). There are two ways to control for such belief biases. Subjects could be asked, before starting an experimental task in legal reasoning, to rate their feelings about two parties that are very similar to those in the actual experiment. These feelings or biases could be used as covariates when analyzing judgments subjects reach after their experimental tasks.

Another way to eliminate belief biases is to use a judgment domain for which people do not have prior biases. Perceptual judgment would be such a domain. Subjects could be asked to rate the similarity of two shapes separated from a target shape by different navigational distances. Similarity would be based on shape, size, color, or even meaning of the illustrations. The order of presentation could easily be counter-balanced with shapes also. To get an objective measure of the effects due to data linkage, it makes sense to start with a domain that is less likely to be interfered by subjects' prior knowledge. If affects are found there, then more complicated areas of human reasoning could be investigated. It could turn out, though, the effects from linkage hold only for simple judgments, like perceptual comparisons, but are overwhelmed by the effects of prior belief in more complicated reasoning domains.

There is one other problem with research in the legal domain focusing on recognition and screen layouts. If subjects are measured on their recognition of parties to a legal dispute, there will only be two parties to recognize, the plaintiff or the defendant. More than two response possibilities are necessary for recognition research to allow for adequate score variability. A study employing shapes and perceptual comparisons could help eliminate this limitation on score variability. Shapes could be displayed in several different places on the screen (e.g., using all four corners of the screen) and contain a letter or word in the middle of them. For one condition, these locations would correlate exactly with some characteristics of the shapes, for example, all blue shapes would be located in the upper right quadrant of the screen. In the other condition, the correlation between color and location would be totally random. After comparing the similarity of all the shapes, subjects would be asked the color (one of four color choices) of the shape surrounding each letter or word. If subjects could remember the color better in the condition with the consistent location, then location would have improved subjects' recognition.

Any study focussing on stimulus effects on recognition should control for individual differences in recognition. Inferential reasoning had some affect here, but perhaps a stronger measure of cognitive memory would be a useful covariate in such a recognition study.

Guidelines for Encouraging Spatial Metaphors

Human-computer interface designs should consider the linkage factor when designing databases, especially when designing to assist subjective human decision making. Reliability in decision making with computers may be improved by carefully designing links between information. This would help decision makers base their judgments on the meaning of information and not on misleading characteristics of the information presentations.

Four guidelines suggest themselves based on this research:

1. Provide shorter navigational distances between related data than between unrelated data. This ensures users' mental models can take advantage of the spatial metaphors implied by navigational distances.
2. Determine which data items should carry the most weight (i.e., be most influential) in users' mental models. Design links so as to make this data easily accessible throughout the database. The more opportunities users have to access this data, the more associations they will build between this critical data and other data.
3. Determine which data items are to carry the same weight in a multi-screen presentation of information. Design the links so that navigational distances are the same length between all the items. Equal navigational distances will prevent biases in users' mental models due to the spatial metaphors implied by navigational distances.
4. If it is critical that subjects do not confuse the importance of various items, do not provide alternate means of data access. More than one navigational path would present multiple spatial metaphors to users and may confuse their metal models.

Software help systems provide examples of how good linkage design might improve our decisions. These help systems assist us in deciding what we can do with software and how to do it. Based on the guidelines above, suggestions can be made for help system design. The goal in linkage design should be to shorten the navigational distances between related ideas.

Providing context sensitive help and word search facilities would probably assist users by encouraging them build stronger associations between their tasks and descriptions of how to accomplish their tasks. Context sensitive help systems (e.g., the help found in Word Perfect 5.1, MS-Windows 3.0, and Macintosh System 7 Balloon Help) take users directly to the information they need. Help that is not context sensitive (e.g., help in Word Perfect 5.0) requires users to traverse any number of screens irrelevant to their immediate task thereby disturbing their memories of the task they are trying to accomplish. Another method for shortening the navigational distances in a help system would be to provide a word search mechanism, as is found in most MS-Windows 3.0 products. Word searches allow users to go directly to a section containing a word that the users feel is related to their task.

