

Cognitive Styles:
A Review of the Major Theories and Their
Application to Information Seeking in Virtual Environments

Paige Lucas-Stannard
Bibliographic Essay
Information Science, Dr. Froehlich
Fall 2003

The concept of cognitive styles is one that crosses many disciplines. Initially part of the realm of Jungian/Piagetan psychology, cognitive style research is now an important part of fields such as, education, computer programming, and information science. All of these fields have common goals for studying cognitive style, namely, how users (students, computer users, or information seekers) process information and how systems (teaching styles, computer interfaces, or information systems) can be better built to accommodate the diversity of the user population. Furthermore, all three fields also have to contend with the issues that arise from the permeation of computers into the daily tasks of users, a fact that can cause difficulty for those with certain cognitive styles. Roberts and Newton point out that by “ignoring individual differences, the quest for making computers easier to use has made them considerably harder for some (2000, 142).”

The purpose of this paper is to provide a background for the information scientist into some of the major psychological theories of cognitive styles. Following this will be a review highlighting some of the research that has been done on user cognitive style and searching in virtual environments. Where appropriate, divergent paths of research and various research tools will also be discussed.

What is Cognitive Style

To understand cognitive style, a definition of cognition must first be understood. Cognition is a collection of mental processes that includes awareness, perception, reasoning, and judgment. The study of cognitive processes has its roots in the Gestalt psychology of Max Wertheimer, Wolfgang Köhler, and Kurt Koffka and in the studies of cognitive development in children by Jean Piaget during the 19th century. At the beginning of the 20th century, Carl Jung published *Psychological Types* (1923) where he postulated that personality comprised of three facets each with a continuum descriptor. The first facet, attitude, can range from extraversion, those personalities that are outgoing, to introversion, those personalities that are focused inward. The second facet, perception, deals with a person’s method of understanding stimuli; an intuitive person is meaning-oriented while a sensory person is detail-oriented.

Judgment is the final facet of personality and deals with a person's approach to making decisions; a thinking person tends to be analytical and logical while a feeling person tends to judge based on values. Jung's theory is evident in the *Myers-Briggs Type Indicator* (MBTI) a standard personality test administered today in many cognitive style experiments.

There is some debate in defining cognitive style. Goldstein and Blackman define it as "a hypothetical construct that has been developed to explain the process of mediation between stimuli and responses. The term cognitive style refers to characteristic ways in which individuals conceptually organize the environment (1978, 4)." They go on to say that cognitive style is an information transformation process whereby objective stimuli is interpreted into meaningful schema. Cognitive style is an aspect of overall personality and cognitive processes. Some postulate that cognitive style is a bridge between cognition/intelligence measures and personality measures (Sternberg & Grigorenko, 1997; Ridding & Cheema, 1991). Cognitive style is unique in its polar nature, having an "either or" measure, where the absence of one characteristic implies the presence of its extreme. This is in opposition to personality measures that are more multifaceted (Ridding & Cheema, 1991). Learning style is also sometimes synonymous with cognitive style (Pask, 1976; Entwistle, 1981) while others disagree stating that learning style is a preferred *strategy*, thereby implying that a person's learning style can change, while cognitive style is an immutable characteristic of personality (Ridding & Cheema, 1991; Roberts & Newton, 2000).

There are a variety of cognitive style measures and Ridding and Cheema (1991), as well as Roberts and Newton (2000), point out that many may be different names for the same personality dimension. This paper will focus on four theories of cognitive style: Reflection -Impulsivity, Field Dependence – Independence, Holist – Serialist, and Deep-level/Surface-level processing. Additionally, two views of cognitive style research outside the realm of psychology/education will be highlighted.