Conclusion

The tools alone, which are used to search and select precedents for use in legal cases, should not influence lawyers' strategies or decisions; however, there is evidence that they might. When a computer database controls the presentation of information to decision makers, it can influence their decisions (see for example, Benbasat, Dexter, & Todd, 1986; Boehm-Davis, Holt, Knoll, Yastrop & Peters, 1989; Liu & Wickens, 1992; & Te'eni, 1990). Knowledge of the role played by computers in the legal system and the role of the legal system in our society should compel scientists to scrutinize the use of computers by lawyers. Studies aimed at increasing the efficacy of legal research will not only improve the outcomes of legal work; it may well enhance the functioning of society. This experiment was a step in that direction.

APPENDIX A

INSTRUCTIONS AND SAMPLE ITEM FROM THE INFERENCE TEST (RL-3)

In each item on this test you will "be given one or two statements such as you might see in newspapers or popular magazines. The statements are followed by various conclusions which some people might draw from them. In each case, decide which conclusion can be drawn from the statement(s) without assuming anything in addition to the infor mation given in the statement(s). There is only one correct conclusion.

Mark your answer by putting an X through the number in front of the conclusion that you select.

Consider the following sample item:

Bill, a member of the basketball team, is 6 feet, 2 inches tall and weighs 195 pounds. To qualify for the team, a person must be at least 5 feet, 10 inches tall.

1-The larger a man is, the better basketball player he is.
2-Basketbali players arc often underweight.
3-Some players or. the team are more than 6 feet tall.
^•-Bill is larger than the average man.
5-The best basketball players come from the ranks of larger-than- average men'.

Only conclusion 3 may 1'e drawn without assuming that you have information or knowledge beyond what the statements give. The statements say nothing about how rood different players are, nothing about whether they are underweight, and nothing about average or taller-than-average men.

Your score on this test will be the number marked correctly minus some fraction of the number marked incorrectly. Therefore, it will <u>not</u> be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have 6 minutes for each of the two parts of this test. Each part has three pages with 10 items. Be sure to do all the items in each part if you have time. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

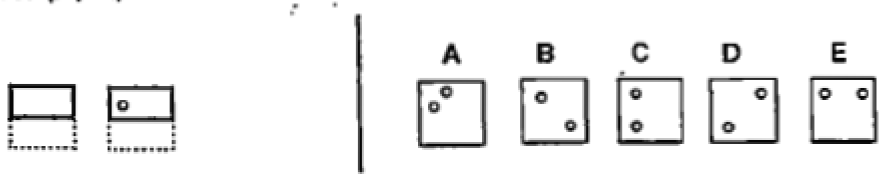
DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

APPENDIX B

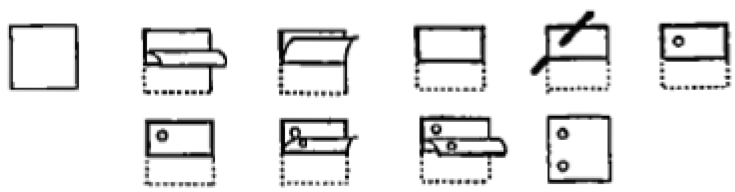
INSTRUCTIONS AND SAMPLE ITEM FROM THE PAPER FOLDING TEST (VZ-2)

In this test you are to imagine the folding and unfolding of pieces of paper. In each problem in the test there are some figures drawn at the left of a vertical line and there are others drawn at the right of the line. The figures at the left represent a square piece of paper being folded, and the last of these figures has one or two small circles drawn on it to show where the paper has been punched. Each hole is punched through all the thicknesses of paper at that point. One of the five figures at the right of the vertical line shows where the holes will be when the paper is completely unfolded. You are to decide which one of these figures is correct and draw an X through that figure.

Now try the sample problem below. (In this problem only one hole was punched in the folded paper.)



The correct answer to the sample problem above is C and so it should have been marked with an x. The figures below show how the paper was folded and why C is the correct answer.



In these problems all of the folds that are made are shown in the figures at the left of the line, and the paper is not turned or moved in any way except to make the folds shown in the figures. Remember, the answer is the figure that shows the positions of the holes when the paper is completely unfolded.

Your score on the test will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will <u>not</u> be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have <u>3 minutes</u> for each of the two parts of this test. Each part has 1 page. When you have finished Part 1, <u>STOP</u>. Please do not go on to Part 2 until you are asked to to so.

APPENDIX C

SAMPLE SCREEN TRAVERSAL HISTORIES

Note: The names on the left are abbreviated screen titles. "Hy" stands for Hynes, the plaintiff. "RR" stands for the Rail Road, the defendant. The numbers (seconds) in the first column are the times corresponding to when subjects accessed the screen, and the numbers in the next column correspond to how long subjects spent on the screen.

SUBJECT = PLAINTIFF-SIDE #12

Start---	0	3
Introduc	3	49
TheFacts	52	7
Issues__	59	16
Parties_	75	22
Hy-Claim	97	28
Hy-Prec1	125	11
Hy-Claim	136	4
Hy-Prec1	140	4
Hy-Claim	144	23
Hy-Prec2	167	17
Hy-Claim	184	12
Hy-Prec3	196	13
Hy-Claim	209	3
Parties_	212	4
RR-Claim	216	8
RR-Prec1	224	8
RR-Claim	232	10
RR-Prec2	242	21
RR-Claim	263	14

RR-Prec3	277	9
RR-Claim	286	3
Parties_	289	4
Issues__	293	13
Parties_	306	7
RR-Claim	313	4
RR-Prec3	317	6
RR-Claim	323	6
Parties_	329	6
Issues__	335	14
TheFacts	349	66
Ratings-	415	11
TheFacts	426	2
Issues__	428	3
Parties_	431	2
Hy-Claim	433	9
Hy-Prec1	442	7
Qk-Facts	449	5
Ratings-	454	20
Qk-Facts	474	2
Ratings-	476	1
Qk-Facts	477	1
Hy-Prec1	478	3
Hy-Claim	481	23
Parties_	504	15

Issues__	519	3
TheFacts	522	3
Ratings-	525	22
TheFacts	547	2
Issues__	549	2
Parties_	551	2
Hy-Claim	553	16
Hy-Prec3	569	5
Qk-Facts	574	1
Ratings-	575	2
Qk-Facts	577	1
Ratings-	578	25
Qk-Facts	603	2
Hy-Prec3	605	5
Qk-Facts	610	3
Hy-Prec3	613	6
Hy-Claim	619	2
Parties_	621	4
RR-Claim	625	4
RR-Prec1	629	4
RR-Claim	633	2
Parties_	635	2
RR-Claim	637	4
Parties_	641	3
Issues__	644	4

Parties_	648	2
Issues__	650	1
TheFacts	651	2
Ratings-	653	9
TheFacts	662	3
Issues__	665	2
Parties_	667	2
RR-Claim	669	8
RR-Prec2	677	3
RR-Claim	680	2
Parties_	682	2
Issues__	684	3
TheFacts	687	1
Ratings-	688	12
TheFacts	700	3
Issues__	703	2
TheFacts	705	1
Issues__	706	1
Parties_	707	1
RR-Claim	708	4
RR-Prec3	712	3
RR-Claim	715	4
Parties_	719	2
Issues__	721	2
TheFacts	723	1