Reflection – Impulsivity

Also called *conceptual tempo*, studies in reflectivity – impulsivity were first introduced by Kagan in 1965 and are the easiest of the theories to measure. Kagan administered the *Matching Familiar Figures Test* to children and measured the time it took them to make decisions. One group of children made decisions after briefly looking at the figures, thus they were cognitively impulsive, while the other group carefully deliberated the choices before coming to a decision, thus they were cognitively reflective. Kagan tested repeatedly to find that conceptual tempo is stable, that is test subjects will repeatedly test as either impulsive or reflective. There is some hesitation as to whether this applies in high-uncertainty situations only (Sternberger & Grigorenko, 1997). It is also important to note that impulsivity, as a cognitive style is not the same as having an impulsive personality (Sternberger & Grigorenko, 1997).

Field Dependence – Independence

A measure of field dependence is one of the most researched cognitive styles to date (Witkin & Goodenough, 1981) and was initially proposed by Witkin in the 1950's and 1960's and with educational implications by Witkin, Moore, Goodenough, and Cox in 1977. Original testing was done using the *Body Adjustment Test* and the *Rod and Frame Test*. In these tests subjects were asked to determine their alignment/misalignment with true vertical given internal and external stimuli that may differ (experimental set-up described in-depth by Wikin et al., 1977). It was found that one group of subjects determined their alignment as vertical based solely on the visual cues in the room. Witkin states that,

It may be astounding that someone can be tilted as much as 35 degrees, and, if in that position he is aligned to with the room, tilted at the same angle, he will report that he is perfectly straight, that 'this is the way I eat my dinner,' 'this is the way I sit in class' (1977, 5).

These subjects were field dependent, that is they were unable to determine their vertical alignment because of a discordant visual field while other subjects displayed field independence and were able to perceive their alignment as separate from the visual surroundings.

Similarly, the *Embedded-Figures Test* determines a subject's field dependence/independence based on the time they take to find a simple figure in a more complex visual field (see Witkin et al., 1977 for examples). Subjects who were field dependent spent more time finding the figure while field independent subjects found the figure quickly. Most people fell on a continuum between being completely field dependent or field independent.

The importance of this measure of cognitive style to problem solving soon followed. According to Witkin,

The individual, who, in perception, cannot keep an item separate from the surrounding field – in other words, who is relatively field dependent – is likely to have difficulty with that class of problems...where the solution depends on taking some critical element out of the context in which it is presented and restructuring the problem material so that the item is now used in a different context (1977, 8).

The remaining portions of Witkin's paper discuss the interaction between teachers and students and their field dependence/independence. He found that field dependent students prefer to work in groups, and require extrinsic motivation and more structured reinforcement from teachers. Conversely, field independent students prefer individual work and tend to be intrinsically motivated.

Witkin's theory of field dependence – independence does have some detractors. Among them McKenna states that field dependence is not a cognitive style at all but a measure of ability or intelligence. He found significant correlations between scores on the *Embedded Figures Test* and standard intelligence test scores (1983). Others support this view of field dependence as an aspect of intelligence (Sternberger & Grigorenko, 1997; Ridding & Cheema, 1991). Witkin also found a slight but persistent difference among the sexes (namely, that females tended towards field dependence), but this has not held up under experimental duplication (Goldstein & Blackman, 1978).

Holistic – Serialistic

The holistic – serialistic cognitive style was researched by Pask in the early 1970's. He tested a group of children by asking them to categorize a selection of imaginary animals into groups. He found

that some children tend to try to understand the overall principles and will develop and test multiple hypotheses at one time; these subjects were holists or comprehension learners. By contrast, serialists, or operation learners, proceeded with one hypothesis at a time and did not move on until that was tested. Serialists tended not to think about a larger global view of the problem (Pask, 1976).

Unlike Witkin's theory of field dependence, there is little or no statistical correlation between holistic – serialistic subjects and scores on standardized intelligence tests (Ridding & Cheema, 1991). In field dependence one trait (field independence) is generally always associated with higher achievement. Holistic and serialistic personalities are just as likely to achieve or fail regardless of style. Holists, who tend to easily conceptualize the global view of a problem and acquire additional knowledge beyond that related to the problem can become *globetrotters*, e.g. they lose site of the original purpose and make incorrect analogies. Likewise, serialists, who tend to be very analytical and logical in their understanding of the specific goals of the problem can develop *improvidence* where they are unable to identify the overall concept of a problem. Some learners seem to be able to switch between the two styles more readily and are called versatile learners.