Ratings-	724	12

SUBJECT = DEFENDANT-MIDDLE #15

Start---	0	2
Introduc	2	55
TheFacts	57	53
Issues__	110	40
Parties_	150	25
Hy-Claim	175	63
Hy-Prec1	238	57
Hy-Claim	295	19
Hy-Prec1	314	14
Hy-Claim	328	6
Parties_	334	4
Issues__	338	4
TheFacts	342	4
Ratings-	346	23
TheFacts	369	3
Issues__	372	2
Parties_	374	4
Hy-Claim	378	56
Hy-Prec2	434	37
Hy-Claim	471	20
Parties_	491	2
Issues__	493	1
TheFacts	494	2

Ratings-	496	29
TheFacts	525	3
Issues__	528	1
Parties_	529	5
Hy-Claim	534	15
Hy-Prec3	549	12
Hy-Claim	561	4
Hy-Prec3	565	4
Hy-Claim	569	1
Parties_	570	1
Issues__	571	2
TheFacts	573	1
Ratings-	574	18
TheFacts	592	2
Issues__	594	1
Parties_	595	5
RR-Claim	600	5
Parties_	605	9
RR-Claim	614	12
RR-Prec1	626	14
TheFacts	640	3
Ratings-	643	11
TheFacts	654	3
RR-Claim	657	17
RR-Prec2	674	20

RR-Claim	694	14
Parties_	708	1
Issues__	709	1
TheFacts	710	2
Ratings-	712	17
TheFacts	729	1
Introduc	730	2
TheFacts	732	3
Issues__	735	1
Parties_	736	3
RR-Claim	739	1
RR-Prec3	740	2
TheFacts	742	14
RR-Claim	756	3
RR-Prec3	759	12
RR-Claim	771	2
Parties_	773	2
Issues__	775	1
Parties_	776	4
Issues__	780	1
Parties_	781	2
Issues__	783	1
TheFacts	784	1
Ratings-	785	18
TheFacts	803	12

Issues__	815	26
Parties_	841	8
Hy-Claim	849	8
Hy-Prec1	857	18
Hy-Claim	875	22
Hy-Prec1	897	12
Hy-Claim	909	2
Parties_	911	1
Issues__	912	1
TheFacts	913	2
Ratings-	915	20
TheFacts	935	4
Issues__	939	12
Parties_	951	3
Hy-Claim	954	12
Hy-Prec2	966	17
Hy-Claim	983	9
Parties_	992	2
Issues__	994	1
TheFacts	995	1
Ratings-	996	23

APPENDIX D

DATABASE SCREENS FROM THE PLAINTIFF-SIDE CONDITION

INTRODUCTION to Hynes v. the Rail Road

Your job here is to learn about a legal case and reach a decision on the case as if you were the judge. You will learn about the case by reading the information screens on the computer. Clicking the mouse on the green boxes (screen buttons) will take you to the various information screens.

To decide who wins this case, you must determine which party (the defendent or the plaintiff) has found the best precedents (past cases) to support its claims (positions). The more similar a precedent is to the current case, Hynes v. (versus) the Rail Road, the stronger the support.

To help you determine which party has the strongest support for its claims, you will be asked to rate the similarity, that is, the relevance of precedents to the current case.

For further information -> FACTS

FACTS in Hynes v. the Rail Road

James Hynes and his friends were swimming in a river one day, when Hynes broke his leg. The boys were swimming back and forth across the river by jumping off a plank suspended over the river. The plank was suspended from land belonging to the Rail Road. The water directly below the plank was a public waterway where anyone was allowed to swim.

Neighborhood kids had been jumping off the plank and swimming in this river for years. It was a well known swimming spot to the kids living near the Rail Road, despite the No Trespassing sign on the street leading to the Rail Road's land. However, the No Tresspassing sign could not be seen from the river.

One day, a power line belonging to the Rail Road had broken loose and fallen. It hit Hynes, who was standing on the plank, throwing him in the river and breaking his leg.