There are two controversies related to Pask's theory. First is that Pask himself defines his theory as cognitive *strategies* rather than styles. This implies something that can be chosen by the person, however, Pask's further research concluded that holist students that were given a 'serialist-oriented' assignment performed poorly and vice versa. Thus, if these strategies were simply the students' preferences why would they *prefer* to perform poorly (Roberts & Newton, 2000)? The second detraction from Pask's theory is that, according to Ridding and Cheema, Pask used only a small group of students all 15 years of age or older and the experiment has not been repeated (1991).

Deep-level/Surface-level Processing

Similar to the holist – serialists distinction is Marton and Säljö's deep-level/surface-level cognitive style research. Level of processing involves how a student (Marton and Säljö used

undergraduates) approaches material for learning. Surface-level students focused their learning on what Marton and Säljö call *the sign*, or the literal rote learning of given material. Other students, the deep-level processors, focused on what is *signified* rather than the sign itself, these students attempted to learn the intended meaning of the material. According to their study, surface-level processors tended to say things like, “I just concentrated on trying to remember as much as possible,” while the deep-level processors said that they tried to determine “what was the point of the article (Marton & Säljö, 1976, 5 - 6)?”

The processing level approach is very similar to Pask’s theories. Deep-level processors, like holists, tended to quickly grasp the overall concepts and were normally intrinsically motivated but could sometimes miss the details (globetrotting). Likewise, surface-level processors, like serialists, concentrated on the details, required extrinsic motivation, and could sometimes miss the global view of a problem (improvidence). However, both deep and surface-level processing are required to develop a complete understanding of a topic (Ford, 2000), the distinction lies in the way material is initially approached.

The Ever Expanding Realm of Cognitive Styles

There are a number of divergent fields of research that are using cognitive styles. Two that should be highlighted here are in the fields of cognitive neuropsychology and computer systems design. Several studies have been conducted regarding brain hemisphere behavior and its effect on perception and information assimilation. One is Gazzaniga’s work on patients with a severed corpus callosum due to severe epilepsy (1998). Work such as this is serving as a basis for the idea of “left- or right-brained” personalities, which are important in information seeking behavior (Ford, 2000). Computer engineers also look at cognitive styles in humans to design smarter automation programs for safety-critical computer systems. For example, Boy’s work on a cognitive engineering model for aviation-systems, which is using cognitive theories to design cockpit computers (1998). These two views, along with the

major theories of cognitive style are having a great influence on information scientists' understanding of information seeking behavior and on the design of user interfaces for information retrieval. The remaining sections will highlight the current information science research being done in the field of cognitive styles and particularly in relation to virtual environments.

Virtual Environments

The development of the World Wide Web has significantly changed the way that information is presented and retrieved in information systems (Kim & Allen, 2002). Virtual environments refer to information spaces that exist beyond the traditional print world – the World Wide Web, on-line databases, and even CD-ROM products. As Ford points out, “virtual environments allow greater flexibility of navigation than do their physical counterparts (2000, 543).” Specifically there is no longer one route to a particular information source but a variety of ways that users can access the same piece of information and a greater capacity for the user to make autonomous decisions in searching. Research on how users adapt to this new environment is important in building more intelligent information retrieval systems with an understanding of human-computer interaction principles (Saracevic & Kantor, 1991). One of the characteristics that effect user interaction with systems is their cognitive style.

Cognitive Style and Use of Metaphors

With the emergence of virtual environments, tools are being utilized to help the user associate the system with the real world. One of the ways this is accomplished is through the use of metaphors. Metaphors “permit an individual to relate the complexity of the web to something previously experienced (Palmquist, 2001, 24).” Hence references to the “information superhighway” and calling web spaces “desks” and “rooms.” Palmquist hypothesized that a person’s understanding and choice of metaphors would be dependent upon their cognitive style. She did this by determining which metaphor was preferred by a person and why, and then measuring their cognitive style to see if there were

significant correlations. She used Witkin's theory of field dependence – independence as the cognitive style indicator using the *Embedded Figure Test*. Subjects were given a list of metaphors for the World Wide Web, asked to pick their favorite and then describe why they picked that one. There was no correlation between cognitive style and a subject's choice of metaphors; however, there were patterns in the reasons described by field dependent and field independent persons. Field dependents tended to explain their choices in broad terms using words like “vast” and “uncharted.” Conversely, field independents used verbs to explain their choices, for example, “a road with sites along the way.”