For further information -> ISSUES RATINGS

Go back to the -> INTRO

PRECEDENT RELEVANCE RATINGS

Enter your ratings in the gray boxes to the left of the precedents named below. Base your ratings on the relvance of these precedents to the case you are judging. You can change your ratings by using the Delete key to erase a rating, then type it in again. Ratings: (1=low relevance,9=very highly relevant).

Hynes' Precedent 1:
Taylor v. California Electric

Hynes' Precedent 2:
White v. Harris

Hynes' Precedent 3:
Clark v. Hall

Rail Road's Precedent 1:
Wilson v. Jones

Rail Road's Precedent 1:
Davis Orchard v. Miller

Rail Road's Precedent 3:
Brown v. Anderson

Go back to the -> FACTS

ISSUES in Hynes v. Rail Road

1. Who was responsible for Hynes's injuries?

2. Was the plank really on the Rail Road's property?

3. Did Hynes have implied consent to use the plank?

For further information -> PARTIES

Go back to the -> FACTS

PARTIES in Hynes v. the Rail Road

The Plaintiff:

The Hynes Family

The Defendant:

The Rail Road Co.

Hynes, who was 16 years old, required medical treatment to set his leg. His family's lawyers claimed, for several reasons, that the Rail Road should cover the cost of this treatment.

The Rail Road was a fairly large, private corporation. Their lawyers claimed, for several reasons, that the Rail Road should not be held responsible for the cost of the boy's treatment.

HYNES'S CLAIMS <- For further information -> RAIL ROAD'S CLAIMS

Go back to the -> ISSUES

Hynes's CLAIMS

For further information

PRECEDENT 1

1. A land owner (the Rail Road in this case) is responsible for preventing injuries to people using areas adjacent to their land (the river) when those injuries are caused by broken items on the land owners' land. (Please see precedent 1)

PRECEDENT 2

2. Structures (like the plank) extending into a public waterway must be "fixtures" attached to a land owner's property to be considered a part of that property. A fixture is defined as something that serves a useful function as a part of something else. It was not clear what purpose the plank served, if any. (Please see precedent 2)

PRECEDENT 3

3. A land owner is responsible for injuries to people who have an implied consent to use their property. The Rail Road may have given the boys an implied consent because the had not yet warned the boys to stay away. (Please see precedent 3)

Go back to the -> PARTIES

Hynes's PRECEDENT 1

Supporting Precedent:

Taylor v. California Electric Co.

The California Electric Co. was ordered to compensate Mr. Taylor after his son was killed by falling wires temporarily erected in the city streets by the electric company for lighting a parade.

Go back to the Facts to enter your relevance rating.

Go back to the -> HYNES'S CLAIMS

FACTS

Hynes's PRECEDENT 2

Supporting Precedent:

White v. Harris

Mr. Harris was not ordered to pay Mr. White for the repair of the boat dock off of Mr. White's backyard. Mr. Harris had crashed his boat into the dock, but Mr. White had never used the dock because it was too old and unsafe to serve any useful purpose.

Go back to the Facts to enter your relevance rating.

Go back to the -> HYNES'S CLAIMS

FACTS

Hynes's PRECEDENT 3

Supporting Precedent:

Clark v. Hall

Mr. Hall was ordered to pay Mr. Clark's medical bills after Mr. Clark's son was bitten by a dog tied up in Mr. Hall's yard. Mr. Hall had given the children implied consent to touch the dog, since he had known for months that the children played with the dog, and he allowed them to do so.

Go back to the Facts to enter your relevance rating.

Go back to the -> HYNES'S CLAIMS | FACTS

FACTS in Hynes v. the Rail Road

James Hynes and his friends were swimming in a river one day, when Hynes broke his leg. The boys were swimming back and forth across the river by jumping off a plank suspended over the river. The plank was suspended from land belonging to the Rail Road. The water directly below the plank was a public waterway where anyone was allowed to swim.

Neighborhood kids had been jumping off the plank and swimming in this river for years. It was a well known swimming spot to the kids living near the Rail Road, despite the No Trespassing sign on the street leading to the Rail Road's land. Howerver, the No Trespassing sign could not be seen from the river.

One day, a power line belonging to the NY Rail Road had broken loose and fallen. It hit Hynes, who was standing on the plank, throwing him in the river and breaking his leg.

Go to the -> LAST PRECEDENT | RATINGS

The Rail Road's CLAIMS

1. Land owners (the Rail Road in this case) are NOT responsible for injuries to people trespassing on their land. (Please see Precedent 1)

2. Objects that are attached to privately owned land (like the plank attached to the Rail Road's land) belong to the owner of that land, even if they extend beyond the boundaries of the owner's property lines. (Please see Precedent 2)

3. People who enter land marked as private property are trespassing. (Please see Precedent 3)

PRECEDENT 1

PRECEDENT 2

PRECEDENT 3

Go back to the -> PARTIES

The Rail Road's PRECEDENT 1

Supporting Precedent:

Wilson v. Jones Wreaking

The Jones Wreaking Company was not ordered to pay Mr. Wilson after Mr. Wilson's young son had crawled under the Wreaking Company's fence and broken his arm while playing on a bulldozer.

Go back to the Facts to enter your relevance rating.

Go back to the -> RAIL ROAD'S CLAIMS

The Rail Road's PRECEDENT 2

Supporting Precedent:

Davis Orchard v. Miller

Mr. Miller was ordered to stop selling apples from branches of trees that hung over his property line. Mr. Davis' Orchard owned the trees so Mr. Davis was rightfully entitled to the profits from the apples on those branches.

Go back to the Facts to enter your relevance rating.

Go back to the -> RAIL ROAD'S CLAIMS

The Rail Road's PRECEDENT 3

Supporting Precedent:

Brown v. Anderson Delivery Co.

The Anderson Delivery Co. was convicted of trespassing when they drove their trucks onto Mr. Brown's property. The gates at the entrance to Mr. Brown's business were very clearly marked with No Trespassing signs and Anderson was not given permission to make deliveries there.

Go back to the Facts to enter your relevance rating.

Go back to the -> RAIL ROAD'S CLAIMS

APPENDIX E

EXAMPLE OF A PLAINTIFF-MIDDLE SCREEN

Supporting Precedent:

Taylor v. California Electric Co.

The California Electric Co. was ordered to compensate Mr. Taylor after his son was killed by falling wires temporarily erected in the city streets by the electric company for lighting a parade.

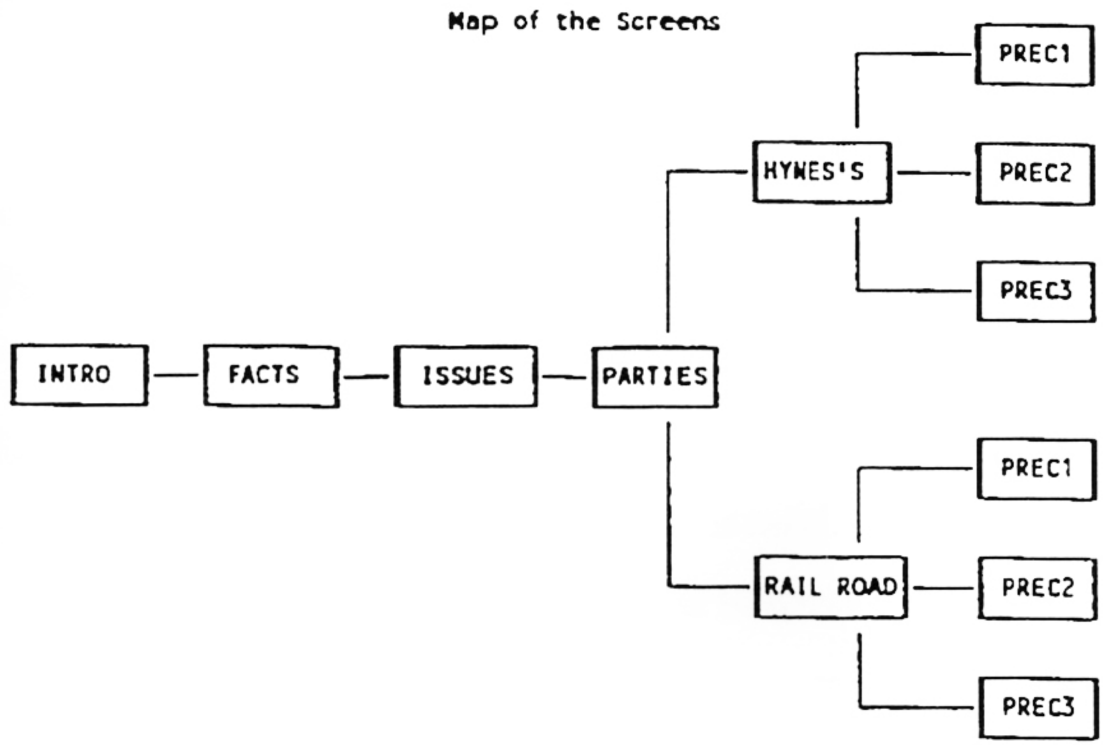
Go back to the Facts to enter your relevance rating.