Palmquist concludes with an overview of recommendations for the use of metaphors in systems. She says that field dependent searchers will enjoy seeing metaphors with a broad concept base and larger social topics. Field independent searchers will prefer metaphors that are action oriented and “supports planning and the anticipation of how a system will work (31).” She thus concludes that further research into a users choice of metaphor can lead to a more insightful understanding of the way users think and to better information retrieval systems.

Cognitive Style and Search Effectiveness

Research has been conducted to determine if cognitive style has an impact on the effectiveness of a search. One study conducted by Wood, Miller, Sobczyk, and Duffin in 1995 using Witkin's theory, found no significant effect of cognitive style on search effectiveness but did find significant differences in search style and efficiency. For example, field dependent searchers tended to use fewer new terms in their searches, to retrieve a high number of relevant results and to rate their success in searching high. Conversely, field independent searchers were much more likely to change their search terms frequently, retrieve a smaller number of relevant results and rate their search success relatively low. The actual effectiveness of both styles of searching was relatively equal, only the strategy of searching differed.

Another study by Ford, Wood, and Walsh in 1994 researched search effectiveness and techniques using Pask's comprehension (holistic), operation (serialistic), and versatile learners

approach. He found that the use of search broadening techniques, such as the use of OR was used more frequently by comprehensive learners and less so by versatile learners and least by operation learners. This finding fits with the knowledge of Pask's theory that comprehensive learners are better able to develop a global view of a topic. Ford found, like Wood, that the overall search effectiveness for operational and comprehensive learners was the same, surprisingly however, versatile performers outperformed both groups even where they should have shined. "Versatile learners were more exhaustive (potentially broad) than comprehension learners and more economic (potentially narrow) than Operation learners (82)." In the portion of Ford's experiment where searchers were given feedback at each stage of their search, he found that the two extreme groups more closely approximated the versatile learners as they adapted their search strategies.

In Ford's testing of subjects categorized by Witkin's theory, he found that field independent participants used truncations more than field dependent. Also, field dependent searchers used more natural language, which perhaps accounted for the longer search time (which Ford relates to lowered search efficiency). Ford states that the field independent searcher's ability to use broadening terms such as OR and truncation fits with their being able to force their own structure on the environment, a task that field dependent persons find more difficult.

This is also supported by Kim's study of navigation among field dependent and field independent users (2001). She studied the use of linear links, such as embedded links and forward/backward buttons, and non-linear links, such as the history list, bookmarks, or jumping to a specific URL. She also looked at the use of the Home button, which tended to indicate that a user was lost and wanted to start over. She found that field dependent users tended to search the web in a linear fashion, get lost more frequently (evidenced by use of the Home button) and to take longer in their search than field independent searchers.

Finally, of interest to search effectiveness, is the comparison of novice to experienced searchers (Marchionini, 1989; Palmquist & Kim, 2000; Kim, 2001). All experiments found that the disadvantage

that field dependent persons' have in search efficiency (time) is neutralized through experience.

Palmquist and Kim (2000) note that field dependents are "more likely to spend extra time following unnecessary links, or to spend more time assessing a wide variety of stimuli that are attractive or to find those that lead toward, not away from the desired goal (565)." However, "among online search EXPERIENCED individuals, both field dependent and field independent retrieved a piece of information after spending almost the same length of time to do so, and after visiting almost the same number of nodes [links](564)." Thus on-line experience in virtual environments can help field dependents adapt to the spatial complexity of the medium. This is supported in Marchionini's study of children. Younger children often chose strategies that showed their lack of understanding in the system and how it worked (e.g. using whole sentences as a search term), while older students were able to adapt their strategies to their knowledge of the system. Kim (2001) and Kim and Allen (2002) also found that searching for a known-item as opposed to a subject search also brought field dependent users level with field independent users in terms of search efficiency.