Go back to the -> HYNES'S CLAIMS

FACTS

APPENDIX F

MAP OF DATABASE SCREENS



APPENDIX G

SUBJECTS' INSTRUCTIONS

LEGAL REASONING

How do judges make decisions in legal cases?

If the law is to be fair, judges must reach similar decisions in similar cases. For example, if your car ran into a taxi and wrecked it, a judge would decide that you must pay to fix the taxi. Let's say that the taxi driver was a friend of the judge. THIS time the taxi ran into YOUR car and the judge decided that the taxi company did NOT have to fix your car. That wouldn't be fair. Judges must be CONSISTENT in how they apply laws to all cases.

People differ in their beliefs of whom is right or wrong. For this reason, judges are trained NOT use their personal beliefs to make decisions. If judges used their personal beliefs to decide cases, the law would be applied unfairly to some people.

Instead of using their personal beliefs, judges are trained to reach decisions based on past decisions. **Precedents** are the decisions reached in past cases. Decisions reached in past cases determine how future cases are to be decided. "To set a precedent" means to decide a case that will influence how future cases will be decided. Precedents set examples for judges to follow.

How does a judge decide what precedents to follow?

All legal cases are not alike, so selecting relevant (appropriate) precedents is not always easy. The more a past case resembles the current case before the judge, the more the past case should influence the judge's decision. When deciding if a past case resembles the current case, the judge looks at the **FACTS** in both cases. Judges compare facts about cases, such as the kind of damages that occurred as well as any extenuating circumstances.

An **extenuating circumstance** is something that a person has little or no control over. For example, if you crashed your car into a taxi, a judge would make you pay for the damage to the taxi, and he may convict you of reckless driving. But, if your car's brakes didn't work and you couldn't stop the car, that would be an extenuating circumstance. In this case, you would still have to pay to fix the other car, but you wouldn't be convicted of reckless driving.

Now, YOU be the Judge

In this legal case, Hynes v. (versus) the Rail Road Co., you should make a careful comparison between the facts concerning the case and the facts in the precedents. Each side (party) will present three precedents that they hope will influence the judge's decision.

None of the precedents is exactly like this case, but they all have some factors in common with it. You have plenty of time to make your decision, so give it some thought. Don't hesitate to look back at the facts in the current case because you may not remember them all or you may have overlooked something. You decide how relevant the precedents are to this case, and make a decision. Make a fair decision based on past precedent. You would still have to pay to fix the other car, but you wouldn't be convicted of reckless driving.

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