Cognitive Styles and Interface Design

The above studies conclude that additional research should be devoted to cognitive style and searching. This could result in better systems and better methods of training users to overcome the weaknesses of their particular cognitive style (Wood, 1996). Also, the importance of system feedback in leveling the differences between cognitive styles can be a valuable tool in systems design. Wood et al. (1996) designed computer-assisted learning packages (CAL's) based on what they had learned from their cognitive style studies.

Additional research by Ford in 2000 illustrates further that systems can benefit from this research. In this study, Ford sought to view more realistic searching behavior by applying less experimental structure. For example, he allowed the searchers to use topics of importance to them and he logged behavior electronically so the user could browse free of overt observation. He discusses

systems where a weighted user model would generate links based on past navigation history of the particular user. This type of adaptive intelligence is being modeled in neural network systems and may be available more readily in the future (Ford, 2000; see also, Boy, 1998). By using the full range of flexibility of the virtual medium, systems can be designed that appeal to more types of users.

Conclusion

The concept of cognitive styles has crossed the line from psychology and educational theory and has become an important part of information science research. This research, briefly overviewed here, depends on knowledge of past theories to gain a better understanding of user needs. Implications exist both for user-centered training programs and in system designed adaptive technologies. With an integration of this research, virtual environments can become and even more versatile tool for information retrieval.

Annotated Bibliography

Boy, G.A. (1998). Cognitive Function Analysis for Human-Centered Automation of Safety-Critical Systems. *CHI 1998*, April 18 – 23, 265 – 272.

A computer adaptive technology for aviation design is presented. This research shows one of the emerging uses of cognitive style research, where the understanding of human cognition is not simply making better interfaces for humans but also smarter systems for safety-sensitive computers. A focus on copying the human task of being simultaneously intentional and reactive is a desirable goal for these systems.

Entwistle, N.J. (1981). *Styles of Learning and Teaching*. London: Wiley & Sons.

The author explores students' approach to learning determining that some students take a deeper approach in trying to find meaning while others concentrated on rote memorization of specific facts. Implications for instructional design are discussed

Ford, N. (2000). Cognitive Styles and Virtual Environments. *Journal of the American Society for Information Science*, 51(6), 543 – 557.

Ford discusses the a variety of cognitive styles including serialist – holist, field dependence – independence, and deep – surface processing. The effects of cognitive style in hypertext navigation, database searching, a free searching is discussed. A model for adaptive virtual learning environments is also discussed.

Ford, N., Wood, F., Walsh, C. (1994). Cognitive Styles and Searching. *Online & CDROM Review*, 18(2), 79 – 86.

Subjects were tested for Pask's comprehensive/operational/versatile and Witkin's field dependence/independence styles and observed performing searches in an online database. The amount of descriptors used, system tools used, and search time was recorded. Among the findings were that versatile learners preformed the best searches and that field-dependent searchers were more flexible in changing their searches based upon system feedback.

Ford, N., Wilson, T.D., Foster, A., Ellis, D., Spink, A. (2002). Information Seeking and Mediated

Searching. Part 4. Cognitive Styles in Information Seeking. *Journal of the American Society for Information Science and Technology*, 53(9), 728 – 735.

This study sought to evaluate searching success/strategy with cognitive style. Both Pask's and Witkin's styles were used. It was found that differences do exist, particularly with field independent searchers being more analytic and active and holists exhibiting more exploratory and serendipitous searching techniques.

Gazzaniga, M. S. (1998). The Split Brain Revisited. *Scientific American*, 279(1), 50 – 56.

Discusses ongoing research into the nature of each hemisphere of the human brain. Highlights research of patients who had their corpus callosum severed leaving their hemispheres uncommunicative. Studies show that the left hemisphere is primarily the center of cognition while the right is spatial/visual. These studies can help us understand the nature of human cognition.

Goldstein, K.M, Blackman, S. (1978). *Cognitive Styles: Five Approaches and Relevant Research*.

New York: Wiley & Sons.

This book is an excellent overview of the main research that took place in cognitive styles in the 1960's and 1970's. Also includes descriptions of the major tests and tools employed in cognitive style research.

Jung, C.G. (1923). *Psychological types*. Princeton, NJ: Princeton University Press.

This is considered the definitive treatise on personality types and is the primary basis for the foremost personality tool, the *Myers-Briggs Personality Type*. Originally published in 1923, this edition is a revision by R. F. C. Hull of the translation by H. G. Baynes.

Kagan, J. (1965). Impulsive and Reflective Children: Significance of Conceptual Tempo, in J.D.

Krumboltz (Ed.) *Learning and the Educational Process*, Chicago: Rand McNally

Using the Matching Familiar Figures Test, Kagan found that some students respond quickly which he called cognitively impulsive students, while others deliberate before responding, which he called cognitively reflective. Pluses and minuses of both styles are reviewed.

Kim, K-S. (2001). Information Seeking on the Web: Effects of User and Task Variables. *Library and Information Science Research*, 23, 233 – 255.

Kim studies three variables on search success: cognitive style (using Witkin's field dependence/independence), experience, and task type (known or subject search). She also examines navigation on a linear/non-linear scale as it is effected by the three variables. She found that all three variables do have an effect on search success with perhaps experience having the most surprising effect of negating cognitive style differences. She concludes with recommendations for interface design that will facilitate these differences in users.

Kim, K-S. & Allen, B. (2002). Cognitive and Task Influences on Web Searching Behavior. *Journal of the American Society for Information Science and Technology*, 53(2), 109-119.

The authors study three aspects of personality: cognitive abilities, cognitive style, and problem-solving style. The distinction between cognitive ability and style is that style is a preferred tool for approaching a problem. It was found that the type of task given greatly influenced search success for all types of users.

Marchionini, G. (1989). Information-Seeking Strategies of novices Using a Full-Text Electronic Encyclopedia. *Journal of the American Society for Information Science*, 40(1), 54 – 66.

Study of elementary school children's searching strategies. This study provides a good example of novice search techniques and supports some of the findings of other authors included here. This study collected data regarding search success, search time, and use of system tools such as truncation and Boolean operators.

Marton, F & Säljö, R. (1976). On Qualitative Differences in Learning: I – Outcome and Process. *British Journal of Educational Psychology*, 46, 4-11.

Based on a paper delivered at the 1975 Annual Meeting of the American Educational Research Association. Describes research involving undergraduate students asked to read a passage and describe its meaning. Subjects fell into two categories based upon their approach to the task: deep-level processors, who replied with broad meanings, and surface-level processors, who replied with details from the text. The authors conclude that learning cannot be described in terms of what is learned but rather in terms of the complexity and variety in which a topic can be learned.

McKenna, F.P. (1983). Field Dependence and Personality: A Re-examination. *Social Behavior and Personality*, 11(2), 51 – 55.

McKenna re-evaluates Witkin's research and find that it is in fact not a cognitive style but is a measure of ability as measured on standard intelligence tests. He also states that previous relationships between field dependence and extroversion are false as well as sex differences. Therefore, according to McKenna, Witkin's research is flawed. However, from other literature it is clear that field dependence has been a valuable tool in studies of searching style in virtual environments. However, it is important to realize the criticism that this theory has received.

Palmquist, R.A. & Kim, K-S. (2000). Cognitive Style and On-line Database Search Experience as Predictors of Web Search Performance. *Journal of the American Society for Information Science*, 51(6), 558 – 566.

The authors use Witkin's cognitive style and online searching experience to determine search effectiveness. Differences were found between field dependent and field independent individuals in search style but overall search effectiveness was effected to a larger degree by experience where field dependent users were more likely to use field independent strategies. Recommendations for web design and training techniques are also discussed.

Palmquist, R. A. (2001). Cognitive Style and Users' Metaphors for the Web: An Exploratory Study.

Journal of Academic Librarianship, 27(1), 24-32.

Describes research conducted to identify students' use of metaphor for the World Wide Web and correlation among metaphor use and cognitive style as determined by Witkin's field dependence / field independence. Small but significant differences were found amongst the sexes but not different cognitive styles. Between cognitive styles, differences were found in their definition of the Web. Conclusions are drawn regarding the use of a variety of metaphors in opacs and on-line tutorials.

Pask, G. (1976) Styles and Strategies of Learning. *British Journal of Educational Psychology*, 46,

128-148.

Describes research resulting in one of the foremost views of cognitive style: holistic, or comprehension vs. serialistic, or operational. Subjects were high-school aged children asked to match imaginary life-forms based on a series of characteristics. The holist approach involved broad concepts whereas the serialist approach was more narrowly defined. The present study used the *Spy Ring Test* to further determine strengths and weaknesses among holists and serialists.

Ridding, R. & Cheema, I. (1991). Cognitive Styles: An Overview and Integration. *Educational*

Psychology, 11(3/4), 193 – 216.

The authors attempt to integrate the multitude of cognitive style labels into two distinct groups: wholist-analyst and the verbalizer-imager. They then detail some of the other theories (Pask, Witkin, Kagan, etc.) and attempt to define a relationship among the styles. The authors are particularly critical of Pask's theory for its lack of internal and external experimental validation.

Roberts, M.J. & Newton, E.J. (2001), Understanding Strategy Selection. *International Journal of*

Human-Computer Studies, 54, 137 – 154.

The authors propose that the concept of cognitive styles, although useful, is not complete to understand strategy selection in interacting with computer interfaces. They review the existing literature on cognitive styles, learning style, and strategy and propose a new theory of strategy selection where success stems from the ability to find and adapt to new strategies and that this is strongly linked to ability as an intellectual trait.

Saracevic, T., Kantor, P. (1991). Online Searching: Still and Imprecise Art. *Library Journal*,

116(16), 47 – 51.

This article is an overview of additional research by the authors. Professional searchers were tested for cognitive style and subject expertise and then asked to conduct DIALOG searches. The authors discuss precision and recall and a variety of aspects of relevance. Overall, it was determined that searching is a highly personalized activity that is different for each person.

Sternberg, R.J. & Grigorenko, E.L. (1997). Are Cognitive Styles Still in Style? *American Psychologist*, 52(7), 700 – 712.

Presents a view of the literature in cognitive style research, which the authors group into three categories: cognition-centered, personality-centered, and the activity-centered approach. They then introduce the theory of self-government as an encompassing new view of cognitive style.

Witkin, H.A., Moore, C.A., Goodenough, D.R., Cox, P.W. (1977). Field Dependent and Field-Independent Cognitive Styles and Their Education Implications. *Review of Educational Research*, 47(1), 1- 64.

Details of three tests to determine a person's field dependence: *The Rod and Frame Test*, *The Body Adjustment Test*, and *the Embedded Figures Test*. Educational implications involve students and teachers field dependence and their teaching/learning styles. This is the most widely used cognitive style reference in user study research (along with Pask's).

Witkin, H.A., Goodenough, D.R. (1981). *Cognitive Styles: Essence and Origins*. New York: International University Press.

This book includes the historical development of field-dependence/independence including details of the Rod and Frame Test, Body Alignment Test, and Embedded Figures Test. Interaction between field dependent and field independent teachers and their students is discussed in detail.

Wood, F., Ford, N. Miller, D., Sobczyk, G., Duffin, R. (1996). Information Skills, Searching Behaviour and Cognitive Styles for Student-Centered Learning: A Computer-Assisted Learning Approach. *Journal of Information Science*, 22(2), 79 – 92.

This study is similar to Ford et al. 1994, however it also incorporates the searchers perceived search success and subject knowledge. The researchers developed computer assisted learning programs that were adapted to each category of cognitive style. The principal findings were that students would benefit from being aware of their cognitive style and having training that was tailored to them.

